Albirini, A. (2007). The Crisis of Educational Technology, and the Prospect of Reinventing Education. *Educational Technology & Society*, 10 (1), 227-236.

The Crisis of Educational Technology, and the Prospect of Reinventing Education

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ABSTRACT

With the fading monopoly of the industrial mode of production and the emergence of the "information revolution," modern technology has pervaded almost every aspect of human life. In education, however, information technology has yet to find a place, despite the unceasing attempts to "fit" it into the existing educational system. The paper argues that the industrial mode of production was successful in inventing "education" as a new paradigm, institutionalizing it in schools, and implementing it through a number of tools, such as "certified" teachers, curricula, and textbooks. By contrast, the information mode of production has created the tools, namely "educational technology," before developing a corresponding paradigm or institution. This crisis of educational technology is therefore a corollary of its misplacement, and subsequent malfunction, in the still-in-use industrial paradigm and institution (education and school). The paper suggests that, in order to ensure a proper functionality of modern technology, we need to resolve this theoretical inadequacy. A possible solution would be to thoroughly restructure "education" and schools, as remnants of the industrial age, into a new paradigm and institution.

Keywords

Education, Educational technology, Paradigmatic conflict, Information age

Introduction

The widespread use of computers and telecommunications in the second half of the last century has caused fundamental changes in the character of modern societies. The ubiquity of computers and telecommunication devices in many areas of human activity and the increasingly important role of information as the main driving force of the post-industrial era have created a new mode of production and, to many, a new age. Often referred to as the Information Age, the current era is marked by a shift from the emphasis on producing and controlling material goods to controlling information (Negroponte, 1995). The current shift affects a range of issues from manipulating digital data with all the implications on human communication, perception, and understanding (Negroponte, 1995), conducting business (Tapscott, 1996), and relying more on services than on industrial production (Poole, 1995).

With the increasing availability and capability of computers, "computerization has risen to ideological prominence, an expression of grand hopes and ideals" (Winner, 1986: p. 595). Computers and their related technology have become associated particularly with the images of positive change and renewal (Watson, 1998). In education, however, the impact of computers and their related technologies has been minor. As Bennet (1999) notes, "The only important field that computers have failed to change significantly is education" (p. 46). Despite the huge expenditure, wide experimentation and research, and discursive enthusiasm, educational technology has failed to show substantial benefits to the field (Gentry & Csete, 1995; Bennet, 1999; Salomon, 2002). This has created a crisis in educational circles and generated a wide controversy among educators and scholars concerning the place of modern technology in education and the feasibility of the various attempts to fit it into the existing educational system (Stoll, 2000; Clark, 1994; Salomon, 2002).

Efforts to explain and subsequently resolve the crisis of educational technology have centered mainly on the material obstacles to the implementation of educational technology in schools: lack of planning, paucity of funds, shortage of hardware, absence of standards, inadequacy of teacher preparation, need of software updates, lack of computer expertise, lack of knowledge of how to apply technology in the classroom, insufficiency of access to computers, polarity of research, computer misuse, commercialized web content, digital divide, gender bias of technology, health issues, exposure to improper material, etc. (Stoll, 2000; Alliance for Childhood, 2001; Becker, 1998; Pelgrum, 2001; Earle, 2002). The paper seeks to demonstrate that the real causes of the crisis extend beyond these concrete problems to more theoretical issues related to the "identity" of educational technology, its theoretical assumptions, and its

paradigmatic conflict with education. It suggests that understanding these theoretical underpinnings is an essential starting point for finding appropriate solutions to the current crisis. A comparison between the educational system in the industrial age and its counterpart in the information age might help in putting the crisis in perspective before considering its main causes and possible solutions.

Industrial Education

Education in its presence sense was completely unknown before the Reformation, except as that part of early upbringing that is common to all human beings (Illich, 1973). According to Illich (1973), education was different from instruction needed by the young; and from learning, which was informal and lifelong, i.e., people could learn from their environments and their own experiences; and even from study which required a tutor/scribe and dedication. Although "study" was the preferred method of knowledge advancement in particular fields (e.g., religion, philosophy, mathematics, etc.), all of the other knowledge patterns were viable for increasing people's knowledge of their environments and the world (Gulati, 2003). That is, no matter what the route to knowledge was, one can still be called knowledgeable based on his/her ingenuity, skill, and ability to resolve problems and answer questions that faced people in their daily lives.

