Designing for Designing: Information and Communication Technologies (ICTs) and Professional Education

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Abstract

Information and Communication Technologies (ICTs) appear to be well fitted to the education of design professionals, such as architectural and engineering students, mainly because of the unique culture of these professional schools, where the emphasis is on creativity, collaboration, social relevance and rapid communication of ideas. Attention is focused on the reflection-in-action theory of Donald Schön as well as the educational paradigm of constructivism as it is articulated by Dewey and Vygotsky. It is also argued that the full implementation of ICTs for professional education would also be extremely beneficial to the development of professional collegiality beyond the borders of geography and culture. All of this is followed by a consideration of important criticisms brought to bear upon both the use of ICTs in the classroom and the commonly held assumption that constructivism is the optimal educational paradigm.
Introduction
This article makes a case for a carefully considered implementation of Information and Communication Technologies (ICTs) in university programmes for the education of professionals, typically architects and civil engineers – those who are learning to design in the marketplace of the future. It is sometimes assumed that ICTs have no intrinsic value or essential meaning, and therefore they are neutral and subservient. In other words, ICTs are conceptualised as being tools that can, according to technological optimists, such as Bolter (2002), be used by humanity to make the world a better place. This view, identified by Feenberg (2003) as instrumentalism, is often adopted by governments and other institutions, such as universities, in the belief that ICTs will solve all our problems. Feenberg also identifies two other traditional views of technology: determinism and substantivism. Technological determinism is linked to post-Enlightenment progressive rationality in the commonly held opinion that ICTs are needed for any society to participate in the benefits of globalisation and the ‘Information Age’. Thus determinism is simply instrumentalism on a macro level, though it appears to be an impersonal and inevitable force of modernity. Technological substantivism represents a romanticist revolt against the utopian claims of instrumentalists and determinists. Holders of this view – most famously Heidegger (1977a) – argue that technology has human value and meaning and potential, but that it is no longer under human control, so it is ‘enframing’ and indeed enslaving us. Feenberg also identifies a new conceptualisation of technology that he simply calls critical theory, arguing that technology is no more than another cultural artefact that can be used by the powerful elite to subjugate less privileged members of society.

None of these views seems to be completely satisfactory. ICTs are not merely tools of progress, but neither are they simply artefacts of power. In reality, the meaning of ICTs depends entirely on how they are used within any cultural setting. The reading of technology in general and ICTs in particular that this article assumes is accurately described by Leaning (2005, 39): ‘ICTs are a modal form of media and their use and appropriation may vary according to the environment in which they are used.’ The primary argument of this article is that the culture of professional designing schools is very well suited to the potential benefits of ICT implementation.

After exploring the cultural framework involved in the accommodation of ICTs to professional education, I will go on to discuss the theoretical dimensions most fitting to the implementation of ICTs in the education of design professionals. This will bring us into contact with the overarching spirit of John Dewey and the pedagogical paradigm of constructivism, but I am specifically interested in the concepts of reflection-in-action and knowing-in-action put forward by Donald Schön (1983, 1984, 1987). I will follow up my examination of the cultural and pedagogical dimensions of using ICTs for professional education with a brief consideration of the effects of ICTs on faculty collegiality. I will conclude by discussing some of the problems and criticisms of implementing ICTs for educational purposes. Nevertheless, throughout the article I contend that ICTs should be implemented integrally and extensively in the future education of design professionals.

ICTs and culture
This article focuses exclusively on the culture existing in higher education schools of professional design. First, what is being taught in these institutions? Schön (1987, 41–2) sums it up succinctly:

Designing in its broader sense involves complexity and synthesis. In contrast to analysts or critics, designers put things together and bring new things into being, dealing in the process with many variables and constraints, some initially known and some discovered through designing. Almost always, designers’ moves have consequences other than those intended for them. Designers juggle variables, reconcile conflicting values, and maneuver around constraints – a process in which, although some design products may be superior to others, there are no unique right answers.
It is immediately apparent from this that what happens in the professional school of design – even if it is part of a university – is quite different from what happens in the university at large with its emphasis on painstaking research, profound reflection and the publication of scholarly papers. The culture of the professional school of design is focused, first and foremost, on creativity in regard to urgent practical matters at hand – not the kind of creativity based on careful research and rationality. In other words, design education involves intellectual synthesis much more than intellectual analysis, and critical thinking has not traditionally provided a common ground, though there are signs that this might change rapidly in the near future as designers are being expected, more and more, to learn and exhibit democratic multi-cultural awareness and concern for environmental sustainability.

