*Journal of Research in Rural Education*, Spring, 1997, Vol. 13, No. 1, 57-63

# Meeting National Science Standards in an Integrative Curriculum: Classroom Examples from a Rural Middle Level Program

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*The new science education standards generated by national and state organizations are challenging middle level programs across the country to alter their school's curriculum. In their most recent position statement, the New England League of Middle Schools (1995) called on middle level programs to adopt a curriculum that was integrated and not separated by single subject boundaries. Attempting to dissolve the boundaries of the separate subjects has pushed middle level teachers and administrators into a process of exploring feasible options for blending the science curriculum with other disciplines. To meet the challenge, many middle level programs use the integrative curriculum planning strategies outlined by James Beane (1990, 1993). Curriculum development under the best of circumstances is hard work, but it can be especially challenging for small, rural schools that perceive small size and strained economic resources as limiting factors in this endeavor (Lee & Milburn, 1994). Although Beane's (1990) curriculum planning process, in several different forms, is used by middle level programs across the country, research concerning the effectiveness of this curricular approach is sparse (Beane, 1993; MacIver & Epstein, 1993).*

*This report examines the effectiveness of an integrated curricular model operating in a rural middle level program in meeting the national life science curriculum standards as outlined by the National Research Council (NRC, 1996).*

## Introduction

The new science education standards generated by national and state organizations are challenging middle level programs across the country to alter their school's curriculum and create a more process-oriented science classroom. At the same time, the New England League of Middle Schools (1995) has called on middle level programs to adopt a curriculum that is integrated and not separated by single subject boundaries. This attempt to dissolve the boundaries of the separate subjects model of curriculum and to create a process-centered science experience for students has pushed many middle level teachers and administrators into a process of exploring feasible curriculum options for blending science with other disciplines. Middle level programs across the country are meeting this curriculum challenge by using the integrative curriculum planning strategies outlined by James Beane (1990). Curriculum expansion in any school system is hard work, but it is even harder work when teachers and staff believe that the size of their school and its rural location negatively impacts their ability to succeed. Lee and Milburn (1994, p. 7) illustrate this point in their conclusion that, "many teachers throughout the midwest and other sparsely populated areas of the country, feel it is impossible to implement middle level concepts in schools which represent a largely rural population."

Lee and Milburn (1994) go on to state that based on a survey of 28 rural middle level programs in South Dakota,

> A full 91% of the respondents recognized the need for a special curriculum for young adolescents, yet only 42% felt their middle school offered a balanced curriculum for these students. School size was cited 28 times as a hindrance to this and limited resources was listed 34 times. (p. 8)

The above work illustrates that school size and availability of resources has some impact on the perceived ability of a rural middle level program to implement curriculum changes. In light of this concern, it seems extremely valuable to explore one rural school's experience with Beane's planning strategies and to examine the effectiveness of their program in meeting national science standards.

Although Beane's (1990) curriculum planning process, in several different forms, is being used by numerous middle level programs across the country, research concerning the effectiveness of this curricular approach is sparse (Beane, 1993; MacIver & Epstein, 1993). However, the need for this type of research is illustrated in the U.S. Department of Education's (1991, p. 90) report, *An Agenda for Research*

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*and Development on Rural Education*, where it lists as its two top priorities:

1. The Effectiveness of Rural Schools
2. Curricular Provisions in Rural Schools.

The purpose of this report is to examine the effectiveness of an integrated curricular model (with no traditional science class), operating in a rural middle level program, in meeting national life science curriculum standards as outlined by the National Research Council (NRC, 1996). This paper is derived from a much larger study (Hicks, 1995) where the integrative program and course work used by the grade 6-8 team of teachers and students at the Solon Elementary School was documented. Solon Elementary School is located in rural western Maine, and at the time of this study was operating its middle level integrative program for three multigrade groups of 6th-, 7th- and 8th-grade students.

The academic program observed was derived from a student generated integrative unit, titled Wildlife, and consisted of five separate courses developed by the Solon teachers. An integrative unit, as defined by Beane (1990), is developed collaboratively between teachers and students. The themes or topics for each unit are derived by students as they explore questions and concerns they have about themselves and the larger world. George, Stevenson, Thomason, and Beane (1992, p. 90) provide an illustration of an integrative curricular unit by describing the concepts, themes, and topics that might come out of this process.

