

Five Delivery Models for Elementary Science Instruction

In thinking about the models for the delivery of science instruction, there are a multitude of alternatives. At one end of the spectrum, each elementary teacher is responsible for science instruction; at the other end, only science specialists are adequately prepared to handle such a task. The relative merits of these two positions have been argued in the literature for nearly 20 years (Abell, 1990; Hounshell & Swartz, 1987; Neuman, 1981; Olson, 1992; Williams, 1990). Between these two extremes, other delivery models exist. In this article I will describe five delivery models for elementary science instruction. This delineation of models is not intended to be exhaustive, but illustrative of the options that exist. Each model will be described in terms of the assumed characteristics of classroom practice, teacher preparation, and potential advantages and disadvantages. Following the example set by Abell (1990), similar delivery models in other content areas will be identified.

Classroom generalists

Elementary teacher preparation typically follows a generalist model, with each teacher taking content and methods courses in each of the areas typically included in the elementary curriculum: reading, writing, mathematics, science, social studies, health, physical education, and the fine arts. As a result, it is assumed that the teacher has sufficient knowledge and preparation to design and deliver a curriculum that adequately covers each content in a self-contained classroom. Once employed, each teacher has the flexibility to organize and allocate class time to the various content objectives as they see fit.

Model advantages include a deep understanding of student interests and development, curricular flexibility in terms of planning for thematic, interdisciplinary or integrated instruction, and no need for additional personnel. Disadvantages include limited content knowledge, limited science-specific pedagogical and curricular knowledge, and dispersed material resources. The most devastating disadvantage of this model may be the lack of time dedicated to science instruction resulting from multiple teaching responsibilities, pervasive accountability measures for reading and mathematics (but not science), and low levels of interest or self-confidence in science teaching.

Classroom science specialists

Most classroom teachers find that they have a preference for one or more of the content areas that they teach. Allowing teachers to identify a specialty area--either through a content major or minor, additional course work or workshops, or other forms of formally or informally recognized advanced preparation--would create classroom-based content resources within schools. For instance, a classroom science specialist would still be responsible for a self-contained classroom, but would take leadership or offer assistance to other teachers in the area of science instruction. The science specialist could be given the primary responsibility for previewing and selecting

science curricular materials and ordering and maintaining science equipment, thus creating a division of labor for the benefit of all. This model is similar to the one proposed by the National Commission on Teaching and America's Future (1996) and would flatten school-based hierarchies and result in the maximum number of specialists in contact with students.

Advantages for the students of the classroom science specialists include increased teacher content and curricular knowledge, and time dedicated to science instruction. While other teachers have access, close proximity, and the support of a science specialist, unless there is an infrastructure of support within the school, few benefits may extend beyond the boundaries of the specialist's classroom. For instance, unless there is time planned into the school day for teachers to collaborate, the presence of the specialist will be underutilized. In addition, unless differential hiring patterns for specialists are introduced, there would be limited incentive for a teacher to become a science specialist. Most elementary teachers, if required to select a speciality area, would gravitate toward the language arts (Tilgner, 1990). Only if a per-school number of science specialists were required would the market demands encourage teachers to focus in this area.

Science support teams

With the addition of personnel, increased support in the area of science instruction can be achieved. A science specialist, a scientist, or a paraprofessional with science expertise could be assigned to a self-contained classroom for some part of the school day to promote science instruction. Three levels of support could be provided. In the first, the science specialist would take primary responsibility for science instruction with only minimal assistance from the classroom teacher. For instance, the classroom teacher would help select science content or activities that the specialist would then plan and implement. The teacher would assist with classroom and material management. A second scenario would include the teacher and specialist co-planning and implementing the lesson. In the third, the teacher would co-plan the lesson with the specialist and would then take the lead role in lesson implementation. The specialist would help locate curricular resources, collect and manage science materials, and assist in lesson delivery. Versions of the model may be equated with the role played by the school media center specialist (Abell, 1990).

Depending on the support level used, the advantages and disadvantages of the science support team model vary. Advantages include the shared expertise of two adults with differing specializations. The classroom teacher would specialize in knowledge of students, pedagogy, and the general curriculum, and the specialist would contribute knowledge of science content and curriculum. Depending on the level of support, teaching generalists would have a structured and supported opportunity to increase their knowledge and confidence in science instruction. Time for science instruction would be guaranteed and opportunities to integrate science into the rest of the curriculum would be maintained. Potential disadvantages are increased personnel costs, administrative structure, and time for collaborative planning.

