Quality programs require lengthy commitments

Successful science teaching in a rural setting

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Teaching science in a rural setting offers numerous challenges. Frequently there is a support system lacking for the teacher especially for opportunities to share ideas with peers and for review by knowledgeable science educators. Rural communities are frequently separated from centers of scientific and technological activity with little opportunity to draw upon these resources in establishing a climate favorable to science teaching. Furthermore, the opportunity to relate science content to the industrial needs and activities of the community is reduced to the point that these activities are usually missing. The isolation of the rural setting may also lead to a lack of free flowing ideas and knowledge of recent scientific developments. Students also have difficulty identifying the science-related career opportunities available to them.

There are also advantages to science teaching in a rural setting. Science teachers can relate science content to natural environments which are close at hand. They also may have greater potential for establishing positive relationships with the community, facilitating access to natural resource areas and providing support from a broad spectrum of local business and industry.

Several questions arise about science teaching in rural schools. For example, how might a teacher develop a high quality science teaching program? What are the problems inherent in this setting and how can the teacher find a balance between supporting and opposing factors in program development? In this article we describe a case study involving what we judge to be a successful science program in a rural area. Out of this, we draw numerous ideas about how successful science education programs might be initiated into other rural school districts.

Wamego, Kansas: A case study

The setting

Wamego, with a population of about 2,700, is located about 100 miles west of Kansas City and 40 miles from Topeka. The district includes portions of Pottawatomie, Wabaunsee and Riley Counties and encompasses approximately 192 square miles. The district has a student population of 1,150 with 325 of these enrolled in a four-year high school. The original building was erected in 1938 with an addition for science and music added in 1963. While these science facilities are certainly adequate, they probably do not go beyond the average for facilities built at that time.

The teacher

Most educators recognize that the teacher is the key to a successful program. In setting up a successful rural education program it is probably even more true that the teacher is the most significant determiner of success. In this case, the teacher is a male, 45 years old, who has held his current position for the past 16 years, and has taught science for 21 years. He holds one of two staff positions in science with the responsibility for teaching all of the physical science courses. The other position is a full-time biology and laboratory science position. The teacher preparation is extensive, but we have no basis for saying that his preparation is greater than most teachers who have taught science for 21 years. He completed his bachelors degree in 1957 from a nearby teacher training institution. He subsequently completed a Masters Degree in 1961 at another teacher training institution in Kansas, and took additional graduate work beyond the masters at various universities both in and out of state. He is currently completing a Ph.D. in science education. Most of his preparation has been in science content areas with a minimum amount of emphasis on pedagogy, philosophy and teaching techniques. Only the Ph.D. degree includes a major emphasis in the area of education. His preparation is broad in terms of the types of experiences he has had in the classroom, in the laboratory, and in field-related science teaching.

The program

When his work began at Wamego High School in the fall of 1965, the established program was a rather traditional sequence of general science, biology, chemistry and physics. These courses were taught primarily from a textbook approach with very little content being taught through laboratory experiences. The first change to be made in the curriculum was to establish the "Laboratory Science" course to replace General Science. The new course centered around laboratory investigations prepared by the teacher.

Secondly, a new text was chosen for the biology course, **High School Biology** (BSCS-Green Version) and **Chemistry: An Experimental Science** was chosen as the core curriculum for the chemistry program with some conventional chemistry experiments retained. Physics was converted to a blend of Harvard Project Physics and Physical Science Study Committee programs again retaining some conventional approaches.

Two other changes were also made. One was to institute the course "Senior Science," which integrated science content from both biological and physical sciences and included such topics as: plant physiology, biochemistry, qualitative and quantitative analysis, nuclear radiation and electronics. This course could follow or be taken concurrently with physics.

The second to initiate the "Independent Study Program" which provided students with an opportunity to work on an independent research project of their own choosing. Students might take this course during any or all grades as long as they were enrolled in one other regular science course. Each student was required to prepare a research paper reporting his results in a scientific form for possible entry in a science fair or Kansas Junior Academy of Science competition.

