Developing a Methodology for Learning BIM through Education-Practice Collaboration

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Architecture, like other practice-oriented schools, aims to teach skills and knowledge required in professional practice. The aspired architecture profession increasingly requires practitioners who are able to work in collaborative BIM environments. This creates a task for education to develop new ways of teaching BIM concepts and tools to prepare the next generations of students who will enter the work force. To address this need, this study developed a methodology for learning BIM in architecture education by establishing relationship between practice and education. As substantial part of methodology development process, this paper will present the ongoing research that focuses on collaborative teaching process between AE practitioners and teachers. The benefits and challenges of this process will be presented and discussed.

Keywords: BIM, education-practice partnership, hybrid model, collaborative teaching, case method, hands-on

INTRODUCTION

The misbelief common in architecture education for many years is the idea that education should follow behind practice rather than work as an equal partner. With the rise of building information modeling (BIM), an opportunity to rethink this relationship has arisen. BIM points to new ways of practicing and teaching architecture that requires understanding not only of the tool, but also grasping the requirements of the aspired professional practice, knowledge of materials and construction methods used in it (Cheng, 2006). To meet these requirements, finding the ways for knowledge extraction and exchange between practice and education is needed.

In more than ten-year history of BIM, various research were conducted searching for the best ways to teach BIM in university education. Even though architecture schools were among pioneers showing interest in BIM adoption when it first appeared, today, they are the ones with the least agreement on how to do it (Barison, 2018). The underlying reason for this status could be in the fact that architecture education and practice still have divided opinion about BIM’s value for architect. Most commonly, architect’s work is defined by the creative act of sketching and conceptual design which architects so proudly keep for themselves. Though BIM changes design process from individual to collaborative activity in which everyone can contribute to design, no one is ever going to expect from a mechanical engineer to propose a creative design of a building, but will surely expect it from an architect. It is believed that BIM is suppressing this creative act by congesting architect’s mind with large amount of information and complex
tools. However, conceptual design is typically only 10-20 percent of the architect’s fee and even in this phase, sketching is only one stage. Though very important part of design process, one is not becoming architect only by sketching or proposing conceptual design. Architect’s task is also to successfully communicate design ideas with other project stakeholders (Kiviniemi, 2013). Here, the role of BIM is not to serve as architect’s design tool by itself, but rather to be used as common medium for collaboration in various tasks of design-build process (Bernstein, 2012; Scheer, 2014, Kiviniemi, 2013).

Additional reasons for not welcoming BIM to architecture curricula include difficulty in learning and using BIM software, overloaded and unsuitable structure of the architectural curriculum for the adoption of BIM, incompatibility of practice-driven approach of BIM with the explorative character of design thinking and lack of BIM expertize among teachers (Deamer and Bernstein (2011, Kymmell (2006). Moreover, teaching intelligent model-based collaborative BIM processes would require replacement of traditional fragmented with collaborative approach to education among AEC disciplines, which would require almost complete restructuring of the curricula.

**RESEARCH PROBLEM**

When it comes to BIM, late majority are the countries that did not develop the BIM tradition in professional and academic environment. Here, BIM adoption is being newly discussed as the pressure from the AEC industry grows requiring increased number of practitioners who are able to work on BIM-based collaborative projects. In such context, developing educational program for teaching BIM has to deal with the two major challenges:

1. **How to teach BIM** - is commonly present question in architecture education, as the clear guidelines and methodologies do not yet exist (Kocaturk & Kiviniemi, 2013; Becerik-Gerber & Kensek, 2009).

2. **Who will teach BIM** - BIM is complex and constantly growing field which requires substantial experience on real-life projects. Teachers usually do not have the required expertize in this field nor does the time allow it. To overcome this, there is need for establishing model that will allow knowledge to be extracted from practice and be utilized in teaching.

To address these challenges, this study will develop a methodology for learning BIM in architecture education that is based on partnership between architectural practice and education. Involving practice into education implies transformation of teaching into collaborative activity between teachers and practitioners which yet opens another question: how to utilize the expertise from practice and successfully combine it with pedagogical methods to teach BIM skills and knowledge required in practice?

