The Effects of Technology on Architectural Education

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Architectural education has evolved to integrate innovative technological tools in alignment with rapidly shifting global market behaviors. The use of innovative technological tools in seminar and studio environments must encourage students to work more collaboratively yet foster autonomy. Though new media technologies may encourage students in architectural education programs to collaborate more effectively, their ability to produce sustainable outcomes depends on how strongly instructors emphasize a goal-directed problem-solving approach to produce sustainable outcomes in seminar and studio environments. Since the effects of technology on architectural education remain profound, students and instructors must work stridently towards closing theoretical and practical knowledge gaps to produce more sustainable outcomes. In sum, the effects of technology on architectural education remain profound insofar as instructors and students may emphasize the utility of ICTs integrated into seminar and studio environments. Regardless of the drive towards integrating technological innovation, the theoretical paradigms adopted by instructors and students must have direct real-world implications for informing decision-making processes, fostering improvements to problem-solving skills, and enhancing professional development. Because the effects of technology on architectural education will maintain their profundity, instructors must continue to reinforce the benefits of communication to enhance collaborative decision-making processes as well as engage in theory-building.

Keywords: Architectural education, technology, information and communication technologies, computer-aided drawing (CAD) tools, problem-based learning (PBL) approach

INTRODUCTION

Architectural education has evolved to integrate innovative technological tools in alignment with rapidly shifting global market behaviors. The use of innovative technological tools in seminar and studio environments must encourage students to work more collaboratively yet foster autonomy. Innovative technologies may not always, however, foster the conditions for creating structurally sound designs regardless of how effectively students collaborate in seminar and studio environments (Al-Matarneh & Fethi, 2017; Rider, 2014). Along these lines, major changes in social and industrial patterns provide researchers with sufficient information to encourage instructors of architectural education programs into adopting more rigorous theoretical paradigms that have valuable and long-term implications for the future (Álvarez, Lee, Park, & Rieh, 2016; Gray, 2013; Schwartz, 2015). Computing and new media technologies also have significance for how instructors deliver curricular materials to graduate students (Etayies, 2017; Gray, 2013; Jones, 2016). However, the integration of information and communication technologies (ICTs) must guide the development of theoretical paradigms instructors and students adopt into professional practice. Though new media technologies may encourage students in architectural education programs to collaborate more effectively, their ability to produce sustainable outcomes depends on how strongly instructors emphasize a goal-directed problem-solving approach to produce sustainable outcomes in seminar and studio environments. Since the effects of technology on architectural education remain profound, students and instructors must work stridently towards closing theoretical and practical knowledge gaps to produce more sustainable outcomes. As explained further, the types of outcomes produced from integrating ICTs into seminar and studio environments have their basis in how instructors foster improvements in collaborative decision-making processes.
THEORETICAL PARADIGMS OF ARCHITECTURAL EDUCATION

The theoretical paradigms of architectural education often have a goal-directed problem-solving approach that involves collaboration between students and instructors (Al-Matarneh & Fethi, 2017; Álvarez et al., 2016). The goal-directed problem-solving approach ensures that students accepted into architectural education programs receive the conceptual and practical knowledge to construct structurally sound designs (Al-Matarneh & Fethi, 2017). Interestingly, some architectural educations have instructors who draw from critical theory as a pedagogical framework with implications for cultivating tacit knowledge among students (Gray, 2013; Schwartz, 2015). The central propositions of critical theory suggest that students in architectural education programs must analyze the role that technology plays in personal and professional life. Particularly among graduate students in architectural education programs, the ability to build upon existing technological knowledge pertains directly to how instructors integrate design concepts towards cultivating digital literacy.

