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Project-based science instruction for general-education undergraduates and seventh graders: Practices, proficiency, and pitfalls

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For three semesters we conducted a general-education course designed for both undergraduates and seventh-graders in which students investigated contaminant sources and water quality of a local stream. The middle school students attend a local, county school that draws its students from disadvantaged areas of the town of Richmond, Kentucky. Undergraduates were general-education honors students with little predilection toward science. The instructors guided undergraduates through the project, and our honors students then mentored the middle-schoolers in their scientific endeavors.

Both sets of students serially investigated the chemical and biological properties of a typical upland stream (Tates Creek, Madison County, Kentucky) impacted by anthropogenic activities as dictated by land use. Students measured water properties such as temperature, conductivity, pH, and oxygen content then sampled stream waters to quantify dissolved nutrient concentration, fecal microbes (*Escherichia coli*), and stream macroinvertebrates. Nutrients (ammonium, NH_4^+ ; nitrate, NO_3^- ; phosphate, PO_4^{3-}) were measured by colorimetry and *E. coli* were counted using rapid-assay, IDEXX methods. Students also assessed water quality by classifying and counting macroinvertebrates, and using an established water quality index. Students then summarized their findings with group presentations. Middle-schoolers researched aspects of anthropogenic contamination and stream ecology to present their work as poster projects at an event on the campus of Eastern Kentucky University. Undergraduates gave group presentations in class following the format of an oral presentation at a scientific conference.

Courses with embedded projects are challenging from logistical, fiscal, and pedagogical standpoints. Assessment of overall course effectiveness continues, but several aspects emerge. The course seemed most effective for middle-schoolers where teachers saw students actively engage in all aspects of the project, even those students who are generally disinterested in science. Results from undergraduates were mixed. Honors students enjoyed mentoring the seventh graders, but did not fully grasp the impact and nuances of project findings.