**FRAMEWORK**

Teaching BIM will be explored within the context of current transformations of 21st century education. The growth of technology expanded the learning arenas outside the boundaries of university classes through various media- and technology- based environments where learning usually occurs through self-led process. Various high-quality online resources are available for learning BIM and they can be utilized as complementary component to university classes. In addition, BIM technology is changing in high speed requiring continuous ‘upgrade’ of skills and knowledge. It is clear that all the required knowledge cannot be taught in duration of university class. Learning continues after graduation, through a lifelong learning process. In such context, the role of university classes becomes providing guidelines on - an approach of ‘learn[ing] how to learn’ (Boud & Feletti, 1999) and teachers become moderators in learning process, like scaffolding for a new building (Niemi, 2009).

Furthermore, hands-on BIM projects are critical to prepare students for future roles in the rapidly changing fields of design and construction. Along with gaining skills in using BIM technology, students should learn techniques for successful collaboration by being exposed to real-life collaborative BIM settings. A wide range of professional schools, including
Harvard’s law, business, and medical schools, have concluded that the effective way to teach skills and concepts required in professional practice is by the case method (Garvin, 2003). The main idea of this method is having ‘hands-on’ real-life cases and expertise from practice while analyzing and solving real-life problems. This enhances hands-on tasks and learning by doing which are essential for education in practice-oriented fields like architecture and engineering.

HYBRID MODEL
Based on the above mentioned, this study proposes a methodology for learning BIM in architecture education based on hybrid model combining three complementary components (Figure 1):

1. University class - provides supporting structure for learning process
2. Architecture-Engineering (AE) practice - involving practice brings new teaching methods, contents, expertise and real-life cases from professional practice into the university class.
3. Online learning repository - available to students as supplement to in-class teaching to encourage students’ self-learning processes. Learning new technology and associated concepts, like BIM are greatly depend on online sources. Examples like Lynda and Autodesk University, continuously develop high-quality online bases engaging professionals and instructors from all around the world. Learning using these sources allows the flexibility for learners to choose according to personal interests what to learn and when to learn.

METHODLOGY
The development of the proposed methodology is based on action research methodological approach which consists of a spiral of cyclical steps: planning - acting - observing - reflecting & critical analysis (Kember, 2000; Swann, 2002). The main idea of this approach is that the results from previous stage are used as inputs for the next stage in development process. The process develops in several stages in order to explore the research issue more thoroughly and to address the limitations of the study such as time and number of students in duration of one stage. Data was collected by observations and recording the work sessions, encouraging students to get actively involved in discussions with practitioners, having them fill questionnaires and analyzing their assignments.

This study will present one stage of this process which focuses on collaborative teaching.

SELECTION OF AE PRACTICE
In selecting the practice that would best contribute to BIM teaching, a series of interviews with professionals were conducted to determine their patterns of BIM usage and the ways it transformed their working methods. BOLD Architecture from Istanbul was selected according to following criteria:

• Design approach - The selected practice was used for their interdisciplinary approach to design and collaborative working methods. Architects, structural and MEP engineers work together in collaborative environment though the entire project. BIM is used as catalyst in this interdisciplinary process. The goal was to bring this into the classroom and demonstrate how architectural design gets transformed from fragmented into collaborative activity in current practice.
• BIM usage - the way information is produced, organized and shared in BIM information models was of special importance as many practices in Turkey use BIM only as modeling tool for faster drawing and visualization. However, the selected practice developed BIM tradition over the period of more than ten years by structuring their processes according to BIM standards and accordingly developed planning, management, organization and sharing procedures.
• Readiness to collaborate and openness to share their experiences and knowledge with teachers.
After the practice was selected, the class content was prepared through collaboration between teachers and practitioners. This included visits to the office, interviews, detailed analysis of their working processes and models to find the most convenient way of presenting BIM to beginner learners. The examples to be used in teaching also had to be adjusted for the educational purposes. The class structure and content was flexible and constantly revised and developed throughout the course based on the response of students.