By drawing from critical theory, instructors in architectural education programs focus seminar discussions on how various dimensions of social drive major shifts in design principles (Gray, 2013; Schwartz, 2015). However, researchers have identified a significant divide between architectural theory and practice (Kocaturk & Kiviniemi, 2013). When instructors of architectural programs draw primarily from critical theory to critique the role of technology and deliver seminar materials covering design principles, discussions may turn into political debates about which cultural variables will influence practice. Despite the importance of discussing the relationship between technological innovation and design principles, a diminution of practical knowledge may have negative implications for building structurally sound designs even if students receive large amounts of public recognition as “starchitects.” In considering how many of the most renown architects relied on innovative technological tools to design monumental buildings of larger cultural importance, the emphasis placed on critical theory contrasts sharply with a goal-directed problem-solving approach.

Researchers inspired by educational theory have discussed the impacts of technology on academic program outcomes in suggesting that an emphasis on visual training produces sound aesthetic judgments. Specifically, Jones (2016) noted how the 80-year tradition of education theory needs instructors capable of challenging dominant theoretical paradigms. Technological innovation allows university instructors and faculty to challenge assumptions about what types of coursework will produce students who achieve success after completing a graduate-level program. Yet, some researchers noted implicitly how technological innovation may not always produce high retention and completion rates for graduate-level architectural education programs. Iyer and Roberts (2014) noted how graduate students enrolled in architectural education programs distinguished between design principles and theoretical concepts. Design principles typically entail the application of a goal-directed problem-solving approach that produces sustainable outcomes (Al-Matarneh & Fethi, 2017; Iyer & Roberts, 2014). However, Rider (2014) pointed out how some graduate students enrolled in design courses have little interest in applying theoretical concepts towards completing a construction project. These students are more interested in using technologically innovative tools to apply practical design principles towards constructing structurally sound buildings. Unfortunately, graduate-level architectural education programs continue to reinforce the gulf between theory and practice as academic discourse does not relate to the language contained in technical documents.

Historically, the theoretical paradigms related to technology in architectural education draw from the “cramming teaching method” that represents a “disconnection between theory and practice” and an “assessment method based on a given score” (Hao & Xiao, 2017, p. 3494). Graduate-level architectural education programs with instructors who draw from critical theory to teach design principles typically apply a narrow theoretical focus to emphasize the relationship between technological innovation and structural soundness (Gray, 2013; Schwartz, 2015). Yet, the fact that most seminar discussions rooted in critical theory appear to produce actions of practical value, pedagogical practice indicates that students are responsible for experimenting with technological tools to create new knowledge (Daemei & Safari, 2018; Hao & Xiao, 2017; Schwartz, 2015). Given how construction activities included in the instructional curricula are not new, graduate students in architectural education programs may receive an adequate introduction to design principles (Schwartz, 2015). However, instructors may perceive themselves as lacking the self-efficacy considered useful towards producing sustainable programmatic outcomes. Instructors who lack self-efficacy about creating practical knowledge of the relationship between technological innovation and design principles have students who cannot effectively strategize collaboratively in many professional settings.

Graduate students who are more interested in emphasizing the technical and practical aspects of technological innovation do not require proficient knowledge of conceptual terminology to build structurally sound designs (Demirkar, 2018; Hao & Xiao, 2017). Instead, as Jones (2016) argued, graduate students in architectural education programs may benefit when instructors draw from visual training theory linking conceptual and technical knowledge rooted in design principles. Visual training theory provides instructors and students with the assurance that theoretical discussion about the role of technological innovation in architecture
will have practical relevance towards constructing structurally sound buildings. Of note, nonetheless, is how graduate-level architecture students more interested in creating practical knowledge actively create a theory about the relationship between technological innovation and design principles. As instructors draw from narrow constructions of critical theory to inform seminar discussions, students are still responsible for building professional skills outside of the academic environment (Daemei & Safari, 2018; George, 2017; Hao & Xiao, 2017). Students may acquire knowledge about design principles and theoretical concepts from using information and communication technologies (ICTs) to facilitate the development of practical skills.

