CONSTRUCTIVIST INSTRUCTIONAL PRINCIPLES, LEARNER PSYCHOLOGY AND TECHNOLOGICAL ENABLERS OF LEARNING

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Abstract: Constructivists generally assume that the central principles and objectives of the constructivist pedagogy are realized by information and communication technology (ICT) enhanced learning. This paper critically examines the grounds for this assumption in the light of available empirical and theoretical research literature. The general methodological thrust comes from Alavi and Leidner (2001), who have called for research on the interconnections of instructional method, psychological processes and technology. Hermeneutic psychology and philosophical argumentation are applied to identify some potential or actual weaknesses in the chain of connections between constructivist pedagogical principles, psychological processes, supporting technologies and the actual application of ICT in a learning environment. One example of a weak link is personalisation technologies whose immaturity hampers the constructivists' attempts at enabling learners to create personal knowledge. Pragmatism enters the picture as a ready source of criticism, bringing out a certain one-sidedness of the constructivist view of man and learning.

1 INTRODUCTION

As technology keeps evolving, things like mobile learning and edutainment become more commonplace, challenging the old pedagogical principles and practices. Yet it is not clear how the new ICT will (if at all) change the ways we perceive the world around us, and how educators could or should use the new tools? In fact, we are still struggling to make sense of the impact of the more traditional forms of ICT, like PCs, on learning. Kuh and Vesper (1999) and Flowers *et al.* (2000) number among the very first major empirical studies on the cognitive effects on learning exerted by more traditional ICT.

Constructivist pedagogy has been here singled out for scrutiny because, in the happy phrase of Richard Fox (2001, p. 23), constructivism is "the uncritically accepted textbook account of learning". In modern constructivist learning theories, knowledge is seen essentially as a social construct. Because the learner builds on his prior knowledge and beliefs as well as on the knowledge and beliefs of others, learning needs to be scrutinized in its social, cultural and historical context (Piaget, 1982; Vygotsky, 1969; Leontjev, 1977). According to Järvinen (2001), technology enhanced learning supports "naturally" learning by manipulation, comparison and problem solving in a non-prescriptive real-world-like context that leaves room for creative thinking and innovation. Consequently, one major reason for educationalists to embrace ICT is because ICT enhanced learning seems to tally with the central principles and objectives of constructivist pedagogy.

The inspiration for this paper derives from Alavi and Leidner (2001), who have called for research on how technology, learning theory/practice and the learners' psychological processes are related and influence one another. The knowledge is drawn from the current theoretical and empirical research literature on learning and on the impact of ICT on learning. Methodologically, this is an exploratory study, building on hermeneutic psychology and philosophical argumentation.

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2 CONSTRUCTIVIST INSTRUCTIONAL PRINCIPLES AND THE IMPACT OF ICT

Recent research literature indicates that there is a fairly clear consensus on a broad set of constructivist instructional strategies (see e.g. Järvinen, 2001; Ahtee & Pehkonen, 1994; Jonassen, 1994; Johansson, 1999; Poikela, 2002). First of all, constructivist pedagogues underline the importance of *a larger goal* that organizes smaller tasks into a sensible whole, giving an incentive to take care also of the less exciting intermediate routines. Learning is not focused on separate facts but on *a problem*. The learner needs to feel that the problem in some way concerns him (i.e. to *own the problem*) in order to be motivated to try to solve it. The problem should be *close to a problem in the real world*. Unlike in traditional teaching, in constructivist learning there is no one right answer but *many possible solutions to a problem* or at least if there is one right solution, there are many alternative routes to it.

It follows from what has been said above that it is the learner and not the teacher who needs to take in a significant degree the *responsibility for gathering knowledge*. The learning environment, too, should be in some sense *similar to a real-world environment*. This usually means going out from the traditional classroom, and learning things in their authentic environment. The learner's prior knowledge, experience and skills should be taken into account because the learner will better understand and remember new things if they are *built on his prior knowledge and experience*. People are different, with different experiences, skills, interests and goals. Constructivist education seeks to take this fact into account by leaving *room for alternative individual learning strategies*.

