of real-world systems and problems. Genuine technological literacy can only be developed by providing students with opportunities to learn MST concepts in the context of real systems and problems that have meaning for them.

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2. Is the Integrated Curriculum the Answer?

by Tom Loveland

The need for curriculum change is briefly reviewed. Some pilot integrated curriculum efforts, with emphasis on an effort in Florida, are described, and challenges and recommendations related to these are offered.

CHANGE

Secondary school statistics over the last 80 years have revealed some startling trends. High school entrance rates have gone from 50% in 1950 to 95% in 1980 and high school graduation rates have gone from 10% in 1900 to 73% in 1980 (Department of Curriculum, Instruction, and Assessment, 1996). Standards and methods of instruction remained relatively static during these years. Specialized instructors lectured to whole classes and assigned work out of textbooks. While this method of subject-centered curriculum and teacher-centered instruction is familiar to most Americans, students today are markedly different and require new ways of being reached.

Changing school demographics are well documented. There are increasing numbers of students living in single-parent households. Many of these families are living in poverty. Many students have non-English-speaking parents. In the 1940s, nonscholastic classroom problems included talking, chewing gum, making noise, and running in the halls. In the 1990s, the problems are drug abuse, rape, assault, and suicide.

Demographics are just one reason for schools to change. Other compelling reasons include legislative mandates, work requirements of new workers, competition from charter schools, and refinements in learning theory. Goal 3 of Florida's Blueprint 2000 states that "students successfully compete at the highest levels nationally and internationally, and are prepared to make well-reasoned, thoughtful, and healthy lifelong decisions" (Bureau of Curriculum, Instruction, and Assessment, 1995, p. 30). The Secretary's Commission on Achieving Necessary Skills report of 1991 identified the following five competencies and three foundation skills that graduating high school students will need to succeed in the workplace:

Competencies:

1. Resources: identifies, organizes, plans, and allocates resources.
2. Interpersonal: works with others.
3. Information: acquires and uses information.
4. Systems: understands complex interrelationships.
5. Technology: works with a variety of technologies.

Foundations:

1. Basic skills: reads, writes, performs arithmetic and mathematical operations, listens, and speaks.
2. Thinking skills: thinks creatively, makes decisions, solves problems, visualizes, knows how to learn, and reasons.
3. Personal qualities: displays responsibility, self-esteem, sociability, self-management, integrity, and honesty.

In 1996 the Florida legislature passed several laws that allowed for public funding of charter and private schools. Some charter schools will be linked with businesses, providing technology and expertise that standard public schools will find difficult to match. The final compelling reason for a change in curriculum and instruction techniques comes from studies in learning principles. Gardner's theory of multiple intelligences breaks learners into seven categories including verbal/linguistic, logical/mathematical, visual/spatial, and others. Not all learning styles can be affected by an autocratic teacher/lecturer with rigid curriculum barriers (Gardner, 1995).

The usual secondary school curriculum is delivered in distinct 50-minute blocks of specific content areas. Teachers are certified as specialists in their content areas, and students are expected to study the content areas separate from their other classes. The problem with this delivery system is that it bears little resemblance to the real world. People link and use all of their skills as they move about the day solving problems. With the explosion of information, increasing legislative mandates, fragmented schedules, and a lack of applied knowledge in the school curriculum, an interdisciplinary approach to a curriculum offers a feasible solution.

INTERDISCIPLINARY CURRICULUM—ADVANTAGES AND OBSTACLES

An interdisciplinary curriculum is "a knowledge view and curriculum ap-

proach that consciously applies methodology and language from more than one discipline to examine a central theme, issue, problem, topic, or experience" (Jacobs, 1989, p. 8). A group of teachers representing all or many content areas from a team develop thematic units of study that can be linked to all of the content areas. Students join the learning community. Their studies during the year are linked from class to class by integrated thinking and learning skills, content, themes, or units of study and methodology. "Thus the 'multidisciplinary' approach transcends all boundaries of traditional disciplines and is highly interactive, actively combining social and intellectual domains" (Relan & Kimpston, 1991, p. 4).

Support for this new curriculum comes from administrators in the form of increased funding, in-service training, and school schedules that provide common planning time. Informed parents and local industry will support curricula that lead to higher qualified graduates. The biggest supporters will be the students themselves. Their classwork will be more stimulating and have more application, meaning, and relevance (Jacobs, 1989).

The advantages of an interdisciplinary education have been extolled in the popular and educational literature: There will be better student attitudes toward school. Students will assimilate lifelong learning skills, become more creative, flexible, active learners, and critical thinkers. Students will feel part of a team because they are with the same group of teachers throughout their high school years. Integrated education will help students to organize their learning, a difficult thing to do with the explosion of knowledge and information in the world. This way of learning lends coherence to abundant facts by showing how they interrelate. The advantage most visible to students is that student class schedules have first priority.

