Great discoveries and improvements invariably involve the cooperation of many minds.  
– Alexander Graham Bell

Technological innovations in the area of digital media have opened up the possibility for a great number of inventive ways to share and transfer knowledge in online science learning environments. Knowledge transfer may involve interaction between a learner and learning resources such as learning objects or, conversely, knowledge transfer and sharing may be social, that is to say between individuals and/or groups. The types of knowledge transfer that can now be hybridized in educational settings are delineated by Puntschart (2005) as follows: (1) technology-enhanced versus face-to-face, (2) asynchronous versus synchronous, (3) voluntary versus obligatory, (4) self-directed versus externally controlled, (5) learning object transfer versus person-to-person, and (6) open versus closed communities. Such a wide variety of interaction options gives way to a variety of communication and collaboration approaches in online science education. Many of these options prospectively support more individualized learning. For example, learning scenarios are now possible where a science student conducts online remote experiments sponsored by another institution in the dead of night in the absence of an instructor. Moreover, a student may opt out of attending
an onsite class session in favor of a streaming video lecture where they still contribute to the discussion through a mobile learning, or m-learning, device. Alternatively, a student may pursue learning at his or her own pace and learning style by reviewing relevant digital library learning objects on a science subject.

Of course, innovative technology for knowledge transfer has its benefits, requirements, and compromises. On one hand, technology-enhanced science learning environments offer students and teachers exciting opportunities to join together and collaborate with learning communities beyond the classroom as well as utilize m-learning options and devices to accept knowledge transfer anytime or anywhere (considered in depth in Chapter VIII). For instance, Web seminars sponsored by the National Science Teachers Association through the association’s learning center resources (see http://learningcenter.nsta.org/) facilitate K-12 instructor ties to online communities of practice who share an interest in furthering humanity’s knowledge in general or particular science areas, such as the organizations NSF, NOAA, NASA, and FDA. Then again, the removal of time and place constraints required of a face-to-face classroom by online technologies places a greater demand on a student’s self-direction skills such as setting goals, time management, motivation, online interpersonal competence, and assessing their own learning progress.

### Collaborative vs. Cooperative Online Learning

Learning configurations enabling students/groups to learn online and capitalize on the chief online social interactions fall into two major categories, cooperative or collaborative (Haythornthwaite, 2006; Williams, Duray, & Reddy, 2006). Cooperative (or coordinated) learning advances through instructor-delegated assignments with individual efforts assembled into a whole (e.g., readings and discussion questions). In contrast, collaborative learning evolves as groups of students address problems/issues regarding the course subject matter. In collaborative learning students are a source of authority and knowledge on assignments, and direct a significant amount of the learning. Adhering to these categorical distinctions, a cooperative learning paradigm online is less team-centered and more instructor-driven. Conversely, achieving veritable collaborative learning is a more complex process accentuating the development of team roles and processes with respect to learning objectives. Bermejo (2005) characterizes the components of online collaboration as: (1) positive interdependence, where respective student roles are defined within the team, (2) promotive interaction, where mutual help, feedback, and information exchange occurs between students, (3) individual accountability, and (4) group processing, where an instructor monitors and provides in-progress feedback to individuals and groups, and the whole-class reviews all team-learning. Therefore, collaborative learning requires that the learner be responsible for both their learning and the learning of others (Pimental, Gerosa, Fuks, & de Lucena, 2005). Both types of social interaction, cooperative or collaborative, can be readily facilitated in online science learning through current learning management systems (LMS) that offer basic discussion forums and communication tools, however they can be enhanced further by other technological tools such as Web-conferencing and virtual classrooms.