Moreover, the pace of the professional school is much faster and less concerned with tradition than the pace of the rest of the university, and the professional school is also more closely linked than the university as a whole to the world outside the ‘ivory tower’. Therefore, the professional school needs to operate in much the same way that the profession itself operates. Critical theorists might censure schools of design for reinforcing the elitist socio-economic power structure by preparing students to work in that environment, but the same might be said of schools of medicine and law. Moreover, as Valkenberg (2001) points out, design projects in the real world are usually so large that they require extensive teamwork, and teamwork, in turn, requires both social interaction and rapid communication. It follows, then, that the principal values that the culture of professional design schools consider to be most important are creativity, social relevance, collaborative habits and rapid communication. All of these values can be enhanced through an extensive implementation of ICTs in schools of professional design.

Mishra & Koehler (2006) offer a theoretical grounding for incorporating ICTs into educational practices in general. Arguing that contemporary educational models need to be situated in relation to the complex interplay between the essential components of Technology, Content, Pedagogy and Knowledge (TCPK), these authors illustrate the importance of designing educational frameworks for particular educational needs. Such designs would functionally integrate ICTs with the content and educational goals of professional education and thereby have the power of completely transforming the teaching and learning experience. The TCPK model does not isolate technology; instead, it insists that technology must be learned and taught in relation to specific tasks. What this means in terms of the culture of professional education is that ICTs, with their potential for rapid global communication and their ability to enhance and extend creativity, need to be recognised as an indispensable part of what might be called ‘designing for designing’.

How computers can benefit design education

Reffat (2003) explains that in the contemporary ‘paperless’ Design Computing School (DCS) the computer is not a tool but an ‘interactive partner’, and this author provides an excellent summation of how ICTs can enhance the education of design students:

> The comprehensiveness of a successful paperless DCS allows for design ideas to be created, sketched, developed, drafted, rendered, and animated in real-time. The digital design is then printed, presented on-screen or projected, sent around the world over the Internet, and even fabricated by a numerically controlled rapid-prototyping machine, without ever existing on paper. (Reffat 2003, 348)

Admittedly, facilitating rapid communication does not necessarily mean improving the quality of communication, but high speed – whether we like it or not – is one of the competitive advantages of the marketplace, where design students are being educated to work.

Knight et al. (2005) argue that ultimate use of the computer in design education is to increase the creative capabilities of students and future designers. Originally viewed as an aid to the traditional designing process, computer technology served, basically, as an electronic drawing board.
for the later stages of the designing process. Early hardware and software were both expensive and somewhat unfriendly to users. The challenge has been for designing software to transcend the tradition that it was simply an advanced tool, no different, essentially, than a drafting pencil and paper. According to Knight et al., however, recent software applications have made computers not only more affordable and user-friendly but also more truly interactive:

All of these programs and environments take the approach of trying to give designers digital replications of traditional tools (pen or pencil and paper) to use in a manner that mirrors the traditional way of design; but with the assistance of the computer to enhance and augment the process. (Knight et al. 2005, 166)

Of particular importance is that fact that computers are now being used in design education as sketching tools from the very beginning of the design process. This represents a daring innovation that many design educators still resist, but there seems to be no doubt that this is how ICTs will be used to increase the creative capabilities of students in the future. As we have already learned from Schön, what designers do most of all is synthesise or create, so anything ICTs can do to enhance creativity is certainly valuable for design education.