The benefits don't stop with the students. Teachers reap huge rewards from teaching this way. Teachers feel part of a team and less isolated from colleagues. Teaching is more relevant and stimulating. Teachers enjoy the support of their administrations. Curriculum supervisors like interdisciplinary teaching because the learning reflects the real world and knowledge gained in one content area transfers to other areas. Student achievement scores should rise.

There are numerous obstacles and considerable resistance to the integrated curriculum. These include the cost of new materials, misguided curriculum materials that are not thoroughly developed and evaluated, multiple themes that lack coherence and connections, inflexible high school student schedules, difficulty in setting common teacher planning time, and state certification requirements that do not allow teachers certified in one content area to teach other content areas. In addition, it is costly to write performance-based assessments that cross multiple disciplines. Did a student do well on his or her language arts portion of the SAT because of an integrated curriculum, reading at home, low teacher-to-student ratio, or some other factor? There are social issues as well. Highly autonomous teachers may be reluctant to team teach. There could be subject area territoriality—an inability to be open to other content areas. The use of different terminology and language in content areas is a hindrance to communication.

Resistance can and does come from other parties: students who are not accustomed to seeing academic and vocational teachers working together, skeptical parents, half-hearted administrators, and out-of-the-loop teachers.

SOME CURRICULUM EFFECTS

The Ringe School of Technical Arts (RSTA) in Cambridge, Massachusetts, switched to an interdisciplinary approach in 1989. RSTA is a school within a school that integrates a strong academic program with its vocational program. In 1993 and 1994, test data from the students in the program showed improvement in student performance (Vo, 1996b). RSTA 10th-grade reading scores increased by 10.6 points and math by 3.5 points over the previous year on the California Achievement Test. Eighty-five percent of internship completers went on to college versus 71% of the students in the adjoining comprehensive program. Daily attendance increased from 80 to 91%, and the number of students on the honor roll quadrupled.

Another program, Academy 2000, at Baltimore's Frederick Douglas High School showed increased attendance figures (Vo, 1996a). The 1995-1996 attendance in the academy was 82% versus 68% in the high school. The national Schools of Excellence program showed that 68% of these schools were using interdisciplinary units while only 29% of those schools in a random group did (George, Stevenson, Thomason, & Beane, 1992).

Most interdisciplinary teaching evidence is anecdotal instead of empirical. A typical example is a report on the Cardigan Unit, a 10-week integrated curriculum for eighth graders focusing on the environment. Teacher assessment of the program indicated it was "a vital, interesting, motivating educational experience for children in which a lot of learning took place" (Carper, 1991, p. 40). No formal assessment was cited comparing this program to traditional programs. This program was started in 1971 and still uses traditional assessment tools. In 1990 a redesign of their Progress Report form was done for the purpose of reform.

In Los Angeles, California, a five-year-old program called Teaching Excellence for Minority Student Achievement (TEAM) focused on delivering science and math through interdisciplinary instruction. Adenika-Morrow (1995) reported achievement test scores leaping by 10 to 20 percentile points. TEAM tested students who had baseline achievement levels of 5%. These students were taught on a one-to-one ratio with the teachers virtually guaranteeing remarkable test improvement. Los Angeles dropped the program in 1993 due to the high costs.

There is a lack of research concerning interdisciplinary learning from all perspectives: learning theory, brain research, achievement tests scores, and sociology. According to Relan and Kimpston (1991), "practically no long-term evaluations or studies systematically investigating the effects of any kind of integration exist" (p. 6). As more learning communities and academies are created in high schools, research will undoubtedly become more common. Use of control groups and careful development of interdisciplinary variables should help to prove or disprove the claims.

THE EFFORT IN FLORIDA

Pasco County is field testing the concept of the interdisciplinary curriculum for the Florida Department of Education. The elementary schools began a program in 1990 called Houses that placed students within teams of teachers. The students stayed with their team teachers throughout their elementary school years. The teachers developed themes to link their curriculum and classes together. Within this structure, different types of student groupings were possible: grade level, reading ability, or student interest.

In 1993-1994 the middle schools introduced their pilot program called Streams. Two years later the high schools inaugurated Learning Communities. Learning communities are developed around career clusters. In Pasco County, the four career clusters are technology, business, criminal justice, and health. Each high school initiated its choice based on local industry needs. At Ridgewood High School in New Port Richey, the two learning communities are called The Academy of Science and Technology and The Academy of Business Education.

After the learning communities were formed, the teachers worked to develop an integrated curriculum. This curriculum was based on many considerations: school demographics, definition of the career cluster, available resources (people, materials, and community), an advisory group, targeted performance outcomes, and theory (working with multilevel students, instructional strategies, new assessment methods, and leadership skills). This information was necessary for the building of the annual plan. After the annual plan was written, the quarterly and weekly content area schedules were developed. At this point the links between content areas became apparent.