Departmentalization within grade levels

Following a model most often seen in secondary schools, some elementary grades have elected to departmentalize. This arrangement is often informally organized by a group of teachers as opposed to mandated by the administration. In this model, each teacher is responsible for the majority of the academic content taught within a self-contained classroom. During specified times each week, however, the teachers "rotate" classes, teaching a specialized content. Science, along with social studies and health, is often taught in this fashion.

Departmentalized models guarantee time for science instruction and allow for science resources to be centralized with each grade level. While instruction from a teacher who has science content and curricular specialization would appear a likely benefit, conversations with teachers indicate that departmentalized arrangements are rarely induced with student learning in mind. More often, efficient use of teacher planning time is cited as the reason for departmentalization and content assignments are made by convenience or seniority rather than by specialized content knowledge. Disadvantages include decreased knowledge of students and minimal opportunities to integrate science with other curricular topics. Most important, departmentalization may result in relegating all the responsibility for science content to a single team member.

Science specialists

The delivery model most often depicted in the literature employs a science specialist who maintains a science laboratory/classroom. Hired as a science specialist, this teacher is solely responsible for science instruction and therefore has a higher degree of science interest, enthusiasm, and content expertise. As a recipient of specialized preparation, the specialist is skilled in the implementation of reform-based science instruction, assessment techniques, and knowledgeable of curricular guidelines and resources. In this model, classrooms have regularly scheduled times in the science lab. Science instruction is the primary responsibility of the science specialist who may interact to varying degrees with the classroom teacher. Similar to specialist programs in the fine arts or physical education (Abell, 1990), the classroom teacher generally "drops off" his or her students and uses the much-needed release time for planning rather than assisting in science instruction.

Advantages to the specialist model include guaranteed time for science instruction by a highly qualified individual and the centralization of science materials. Disadvantages include limited knowledge of individual student development and interests, decreased opportunities for content integration, the potential creation of elite images of science, and increased costs for personnel and administration.

Evidence and Argument for Model Effectiveness

The models offered in this article are not new. Advocates for science specialists argue for the benefits of increased time, interest, and expertise in the teaching of science, as well as the ability to centralize science materials (Abell, 1990; Hounshell & Swartz, 1987; Neuman, 1981; Williams, 1990). In support of this contention, research has shown that content knowledge is often the limiting factor to effective science instruction (Dobey & Schafer, 1984; Gess-Newsome, in press), and that teachers' level of content knowledge positively correlates with student outcomes on standardized tests of science (Schwartz et al., 1999). Specialist preparation programs would concentrate efforts on those individuals who show enthusiasm for the science rather than dilute their impact across all teachers. Proponents of the classroom generalist model worried about the uncertain financial resources for specialists as well as decreased opportunities for content integration, decreased knowledge of individual students, and the creation of the view that science is the providence of only a privileged few (Hounshell & Swartz, 1987; Olson, 1992). Advocates for science specialists counter that integration and knowledge of students can be fostered by communication and planning with the classroom teacher.

Table 1 characterizes the five delivery models of elementary science instruction in terms of the four teacher attributes needed to teach for scientific literacy. Each category has been assigned a ranking of low, medium, or high based on the perceived level of expertise held by the model's science instructor(s). In addition, categories related to the amount of time spent in science instruction, personnel needs (in-house versus extra staffing), and the centralized or dispersed nature of science-based equipment and materials are included. Finally, infrastructure requirements (relating to the time needed for planning, coordination, and collaboration) and teacher preparation needs (as academic generalists, science specialists, or a combination) are considered.

Table 1: Characterization of delivery models for elementary science instruction

	Classroom Generalists	Classroom Specialists	Support Teams*	Departmentalization	Science Specialists
Science content knowledge, skill, & attitudes	low	medium	low/high	medium	high
Pedagogical knowledge & skill	medium	medium	med/high	medium	high
Knowledge of students	high	high	high/low	low	low
Knowledge of curriculum	medium	medium	medium/high	medium	high
Time in science instruction	low	medium	high	high	high
Personnel costs	in-house staff	in-house staff	extra staff	in house staff	extra staff
Science material location	dispersed	dispersed	dispersed	centralized	centralized
Infrastructure requirements	minimal	high	high	minimal	high
Type of teacher preparation	generalist	gen/specialist	gen/specialist	gen/specialist	specialist

* The dual characterizations represent the independent expertise held by the classroom teacher and the science support specialist. The resulting impact on students would be the merged value of the teacher/specialist team.