ICCs and the paradigm of constructivism
As we have seen, the culture of professional education, particularly for those learning to design in such fields as architecture and civil engineering, is by its nature well suited to the learning and use of ICTs. If this is so, a question arises about which educational paradigm or theoretical framework should be used to accommodate the technological education of professionals. Mishra & Kohler’s (2006) TCPK theory suggests that pedagogical dimensions must never be forgotten when making choices about incorporating technology for educational purposes. Over the past few decades the epistemological paradigm of constructivism, strongly promoted by Vygotsky (1978) and von Glasersfeld (1989, 1990, 1997), has come to be generally accepted as the most culturally appropriate educational model for the present age. This is particularly true of the interpersonal, situated form of constructivism, whereby collaboration results in social, culturally meaningful learning, as opposed to the intrapersonal, cognitive form of constructivism, whereby collaboration results in greater individual understanding. Moreover, constructivism has already been linked positively to the implementation of ICT in educational settings. See, for instance, Dirckinck-Holmfeld & Lorentsen (2003) for a typical account.

As an educational theory, constructivism derives mainly from the philosophy of Dewey (1897, 1929, 1938) with his central tenets that the process and the goal of education are one and the same, the purpose of education is to acquire ongoing knowledge through experience, and the scientific concept of the dualism between the individual and nature is false. Constructivism is also fully compatible with Kolb’s Experiential Learning Theory (ELT) (Kolb 1984; Kolb et al. 1999). According to ELT, knowledge is created holistically through transformations in both long-term memory and behaviour caused by the experience of learning itself. Not only does ELT combine cognitive and behavioural learning theories, but it also allows for affective changes to be recognised as learning. In addition, ELT recognises four distinct learning styles: (1) assimilating, whereby learners read and think and employ rationality; (2) diverging, whereby learners work in groups and use imagination; (3) converging, whereby learners experiment with technical tasks and value practicality; and (4) accommodating, whereby learners confront challenges and collaborate to find original solutions. Traditional instructivist models emphasise learning as assimilating, while constructivist models regard learning as a combination of diverging, converging and accommodating. All things considered, constructivism, with its emphasis on student-centred, collaborative problem solving and its vision of the teacher/professor as a coach or a facilitator, instead of a disseminator of knowledge, seems to be very well suited to the education of professionals.
Schön and the reflective practitioner

In a series of books and articles published between 1983 and his death in 1997 Schön established the epistemological and educational concepts of reflection-in-action and knowing-in-action. The essence of these ideas is that professional knowledge is not limited to the application of scientific knowledge to professional problems. The model for the traditional kind of professional learning and professional practice is the medical school, where what Schön calls ‘technical rationalism’ is transmitted to students through an extensive and formal educational process in order to prepare them for the problems they will face in the real world. But, argues Schön, there is another educational model for professionals, namely the music conservatory, where students learn how to become fine musicians through informal coaching and much hands-on practice, two of the prominent features of education for the reflective practitioner. These students do not learn through the acquisition of technical rationalism but through the acquisition of artistic experience – a form of knowing-in-action – something that is often ineffable but is always educative. The medical school provides intellectual rigour, but the music conservatory provides cultural relevance, and this is precisely what Schön believes is needed for young professionals to face the uncertainty, opacity and value conflicts they will find waiting for them in the workplace.

Schön (1984, 3) describes the kind of informal and collaborative knowledge that is taught and acquired in the architectural school studio as an ideal for professional students, particularly those engaged in design:

I propose another possible response to the dilemma of rigor or relevance, a response that turns the problem on its head. It is based on the notion that rigorous professional knowledge does not consist only in the application of science to practice. There is also knowledge, or better yet, knowing in practice. People have in their doing a tacit kind of knowing. They know more than they can say and, in zones of uncertainty, uniqueness and conflict.

This is what Schön means by the reflective practitioner: a person who learns by doing and is encouraged by the coaching of educators to reflect on what he or she knows in order to grow in professional understanding and be able to meet the constantly evolving problems of the workplace. According to Schön, this is the most useful kind of education for design professionals. Although Schön himself is not concerned with ICT, his approach to the education of professionals is perfectly compatible with the transformative potential of fully implementing ICT and HCI or Human-Computer Interactivity.