Constructivists underline the social aspect of learning; *all forms of interaction are encouraged*, and usually assignments involve teamwork or other forms of cooperation. The final feature stressed by constructivist pedagogues is *guidance*; the teacher's role is to facilitate learning by giving pieces of advice and guiding onto the right direction. Although teachers do not slavishly follow these strategies every time, their impact on educational practices is considerable.

A cursory look at what educationalists say about ICT in education indicates that ICT-mediated learning seems exceptionally well to tally with the constructivist instructional principles. According to Sotillo (2003), "New developments in wireless networking and computing will facilitate the implementation of pedagogical practices that are congruent with a constructivist educational philosophy. Such learning practices incorporate higher-order skills like problem-solving, reasoning, and reflection". It seems that the students cooperate more, work more intensively and are more motivated than in conventional classroom teaching. ICT enhanced teaching is an efficient equalizer, levelling regional and social inequalities (Puurula 2002; Hussain *et al.*, 2003). Langseth (2002) stresses creativity and the fact that the pupils take responsibility for their own work, and, instead of using their logical and linguistic faculties, use a "broader range of intelligences according to their personal preferences" (pp. 124-125). Langseth continues: "The web offers individuality in the sense that you can choose your own pace, your own source of information, and your own method; in a group or alone" (p. 125; Hawkey, 2002; Kurzel *et al*., 2003). Furthermore, the focus is on collaborative work, not on the final product.

The above views are presumably quite representative of the enlightened popular idea of how ICT affects learning. All in all, ICT mediated learning is supposed to be more democratic, more personal, give broader skills, more creative, more interactive, and so forth. To cut a long story short one could say that both constructivist pedagogy and ICT enhanced knowledge and learning are supposed to be, by nature: cross-disciplinary, democratic, personal, collaborative, independent and practical (i.e. favour learning by doing). So, at least on the surface, it seems that ICT mediated learning and the constructivist educational doctrine is a match made in heaven.

3 CRITICISM OF CONSTRUCTIVISM

Instructional principles should be based on an adequately correct understanding of the learning process. According to Kivinen and Ristelä (2003), cognitively oriented constructivists exaggerate the role of cognitive structures in learning. Contrary to what the constructivists say, what we humans do (i.e. construct) when we learn is not primarily cognitive structures but practical ways of doing things (habits of action), which we are not necessarily conscious of or able to articulate. Consequently, the role of deliberation in learning is

not quite as central as cognitive constructivists tend to think. Constructivists also put too much emphasis on verbal knowledge (Fox, 2001). For pragmatists, in turn, words and ideas are tools like any other man-made objects, and the creation of new knowledge is the creation of new ways of verbal and nonverbal action (Kivinen & Ristelä, 2003). Likewise, as constructivists underline creativity and the active construction of personal meaning, they at the same time tend to ignore memorisation. Memorisation still serves an important function in everyday life and learning. Understanding without remembering would send us to endlessly repeating old errors (Fox, 2001).

The human innate capacities and the maturation of the nervous system are not being sufficiently taken into account by constructivists. In context we passively absorb knowledge and adopt behavioural patterns. Fox (2001) implies that constructivism is to blame for the fact that nowadays teachers are unwilling to confront "the upsetting differences in innate ability or talent" (p. 33).

The role of training (drills) as part of learning is not acknowledged nor appreciated enough by constructivists. Training has its place in life because certain routines need to be performed quickly and correctly in order to enable us to direct our attention to matters of greater consequence. Richard Fox's (2001) example of training is a musician practising a musical piece. Fox says, "to the extent that a trial *is* an exact repetition of a previous trial, nothing has been learnt. The point of practice, in this sense, is to eliminate errors" (p. 32). Another favourite example that pragmatists typically present is driving a car (Kivinen & Ristelä, 2003). The above examples nicely illuminate certain quite fundamental differences between the constructivist and the pragmatist views on learning. Consider the following example. One may practice writing one's signature, in which case an exact repetition implies that something *has* been learned. Golf training is another good example. Many golf players strive to train their swing so that it would be exactly the same every time. The difference in the trajectory of the ball is introduced by changing the club. Consequently, many cases of training have little or nothing to do with creativity but the overriding aim is to make the performance as machine-like and repeatable as possible (Collins & Kusch, 1998). The traditional method of authority, applying the techniques of learning by rote, was used especially in the Middle Ages to ensure that the learners' performance adhered to and copied faithfully what the Church Fathers had written down. Army drills is another well-known example. Presumably, a more veiled or forced point in Fox's criticism is to imply that constructivism is poor at eliminating errors. Fox is perfectly right, but compared with the method of authority neither constructivism nor pragmatism succeeds very well in the elimination of errors.

