Educ Psychol Rev (2007) 19:235–238
DOI 10.1007/s10648-007-9052-5

EDITORIAL

Interactive Learning Environments: Contemporary Issues and Trends. An Introduction to the Special Issue

Alexander Renkl · Robert K. Atkinson

Published online: 1 September 2007

Many of the affordances associated with computer-based learning environments are due to their interactive nature. Such interactive learning environments do not merely present information like a book or an instructional video; instead, they permit learners to actively engage in order to learn.

Although at first glance it would seem clear what the terms "interaction" and "interactive" mean in the context of learning environments, there is, in reality, little agreement regarding these terms in the corresponding literature. There are almost as many different definitions as articles that attempt to illustrate these terms (see, e.g., Betrancourt 2005; Kennedy 2004; Kettanurak *et al.* 2001; Mayer 2001; McMillan 2002; Rafaeli 1988; Wagner 1994). Whereas some characterizations of interaction detail how such an interchange between learners and a learning environment might occur (e.g., control over pace, having influence on what will be presented and how this is done), we propose a rather general definition for the purpose of this Special Issue. Similar to Wagner (1994), we define interactions in the context of computer-based learning as a process in which the "actions" executed by learners and their learning environment are mutually dependent on each other. The mutual dependence of actions can be due to technical features of learning environments (e.g. problem-solving interfaces) or to the fact that cooperation with others is afforded by the technology. Examples of interactivity that were considered in this Special Issue are dialoguing, controlling, manipulating, searching, and navigating in learning environments with *multiple presentation modes* (Moreno and Mayer 2007); sequencing, controlling contents, and representation format in *hypermedia environments* (Scheiter and Gerjets 2007); pacing (i.e., control over the continuation) of a *video-based model*; controlling over appearance and task selection with respect to the model (Wouters, Tabbers and Paas 2007); predicting, reacting to reflection, or self-explanation prompts in *example-based environments* (Atkinson and Renkl 2007; Wouters *et al.* 2007); problem solving with *intelligent*

A. Renkl (✉)
Institute of Psychology, Educational and Developmental Psychology, University of Freiburg,
Engelbergerstraße 41, 79085 Freiburg, Germany
e-mail: renkl@psychologie.uni-freiburg.de

R. K. Atkinson
Arizona State University, Pheonix, USA

tutorial assistance (Koedinger and Aleven 2007); acting in *virtual inquiry worlds* (Nelson and Ketelhut 2007); and computer-meditated *dialogic argumentation* (Clark *et al*. 2007).

Although the forms of interactivity considered in these articles involve some overt action, all authors share the conviction that it is not the overt action per se that fosters learning but the cognitive processes that can be elicited by the interactivity. There is also agreement that interactivity can distract the learners from deeply processing the learning materials (see also the commentary of Kalyuga, this issue). For example, the possibility of learners' selecting their own information in a computer-based learning environment may lead to disorientation, a phenomenon typically referred to as *lost in hyperspace* (Scheiter and Gertjets 2007). Hence, it is important to consider which aspect of interactivity is crucial for learning. In addressing this issue, we can leverage three theoretical stances that emerge from research on learning which are especially relevant when discussing the issue of interactivity: active responding, active processing, and focused processing. The first two stances were introduced by Mayer and colleagues (e.g., Robins and Mayer 1993) whereas the latter (i.e. focused processing) is a differentiated version of the active processing stance.

The *active responding stance* considers visible, open learning activities as necessary for effective learning. The quintessential example of this stance is Skinner's (1954) operant conditioning model in which the immediate reinforcement of correct reactions or answers is seen as crucial. Today, there are "more modern" models of the active responding stance under the labels of constructivism (in a Piagetian sense) or socio-constructivism (referring to Vygotsky) which emphasize open behaviors such as manipulating learning objects, joint problem-solving activity, or actively engaging in academic discourse (e.g., Roschelle and Teasley 1995; Quintana *et al.* 2006; Stahl *et al.* 2006). With respect to the issue of interactivity, the active responding stance emphasizes that it is the "visible" exchange between the learners and their learning environment that fosters knowledge acquisition. None of the contributions to this Special Issue, however, adopts this position. Based on their research results and cited literature, all of the contributing authors acknowledge that the *cognitive processes* induced by interactivity are crucial.

The *active processing stance* is adopted by most cognitively oriented researchers focused on learning and instruction. It can also be characterized more generally as a constructivist position because it assumes that knowledge cannot be imparted on the learners but has to be actively constructed by information processing in the working memory. The contributions in this Special Issue all acknowledge that interactivity helps learning if it leads not only to overt action but to active processing of the learning contents. In some contributions, this stance—or a slight variation of it—is implicit, while others make explicit reference to it (e.g., Moreno and Mayer 2007: knowledge construction view; Wouters *et al.* 2007: cognitive interactivity).

We propose a differentiated version of active processing as a third stance in this Introduction: *focused processing*. The active processing stance does not explicitly specify that it may be crucial that the learners' active processing is related not only to the learning contents but to the central concepts and principles to be learned (e.g., mathematical theorems, physics laws). Unfocussed processing, as it may occur in hypermedia learning, for example, may cost time. If learning time is restricted, reduced learning outcomes may result (see also the commentary of Kalyuga, this issue). Other examples of active but unfocussed processing refer to the acquisition of "seductive details" (Garner *et al.* 1989) instead of central information in text learning. Mandl *et al.* (1993) found that vocational students can acquire "malprioritized concepts" in the domain of economics when working with computer-simulated jeans manufacturing. In this case, many learners were so preoccupied with the jeans not selling that they focused on keeping their stock rather

empty. Unfortunately, this strategy was counterproductive to the original goal of the task, which was learning to maximize profits.