Weighing and considering the union of ICTs and constructivism

There seems to be little doubt that the trend today of current professional education, especially for students involved with problem solving and design, favours a social constructivist paradigm of education. The advent and ubiquity of ICTs and HCI appear to have given constructivism even greater popularity than before among educators, for these new technologies seem to be made to be used collaboratively for both communication and creativity. The currently prevailing assumption in kindergarten through high school educational settings is that learning must be student-centred, not teacher-centred or even knowledge centred, as in the past, and this assumption is gaining more and more acceptance in post-secondary settings. After all, most students in Western nations arrive at university expecting to be the centre of the educational process as they already have been for 13 years (Howe & Strauss 2000). These same students have also grown up using computers and other kinds of ICT in the daily routine of their lives (Carlson 2005; Nimon 2007). It seems inevitable, then, that such students would be much more comfortable collaborating on computers with their peers, while being guided or coached by instructors, than they would be listening to chalk-and-talk professors.

There are, however, detractors and problems. Valkenberg (2001), for example, points out that Schön’s concepts of reflection-in-action and knowing-in-action have neither been operationalised nor verified through empirical studies. As Stensaker et
al. (2007) remind us, such a gap or missing link between the theoretical promise of ICTs for transforming education and the actual academic performance of students using ICTs has been a problem since the first computer was introduced to a classroom. It seems likely that the same problem will also haunt constructivism as an educational model. Nonetheless, constructivism has proved itself to be a strong educational theory, and ICT is already firmly established on a global scale. It is not unreasonable to assume that a theory and a technology that are so compatible will evolve together more and more in years to come.

ICTs and professional collegiality

In an extensive empirical study of teachers in American schools Becker & Riel (2001) found that collegiality or involvement in professional activities was influenced by two variables: a commitment to constructivist teaching and an active use of ICTs. Their findings indicate that the more teachers are committed to the constructivist paradigm, and the more they actively use ICTs, the more likely they are to interact with other teachers in a professional and collegial manner. These findings likely apply to higher education institutions just as convincingly. In fact, Jankowska (2004) reports that an empirical study reveals that university libraries are finding that professors are currently exhibiting a strong demand for the provision of a greater amount of ICT services. Moreover, Dexter et al. (2002, 197) report on case studies that demonstrate a strong correlation between the use of ICTs and educational collegiality. Such findings confirm the theoretical intuition that because ICTs enhance the means and speed of communication among both faculty and students, on a particular campus or anywhere in the world, these new technologies are bound to increase the professional collegiality of educators.

Not every professor, however, is happy about the increased connectedness they are afforded through the implementation of ICTs in universities. Menzies & Newson (2007, 84) interviewed many professors about their experiences in the new wired academic setting, and the results were often surprising: “While most respondents felt better connected, especially nationally and globally, many also felt more isolated; and while considering themselves more productive, many also felt that they were becoming less creative.” It should be noted here that this study focuses on university professors in general, not specifically on those engaged in teaching students in professional design programmes such as architecture and civil engineering. Nevertheless, the reported distinction between productivity and creativity should be taken very seriously. The principal focus of design education is on creativity, and the argument is that ICTs foster creativity, but if ICTs actually foster mere productivity more than genuine creativity, this argument might need closer examination. Moreover, professors often report that using computers tends to isolate them from their colleagues on campus, and this is certainly not desirable. Just the same, design educators are mainly engaged in the immediate demands of helping students collaboratively to create designs that have social relevance and cultural authenticity in the contemporary world. For such educators, ICTs are not only practical but also effective, and the collegiality these professors experience through these new technologies helps them to solve problems at the new pace demanded by globalisation in the twenty-first century.