The established knowledge patterns underwent a significant change under the industrial system, which was simultaneously changing its work and cultural patterns and promoting science as the ultimate means for understanding phenomena (Olson, 1974). The industrial system "re-invented" education and placed it at the top of the knowledge tree. Education came to indicate the process of internalizing, typically via dedicated study and learning and with the aid of instruction, a number of prescribed topics, attitudes and values arranged into curricula. Within this knowledge system of industrial management, students were situated at the receiving end of the "knowledge transmittal" process; they had no control over the content or the method of their "education" (Jones & Maloy, 1996; Berryman, 1993). The acquisition of the types of knowledge promoted through the new system became a necessary route for attaining other ends (positions, social status, well-being, etc.). Eventually, education became *the* new knowledge paradigm and sole legitimate way of knowing.

The creation of education as a paradigm was escorted by the founding of science-based schools, which departed *conceptually* from the common religious schooling of the time. This was a necessary step for institutionalizing the new paradigm. John Amos Comenius, a Moravian bishop of the seventeenth century, was one of the founders of the modern school within which the education paradigm operated (Piaget, 1993; Illich, 1973). In *Great Didactic* (*Magna Didactica)*, Comenius maintained that education is an inevitable route to help children attain full humanity and that schools should be the context of this educational process. Further, he advocated a science of education that would take a step-by-step approach to learning. Schools would refine raw elements (i.e., students) by graduating their spirits through stages of enlightenment, "teach everybody everything," and eventually enable everyone to become a functional member of society (Illich, 1973). Through his approach, Comenius did not simply make an outline for the assembly-line production of knowledge, but also solidified a theory of mass production in educational terms. Education became a mechanism that would bring forth "a new type of man who would fit into an [industrial] environment created by scientific magic" (Illich, 1973: p. 19).

Not only did the industrial mode of production succeed in creating a new paradigm and in institutionalizing it, but it also created the tools needed to run it. Hence was the invention of "certified" teachers, curricula, textbooks, tests, and so on. With these developments, a whole knowledge system was primed to attain the ends set forth by the industrial society. The knowledge system was a means for an end; it was a means for legitimizing the industrial mode of production, for indoctrinating people into this mode, and for preparing people to serve the assembly line. On the other hand, the new knowledge system helped de-legitimize the agricultural mode of production and simultaneously create the myth of science as a meta-narrative and a substitute to metaphysics, which was then labeled "superstition."

With the paradigm shift and the subsequent establishment of schools, the industrial mode of production did not merely form a new knowledge system, but also created a new society and new men. As Rorty (1989) suggests, "Changing languages…may produce human beings of a sort that had never before existed" (p.7). Knowledge came to mean the amount of schooling one received. The redefinition of knowledge as schooling made education seem necessary, thus compounding "the poverty of the unschooled with discrimination against the uneducated" (Illich, 1973, p. 19). People who have climbed up the schooling ladder were also climbing the socioeconomic ladder. People

who had a higher level of education were entitled to decision-making and management positions, whereas the assembly line jobs were relegated to those with elementary-level education (Welker, 1991). Those who had no schooling were labeled ignorant, backward, stupid or at best "uneducated." Licenses, certificates, diplomas became the "emblems" of knowledge. A certified physician, for example, would be called a doctor, while a non-certified one would be called a quack, even when the latter knew more about the field than the former. By accepting the authority of the school agency to define and measure their level of knowledge, people were under the mercy of other industrial agencies that defined for them their level of fitness into the society (Illich, 1973). Once people came to believe in the value of the "knowledge stock" they acquired in school, education became the measure of success, income levels, well-being, social class, and so on (Welker, 1991).

The development of education into a full functional social structure allowed the industrial system to redefine institutions, patterns of behavior, expectations, and contexts of power exercise. Together with schools, education became a perfect means for streamlining people and regulating them according to the ideals of the industrial society (e.g., more goods equals well-being, health, etc). This pattern of mass production education served the purposes of the industrial society till the first half of the twentieth century. By the mid 1950s, the information revolution was underway (Toffler, 1980), coinciding with widely reverberating calls for educational reform (although similar but less fervent calls existed since the break of the twentieth century) (Besser, 1993).

