Building Information Modeling (BIM) in Higher Education Based on Pedagogical Concepts and Standardised Methods

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ABSTRACT

The implementation of BIM in higher education (HE) curricula for architecture and engineering is limited and does not meet the demand for competency in the industry. BIM education is mostly initiated by enthusiasts offering software training in isolated courses. The transfer of educational experiences is limited and partial. This conceptual paper explores the use of pedagogical frameworks to enable the systematic implementation of BIM in higher education. The following pedagogical frameworks are explored: (a) Integrated Design and Delivery Solutions (IDDS), (b) Technological Pedagogical Content Knowledge (TPACK), and (c) Trinity of BIM as building information model/-modelling/-management (BIM3P). BIM-related methods are connected to the pedagogical framework to illustrate applicable implementation. This enable BIM to be integrated into most architecture and engineering subjects without separate training in software. Focus is given to understanding relevant information to support design and fact-based decisions. The approach is learning BIM for learning architecture and engineering.

KEYWORDS

BEP, BIM, Higher Education, IDDS, IDM, ITO, Pedagogical Framework, TPACK

INTRODUCTION

This concept paper explores three pedagogical concepts for implementation of Building Information Modelling (BIM) in higher education (HE) in architecture and engineering. There exist good examples where students have used BIM software tools in design and analysis to enable advanced solutions. Feedback from students and lecturers is generally very positive. Software providers support this approach by offering student software for free. The technical foundation for students’ use of BIM has never been more facilitated. It is hard to find reports of BIM used in HE that has failed. It could therefore be expected that the use of BIM would be integrated as a mandatory and natural part of the architecture and engineering curriculum. However, this is not the case. The use of BIM in HE appears to reproduce the technical college approach by regarding BIM as a technical skill. Examples in use of BIM are isolated and limited compared to the total number of courses offered in HE (Rooney, 2016; Sacks & Pikas, 2013). The use of software is normally the main criterion for the identification of BIM in education (Barison & Santos, 2010; Lee & Dossick, 2012).

Focus is often placed on software skills, presented either by experts at a university or with support from industry professionals, such as architects, engineers, contractors, operators, and owners (AECOO) or experts in the field of information technology (IT). An indication of BIM being used only for software training is illustrated by the fact that all of the 197 BIM courses listed at the LinkedIn

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course portal (2016) were related to software training alone, and not the use of standards, processes, or guidelines. An analogue to this would be that architects and engineers get training in carpentry and concrete casting works. You show that you are at good architect by referee to how fast and advanced you can build. This craftsman’s approach for BIM is often illustrated by statements like: “We have a BIM course/project and use Revit”. The approach in this concept paper is different an intention to exemplify understanding BIM without use of Revit, ArchiCAD, Tekla and similar design/authoring software.

The above-presented situation contributes to a gap in HE between learning architecture / engineering and learning BIM. The research question in this concept study asks: “How can pedagogical frameworks support BIM as a concept for learning architecture and engineering in higher education?”

BIM is structured information – related to the built environment. Architects and engineers are processing huge amount of information in their studies and works. Focus on information management will increase by higher levels of BIM, Internet of Things and Big Data. It is therefore important to prepare the students for this future. This priority can be expressed in the quote by Albert Einstein. “Education is not the learning of facts, but the training of minds to think.”

**BIM IN RESEARCH AND HIGHER EDUCATION**

**Research Related to BIM in Education**

Education is a well-established topic within the BIM research community, as illustrated by the following list of research communities that include education as conference topics: the Association for Education and Research in Computer-Aided Architectural Design in Europe (eCAADe, 2016), the International Society for Computing in Civil and Building Engineering (ISCCBE, 2016), the IT in Construction by the International Council for Research and Innovation Building and Construction (CIB W78, 2016), and the European Conference for Product and Process Modeling (ECPPM, 2016).

A study by Chegu Badrinath et al. (2016) identified 70 academic BIM education publications based on search engines such as Google Scholar and Scopus. Of these, half were published in 2015, 71% of which were conference papers. Case studies and experiences were the dominant type of publication in this study. Studies by Överland (2016) showed that most case studies were conducted without use of pedagogical theories or pedagogical frameworks in BIM-related studies. The BIM-related research within education has mostly focused on presenting cases from a stakeholder’s point of view, without analysis based on pedagogical frameworks. Transfer of experiences will therefore be similarities to case, and not to a joint pedagogical framework.

**Status of BIM in HE**

There are challenges regarding BIM in terms of establishing (1) a common understanding of what BIM really is and (2) how to determine whether, to what degree, and for what purpose BIM is introduced in HE.

The first challenge has been experienced by other scholars; for instance, in a study about BIM teaching strategies by Barison and Santos (2010, p. 1), the authors stated: “it is still unclear how BIM should be taught as most experiences are very recent.” They identified BIM in education by looking for single courses, interdisciplinary projects, and distance collaborations. The NATSPEC survey (Ronney, 2015), however, did suggest increased interest in and a focus on BIM in a number of countries. According to Rooney (2014, p. 1):

> It would appear that the majority of BIM education available to date focuses on training in the use of particular BIM software packages, particularly seen as a lot of training for professionals appears to be provided by the software vendors. Training for both graduates and professionals in openBIM concepts, BIM management and working in collaborative BIM environments appears to be still in its infancy.
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