Pragmatists recommend that learners concentrate on the subject matter, not on the learning process itself:

> Practices encouraging the observation of one's own learning as an end in itself can basically be seen as a mere rejustification of testing that has traditionally ruled school activities. Instead of the pupils being taught new skills and knowledge, they are trained to monitor their own studies. A gradual improvement in the ability to work independently is quite rightly an aim for education, but it is by no means self-evident that this can be achieved or promoted by intensive concentration on the operative aspects of one's own thinking (Kivinen & Ristelä, 2003, p. 371).

Ignoring some obvious exaggerations, one could say that the most salient point of criticism in the above quotation is that too much introspection may be harmful. In defence of constructivism, one could say that it depends on what one is learning. Let us take foreign language pronunciation as an example. It stands to reason that a regular language learner should not consciously focus on the performance of the speech organs, unless there is a problem with the pronunciation. However, for a foreign language teacher trainee, who is learning to teach pronunciation, it makes sense to focus on the learning process itself (i.e. to consciously focus on how the speech organs work). Likewise, correcting speech impediments often requires conscious attention to the learning process itself. These two examples bring to light a genuine need for thinking about thinking retrospectively – as opposed to training in cases where there is no need to verbalise or make conscious the task or process itself. So, even student learners, not just university professors, may need to think about their thinking in retrospect for learning to be successful. In other words, to know what one knows is in some cases a valid learning goal by its own right.

4 SHERLOCK HOLMES MEETS FORREST GUMP

A certain kind of view of the learning process suggests a certain kind of (prototypical) learner profile. Constructivists strongly stress the element of active

construction in human thinking and perception. A central inferential process behind the constructedness of human experience is abduction, which is also the principal method used by the famous literary figure, Sherlock Holmes. Abduction conveys the manner in which people reason when making discoveries in the sense of coming up with new ideas. Hence, abduction is considered a logic of discovery. As a logic of discovery, abduction is essentially a matter of finding and following clues. The observation of a clue is always in relation to the observer's background knowledge. The clues are there for all to see, which makes knowledge by abduction democratic by nature. However, all people do not detect these clues because the clues are qualitative and unique. This sets the stage for knowledge that is essentially personal. It is personal in the sense that individuals differ in their ability to detect clues, due to individual differences in their prior knowledge and experience as well as logical acumen (Peirce, 1996; Ginzburg, 1989; Peltonen, 1999).

Table 1: Links between constructivist pedagogy, psychology and technology.

	Instructional theory: Constructivism	**Psychological processes**	**Technological enablers**	**Instructional practice: ICT enhanced learning**
Environment related factors	Problem-based, Close to real life, Many solutions	Abduction	Mobile technology, Virtual reality, Simulation	*Cross-disciplinary*
Personality related factors	Prior knowledge, Alternative learning strategies	Abduction, Induction, Deduction	*Personalisation technologies, End-user programming*	Personal, Cognitively flexible, Democratic
Action related factors	*Learning by doing or by manipulation*	Trial and error	Simulation technologies, e.g. computer games	Practical
Cognitive factors	Learner responsible for searching information	*Motivation*	Information retrieving technologies, e.g. the Internet	Independent, Democratic
Interactional factors	Interactive	Communicative and team work skills	Interactive technologies, e.g. hypertext and email	*Collaborative, Democratic*

