

▶ **Learning Science Online:**

*A Descriptive Study of Online Science
Courses for Teachers*

Executive Summary

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Executive Summary

Online education is a rapidly growing phenomenon for science teachers that is not only well suited to many teachers' lifestyles, but also offers interesting new opportunities for teaching and learning science. The role of online learning environments as a tool for science teacher professional development has expanded at such a rate that the dearth of even the most descriptive knowledge about these online environments is startling. To begin addressing the gaps in research, the Learning Science Online (LSO) project, funded by the National Science Foundation, undertook a study of 40 graduate-level online science courses for K-12 teachers, asking:

- Who are the students in online science courses for teachers?
- Who are the instructors in online science courses for teachers?
- What does science teaching and learning look like in these courses?

The emphasis in this study is a description of patterns across all courses, rather than the evaluation of individual courses.

Research Methodology

LSO is a mixed-method longitudinal study of 40 science courses for K-12 teachers offered during the 2004-2005 academic year focusing on science content, offered for at least one graduate credit, and with the majority of interactions online. LSO collected data from program coordinators at institutions offering courses, course instructors, and students. All program coordinators, 85 percent of the courses, and 40 percent of students provided complete information and were included in these analyses. Courses targeting high school science teachers and students who performed well in the courses are over-represented in this study—two limitations central to interpreting the findings.

Pre- and post-course questionnaires from instructors and students are the primary data sources reported here, with program coordinator interviews and instructor reports of student performance woven throughout. The data collected include perceptions from students, instructors, and program coordinators about many dimensions of the courses including course design, course climate, use of instructional materials, quality of science content in the course materials, nature of communication, grading practices, as well as student performance within the course. Together, these data paint a rich portrait of the educational experience.

Who are the students in online science courses for teachers?

The rapid growth of online learning for teachers raises the question of whether or not there is equity and broad participation in this new phenomenon. *Do students in online science courses for teachers reflect the broader teaching population, or are these courses reaching an audience of teachers different from the audience reached by other forms of professional development?*

Compared to the general K-12 teaching population, the answer would be these courses are reaching a different audience than that reached by other forms of professional development—students in online science courses for teachers include more females, fewer minorities, more early career teachers, and more teachers from small towns and rural communities. They are similar to the general teaching population in their distribution across public versus private schools—the overwhelming majority (90 percent) teach in public schools.

When considering most of these courses targeted high-school teachers, however, the demographics of students in these online courses appear to reflect the broader high-school science teaching population. The percentage of minorities in these online courses (10 percent) is comparable to the percentage of minorities in the high-

school science teaching force (10-15 percent, depending on the field) (CCSSO, 2005). The high percentage of females in these courses (67 percent) becomes more of an anomaly considering the even smaller percentage of females among high school science teachers (30-50 percent, depending on the field) (ibid). This could be the “anytime, anyplace” nature of online learning suits female teacher’s needs for flexibility created by the “third shift” phenomenon (Kramarae 2001), where women are fitting their education in among their regular work and home duties.

Who are the instructors in online science courses for teachers?

Online courses also offer fresh opportunities for faculty that may lead to a new breed of instructor that diverges from traditional science or science education faculty. The same matters of convenience and proximity that are argued as an advantage for students apply for instructors as well, and online courses may attract instructors who would not ordinarily consider teaching in a traditional face-to-face setting. *Do instructors in online science courses for teachers represent the typical science professor, or are these courses tapping a different group of potential instructors?*

The answer to this question depends on whether instructors are situated in a university or non-profit program. In university programs, instructors of online science courses for teachers resemble the broader science professoriate—predominantly male, mid-fifties, a Ph.D. in science, little K-12 teaching experience. There is one notable difference between the online instructors in university programs and typical university science professors—no instructor of an online course was actively pursuing tenure. They were either graduate students, adjunct faculty, already tenured, or retired. In nonprofit programs, instructors of online science courses for teachers did not resemble the broader science professoriate in other ways as well—they were predominantly female, were less likely to have earned a Ph.D. in science, and had considerable K-12 teaching experience.

What does science teaching and learning look like in these courses?