This curriculum program made it possible to set up three different channels for student involvement. Channel 1 involved students taking ninth grade Lab Science and moving sequentially through the other science courses at the rate of one course per year. Channel 2 made it possible for better students to enter the sequence at the biology level in their ninth grade year and move sequentially through Senior Science at the 12th grade level. The third channel involved the Independent Study course which ran parallel to one of the other two channels. Of course, students could abandon the sequence at any point.

Auxiliary program elements

Another important dimension of the science program has been the development of certain kinds of auxiliary science activities. The science club was basically a support group. It conducted numerous fundraising projects and provided small financial grants to cover the cost of awards and expenses associated with the rest of the science program.

A focal point for each year's work is a local science fair offered to grades K-12. For the 1980 science fair 150 student projects were entered from the Wamego and surrounding school districts. Thus, Wamego serves as a focus for science fair participation for many schools in the area. Primarily the science fair offers students the opportunity to exhibit their work from independent study and from other courses taken during their high school career.

Another activity which has captured the attention of many students is participation in the Kansas Junior Academy of Science. This regional and state program offered students the opportunity to present their ideas to their peers and to scientists and to gain feedback regarding the quality of their scientific work. During 1980 Wamego sponsored the regional Junior Academy of Science.

Other significant parts of this program are annual awards. Since athletic, thespian and debate awards were made at the end of the year, two science awards were added. The first was the Leonard Nehring Senior Science Award. This award began in honor of Leonard Nehring following his retirement from teaching science for 42 years. This was awarded to the two top science students (seniors) selected by the science department. A plaque is presented to each winner plus the winner's name is placed on a school plaque prominently displayed in the school trophy case. The second award, the Wamego Research Award, was given to the two best research projects for each year. The students could be in grades 9 through 12. Again, each student receives a plaque and their name is placed along side those of previous winners on a school plaque.

Determining the success of the program

How does one evaluate such a program? Certainly the products of the program are an important assessment of its effectiveness. As indicated the students have competed in science fairs at regional, state and international levels. They have also participated in and competed in the Kansas Junior Academy of Science programs for the past 13 years. During this time, 13 students have participated in the International Science and Engineering Fairs. Two have won the coveted Atomic Energy Commission Award which provided for one-week, all-expense paid trips to the Argonne National Laboratories Research Center in Chicago. Others have won third and fourth places in their respective divisions. Several have received recognition through the American Chemical Society and the United States Department of Transportation. Recently one student won the first place award from the U.S. Department of Transportation, the U.S. Atomic Energy Award, and fourth place in his division with a project on gasohol. Several students have been recognized in the Westinghouse Talent Search. Wamego science students have received over $150,000 worth of awards, trips and scholarships over the last 13 years.

Wamego High School has also had state winners in the Kansas Junior Academy of Science each year since they first entered competition. There have been as many as five first-place winners at the state level in one year alone. One student from this group was selected to present his research paper to the American Association for the Advancement of Science meeting in Washington, D.C. and another presented his findings to the National Science Teachers Association meeting in St. Louis, Missouri.

Five students have won trips to West Point through the auspices of the U.S. Army Research Center. After presenting their findings at a science and humanities symposium, one of them was selected to present his research at the national meeting in West Point.

Students who have finished this program have been recognized through the presentation of awards and scholarships. They have won many scholarships for having the best science project at science fairs in Maryville, Missouri, and Emporia, Kansas. Many have been Seaton Scholars at Kansas State University and some have graduated as the top engineering student in their respective fields. Many have gone on to receive their masters and Ph.D. degrees in several science areas including civil, mechanical, electrical, industrial, agricultural, nuclear, and chemical engineering. Medical doctors and dentists are also graduates of this program. The teacher points with pride to students who have gone on to be science teachers.

In assessing the significance of the numbers of student awards, it is important to remember that only about 80 students graduate each year from this school and that in a typical year, fewer than 25 seniors are enrolled in science.

Another measure of the success of the program is the kind of peer recognition received by the teacher. This year the State Department of Education chose him as the Kansas Teacher of the Year from a population of over 25,000 teachers. Further, he was awarded the Outstanding Physics Teacher of the Year Award by the Arkansas, Oklahoma, Kansas Chapter of the American Association of Physics Teachers (1980), and in 1979 he was selected Master Teacher of the Year by the Emporia State University Selection Committee. In 1973 he was selected as one of the top 10 innovative physics teachers in the nation by the American Association of Physics Teachers.