Alternatively, students may integrate ICTs with computer-aided drawing (CAD) tools to inform practice (Álvarez et al., 2016; George, 2017; Guney, 2015). Software programs like Revit provide students with the tools for testing the relationship between theoretical concepts and design principles while constructing models of buildings or other structures intended for construction (Tang, Jin, & Fang, 2015). Graduate students encouraged to use Revit acquire knowledge of topography, structure, mechanics, plumbing, and wiring. Revit facilitates practical architectural knowledge as students use innovative software tools to construct three-dimensional designs in a collaborative environment (Al-Matarneh & Fethi, 2017; Álvarez et al., 2016; Tang, Jin, & Fang, 2015). Yet, despite the utility of Revit, the effects technology has on how students acquire practical knowledge from theoretical concepts and design principles have direct implications for creating new media to communicate ideas applicable to real-world scenarios. In concurrence, the type of learning culture that instructors choose to develop in architectural educational programs largely reflects the real and perceived advantages of technological innovation (Guney, 2015). Since technology allows students in architectural design programs to apply design principles in unique ways, its effects on computing indicate that a theory-building project must emerge from each opportunity to create structurally sound buildings.

METHODOLOGICAL IMPLICATIONS OF TECHNOLOGY AND COMPUTING FOR ARCHITECTURAL EDUCATION

Insofar as technology has profound implications for producing successful outcomes among students enrolled in graduate-level architecture education programs, researchers have demonstrated how ICTs implemented in seminar and studio environments provide students and instructors with a greater sense of responsibility concerning the links between theoretical paradigms and design principles (Al-Matarneh & Fethi, 2017). Specifically, in studio environments, the implementation of ICTs indicates that students enrolled in graduate-level architectural education programs must possess the tacit knowledge of how collaboration reduces costs and produces more environmentally sustainable outcomes for constructed projects (Gray, 2013; Iyer & Roberts, 2014; Kocaturk & Kiviniemi, 2013; Mitache, 2013; Rider, 2014; Schwartz, 2015; Smith, 2014). Conversely, implementing ICTs in seminar and studio environments entails that instructors must address the theoretical assumptions of design principles linked with concepts in narrow paradigmatic constructions of critical theory (Guney, 2015; Jones, 2016; Schwartz, 2015). Historically, however, the implementation of ICTs represents a significant paradigm shift that started in the mid-twentieth century as students argued about the right to create structurally sound designs from participating in group activities (Daemei & Safari, 2018; Mitache, 2013). Currently, many seminar and studio environments have students in who use ICTs to establish collaborative networks and foster a collective spirit that facilitates practical knowledge production. Nevertheless, some studio instructors expressed reluctance towards integrating ICTs to facilitate professional development in students.

Yet, as Mitache (2013) observed, the use of ICTs encourages students to enhance spatial knowledge applicable towards creating structurally sound designs. ICTs allow students in architectural education programs to experiment with software tools to create unique designs. However, all opportunities to create structurally sound designs must involve diligent work towards closing gaps between theory and practice. The computer on architectural education depend on how effectively instructors deliver curricular materials on visual training and physical modeling (Al-Matarneh & Fethi, 2017; Daemei & Safari, 2018; Iyer & Roberts, 2014; Jones, 2016). CAD tools are also representative how computing has significance for delivering effective instructional materials to students in graduate-level architectural education programs. CAD tools have assisted students in architectural education programs by encouraging instructors to set clear parameters for design templates. Moreover, CAD tools have provided students in architectural education programs with the curricular structure for extending new forms of creativity outside of the seminar environment.