As this very brief characterization of abductive reasoning indicates, knowledge by abduction is, by nature, personal, democratic, creative and based on prior knowledge. A Sherlock Holmes type of learner calls for laying out the learning materials as in a detective story. Pragmatists imply that more often than not deliberation is not worth the effort and one should not worry too much about the potential consequences of actions. The hero of the pragmatist learning ideology is Forrest Gump, and his slogan is: Just do it! The exhortation to go with one's gut feeling is seductive to many, but it smacks of irrationalism. Did Forrest Gump succeed because he did not reflect upon the tasks he was given or because he was dedicated, sympathetic and endowed with special innate talents? Human-computer interaction designers and researchers have noticed that some users are reluctant to read the manual, and rather resort to learning by doing (Carroll, 1990). Forrest Gump, if anyone, seems to fall into this category of users. Unfortunately, the Sherlock Holmes of this world are no better themselves in this respect, prone as they are to figure things out on their own, hypothesize and overgeneralize. Hopefully there will be room for both Forrest Gump and Sherlock Holmes in each of us, although in some cases neither of them gets it right.

5 LINK BETWEEN TECHNOLOGY AND EDUCATION

Empirical evidence for the beneficial impact of ICT on learning is scarce (Gorard *et al*., 2003). One reason for the scarcity is that we seem to lack the ability to estimate the influence of ICT, owing both to the complexity of ICT itself and disagreements among researchers concerning empirical methods or the interpretation of the findings (Jadad & Delamothe, 2004). The brief and tentative discussion below is based on the available empirical and theoretical research literature, weighing the arguments pro and con presented there. Methodologically, the discussion applies the hermeneutic psychology of Carroll and Kellogg (1989; Carroll, 1997); the idea is to interpret the psychological claims embodied in artefacts, or rather, in whole technologies. Equipped with a critical conception of the constructivist features of learning, one should be able to see clearer than before how well the constructivist pedagogy matches the most prominent features of ICT. Other important features of ICT enhanced learning of course exist – for instance time-to-performance (Wolpers, 2004), cost efficiency, time savings (Marcus, 2000; Eales, 2004; Judge, 2004) and quality (Inman & Kerwin, 1999) – but these features lack a clear connection to psychological processes. The table on the previous page lays out the interconnections between the constructivist pedagogy, psychology and technology, indicating the weakest link in each row by italics. A similar table with the pragmatist or, indeed, with the knowledge-creation movement's (Paavola et al. 2002) learning principles would look different.

It is generally assumed that both constructivism and ICT provide ample leeway for integrating many disciplines into a meaningful storyline, for instance thanks to simulation technologies. Mobile

technologies, too, expand the potential of problem-based learning environments, but to the direction of the real world, as they enable the learner to go outside of the traditional classroom. The weakest link in the first row (environmental factors) is cross-disciplinarity because therein the instructional design is difficult to arrange, owing to a compartmentalization of teaching subjects, inflexible curricula, a lack of ICT skills and a lack of teacher cooperation (cf. Spector, 2000). In other words, attempts at cross-disciplinarity are riddled with the practical problems of daily teaching arrangements rather than with any fundamental problems in technological support, pedagogical theory or learner psychology.

Personalisation does not mean just accommodating materials to fit the learners' expectations, skills and experience but it also allows students "to break away from the expert view and follow personalised goals" (Kurzel *et al.,* 2003). Personalisation is a central enabler for ICT enhanced learning, especially if and when learning breaks free from the desktop environment and becomes mobile and ubiquitous. Mobile devices are personal in the sense of being rarely shared by other people. They are also traceable, which makes it possible to link an individual with a particular device, and therefore tailor for instance services to suit the individual in question. By personalisation is also meant the malleability of the technology, allowing either the user himself to mould and adjust some of the device and interaction features or the technology to learn about user preferences, and automatically adapt to them (Lim *et al.* 2003, Smyth 2003). Unfortunately, we are still very much trapped in the old world of fixed computing platforms, accessed by users with the same (personal) device from the same IP address. Personalisation technology just is not yet mature enough to support the creation of truly personal knowledge (Dolog *et al.,* 2004; Kurzel *et al.,* 2003). The creation of personal knowledge is also hampered by barriers (e.g. copyright) to end-user computing.