Unwin (2007) argues that higher education professionals are situated in the middle of academic, socio-economic and technological change, and that ICTs have a potential for increasing collegiality, provided they are used wisely. Moreover, Unwin gives a strong description of how, for him, collegiality begins with teamwork in the classroom. He laments the fact that in recent times higher education professionals have become more and more controlled by the culture of the marketplace, and he is quick to point out that ICTs are a major force in the global spread of the culture of consumerism. Nevertheless, he believes that if professors are educated and encouraged to use ICTs for clearly defined, rational ends – especially if they adopt Mishra & Koehler’s (2006) TCPK educational model – ICTs will be found to enhance both particular teamwork performances and general collegiality in the world of higher education.
Discussion

As Nora and Snyder (2008 / 2009) observe, there has been a great amount of theorising about the advantages of ICT for higher education, but all too little publication of empirical studies to verify the glowing claims of the champions of ICT. Theorists intuitively believe that because ICTs encourage collaboration, enhance the speed of sharing knowledge and fit the dominant educational paradigm of social constructivism so well, they should transform the educational process by their mere appearance in the classroom. Moreover, as we have seen in this article, ICTs seem to be particularly well suited to the delivery of professional education to architectural and other design students. The culture of professional designing schools with its emphasis on speed of communication, broad social relevance and solving problems in virtual reality would seem to demand the fullest possible implementation of ICTs. And yet, when ICTs are used intensively for the education of designing professionals, the results are not always positive.

An especially interesting recent study of the impact of ICT on the professional education of architects is that of Wiske et al. (2001). In this monograph, analysts from the Harvard Graduate School of Education report on the ways that three professors in the Harvard Graduate School of Design incorporated ICT into the teaching methodology of their courses on professional architecture. The authors present extensive case studies of two courses, one on the analysis and design of building structures given by Spiro Pollalis and one on the fundamentals of computer-aided design given by Jeffrey Huang and Urs Hirschberg. In each case the authors focus on both the theoretical benefits and the practical challenges of using ICT to deliver professional courses for architectural students. Because the study relies on a wealth of empirical observation and includes a substantial amount of reflective comments by the professors themselves, as well as input from both the technical staff and the students, it captures the complex reality of using ICT to teach the profession of architecture. In the end the authors emphasise the experimental nature of the use of ICT by the three professors, especially the need to listen to feedback and improve the methodology the next time it is tried. Moreover, the authors identify three cross-cutting themes or dimensions encountered by the professors in their use of ICT: namely, the educational dimension, the technical dimension and the institutional dimension. Educational considerations involved balancing the need to meet goals with the need to allow students to discover necessary knowledge for themselves. Technical considerations involved a cost-benefit analysis for the time lost by students in learning to use complex ICT tools and the difficulty for teaching assistants and technicians of implementing and maintaining those tools. Finally, institutional considerations involved the tension caused by the fact that the use of ICT in both these courses was funded by external initiatives that tended to disrupt the normal flow of resources within the university. The authors of this study come close to telling the whole story – not just the propaganda – of using ICT for the professional education of architects, and as such it is invaluable.

Apili & Basa (2006) offer even more surprising – and perhaps disturbing – empirical findings about the use of computers for architectural education. In a study of second-year design students these authors found that there was a strong oscillation in preference between using the hand and using the computer for drawing designs. It would seem to be intuitively reasonable to expect that contemporary students, who are so adept in the use of ICTs, would prefer to use computers instead of pencils for the visual representation of ideas. Nevertheless, many students expressed a preference for hand drawing over computer drawing:

Students acknowledged many advantages of the computers and they also emphasized that in the future computers will continue to be integrated in design practice and education. As members of a generation born to computers and being swift in using computers, the students are well aware of the capacities of computers. Yet, no matter to what extent they are computerized as a generation, the students still believe to a surprising extent, in the importance and value of hand skills.
in the design milieu. Students showed a great recognition of the validity of hand drawings with the indication that hand drawings are more successful in reflecting authorship, one’s ability, and warmth in terms of artistic expression. (Apili & Basa 2006, 279)

Apili & Basa conclude that the oscillation in preference between hand drawing and computer drawing reflects the fundamental dual nature of architecture as both an art and a science. Hand drawings are warmer and allow a personal artistic touch to designs, while computer drawings are easier, quicker and provide more intricate scientific details to designs. The occasional preference of designing students for pencils over computers probably indicates nothing more than the fact that, as reflective practitioners, they are ‘only human’ and are not always committed to technical rationalism with its emphasis on efficiency.