Interestingly, however, researchers how have noted how social and industrial shifts are consequential of integrating innovative technological tools in architectural education programs. Instructors who, for example, use ICTs to deliver instructional materials are still responsible for encouraging students to build professional skills in project management, design, construction, and engineering (Elrayies, 2017). Here, the integration of ICTs in architectural education programs reflects a pedagogical emphasis on student-centered learning that follows directly from a goal-directed problem-solving approach (Al-Matarneh & Fethi, 2017; Álvarez et al., 2016; Elrayies, 2017). ICTs encourage students in architectural education
programs to work more collaboratively towards achieving broader and specific goals of design projects. Likewise, ICTs encourage students to consider how technology has a contingent influence on relationships between individuals, culture, and environment. As students in architectural education with varying levels of theoretical knowledge use innovative technological tools to complete design projects, the goals of working collaboratively become especially pronounced. Students who, for instance, have diverse academic backgrounds and specializations may communicate in a virtual environment to discuss how ICTs influence professional practice. Still, some architectural education programs that integrate ICTs into instructional curricula emphasize a teacher-centered approach that also has contingent effects on outcomes concerning retention and graduation rates.

As Elrayies (2017) pointed out recently, the teacher-centered approach to architectural education confirms how narrow constructions of critical theory may influence how students build practical knowledge from applying design principles to diverse project contexts. Conversely, the student-centered approach entails that learning by doing is a prerequisite for integrating theoretical paradigms and design principles into the seminar environment. Beyond the seminar environment, the student-centered approach to learning entails that students enrolled in architectural education programs remain enrolled until graduation. In contrast to the teacher-centered approach that emphasizes top-down applications of theoretical paradigms and design principles, the student-centered approach promotes real-time engagement with design software programs like Revit to improve interactions with instructors (Elrayies, 2017; Tang, Jin, & Fang, 2015). Students who use Revit to construct structurally sound three-dimensional designs have opportunities to facilitate discussions centered on which design principles will have the most direct long-term implications for maintaining a sustainable structure. Here, the use of Revit indicates how active learning through technology demands that instructors integrate a student-centered approach to discuss theoretical issues and their implications for practice across a wide range of project-specific contexts.

To a similar degree, the use of CAD tools among students enrolled in architectural education programs entails that instructors should consider drawing from case studies in addressing the relationship between technological innovation and design principles (Al-Matarneh & Fethi, 2017; George, 2017). CAD tools have the function of replacing traditional design tools that encourage students to develop manual drafting skills. However, computing indicates that the drafting template is already available and that software programs like Revit should function strictly as an experimental tool (Tang, Jin, & Fang, 2015). Computing also indicates that some ICTs may appear alluring to instructors more interested in implementing cost-effective strategies with contingent effects on retention and graduation outcomes for students (Al-Matarneh & Fethi, 2017). While traditional drafting tools still have significance for encouraging students to acquire knowledge of theoretical paradigms and design principles, computing in architectural education promotes student-centered learning in which instructors deliver curricular material to produce rich knowledge in a seminar environment (Álvarez et al., 2016; Salama, 2017). For instructors, computing facilitates the identification of diverse learning styles that provide a dynamic seminar environment. For graduate students enrolled in architectural educational programs who prefer to work in more autonomous learning environments, computing has contingent effects on the facilitation of cross-disciplinary knowledge across diverse learning contexts.

Unfortunately, computing in architectural education has not kept with pedagogical shifts that reflect the use of ICTs to build critical knowledge and skills that stretch beyond the institutional confines of a graduate seminar environment. Though some instructors who draw from various theoretical paradigms and design principles may encourage students to work collaboratively towards creating structurally sound designs outside of a seminar environment, the types of rich learning spaces produced from an integration of ICTs into instructional curricula influence which theoretical paradigms have the most direct and long-term implications for practice (Demirkan, 2016). Technology-rich learning environments may also improve interactions between instructors and students as both develop real-world conceptual knowledge of how technological innovation guides the design process on nearly all projects. However, as the next section explains, the ongoing introduction of new media in architectural education should encourage instructors to consider emphasizing the links between social and technological paradigms to facilitate a dynamic view of knowledge among students who demonstrate a sincere interest in using ICTs to create unique yet structurally sound designs.