Information Age and the crisis in education

Historically, the information age was envisaged a long time before computers ever existed. Arguably, Jorge Borges' playful description of a "labyrinth of symbols… a book which had the possibility of continuing indefinitely" (1941: p.33) and Vannevar Bush's notion of a "future device for individual use, which is a sort of mechanized private file and library" (1945: p. 45) pioneered the earliest visions of the current networked computers and put the information age on track. However, Borges's book-garden-maze and Bush's desk-library-machine had less to do with the "physical" computer and much more with "a change in how our minds are working" (Murray, 2003: p.3). In other words, those two thinkers had envisaged a new paradigm and possibly a new social order away from the prevailing industrial social structure.

Unfortunately, later developments in the computer industry took on a totally physical form with no corresponding paradigmatic developments, that is, with little change in how people envision and practice their social lives. The field of education, in particular, has remained theoretically unaffected by the introduction of the digital media despite the proliferation of computers in schools and in society at large. In fact, the advent of the new media has not merely failed to produce any tangible changes but also engendered tensions in the established educational system. A quick overview of the rise of electronic technology might help delineate its current problematic situation in schools.

The idea of using computers in education goes back to the mid 1950s as the winds of reform were surrounding the educational enterprise in the United States (Poole, 1995). First sponsored and then further propelled by the military-corporate complex (Besser, 1993), the thrust toward technologizing schools and the related reform thereupon originated partly in the information industry's quest to legitimize itself through a knowledge system, to "program" people in this system, and to produce people who would serve its industry. Early computers found their way into American education through the early projects of IBM, which were attended by a wide optimistic belief that such a machine "could be programmed to handle almost any problem demanded of it" (Poole, 1995: p. 42). As the information revolution gained momentum and computers showed greater potential in various human realms, it was suggested that the new technologies would revolutionize education just as they revolutionized industry (Fouts, 2000).

The notion of "revolutionizing" the existing educational patterns was quite explicable, given the promise of the new technologies to democratize learning, to decentralize instruction, to increase access to multiple information resources, to remove hierarchies in communication and interaction, to enhance students' collaboration and exploration, and to obliterate the stringent structure of the classroom (Poole, 1995; Olson, 1974; Warschauer & Healey, 1998). In educational thought, the realization of this vision has remained indefinite. The strong belief that the electronic technology is of profound significance to education was debilitated by the absence of "information revolution" in educational terms. In fact, the vision fell short of its projection when the early behaviorist computer programs were developed partly to cure the ills of the "traditional" classroom and were eventually implemented "with the belief that they could convey information (and hopefully understanding) more effectively than teachers"

(Jonassen, et al., 2003, pp. iii-iv). Thus, instead of being used to explore new learning and teaching possibilities, the early computers were used to make existing practices more efficient. Under the behaviorist model, computers were in control of the learning process; they "present and store information, motivate and reward learners, diagnose and prescribe, provide drill and practice, and individualize instruction" (Tolman and Allred, 1991, p.5). The content of education remained the same in nature for all disciplines; "educational software was mostly textbooks presented in electronic print formats" (Valdez, et. Al., 2000). Relatively little emphasis was put on the learner, who was usually viewed as a passive recipient of instruction. In effect, the new model replicated the industrial learning patterns, with a single difference in the medium of instruction: a computer versus teacher. Fortunately, it did not take many educators long to discover that a mere change in the medium of instruction does not influence students' learning or class dynamics. Critics suggested that behavioral-based computing "took the control of learning out of the hands of the teacher and placed it into the hands of the computer software programmer" (Valdez et al, 2000), dehumanized the learning process (Thompson et al, 1992), and ignored the "learner satisfaction, self-worth, creativity, and social values" (Alessi & Trollip, 2001: p. 37). In response, technological apologists claimed that the current uses of the technology did not exploit the power of the computer, and hence was their low quality (Jonassen, 1988, Striebel, 1986).