With regard to interactivity, the focused processing stance implies that the interactive features of a learning environment should not only elicit active processing of learning contents but also focus attention on (a) central concepts and their interrelations, and (b) central principles and their application in problem solving (Wittwer and Renkl, submitted for publication). In all of the contributions to this Special Issue, the authors elaborate on instructional techniques or instructional problems that fit well within a focused processing stance, for example: *cueing* in modeling environments (Wouters *et al.* 2007), *guided* activity principle (Moreno and Mayer 2007), *principle-based* self-explanation prompts (Atkinson and Renkl 2007), appropriate *assistance giving* in the form of central information (Koedinger and Aleven 2007), *distraction* problems and *serendipity* effects in hypermedia environments (Scheiter and Gerjets 2007), *scripting* dialogic argumentation for focused exchange (Clark *et al.* 2007), and ineffectively implemented inquiry learning caused by teachers' *misconceptions* such as "hypothesis is a guess" (Nelson and Ketelhut 2007).

We hope that this introduction provides an interesting perspective for reading the following articles by highlighting several theoretical stances on interactivity. We also hope that this introduction spurs your curiosity about this Special Issue and its various contributions.

References

Atkinson, R. K., & Renkl, A. (2007). Interactive example-based learning environments: Using interactive elements to encourage effective processing of worked examples. *Educational Psychology Review*. DOI 10.1007/s10648-007-9055-2

Betrancourt, M. (2005). The animation and interactivity principles in multimedia learning. In R. E. Mayer (Ed.), *Cambridge handbook of multimedia learning* (pp. 287–296). New York: Cambridge University Press.

Clark, D., Sampson, V., Weinberger, W., & Erkens, G. (2007). Analytic frameworks for assessing dialogic argumentation in online learning environments. *Educational Psychology Review*. DOI 10.1007/s10648-007-9050-7.

Garner, R., Gillingham, M. G., & White, C. S. (1989). Effects of "seductive details" on macroprocessing and microprocessing in adults and children. *Cognition and Instruction, 6*, 41–57.

Kennedy, G. E. (2004). Promoting cognition in multimedia interactivity research. *Journal of Interactive Learning Research, 15*, 43–61.

Kettanurak, V., Ramamurthy, K., & Haseman, W. D. (2001). User attitude as a mediator of learning performance improvement in an interactive multimedia environment: An empirical investigation of the degree of interactivity and learning styles. *International Journal of Human–Computer Studies, 54*, 541–583.

Koedinger, K., & Aleven, V. (2007). Exploring the assistance dilemma in experiments with cognitive tutors. DOI 10.1007/s10.1007/s10648-007-9049-0.

Mandl, H., Gruber, H., & Renkl, A. (1993). Misconceptions and knowledge compartmentalization. In G. Strube & K. F. Wender (Eds.), *The cognitive psychology of knowledge: The German Wissenspsychologie project* (pp. 161–176). Amsterdam: Elsevier.

Mayer, R. (2001). *Multimedia learning*. New York: Cambridge University Press.

McMillan, S. J. (2002). Exploring models of interactivity from multiple research traditions: Users, documents, and systems. In L. Lievrouw & S. Livingston (Eds.), *Handbook of new media* (pp. 162–182). London: Sage.

Moreno, R., & Mayer, R. E. (2007). Interactive multimodal learning environments. *Educational Psychology Review*. DOI 10.1007/s10648-007-9047-2

Nelson, B. C., & Ketelhut, D. J. (2007). Scientific inquiry in educational multi-user virtual environments. *Educational Psychology Review*. DOI 10.1007/s10648-007-9048-1

Quintana, C., Shin, N., Norris, C., & Soloway, E. (2006). Learner-centered design. Reflections on the past and direction for the future. In R. K. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (pp. 119–134). New York, NY: Cambridge University Press.

Rafaeli, S. (1988). Interactivity: From new media to communication. In R. P. Hawkins, J. M. Wiemann, & S. Pingree (Eds.), *Sage annual review of communication research: Advancing communication science: Merging mass and interpersonal processes* (Vol. 16, pp. 110–134). Beverly Hills, CA: Sage.

Robins, S., & Mayer, R. E. (1993). Schema formation in analogical reasoning. *Journal of Educational Psychology, 85*, 529–538.

Roschelle, J., & Teasley, S. D. (1995). Construction of shared knowledge in collaborative problem solving. In C. O'Malley (Ed.), *Computer-supported collaborative learning*. New York, NY: Springer.

Scheiter, K., & Gerjets, P. (2007). Learner control in hypermedia environments. DOI 10.1007/s10648-007-9046-3

Skinner, B. F. (1954). The science of learning and the art of teaching. *Harvard Educational Review, 24*, 86–97.

Stahl, G., Koshmann, T., & Suthers, D. D. (2006). Computer-supported collaborative learning. In R. K. Sawyer (Ed.), *Cambridge handbook of the learning sciences* (pp. 409–425). New York, NY: Cambridge University Press.

Wagner, E. D. (1994). In support of a functional definition of interaction. *The American Journal of Distance Education, 8*, 6–29.

Wouters, P., Tabbers, H., & Paas, F. (2007). Interactivity in video-based models. DOI 10.1007/s10648-007-9045-4