**RESULTS INDICATING THE USE OF NEW MEDIA TECHNOLOGIES IN ARCHITECTURAL EDUCATION**

In architectural education, new media technologies have received attention by scholars who have identified how concepts such as global experience and sustainability apply towards fostering collaborative, cross-disciplinary instruction. New media technologies have significance insofar as instructors and students use innovative software programs like Revit to produce structurally sound designs from an application of rigorous theoretical paradigms (Al-Matarneh & Fethi, 2017; Álvarez et al., 2016; Gray, 2013; Jones, 2016; Schwartz, 2015). However, some coursework designs in graduate-level architectural education programs that integrate new media technologies tend to have misleading qualities. Graduate students who study theoretical paradigms and design principles in
architectural education programs must demonstrate an authoritative sense of control over the scale of designs included in portfolios (Elrayies, 2017). Yet, students must utilize new media technologies by creating portfolios and releasing on professional websites to receive attention by future employers.

Researchers have also noted how students enrolled in architectural education programs often experience the requirement of using social media technologies to demonstrate marketability in a highly competitive industry. The use of social media technologies entails that innovation in collaborative learning environments demands equal parts autonomy and group responsibility (Abdirad & Dossick, 2016; Elrayies, 2017). However, instructors are still responsible for providing students with valuable instructional content that closes gaps between theory and practice. Unfortunately, no studies to date have included strategic recommendations for instructors of students enrolled in architectural education programs to bridge knowledge gaps in studio and seminar environments. Despite the presence of a large research gap, researchers have noted how the use of new media technologies in graduate-level architectural education programs encourage students to collaborate by creating blogs or online forums to discuss which design principles have the most relevance towards constructing structurally sound buildings.

Here, the research literature that emphasizes a set of practices known as Building Information Modelling (BIM) highlights how students must utilize new media technologies to collaborate effectively (Abdirad & Dossick, 2016; Badrinath, Chang, & Hsieh, 2016; Guney, 2015; Kocaturk & Kiviniemi, 2013; Schwartz, 2015; Tang, Jin, & Fang, 2015). Instructors who integrate new media technologies into seminar and studio environments may also consider how BIM practices help students with overcoming barriers to collaboration (Smith, 2014; Tang, Jin, & Fang, 2015). Though some instructors are reluctant to integrate new media technologies, those who consider the impact of BIM practices encourage students to consider all possible implications of design sustainability while constructing three-dimensional models. Furthermore, BIM practices integrated into seminar and studio environments encourage students to develop technical skills for managing projects and strengthen leadership skills (Abdirad & Dossick, 2016; Badrinath, Chang, & Hsieh, 2016; Elrayies, 2017; Kocaturk & Kiviniemi, 2013). Particularly in studio environments, the integration of BIM practices entails that instructors will adopt a student-centered approach in granting considerable levels of autonomy.

BIM practices have significance for improving curricular designs in architectural education programs as indicated by research studies collaborative new media platforms (Al-Matarneh & Fethi, 2017; Demirkan, 2016; George, 2017; Salama, 2017). While some instructors may appear slow to integrate ICTs into seminar and studio environments, the utilization of new media technologies in graduate-level architectural education programs illustrates how innovative technological developments will continue to have profound effects on knowledge facilitation (Elrayies, 2017). Yet, the future of architectural education programs depends on how effectively instructors who readily integrate ICTs into seminar and studio environments encourage students to apply theoretical knowledge towards developing unique design principles with significant implications for constructing structurally sound, as well as sustainable, buildings.

DISCUSSION OF FUTURE RESEARCH IMPLICATIONS

Considerations of barriers to integrating ICTs in conjunction with BIM practices reflect a need to emphasize visual training theory in ensuring that students facilitate knowledge production of theoretical concepts and design principles. Jones (2016) considered how visual training theory contains goals largely set apart from aesthetic and scientific principles as instructors consider which technology-oriented strategies will produce the most effective long-term outcomes for students. Visual training theory also provides instructors with justifications for integrating new media and computing technologies into the graduate-level curricula of architectural education programs. Many of the concrete problems linked with constructing structurally sound building projects point to how theoretical and aesthetic judgments guide professional development. Yet, the pedagogical implications of visual training theory provide valuable lessons for instructors and students aspiring to achieve high goals.