The early 1980s witnessed an ostensible shift in the functionality of computers and their related technologies in schools; "behaviorist and systems theoretic models and their products (drill programs, tutorials, computer managed instruction) began to give way to principles for designing "learning environments" and "cognitive tools" which make full use of advanced computer based technologies in support of knowledge construction" (Damarin, 1998: p.3). The shift was instigated by the spread of microcomputers, the concurrent improvement in computer power—a technical development that lacked any corresponding theoretical advancement—, and the "re-discovery" of Cognitivism and Constructivism as learning theories well suited for computer-mediated learning environments. Cognitive science perceived learning as interactive rather than reactive and shifted the focus of instructional technology from "procedures for manipulating instructional materials to procedures for facilitating learner processing and interaction" (Saettler, 1990, p. 318). Constructivism emphasized the importance of knowledge construction through action, exploration, discovery, and collaboration and in meaningful learning environments (Gärdenfors and Johansson, 2005). The advances in the power and accessibly of microcomputers allowed for the development of instructional material and software that were based on the principles on cognitive and constructivist learning theories. However, the few cognitivist/constructivist computer-based activities supported through these programs were of limited use/value to the classroom because they needed extended class time to complete (Wyatt, 1987). Besides, they embodied an add-on to a central curriculum (Adams, Morrison & Reedy, 1968) and eventually failed to significantly restructure the established learning environments. By the late 1980s and early 1990s, educational technology came under fire for the computer was still being used in an improvised and disconnected fashion and thus "finds itself making a greater contribution to marginal rather than central elements" of the learning process (Kenning & Kenning, 1990, p. 90). In sum, the bond between cognitivism/constructivism and the digital media did not introduce a real change into education; rather, it was an attempt to rework another component from the exiting educational system, namely, methods of instruction and learning. At this point, many educators predicted that the "media will never influence learning" (Clark, 1994); the "computer will be just another in a series of highly touted technological tools that have neither revolutionized learning nor lived up to initial promises" (Dunkel, 1987: p. 254).

In the 1990s-plus years, educational reform took on a different direction upon the emergence of the Internet and the World Wide Web. The internet was hyped as "a means of bringing the outside world into the classroom, while connecting students to resources hitherto unimagined" (Trend, 2001: p. 68). The transformational capabilities of the Internet for communication, information access and collaboration eventually triggered calls for transforming the curriculum, fitting certain technological applications into the existing curriculum, and even fitting the curriculum to the computer (Earle, 2002). To many observers, however, web-based learning experiences reflect a quantitative increase in information accessibility and availability, rather than a qualitative change in the curriculum (Fullan, 2000; Earle, 2002). Moreover, the majority of web-based applications have not relied on any type of theoretical rationale for their incorporation into the curriculum except for the theoretical framework already built into basic web exercises (Salaberry, 2001). More importantly, while a number of web applications were found educationally relevant, few accompanying changes occurred in the other parameters of the industrial classroom. Given these limitations, the effect of the Internet on the classroom floor has remained virtually imperceptible.

It is no wonder then that the grandiose expectations about the revolutionary role that computerization is going to play in education are now on the wane. After thirty years of experimentation and research in educational technology, little

has been found about its benefits to education (Hirvela, 1988; Clark, 1994; Thompson et al., 1992; Gentry & Csete, 1995; Watson, 1998; Stoll, 2000). This explains the fact that educational reform started with books, chalkboards, and teachers at the head of the class and ended up with the same tools. As Gärdenfors and Johansson (2005) note:

> Some years ago, there was a tendency to believe that if one could only install enough computers in the school, many educational problems would be solved. However, students as well as teachers are to an increasing extent questioning the value of information technology in education. Even if computers are frequently used for word processing, information search, email, and chatting, the worry is whether these tools really improve how students learn (p.1).

Obviously, the problem does not reside in electronic technology itself, but rather with its uneasy and traumatized entry into the classroom. Heeding this problem, Baker (1981) maintains that "a significant factor is that they [computer-based systems] are out of context…Although such systems may be perfectly rational when considered in isolation, they do not fit within the framework of the existing instructional scheme of things" (P. 23). Having been integrated within a system that was created for control and manipulation, educational technology has lost much of its transformative potential.