> Imagine, for example, a thematic unit on transitions in which early adolescents are engaged in learning about the various changes they are going through as part of their own development—and simultaneously about changes that are taking place in the larger world. In doing so, students may study what change is, how it affects peoples' lives, what leads to it, and the ways in which it actually happens.

Along with student involvement in the curriculum planning process, most integrative programs focus on a teaching process that blends processing skills, performance tasks, and problem-solving with the teaching of academic content. One of the main goals of an integrative curriculum program is to create a student-centered school, designed to complement the characteristics of young adolescents by providing students with active, hands-on educational experiences based on genuine, educational concerns of the students.

The activities and content in each course examined were based on student questions and teacher developed course work. Although this theme lent itself to life science, the school had no specific science class.

## Method

Using the illuminative evaluation methodology outlined by Parlett and Hamilton (1976), Patton (1990), and Worthen & Sanders (1987), I gathered data detailing the integrative curriculum process employed by the Solon 6- to 8-grade middle level team. Illuminative evaluation is a qualitative research methodology that is useful in the study of innovative educational programs because it involves collecting data in several different forms—i.e., classroom observation, interviews, and document collection.

During my 20-day stay at the school, I conducted daily observations of the school day, recording events, dialogue, and context. Although this short time period provided only a small window for viewing the Solon curriculum, my visits to the classrooms provided me a rich variety of observations indicative of the school's integrative practices and educational methods.

Along with the observations, I conducted interviews with 3-4 students from each grade level and with the 3 faculty members. The middle level team was composed of 48 students, broken equally into three multigrade groups. Interviews were audio-taped (with subject approval) and transcribed or hand recorded. University human subjects approval was sought and granted for conducting interviews with students and faculty. Student and teacher responses were kept strictly confidential to insure the privacy of all students and teachers. Names, as well as, other identifying information were removed from the data and replaced by fictitious information. Age and gender were the only background information collected. To augment my observations and interview data, I also collected school documents pertaining to the implementation and use of integrative curriculum units at the school.

## Data Analysis

The data was analyzed through constant comparison and the use of triangulation. The three distinct types of data allowed for triangulation across data sets of any phenomena discovered that seemed to be of importance. Analysis of observations, interviews, and documents were essential in determining the academic content of the integrative curriculum, in exploring teacher-student interactions, and in investigating the integrative process.

Because interviews were based on a standardized, open-ended schedule, I used cross-case analysis (Patten, 1990), whereby answers to the same questions were compared looking for similarities in the responses. When choosing material from the interviews for this report, I have chosen passages that clearly expressed the consensus of the group.

The observations were analyzed using the following strategies presented by Patton (1990, p. 377):

1. looking for key events—critical events or incidents;
2. looking for processes—data organized to describe important processes (e.g., integrative curriculum, science content).

Collected documents, including teacher generated course syllabi, were used as a means to examine written rationales of the curriculum, program objectives, and to determine the intent of the academic classes.

From the data collected, I extracted the science content covered, course objectives, and the strategies used by teachers in the classroom to examine: (a) whether teachers are choosing age-appropriate science content, materials, and teaching strategies (based on NRC's recommendations) and (b) whether this program of study can meet the demands of the NRC'S National Curriculum Standards in life science.

## Findings

The integrative program as it is employed by the Solon Elementary School is successful in meeting the national science curriculum standards and age appropriate guidelines as outlined by the NRC. To illustrate how the integrative program successfully aligned itself with the NRC's standards, I will first discuss the standards themselves and then offer several examples of how the Solon School was successful in aligning its program with these standards.

Figure 1 outlines the NRC's life science content standards (1996) for grades 5-8 and the associated skills and processes students at this grade level should actively use. It is interesting to note that NRC's content standards focus more on what a student should be able to do with science content, rather than what specific content a student should have mastered at a given grade level. For example, knowing the basic components of a cell is important for students studying life science, but the standards seem more concerned with whether students can progress beyond that and see the larger picture of structure and function in living systems.