Lessons about rural science teaching

From this case study the authors have identified numerous principles which are believed to have wide applicability to the improvement of rural science teaching and should be applied by teacher educators, rural school districts, and rural science teachers. Those who prepare rural science teachers would do well to consider the following:

1) A broad preparation in academic areas will be necessary if the teacher is to deal with multiple class assignments, diversity of topics that arise out of independent study, and the relative "isolation" of the rural community from the "scientific" community.

2) Teachers should begin teaching with preparation for a process approach to science teaching if they are to understand the significance of independent study; be able to teach the process skills students will require; and develop the commitment necessary to design and conduct a program like the one outlined.

3) The teacher believes that another component of his success has been his industrial training and experiences which have made it possible for him to show practical applications of content and recommend career directions to his students. If he is correct a broad movement should be mounted all across science education to get teachers into industrial settings.

4) Teacher education programs should provide a broadened view of the science curriculum. For too long our view has been restricted to biology, chemistry and physics. While this is a problem in all schools, it is a particular problem with rural schools. This broadened view should not only include topics beyond the traditional courses, but should include the interactions and interrelationships between the various disciplines.

5) Teacher education programs should include the opportunity to develop laboratory teaching skills, including equipment operation, construction and repair. It should also include the development of skills in organizing and managing laboratory instruction.

6) Teacher education programs should seek ways to develop and nurture certain personal qualities or attitudes in their trainees. Prospective rural science teachers should be "risk takers," willing to venture into unknown areas and able to profit from their mistakes. They should be encouraged to develop a strong personal commitment to science teaching in the rural setting, and should exhibit strong enthusiasm for the job of science teaching. They should also be encouraged to develop auxiliary skills such as photography, lapidary, taxidermy and collecting natural specimen.

7) Finally, if teachers teach as they are taugnt, science teacher educators must exhibit the qualities listed above and must move to design programs which will make that possible.

Lessons for rural districts

1) Local rural districts must recognize the value of experienced, effective science teachers. Rumors continue to circulate that districts are hiring "new" teachers because they are "cheaper." In a time of restricted budgets this may be believable, but it overlooks the fact that time is a factor in building an effective program. We are **not** saying keep experienced teachers who maintain the **status quo!** We are saying, value those teachers who are developing an effective science program.

2) Local administrators will be wise to provide a high level of encouragement to the teacher involved in program development. This implies cutting the "red tape" inhibiting curriculum change, making budgetary allowances to cover the cost of equipment and supplies; and providing personal monetary rewards to teachers who demonstrate success. Expensive equipment should be justified on the basis of the program needs, not of the whim of the teacher or some equipment salesman.

3) Local administrators should assist the science teacher in securing community recognition and support for their accomplishments. This will provide both a reward and a motivation for the work. It will also set a climate in the community which will encourage student/parent involvement in the science program.

Lessons for science teachers

Finally there are numerous lessons which science teachers should learn from this case. They include:

1) The teachers should recognize the necessity of their own long term commitment to science teaching. Only with sufficient time and effort will they be able to build an effective program.

2) Teachers should demonstrate a commitment to growth or quality in the program. This quality can be built gradually. It will not happen over night.

3) Teachers should recognize that flexibility in terms of content and student entry should be built into their science program. For example, Independent Study should not be reserved only for those students who have completed two years of science study. Let them in when they are ready.

4) There should be strong emphasis on laboratory learning wherever possible. It is the essence of science. Thus, students grasp the exploratory nature of the discipline and use these skills to solve real problems.

5) A high degree of personal enthusiasm will be necessary for most teachers to continue to grow, even after 21 years of service!

6) Teachers and their students should work diligently to secure strong community support. It developed in this case because of the activities, awards, and scholarships students have received.

7) Auxiliary science activities, including Science Club, Science Fair, Academy of Science and a local awards program all broaden the program and provide opportunities for the students to receive recognition for their work. They should be encouraged.

8) This program has received numerous resources from industries, business, colleges and universities. This has been made possible through the efforts of the teacher to maintain positive contacts with leaders in these organizations.