**Identify Candidate Questions/Challenges for**

**Learning Sciences Research in the 2020 Time Frame**

We provide an overview of the challenges and opportunities in learning sciences research. In this section, we limit our discussion to the theoretical, conceptual, methodological, analytical, and logical issues concerning the existing research on learning with technology-rich learning environments. Technology-rich learning environments refer to any type of learning environment where technology is used as a means to assist learners in achieving instructional goals (Lajoie & Azevedo, 2006). Future research in this area needs to adress the following issues: (a) formulate overarching theoretical frameworks, (b) regard mental processes as events rather than aptitudes, (c) use mixed methods combined with concurrent measures to gather process and product data in regards to the trajectory toward competence in using such processes, (d) specify statistical analyses capable of generating inferences regarding the deployment of these processes and how they influence learning, (e) outline the rationale for deriving theoretically- and empirically-based design guidelines.

Existing theories in the learning sciences specify different types of knowledge and processes (Schraw, 2006) in order to better understand the complex nature of learning across domains. We recommend formulating unified theories to formulate testable hypotheses and predictions that generalize across domains (see Azevedo, 2009).

In order to derive process-oriented models that can guide the design of technology-rich learning environments, researchers should conceptualize theoretical constructs as events rather than aptitudes. Once we conceive of mental processes as events rather than aptitudes, we can capture, trace, and analyze them as they occur through time (Azevedo, 2009).

Mapping the trajectory towards competence in learning through performing authentic tasks enables researchers to design scaffolding mechanisms that integrate assessment and instruction along this trajectory (Lajoie, 2009). In order to capture the mental processes that mediate the transition from novice to expert, empirical research should follow mixed methods combined with concurrent measures to gather both process and product data (Azevedo, 2009).

There is a pressing need to use statistical analyses capable of generating inferences based on (1) converging and aligning large amounts of process data and then (2) triangulating the process with the product data (Azevedo, 2009).

Finally, researchers should outline the rationale for the design of scaffolding mechanisms by explaining (a) the process-oriented model that guides the design, and (b) the reasoning behind the design (Poitras, Lajoie, & Hong, submitted). This enables researchers to formulate different and complementary approaches to the design of scaffolding mechanisms embedded in technology-rich learning environments.

References

Azevedo, R. (2009). Theoretical, conceptual, methodological, and instructional issues in research on metacognition and self-regulated learning: A discussion. *Metacognition & Learning*, *4*(1), 87-95.

Lajoie, S. P. (2009). Developing professional expertise with a cognitive apprenticeship model: Examples from avionics and medicine. In K. A. Ericsson (Ed.), *Development of professional expertise: Toward measurement of expert performance and design of optimal learning environments* (pp. 61-83). Cambridge, UK: Cambridge University Press.

Lajoie, S. P., & Azevedo, R. (2006). Teaching and learning in technology-rich learning environments. In P. Alexander & P. Winne (Eds.), *Handbook of educational psychology* (2nd ed.) (pp. 803-821). Mahwah, NJ: Laurence Erlbaum Associates.

Poitras, E., Lajoie, S.P., & Hong, Y. (submitted). The Design of Technology-Rich Learning Environments as Metacognitive Tools in History Education. *Instructional Science*

Schraw, G. (2006). Knowledge: Structures and processes. In P. Alexander & P. Winne (Eds.), *Handbook of educational psychology* (pp. 245-263). Mahwah, NJ: Erlbaum.