The question of how ICT is conceptualised remains problematic for many people in academia. In effect, the issue is not merely cultural but also ethical. Few debaters today would advocate either determinism or instrumentalism as conceptions of technology. Almost everyone in educated circles agrees that technology has cultural, social and political meanings that need to be both understood and, if possible, brought under some kind of responsible control. Substantivists like Martin Heidegger doubt whether technology can ever be tamed now or put in its place. As he stated in that last interview in 1976, ‘For me the decisive question today is how this technological age can be subjected to a political system and to which system. I’ve no answer to that question, but I’m not convinced democracy is the way’ (Heidegger1977b, 16).

There is certainly no need to bring Heidegger’s alleged association with the Nazis into this discussion, but many current writers, particularly those committed to a conceptualisation of technology based on critical theory – the best example being Andrew Feenberg – are solidly convinced that the advent of ICTs in the last two decades offers a practical opportunity for countless individual users to shape the future of the technological age.

Feenberg (1991) argues that positivistic beliefs about technological determinism and technological instrumentalism must be overthrown – and technological substantivism must be infused with new hope – in order to establish democratic technological practices. Since positivism has already been replaced to a great extent in the philosophy of science and the philosophy of technology, it would seem to follow that technological determinism and technological instrumentalism as general concepts should also have been replaced by now, and within academic circles this has indeed happened. But governments and corporations still often assume – and attempt to assure society – that technology is an exogenous, irresistible force destined to develop material progress to ever greater heights of prosperity. (Unfortunately, the same might be said sometimes about higher education administrations!) According to Feenberg, technological democracy will not happen until the belief that technological determinism can only be administered by authoritarian institutions with a commitment to rational efficiency is finally abolished.

The most serious criticism levelled against regarding professional design students as reflective practitioners, and educating them within a constructivist educational framework, comes from Merrill (2002). This author identifies five principles of instructional design, based on a thorough research of previous empirical findings. These principles can be summarised as follows: Learning is promoted (1) when learners are involved with solving real-world problems, (2) when the learning process activates existing knowledge as a foundation for new knowledge, (3) when new knowledge is demonstrated to the learner, (4) when new knowledge is applied by the learner, and (5) when new knowledge is integrated into the learner’s world. At first glance this list of principles appears to support the constructivist educational paradigm. It specifies the importance of the relevance and the application of learning to both the world beyond the classroom and the learner’s own particular world or cultural reality. But the list also specifies the importance of building on existing knowledge stored in long-term memory and demonstrating
new knowledge for the learner. These last two are, of course, integral to the traditional instructivist educational paradigm. Moreover, Merrill (2007) notes that his five principles of educational design apply just as well to students working as individuals or to students collaborating in groups. Taken together, Merrill’s principles do not give firm support to constructivism as a paradigm. In fact, they tend to support the traditional instructivist model. ‘The [most effective] resulting instructional strategy is a guided task-centered approach as contrasted with more learner-centered problem-based approaches to instructional design’ (Merrill 2007, 6).

In an earlier paper Merrill (2000) also dismisses the relevance of different learning styles, such as those incorporated in Gardner’s (1983) multiple intelligence theory and Kolb’s (1984) experiential learning theory, to effective instructional design, insisting that using the proper educational strategies to achieve the desired learning outcomes is all that really matters in creating effective instructional designs. This conclusion also raises doubts about Schön’s reflection-in-action concept. In short, all of Merrill’s findings and arguments call into question the idea that constructivism is the optimal educational paradigm. This, in turn, has serious implications for the full and uncritical implementation of ICTs in all educational settings – particularly in schools for professional design – since these new technologies are so intricately connected with the fundamental constructivist assumptions of collaborative learning and diversity of learning styles.

