Script And/Or Schema Acquisition Through External Representations

► Supplantation Effect on Learning

Script(s)

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Scripts are a subtype of schema that is used for representing procedural knowledge. More specifically, a script is a predetermined, stereotyped sequence of actions that define a well-known situation. As do schemas, scripts also contain slots and default values that can be filled. The resulting structure is an interconnected whole, and what is in one slot affects what can be in another.

The classic example of a script involves the typical sequence of events that occur when a person dines in a restaurant: *finding a seat, reading the menu, ordering drinks from the staff . . ..*

Scripts were developed in the early AI work by Roger Schank and Robert P. Abelson and their research group. These authors basically assume that procedural knowledge from everyday situations is stored in the human mind in the form of *scripts*. They are very similar to frames, except that the values that fill the slots of a script must be strictly ordered. Understanding a familiar situation involves activating a stored script of this situation.

Cross-References

► Knowledge Representation
► Scaffolding for Learning
► Schema(s)
► Schema-Based Problem Solving

References

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Scripted Cooperation

► Collaboration Scripts

Seamless Learning

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Synonyms

Blended learning; Flexible learning; Ubiquitous learning

Definition

► Seamless learning bridges private and public learning spaces where learning happens through both individual and collective efforts, and across time and different contexts (such as in-school vs after-school, formal vs ► informal learning, physical world vs. virtual reality or cyberspace). Traditionally, ► formal learning is defined as learning that happens at a fixed time following predefined curricula or plan. Informal learning, on the other hand, means a mode of learning driven by self-interest outside of school environment, and is emergent in nature.

Theoretical Background

Seamless learning is marked by the continuity of learning experiences across different scenarios or contexts. The challenge is to enable learners to learn whatever they are curious about and to seamlessly switch between different contexts, such as between formal and informal contexts, between individual and social learning, and by extending the social spaces in which learners interact with each other. Technology plays an important role in mediating the switching between these different spaces.

Our students live in a digital world, and the use of technologies such as instant messaging, video sharing, photo sharing, social network tools, podcasting, and blogging are integrated into their lifestyles. Smartphones are used not only for making calls, but

for taking pictures and uploading them to shared spaces, creating mobile blogs, or accessing the web on the move. The use of these technologies facilitates communication, collaboration, sharing, and learning in informal settings with their peers, friends and family, unbounded by time and location. Students spend more time in such "informal" settings than "formal" settings in the school. One of the fundamental challenges for the twenty-first century learners is that there is a need to understand not only what they learn, but how and when they learn. A deep understanding of how learners learn informally can be used to inform the facilitation of formal and informal learning practices.

A seamless learning environment bridges private and public learning spaces where learning happens through both individual and collective efforts and across different contexts (such as in-school vs after-school, formal vs informal, physical world vs. virtual reality or cyberspace). When thinking about learning scenarios in schools and other places of learning, people often conjure up mental images of a classroom with all seats facing the teacher. The presumption is that learning happens at fixed times and fixed places. However, with the diffusion of technology, the notions of place, time, and space for learning have changed. The learning space is no longer defined by the "class" but by "learning" unconstrained by scheduled class hours or specific locations. With mobile technologies at hand, students can learn seamlessly – both in classroom and out of classroom, both in school time and after school time. While learning can be facilitated or scaffolded by teachers or peers, at other times it could be student-initiated, impromptu, and emergent.

Personal, portable, wirelessly networked technologies will become ubiquitous in the lives of learners. With quick and ready access to these technologies, we enter into new phase in the evolution of technology-enhanced learning (TEL), characterized by "seamless learning spaces" and marked by the continuity of learning experiences across different scenarios or contexts, and emerging from the availability of one device or more per student ("one-to-one") (Chan et al. 2006). These developments, supported by theories of social learning, situated learning, and knowledge construction, will influence the nature, process, and outcomes of learning. One-to-one TEL will push the frontier of technology use in formal and informal learning. The ingenious, emergent, or pervasive use of one-to-one devices in some usage contexts may be close to the tipping point in terms of effecting fundamental shifts in the ways students learn in schools and outside of schools. Previous ► mobile learning research, however, has typically focused on either formal or informal settings and failed to examine the integrated and synergetic effects of linking these two contexts or environments of learning (Sharples 2006).