Explaining the Crisis

Apparently, the cut-and-paste approach underlying the introduction of electronic technology into the classroom suffers from major theoretical deficiencies. Educational technology is the product of the same forces that nurtured the computer culture and gave shape for the information age. These forces, represented mainly by corporations, universities, and the computer industry (Kearsley, 2002), have promoted the revolutionary and reformist role of computers and envisioned a new learning environment that is healthier and more efficient than the industrial educational system (De Castell, Bryson, & Jenson, 2001). However, the advocacy for educational technology has remained bounded by the antinomy of strong beliefs in the power of the new technology to substantially revolutionize education and by the absence of a matching paradigm and institution within which modern technology can operate. Unlike the industrial system, the information mode of production developed modern technology as a stand-alone tool before a corresponding knowledge paradigm or an institution have been established—a flaw that might be caused by the misinterpretation of Borges' and Bush's visions of the new technology. This paradigmatic void is the root of the crisis of educational technology, and it is responsible for the repercussions of its integration into the industrial paradigm, i.e., education.

With the absence of a matching paradigm to host the new media, electronic technology was mapped onto education, and efforts followed to "fit" it into the industrial paradigm. These efforts, however, have been impeded by the substantial disparity between the assumptions of electronic technology and those of education. On the one hand, electronic technologies seek to democratize learning, to decentralize instruction, to reorganize instructional material, to increase access to multiple information resources, to remove hierarchies in communication and interaction, to enhance students' collaboration and exploration, and to obliterate the stringent structure of the classroom (Warschauer & Healey, 1998; Poole, 1995; Olson, 1974). On the other hand, the educational system rests on such assumptions as top-down management, teacher control, textbook authority, hierarchy, competitiveness, individualism, structured classroom, linearly structured activities, discipline, lecturing, knowledge banking, uniformity, locality, and face-to-face interactivity (Welker, 1991; Jones & Maloy, 1996). Such disparity in assumptions exhibits the uncomplimentary relationship between the two and foreshadows the tense integration of the former into the latter.

A feasible scheme for introducing the information-age tool into the industrial paradigm has necessitated a reconfiguration of the role of the digital media; educational technology came to be perceived as "aids" to instruction (Olson, 1974) rather than a way to supersede the existing educational practices. The function of the new media is primarily to provide more effective means for conveying the kinds of information evolved in the last four hundred years, rather than to represent new experiences in ways that reflect the information-age culture. In effect, educational technology was re-oriented to serve the existing educational system, thus relinquishing the assumptions upon which its supposed revolution was based. Salomon (2002) refers to this as a Technological Paradox that results from:

> The consistent tendency of the education system to preserve itself and its practices by the assimilation of new technologies into existing instructional practices. Technology becomes "domesticated"…it is

> allowed to do precisely that which fits into the prevailing educational philosophy of cultural transmission and training for the world of yesterday (pp. 71-72).

Thus, instead of revolutionizing the educational system, educational technology has essentially reinforced the existing educational practices. This explains the fact that little change has occurred in education as a result of the introduction of the digital media.

But even with its new "compliant" role, educational technology has lacked a supporting theory of learning that would provide the theoretical rationale for its operation within the educational system (De Castell, Bryson, & Jenson, 2001; Salaberry, 2001). With the absence of such a theory and yet the impossibility of having educational technology operate in a theoretical vacuum, efforts have centered on pairing the digital media to existing learning theories, such as constructivism and behaviorism, which do not particularly tone with electronic technology or address information-age learning environments. Behaviorism, for example, is an artifact of the industrial thinking; it considers learning as a reactive process and individuals as "machines" that respond to conditioning (Clark & Salomon, 1986). Behaviorism represents "learning without understanding, teacher-centered lecturer with scant opportunities for curiosity and individuality, passive students, reductionistic, and conforming, that is, everything one wants to avoid in modern schools" (Gärdenfors and Johansson, 2005: pp. 4-5). In short, the behaviorist framework is unsuitable for the digital media because of their almost contradictory views to learning and learners. Unlike behaviorism, the constructivist theory shares many assumptions about learning with the digital media; nonetheless, its alliance with the electronic technology was complicated by the theory's vague conceptualization of "knowledge construction": what are students constructing, and how well, how useful, and how deep are these constructions? (Gärdenfors and Johansson, 2005). This inadequacy has further blurred the mission of electronic technology in education and brought to light the failure of the information mode of production to develop a learning theory of its own. As Gärdenfors and Johansson note, educational technology still lacks a unifying theory of learning that would serve as a foundation for its use in the classroom.