It is apparent from this discussion that an extensive implementation of ICTs for the purpose of educating design professionals such as architects and civil engineers is not as simple and straightforward as it would intuitively appear to be. In fact, there are several issues that need to be, if not resolved, at least considered critically. Enthusiasts of ICT tend to be so committed to the ideal benefits of these technologies that they ignore the practical matters of implementation – such institutional matters as time, funding and finding technical support personnel – not to mention the education of faculty members in the requisite use of ICTs. Moreover, even contemporary students are not always convinced that computers are better than pencils for drawing or chalk-and-talk for developing knowledge. In addition, the conceptualisation of ICTs in general is a vexed question. Substantivists such as Heidegger regard all technology as imprisoning the essentially creative spirit of humanity, while critical theorists such as Feenberg cry like voices in the wilderness for a radical democratisation of technology, especially ICTs. The fact that design educators seem to have no qualms about enlisting ICTs in the service of the marketplace – that is, capitalism – by conceptualising ICTs mainly in the positivistic terms of instrumentality and determinism raises questions among some critics about the ethical responsibility of design education as a whole. Add to these issues the fact that the superiority of the paradigm of constructivism, though almost universally accepted in theory, is certainly not verified by empirical evidence, and the problems associated with the full implementation for ICTs for educational purposes become even more complicated.

Nevertheless, two strong arguments remain for incorporating ICT into the education of design professionals. The first of these is that ICTs appear to fit the particular needs of the culture of design professionals. Most of all, ICTs have already demonstrated an ability to enhance the creativity of design students, who are, as Schön points out, learning to make things and to solve problems in the process. These students are not primarily concerned with analysis or criticism, as most university students are. The world of professional designing also demands the ability to work effectively in teams and to socially interact with other professionals and with customers, often at the fastest possible speed of communication. In this regard, the typical design pedagogy of constructivism also seems to be well fitted to the employment of ICTs. Given these facts about the culture of professional designing, it seems reasonable to conclude that ICTs can only assist students to flourish, both as present students and as future professionals.

The second compelling argument for fully implementing ICTs in professional schools of design is that these technologies certainly...
increase professional development and participation among faculty members. Collegiality is an important feature of professional life in higher education, and no one can deny that professors today are able to share their research findings and keep abreast of the latest happenings in their discipline at much quicker speeds and over much vaster geographical and cultural separations than ever before – notwithstanding the fact that some professors complain that while using computers has made them more productive, using computers has actually made them less creative and it tends to isolate them from their colleagues on campus. Even if ICTs do not always transform the learning for students as much as their champions insist they should, ICTs do unquestionably transform the research experience for professors, and this, in turn, benefits everybody in the world of higher education.

**Conclusion**

This article has presented a case for a greater implementation of ICTs in schools of professional design. Not only are ICTs compatible with the unique culture of these educational institutions, but they are also compatible with the educational paradigm of social constructivism that is usually assumed by these institutions. Implementing ICTs fully would both enhance the teaching and learning dynamic of professional design schools and promote greater collegiality among faculty members.

Detractors might claim that by conceptuallising ICTs in the positivist manner of instrumentalism and determinism – tools for inevitable progress in the marketplace – design education is irresponsibly ignoring the socio-cultural and environmental concerns of critical theorists. In a sense, this may be true, but in all fairness the mandate of design schools is to serve the needs of the design profession. Besides, both architectural and engineering design students are currently being educated in matters of cultural and environmental importance, and this trend will surely grow in the immediate future. Critics might also be concerned about the facts that neither the use of ICTs in the classroom nor the assumption of the pedagogical constructivism has been demonstrated by empirical studies to be significant improvements in the education of design professionals. Nonetheless, it is certainly true that students feel comfortable with both ICTs and constructivist pedagogy, and this in itself would seem to justify their full implementation. Finally, it is impossible to deny that professional collegiality has been increased in recent years by the presence of ICTs with their ability to facilitate rapid communications within a globalised context. It may, however, be true that ICTs enhance productivity more than creativity, and this needs to be further investigated. In the end, the best justification for implementing ICTs for design education is the claim that, because of their interactive capabilities, they might enhance the creative dimension of the design process.

**References**


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