There are various advanced simulation technologies that make simulated practice possible. Learning by doing has not been challenged directly by empirical research on ICT enhanced learning, although there must be differences owing to whether one is practical in the real world or in a virtual world. Owing to the conceptual vagueness of the term 'practical,' a closer scrutiny of the mental and behavioural processes at work in these environments seems to be called for.

The weakest link in the row of cognitive factors is motivation because in case the learner does not accept responsibility for seeking information, the constructivist pedagogy seems to have no ready remedy to it. How to motivate a learner to take responsibility if he or she refuses to owe the problem? Moreover, information technologies per se do not give the user information seeking skills.

In an ICT enhanced learning environment the constructivist principle of interactivity translates into technology-enabled collaboration. There seem to be no major problems in terms of supporting technologies but collaborativeness partly undermines or interferes with certain other constructivist learning objectives. Constructivist learning methods generally require more guidance and feedback (Björkqvist, 1994). On the other hand, ICT is supposed to free the teacher's time for just those activities. The dilemma here is that ICT enhanced learning seems to take more, not less, of the teacher's time than traditional teaching (Eales, 2004; Judge, 2004). There is also a danger of too efficient guidance or instruction, which means that the facilitator ends up doing the learner's work. A suggested remedy is the maximization of peer dialogue by means of interactive technologies (Mayes, 2000; Saunders, 2002). However, when the work is done independently in groups, i.e. away from under the watchful eye of the teacher, it may lead to free rider problems (Tétard & Patokorpi, 2005). Hence the problems with collaboration are mainly in the area of instructional practice, as teachers have trouble in handling collaborative learning environments (Wielenga, 2002).

It is generally claimed by constructivists that ICT enhanced learning makes learning more democratic. Interaction is more democratic between the knowledge source and the learner (Hussain *et al.,* 2003). It is also democratic in the equally narrow sense of making the learner relatively independent of others in the seeking of information, and in building on the individual's own prior knowledge and skills. However, according to Gorard *et al.* (2003), ICT cannot solve the social problems of inequality and non-participation because it does not help to give access to ICT when the reasons for non-participation stem from prior long-term economic, educational and social factors.

6 CONCLUSION

Artefacts as well as whole technologies embody social, psychological and aesthetic preconceptions,

directing and moulding the way we learn and live. The designers as well as professional users of ICT (e.g. teachers) should be aware of these preconceptions. We should also become aware of the blind spots that all learning theories have. Then, having avoided these two above-mentioned pitfalls, the teacher applying ICT in educational settings has still to accommodate it into the real-life conditions of the actual learning environment.

In order to critically examine the constructivists' sweeping claim of the perfect match of constructivist pedagogy and ICT, the paper has attempted to unearth the central grievances related to the interconnections of the constructivist instructional method, psychological processes, technology and the practical application of ICT in learning in the hope that the match could be improved in the future. The overall picture attained is sketchy and tentative as it is based on whole technological domains, an individual-psychological view of man and does not focus on any clearly defined level of education or group of learners. Nonetheless, a bird's eye view may be helpful in putting scattered empirical observations into perspective.

Some general observations seem worth underlining. Constructivists put much weight on the learners' own initiative and personal interests, which per se seems commendable, but when the learner lacks motivation the technology may be used for mindless copying (plagiarism). The technology itself can to a certain degree give guidance to the user, but the skills in using for instance the information retrieving technologies do not equal knowledge seeking skills. Constructivists shun certain cognitive processes, like memorisation, although suitable supporting technologies abound. Lastly, it seems that ICT enhanced cross-disciplinary and collaborative learning are difficult to arrange in most schools today mainly for practical reasons related to the learning environment, rather than for theoretical or technological reasons (Lehtinen 2003).

In terms of technology, the biggest hindrance to a further development of constructivistically oriented ICT enhanced learning seems to be immature personalisation technologies, whereas the biggest promise seems to be the mobile technologies. Mobile technologies may be turning us all into nomads, as has been claimed by some visionaries (Keen & Mackintosh, 2001; Carlsson & Walden, 2002). In a nomadic culture learning does not take place in the classroom but wherever one is in need of relevant information or new skills.

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