In considering how many theoretical paradigms of architectural education adopt a goal-directed problem-solving approach, the integration of ICTs in seminar and studio environments should encourage researchers to close theoretical and practical knowledge gaps. Accordingly, instructors who misapply theoretical concepts to inform design principles, the pedagogical methods utilized in seminar and studio environments will leave students with a tremendous loss (Al-Matarneh & Fethi, 2017; Hao & Xiao, 2017). Largely because instructors of graduate-level architectural education programs focus so narrowly on a single paradigm—e.g., critical theory—the practices that students may develop to enhance professional development may produce unsustainable conditions when faulty design principles lead to the construction of structurally unsound buildings (Daemel & Safari, 2018; Hao & Xiao, 2017). In considering the effects that ICT integration has on architectural education, researchers of future studies may benefit from identifying which concepts and theoretical paradigms have the most direct implications for applying design principles into...
practice in seminar and studio environments. Students may believe that ICTs and software platforms such as Revit will ultimately dispense with the practical knowledge acquired from applying design principles towards using CAD tools (Demirkan, 2016; Hao & Xiao, 2017). Here, the growing emphasis on technological innovation in architectural education indicates that instructors should consider developing and implementing more effective strategies for closing theoretical and practical gaps.

Thirdly, future studies may include research on how instructors and students assess learning outcomes based on the continued drive for integrating technological innovation into seminar and studio environments. A project-based learning (PBL) approach applies to this context in suggesting that the integration of ICTs will inform how students build upon theoretical knowledge to inform design principles in practice (Smith, 2014). The PBL approach bears similarity to the goal-directed problem-solving approach based on a need for instructors and students to close theoretical and practical knowledge gaps. Accordingly, technological innovation aims to enhance decision-making processes in seminar and studio environments by fostering developments in spatial thinking and visual training (Jones, 2016; Mitrache, 2013; Smith, 2014). Yet, integrating a PBL approach into architectural education may provide substantial guidance towards solving more complex theoretical issues in their relationship to applying design principles in practice (Rider, 2014). Though instructors may draw from narrow theoretical paradigms to inform how students think about design principles, the PBL approach indicates how not all technological innovations will lead to the construction of structurally sound designs. The PBL approach indicates instead that students must utilize traditional and innovative technological tools to produce knowledge that has significant real-world implications.

CONCLUSION

In sum, the effects of technology on architectural education remain profound insofar as instructors and students may emphasize the utility of ICTs integrated into seminar and studio environments (Al-Matarneh & Fethi, 2017; Gray, 2013; Iyer & Roberts, 2014; Kocaturk & Kiviniemi, 2013; Mitrache, 2013; Rider, 2014; Schwartz, 2015; Smith, 2014). The overarching purposes of integrating ICTs into architectural education are to enhance critical thinking skills as well promote effectiveness in communication. Social and industrial changes reflect how technological innovation plays a necessary role while global markets shift rapidly to produce significant real-world implications across multiple disciplinary contexts. Regardless of the drive towards integrating technological innovation, the theoretical paradigms adopted by instructors and students must have direct real-world implications for informing decision-making processes, fostering improvements to problem-solving skills, and enhancing professional development (Al-Matarneh & Fethi, 2017; Álvarez et al., 2016; Gray, 2013; Jones, 2016; Schwartz, 2015). Graduate-level architectural education programs may produce significant benefits as instructors encourage to use software programs like Revit to construct structurally sound three-dimensional designs in a virtual studio environment. Yet, the research indicates that an emphasis on visual training and problem-based learning (PBL) may foster the ideal conditions for ensuring that students receive the guidance necessary to succeed in a highly competitive field. Because the effects of technology on architectural education will maintain their profundity, instructors must continue to reinforce the benefits of communication to enhance collaborative decision-making processes as well as engage in theory-building.

REFERENCES