The Science and Technology Academy chose the theme Connection and Congruency for the second quarter of the 1996-1997 school year. The scheduling was flexible and centered on units lasting four to six weeks. The science class studied chemical makeup, molecules, and carbon-based atoms and completed a science project. The language arts class did an abstract for science, problem hypothesis, logical fallacies, descriptive writing, and analogies. In social studies, the students studied centers of civilization, environment, government, religious beliefs, and communication's cause and effect. Math included geo-parallelism, triangles, evaluations of formulas, solving equations, distance-rate-time, and systems of equations. Projects were linked between courses. Students were taught overlapping knowledge in order to strengthen the learning process. The entire learning community took three field trips that quarter: to the Dali Museum, Museum of Science and Industry, and a Holocaust memorial.

The Academy of Business Technology is developing their first year and quarter plans for the coming fall semester. The career clusters for business include accounting, communications, computers, management, public relations, marketing, retail, sales, and finance. Teachers in this community will include academic, business education, and technology education. Plans are in development to include links with local Pasco businesses through classroom speakers, mentorships, internships, diversified cooperative training, and on-the-job training.

LEARNING COMMUNITY SURVEY

In January of 1997, a survey was developed to determine the view of current learning community teachers in Pasco County. This survey was sent to the 37 high school classroom teachers identified by the high schools. Twenty-five completed surveys were returned, a 68% response. All but one teacher indicated to which learning community they belonged. They were not asked to identify themselves or their school. This was done so the teachers could express their feelings without jeopardizing their careers. Six of the teachers wrote detailed comments on the back of the surveys. Generally, the teachers expressed strong support for the following:

- More integrated curriculum materials from the district next year.
- More planning time for next year.
- Block scheduling would be helpful to our learning community.
- I feel our learning community will be even better next year.
- Vocational classes were integrated with our learning community.
- Joint planning time was made available to learning community members.
- More learning communities at my school next year.

On the other hand, teacher ratings were low for such statements as "My learning community students seem more mature and focused," "My curricula was integrated fully with all learning community members," "The training from the district was valuable," "I have less behavior problems with my learning community students," and "My learning community experience has been enjoyable." Almost twice as many teachers agreed as disagreed.

Pasco learning community teachers were generally positive about their first semester of the integrated curriculum. They reflected that next year will improve and that they will encourage other teachers to join learning communities.

MEETING THE CHALLENGES

More educators are likely to be introduced to the interdisciplinary curriculum in the near future. It is an educational trend that has many advocates. School systems can make the transition if they develop their program for the end users: the students. Support from the community and district and school administrators is crucial for success. Parents, local businesses, and community leaders should be consulted through their representation on school and district advisory boards. The business leaders should provide information about what they expect from the schools: smooth school-to-work transitions, and exemplary student work and communication skills.

The districts can support an interdisciplinary curriculum in many ways. The most important is to provide in-service training built around development and sharing of applied projects and lesson plans. Teachers in Pasco County, for example, list this as their number one priority. Districts can support an integrated curriculum by communicating with school administrators, school boards, and teacher teams. Funding for materials, studies, and professional development are necessary.

Administrators should examine the research on block scheduling. A careful examination of the benefits of block scheduling will aid them in their discussions with reluctant academic teachers. The benefits include support from vocational and elective teachers, increased

available credit hours for students, and increased team-teaching options.

To avoid hodgepodge programs, educators should be careful about how they set up their units. A systematic analysis of goals, available materials, teacher knowledge, and student outcomes should be used as the foundation of an integrated curriculum. Teachers can help their teams by making more efficient use of their common planning time.

As the teachers become more experienced and creative in developing their integrated curriculum, the achievement levels of the students should rise. As more empirical research is completed, the link between an integrated curriculum and achievement will be apparent. The interdisciplinary curriculum is a new teaching delivery method. Instead of disjointed activities throughout the school year, the curriculum makes the activities link schools and careers. These school-to-work competencies should be the driving force of American high schools. The interdisciplinary curriculum is not a perfect system. Many decisions entail tradeoffs, but it does seem to provide a way for students to develop the higher order thinking and learning skills they will need to survive in the 21st century.

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3. Environmentally Sound and Competitive Processes in the Graphic Communications Industry

by Ute Sartorius

At a time when global competition is fierce, the graphic communications and printing industry is undergoing significant changes as a result of new environmental regulations. Awareness of the precarious ecological situation of our planet has imposed exigencies to reduce waste and contaminants derived from paper making and printing. However, new technology continuously responds to these restrictions by offering environmentally friendly solutions geared towards a reduction in the use of hazardous materials and waste production.

Every year, the United States consumes more than 67 million tons of paper products (Ortbal, Lange, & Carroll, 1996). According to Weiss (1996), 50 to 70% of all printed material is never used, and this figure is only slightly alleviated by recycling. In fact, paper represents about 40% of all solid waste in the United States (Ortbal et al., 1996). In addition, the printing industry has a considerable effect on the environment through the use of hazardous material. Undoubtedly, the graphics industry is seen as a principal culprit in the current environmental conditions.

However, in recent years, a combination of governmental regulations and an increased social awareness has created a demand for environmentally friendly alternatives, such as recycled paper and soy-based inks. Graphic designers and graphic artists share the responsibility to question the environmental impact of a product at all possible stages of its production, from concept development through printing and production. The process thus entails