**CLASS DESCRIPTION**

To develop this research, a master-level course was prepared and taught in collaboration with AE education and practice which provided fully realized BIM model and its documentation. As part of curricula which did not undertake any significant changes in order to adopt BIM, this course was taught as experimental stand-alone course. The specific challenge was to introduce the most important BIM concepts without congesting student’s learning processes with too much information and complexity. The learning outcomes set by this course are defined within the scope of third level of engagement according to BIM teaching impact matrix defined by UK BIM Academic Forum (BAF, 2013). In this level, students should understand how BIM will affect their future and be offered opportunities to engage with BIM in discipline and multi-disciplinary contexts.

Teaching was based on case method whose main idea is having ‘hands-on’ real-life cases and expertise from practice while analyzing and solving real-life problems. Thus, the learning process started with exploration of fully realized BIM model of already designed and completed building. Each discipline involved in development of the model, such as architects, structural and MEP engineers, presented their
components within the model and processes that led to their creation. The projects were explored gradually, as the new knowledge was presented through multi-level BIM exercises. With strong emphasis on ‘hands-on’ approach, exercises were focused on:

- The underlying structure for BIM processes - standards, procedures and guidelines
- Techniques of model-based collaboration
- The meaning and value of information model - extending beyond 3D, organization and management of various tasks in design-build process and their outputs.

As students did not have any knowledge about BIM, the major challenge was to make the shift in their minds from drawing-based fragmented process to model-based collaborative process. To encourage discovering the field in BIM they are mostly interested in, the teaching program aimed to cover the variety of BIM roles and tasks associated with them. For example, not everyone in a team would be a good manager, but might be a good modeler.

Students were encouraged to develop critical thinking and attitude toward solution, rather than a solution to design project. Therefore, the assignments were not focusing on proposing new design, rather analyzing the already designed models. As a final assignment, students’ task was to comprehend what they learned by developing an information model through the processes of planning, organization, collaboration and management.

TEACHING SOFTWARE SKILLS. If provided good sources and structure, acquiring technical skills can be achieved successfully through self-learning process. BIM tools were not taught in the class. Instead, students were directed to high quality online sources with tutorial and step-by-step guidelines in learning technical skills. In addition, one-day workshop was organized to show students tricks in using tools more efficiently and to give them an opportunity to ask questions they could not resolve themselves.

CHALLENGES OF COLLABORATIVE TEACHING WITH AE PRACTICE

Collaborative teaching combined pedagogical methods and expertise from practice. The findings of this study show that in this process, practice and education have essentially different approaches. On one side, practice has top-down approach - they tend to see the project as finished and they need to go backwards to the beginning level. On the other side, education has bottom-up approach - trying to explain concepts from the basic levels. Practice has experience and knowledge in application. However, they usually lack theoretical knowledge and the underlying principles behind concepts. Another thing is that many practitioners are usually able to do, but not to explain how they did something. Specifically they face the difficulty in explaining these to those new in the field. They need to be provided the guidelines on how to teach - pedagogical methods.

BENEFITS OF COLLABORATIVE TEACHING WITH AE PRACTICE

Seeing architectural practice and education as partners in teaching BIM can be beneficial in multiple ways. Collaborative teaching not only influenced positively on student learning processes during the course, but also motivated them to explore BIM further. Involving practice from beginning of learning process and providing the right examples that correspond to the level of learner are essential in better understanding of concepts and appreciation as well as application. Once students see the real life context, the begin to understand more easily.

Even though their task was not to design, they continuously tried to make connection with how to use these concepts in design and can they design better if they use these tools. In future, each of them wished to be involved in real-life project and definitely would want practice to be involved again. Presence of practice also gave them confidence that in this way they are learning skills that are required in today’s practice and that the course will prepare them to work more effectively on BIM-based collaborative
CONCLUSION
This study aimed to present one part of ongoing study that aims to develop methodology for learning BIM in architecture education. This paper presented how collaborative teaching was organized in order to utilize expertise from practice and real-life BIM cases in learning architecture building making that integrates design, construction, mechanics and other sub-disciplines of building making. Future research will address the ways to make practice and collaborative teaching integral part of university education in BIM adoption process. Positive experience from this research shows that with the raise of BIM, the common misbelief in architecture education that practice and education are separate worlds, can be changed to the belief that architecture education can work with practice as an equal partner. Hopefully, schools are conscious that the skills and other knowledge that we share with our students should be the skills of today, not the skills of yesterday.

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