Online learning can take many forms. Online learning may be used to replicate a traditional face-to-face classroom, or it may be used to deploy unique opportunities presented by

the new environment. *What types of instructional methods are used in online science courses for teachers, and how do they compare to the types of practices called for by research and national standards?*

Online courses for science teachers made frequent use of online discussions (55 percent of instructors expected students to participate in them three times a week or more). Instructors reported frequent student participation in minds-on activities during these discussions, such as articulation and reflection of their scientific ideas and the ideas of others. Instructors reported relatively infrequent interaction with real-world phenomena or scientists. Interestingly, the use of other online technologies such as simulations, visualizations, and interactives are relatively absent from these courses. The promise of re-usable learning objects does not seem to have become a reality in this setting, and also notably missing are frequent hands-on activities. In many face-to-face science teacher professional development courses, hands-on investigation is rampant. It appears to have been replaced by more minds-on work and discussion in these online courses. The use of other science education methods such as pen and paper problems, use of authentic contexts, and review of scientific literature varied among the courses.

The communication in online science courses for teachers is dominated by the use of asynchronous discussion boards. While instructors chose most of the topics for discussion, students also reported that most students participated. This begins to portray a vision of a community of learners having possibly found their legitimate roles of participation (Lave, 1988). The instructor still plays an important role for these students—they see the frequent feedback from their instructor as more useful than feedback from their peers.

Students in these online courses perceived high levels of support from their instructor, students, and the course design. Students reported their instructor was accessible and made them feel like a valued contributor to the learning experience. Students rated their support from their fellow students slightly lower than that from their instructor, but still felt valued and supported by their peers. They reported that interactions with their instructor helped them understand the material better, and so did interactions with other students, but again to a slightly lesser extent. The organization of the course materials and

chosen level of instruction were also perceived to be supportive to students, though students were less likely to agree that the materials would suit many different learning styles.

Together these findings suggest that online science courses for teachers have reached a level of maturity where designers and instructors are crafting supportive course climates. The dynamics of communication and instructional methods found in these courses is encouraging and suggests that these environments would be ripe for research on the extent of knowledge construction measurable in these highly social learning communities.

Conclusions and Implications

Online education for science teachers may be opening some doors to participation, but is at risk of closing others. This format may further marginalize some of those who already are intimidated by a science learning setting, or it could open doors to more risk-taking by providing visible anonymity as well as the chance for students to respond when they are ready.

Rural science teachers appear to be taking advantage of online professional development at a higher rate than their suburban and urban counterparts, which is likely because they lack easy access to similar professional development courses locally. Similarly, female high-school science teachers are participating at higher rates than their male counterparts, perhaps because online learning fits better into the ‘third shift’ many women experience (Kramarae, 2001) in ways face-to-face professional development experience cannot.

It appears that online education may be allowing a broader range of potential instructors to participate in the education of science teachers than is found in the science professoriate. While university based courses are taught by instructors who resemble the science professoriate (except they are not actively pursuing tenure), courses based in nonprofit institutions do not—they are less likely to have earned a Ph.D. in a science field, they have more K-12 teaching experience, and they have fewer years of postsecondary teaching experience. A higher percentage of instructors at non-profit institutions than universities are women (60 percent vs. 28 percent). Most instructors had experience in online instruction, often having taught

the course of interest several times. No program advertised positions for online instructors—all instructors were recruited within their networks of known colleagues.

Students participating in the LSO study reported feeling a high sense of support in their courses and communicating frequently with their instructor and other students—debunking myths of isolation and alienation in online education. Discussion is central with frequent exchange of scientific ideas and questions. Instructors reported frequent student participation in minds-on activities, such as articulation and reflection of their scientific ideas and the ideas of others. Content analysis of discussion transcripts from these types of online science courses would indicate whether or not the discussion shows meaningful displays of students’ construction of scientific knowledge.

The LSO findings paint a landscape of online science learning for teachers that is encouraging for the sake of science education and a fascinating horbed for further research. The supports provided by the course design, instructor presence, and peer interactions are all rated very positively by students in LSO courses. This, along with the focus on discussion, leads to many questions about the nature of the communities within these courses. One might seek to measure if they indeed represent substantive communities of scientific inquiry as these preliminary results suggest and if so, how those communities are built and supported by course design, instructors, and through other students.

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