Mobile technology has the potential to mediate seamless learning, challenge the traditional dichotomous distinction between formal learning and informal learning by creating seamlessly connected learning experiences (Looi et al. 2010). While research on cognition and learning during the past decades has emphasized the importance of linking learning in the classroom and learning in the field, the dominant characteristic of school learning still has a strong focus on individual cognition, pure mental activity without tool use, and overly context-general learning. Moreover, there are tensions between formal learning, which is based on fixed curricula enacted in classroom environments, and informal learning where learners are participating in intentional or unintentional experiences outside school settings. We believe that the two forms of learning should not be seen as dichotomous and conflicting situations (Sharples 2006). Instead, by utilizing the affordances of mobile technology, we can bridge the gap between formal and informal learning, and encourage students to learn in naturalistic settings for developing context-specific competencies.

A suitable lens for interpreting seamless learning activities is the distributed cognition (Hollan et al. 2001). In a seamless learning environment, learning takes place through individual learning in private spaces, collaborative learning in public spaces, and interactions with the environment and artifacts across time, context and physical or virtual spaces mediated by technology (Sharples 2006; Chan et al. 2006). Distributed cognition can provide a framework for understanding how learning occurs through the interactions of students, artifacts, and the environment mediated by technology over space and time. Though early studies aim to understand how teams comprising individuals with different skills or assigned roles function together to achieve a specific task, the notion of distributed cognition is applicable to learning as students' expertise

and interactions are also distributed in the classroom (Pea 1993). Hollan et al. (2001) proposed three principles in which cognitive processes occur: They are distributed: (1) across the members of the social group; (2) over time; and (3) coordination between material or environmental structures in the system. Learners interact with the environment in the community, artifacts, activity, and space through the cognitive tools to form a joint learning system (Kim and Reeves 2007). Our seamless learning framework is based on our identification of components in a seamless learning environment and the theory of distributed cognition, namely, space, time, context, community, and tools.

Space: Seamless learning suggests that the learners can move seamlessly between different spaces – physically and virtually. The physical space where students use to conduct inquiry with the mobile device can be used as a resource for learning (Squire and Klopfer 2007).

Time: Over time, when learners operate on artifacts, collaborate with peers, teachers and experts or make discovery, they acquire and construct knowledge. Time can play an important role in shaping and evolving inquiry, and developing deeper understanding as they interact in a seamless learning environment.

Context: The context of the designed or emergent activities in which the learner is engaged and the environment in which these activities occur impacts their learning, application, and plans.

Community: The community in a seamless learning environment comprises learners, teachers, and domain experts. Individual learners in a seamless learning environment can move from individual learning to community learning and from private cognition to public cognition and vice versa.

Tools: As students use the mobile device to record data, capture images, upload data to the online portal and reference them, mobile devices and online portal become cognitive tools where they are able to offload tasks, recall information over time, and modify their initial thoughts.

Important Scientific Research and Open Questions

A large research gap exists in the area of bridging formal and informal settings in order to construct a seamless learning environment. There is also a lack of longitudinal studies to explore the affordances of such learning environments in promoting twenty-first century knowledge, skills, and positive attitudes toward learning. Regarding the use of methodological issues for seamless learning research, the design experiment methodology is typically used to design and implement seamless learning research. The choice of design experiment is ideal as this method stresses upon systemic thinking on the interdependence of design elements, and the importance of examining emerging issues through progressive refining processes (Collins et al. 2004). More importantly, in order to design sustainable twenty-first century learning environments, as researchers, we need to make a commitment to conduct sustainable research, and this necessitates the use of theoretical and methodological lens that are congruent with the goals of this research.

An important consideration in seamless learning research with mobile devices is to understand the enactment of learning activities, which unfold in various situations. Previous research that examined the use of mobile devices in informal settings has shown both promises and challenges (e.g., Sharples 2006; Squire and Klopfer 2007). Mobile technologies with portability, connectivity, and versatility enable learning to be ubiquitous in and out of classrooms, provide potential opportunities for collaborative learning, and enrich learning experiences with the support of technologies. For instance, Price and Rogers (2004) suggest that mobile devices can be used to help students explore digitally augmented physical environments where contextually relevant information and resources are provided. In such digitally enhanced settings, students using mobile devices can explore, capture, and manipulate both physical and virtual (or digital) objects for active understanding. From design and research perspectives, however, studying mobile learning in informal settings is challenging because students are "on the move" across different modes of space (both physical and virtual) and time. Thus, an ethnographic approach (Anderson-Levitt 2006) can be integrated into design research for observing how students are engaged in informal and formal learning settings in their interaction with their handheld devices, peers, teachers, and other people in their learning community.

Studies that focus on examining short-lived learning experiences such as user satisfaction surveys and

strict comparisons of test measures, fail to provide comprehensive perspectives on learners' meaningful experiences across settings over time. Indeed, mobile learning researchers face methodological challenges in terms of the scales of space and time (Lemke 2000): how to record learning across different physical spaces and different technological media, and how to examine learning in the longer timescale including informal learning outside school contexts. However, because of the novelty of the proposed study, there is no "off-the-shelf" methodology for us to adopt. For data collection, the learning trajectory of students using mobile technologies for learning across subjects and over time needs to be recorded.