These theoretical failings on the part of the information mode of production have been aggravated by the resistance of key actors in the industrial educational system to adopt the new tools. Whereas the change staged through educational technology has been pushed by forces that are external to the educational enterprise, internal elements in the educational system are resisting this drive (De Castell, Bryson, & Jenson, 2001; Marshall and Ruohonen, 1998). For one thing, education has been part of human consciousness for so long and its values have been readily imbibed by those involved in the field. A well-known psychologist and educator, Sarason (1982, cited in Jones & Maloy, 1996) acknowledges: "Today we support this effort at educational change, tomorrow that one, or we may do both at the same time, but when we see that the more things seem to change the more they seem to remain the same, we direct blame outward because we cannot entertain the possibility that we, and those we blame, have basically the same conception of what schools are and should be" (p. 21). This conceptual incapability to change has theoretical grounds in the indoctrination of the industrial paradigm. For example, teachers' resistance to the change that computer technologies may bring into their teaching practices is a phenomenon well documented in educational research (Watson, 1998; Ridgeway and Passey, 1995; Pelgrum, 2001). Watson (1999) reports Willis (1992) asking "why do some teachers, when faced with an opportunity to begin using technology in the classroom, treat it more like a disease to be avoided than a promising aid to effective instruction" (p. 190). In fact, teachers feel uneasy about the computers' challenge to the values and roles set up for them by the industrial paradigm. Hence is the contention that "teachers tend to teach the way they are taught" (Dils, 2004). It might be said that teachers' challenge to the digital media is but an incident of the resistance of the industrial paradigm to modify its setup or functionality.

Indeed, the above theoretical tensions, as a corollary of the lack of a knowledge paradigm and institution congruent with information age, lie at the heart of the current crisis of educational technology. The malfunction of the information media within the present educational structure is the manifestation of this problem.

Conclusion and Implications

As the above overview demonstrates, the "technological revolution" in schools has been beset by theoretical inadequacies that have kept educational technology at the margins of the established educational system. As Jones and Maloy (1996) argue, "In the struggle for a computer revolution in schools, "the classroom wins for now"" (p.282). Unfortunately, technology's lack of impact on day-to-day classroom practices has been "construed as an

implementation failure, or as resulting from a temperamental shortcoming on the part of teachers or technologists" (Hodas, 1993: p.1). Efforts to resolve the crisis of educational technology have centered on overcoming these material obstacles, thus overlooking the theoretical side of the integration process. No wonder that most of the models proposed to resolve the crisis have met with little success. Gentry and Csete (1995) note that:

> Efforts to set up prototype educational systems that can demonstrate the power of restructured educational environments in concert with the best of educational technology have not been successful, despite the many schemes proposed by many authors (p.21).

Though valuable and necessary, these efforts have a narrow sight of the scope of problems surrounding educational technology.

What is needed then is a conceptual shift in emphasis from the tangible barriers of the implementation process to more theoretical issues related to the identity of educational technology, its theoretical assumptions, and its paradigmatic conflict with education. Such a shift implicates a fresh vision of educational technology as an artifact of the information age that is extraneous to the industrial paradigm. Because of their different assumptions about the knowledge-acquisition process and because paradigms—and, by extension, their essential elements— cannot coexist (Kuhn, 1962), the digital media and education may neither work together nor attain a common goal. Hence, a resolution for evading education's present crisis starts out from choosing one of two options: (1) leave education and schools *untouched*, or (2) avail the potential of the new technology after thoroughly restructuring education and schools, as remnants of the industrial age, into a new paradigm and institution. While both options are possible and viable at this point, the increased presence of technology in schools and society at large will eventually make the second option inevitable. In that case, technological theorists need to initiate a shift from "education" to a new paradigm.

A paradigm shift begins with fresh reflections on new ways of considering social institutions and structures (Paul & Ward, 1995). Since paradigmatic shifts are revolutionary by nature (Kuhn, 1962), the new paradigm should not simply extend the models hitherto proposed to modify, renovate, or enhance specific elements in the educational system— all of which share their inability to move beyond the orbit of the industrial paradigm. Rather, it should depart altogether from the concept of education as a filtering and control system and reconcile with the vocational and cultural patterns of the information age. Eventually, such a move will necessitate the "reinvention" of education and schools and the transformation of other constituents of the industrial classroom, such as textbooks, curricula, and tests. The formation of such a paradigm will expectedly resolve the current crisis of educational technology and provide a framework for its proper functionality in the information age.

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