Possible data sources include but are not limited to observations, field notes, audio and video recordings, interviews, student artifacts, self-documentation by participants, and log files on computers. There are also methodological issues involved in observations such as distorted behaviors and artificial tasks (Gardner 2000), and also ethics and privacy issues for observing students outside school settings. Researchers should aim to minimize potential problems by employing unobtrusive methods such as log files, which provide an authentic, time-efficient means of recording student learning behaviours. In situ sampling of the students' daily experiences with mobile devices can be captured using the experience sampling method (ESM) (Csikszentmihalyi and Larson 1987). This method may provide us with a better understanding and natural assessment of how students are engaged in informal learning everyday with mobile devices as they are using it.

By employing ethnographic methods, in situ self-report procedures, constant comparisons, and sustained observations as well as analyzing quantifiable measures, we can critically examine how learners use mobile technology across subject areas and how different user experiences and motivation levels affect learning over time.

Important assessment issues loom in the space of seamless learning. With students' use of devices for informal learning, what are the indicators of learning? Or what accounts for learning at the first place. One well-cited definition of learning is "changing through experience . . . acquiring relatively permanent change in understanding, attitude, knowledge, information, ability, and skill through experience" (Wittrock 1977, p. ix). To us, the more important change might be in student value and character change, which can gauge students as lifelong learners and persons-to-be. Therefore, challenges exist in assessing the skills, knowledge, identity, values, and epistemology (Shaffer 2007) as students become adept in using the mobile device as routine practice in the classroom and out of the classroom.

One approach for assessment in seamless learning environment is to adopt a preparation for future learning (PFL) framework (Bransford and Schwartz 1999) to emphasize assessment for learning. The purpose of PFL is to promote deep understanding and knowledge transfer in multiple contexts, and mobile devices can act as a mediating tool enabling such learning transfer. Traditional approaches of assessment focus on measuring student abilities to directly apply their previous knowledge to new problems without help or resources. This type of direct application, however, fails to measure the zone of proximal development (Vygotsky 1978), that is, students' potential abilities to learn in knowledge- and resource-rich environments. In seamless learning research, researchers can explore different sequencing of learning conditions such as (a) formal vs. informal learning, (b) intentional vs. unintentional learning, and (c) abstract context-general vs. and concrete context-specific settings in order to identify enabling conditions that better prepare students for future learning.

The motivation for promoting informal learning probably first started from the training work place skills because it involves obvious costs. Another term we have not mentioned is "nonformal" learning, which refers to learning that happens in formal learning settings but is not tested or assessed in traditional ways. So, formal, informal, and ► nonformal learning are all learning. As we have argued, learning can happen at any situation and context. However, how to capture learning that is not planned, not fixed and probably without validated instruments to measure, and usually individualized poses great challenges to learning science researchers. We need also to collect multiple data sets over time for triangulation purposes. When considering the linkage between formal and informal learning, we might be able to infer the effectiveness of informal learning through assessing the conceptual equivalents specified in formal curricula. On the other hand, performances in informal settings can be a result of formal learning in terms of preparing the students for future learning.

Studying school-based learning and following through with after-school learning will enable the exploration of a theory of mobile learning for seamless learning tied strongly to empirical evidence. For instance, the PFL perspective can be adopted to frame the use of mobile devices in informal settings as enabling students to familiarize with a problem and its context before in-school learning of formal concepts. Our findings will be used for further understanding of the application of the PFL framework, as well as providing evidence of the efficacy of different sequencing of formal and informal learning activities.

Research into seamless learning needs a strong focus on pedagogy, professional development of teachers, co-design of lessons with teachers, a design research perspective, and low-cost affordable mobile learning devices. International collaboration and innovation can contribute toward the broader research agenda. By organizing and sharing information across design experiments in diverse settings, a collaboration of researchers can more rapidly and systematically explore the design space (Hawkins 1997). For instance, the same-grade classrooms across different countries can implement mobile learning devices for all subject areas, allowing a broad examination of solutions and challenges. By collaborating across the globe, researchers could take advantage of different student device preferences, exchange curriculum ideas, understand cultural differences, and better address issues of scale.

Cross-References

- ► Blended Learning
- ► Formal Learning
- ► Informal Learning
- ► Lifelong Learning
- ► Mobile Learning

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Second Language Acquisition

- ► Second Language Learning