The standards also address a student's ability to see life science in a much broader context. This is evident from the inclusion of personal and social perspectives in the standards as well as the discussion of unifying concepts. This type of approach to curriculum standards seemed to correlate well with the more hands-on, student-based methodologies evident in the integrative classes at Solon. The integrative courses were 20 days long and were offered three times during the 60-day thematic unit, except for one course, titled Animal Classes, that covered all five groups of vertebrates and ran the entire 60 days. All students participated in the courses offered by the teachers sometime during the unit. The topics or themes for the units were chosen by students in the springtime so that teachers had the summer to prepare course syllabi and lessons. Having this time for preparation seemed essential to the success of creating a hands-on curriculum based on students' questions.

### Classroom Examples

An activity used as part of a larger lesson in the Rain Forest class illustrates Solon's compliance with national standards. In this lesson, students were involved in exploring the rain forest ecosystem and some of the physical factors that determine this biome. During this lesson the teacher began an activity where the students compare Borneo Island to the state of Maine.

> Ms. Beach had given the students a list of average monthly temperatures of Borneo and Maine, and the students were going to graph these on paper, one over the other, each traced in a different color. Ms. Beach worked out an example of a graph on the board as students worked in their seats. (Field notes, December 14, 1995)

This activity enabled the students to become aware of the differences between Maine, where they lived, and Borneo, which is halfway around the world. Ms. Beach told me that she had originally wanted to compare Borneo to Solon, but she couldn't find average temperature data for the town, so she opted for temperatures in the state of Maine. When a student commented on the temperature comparison activity during his interview, it illustrated the importance of comparing something unknown to something that is familiar.

> . . . how the difference is between Maine and Borneo as far as temperature. We are graphing that, too. It's weird because Borneo is like, it ranges from 81 to 83 degrees for the whole year and in Maine the average is from 15 to 67 degrees in a year. So there's a big difference. (Interview, January 17, 1995)

Ms. Beach commented on this activity during her interview when talking about how she tried to get students involved in the integrative activities:

> I'm more successful when I give students more structure and parameters. It's not just saying, "Here's what I want you to know. How do you want to approach it?" I haven't had much luck with that. I have a concept that I want them to pursue, like the rainfall and average temperature of Borneo is pretty constant all year round compared to Maine's, which is more like a bell curve. I generally present the concept in a way the kids are go-

I. Life Science
   1. Structure and function in living systems
   2. Reproduction and heredity
   3. Regulation and behavior
   4. Populations and ecosystems
   5. Diversity and adaptation of organisms

II. Science as Inquiry
   1. Abilities related to scientific inquiry
   2. Understanding about scientific inquiry

III. Science and Technology
   1. Abilities of technological design
   2. Understanding about science and technology

IV Science in Personal and Social Perspectives
   1. Personal health
   2. Populations, resources, and environments
   3. Natural hazards
   4. Risk and benefits
   5. Science and technology in society

V. History and Nature of Science
   1. Science as a human endeavor
   2. Nature of science
   3. History of science

VI. Unifying concepts and processes
   1. Order and organization
   2. Evidence, models, explanations
   3. Change, constancy and measurement
   4. Evolution and equilibrium
   5. Form and function

*Figure 1.* Outline of NRC's Science Content Standards for Grades 5-8 and Associated Skills and Process.

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> ing to discover that. I have an activity plan that will help them arrive at that point. They say, "Oh, look at this. The line is like flat and the other goes like this. What do you think caused this?" (Interview, January 20, 1995)

This type of activity addressed NRC (1996) standards in life science, particularly in understanding ecosystems, and provided an opportunity for students to see science in a personal and social perspective (see Figure 1).

Another lesson that shows alignment with national standards was in Ms. Foster's Maine Animals course. This lesson involved each student focusing on a different indigenous animal. According to the syllabus:

> Each student will concentrate on the Maine animal of his/her choice for the topic of study in this class. Students will use human and printed resources to answer questions about their animal and supply information to complete individual projects which they will design. There will be a project contract to be signed by the student, a parent of the student, and the teacher. (Documents, January 1995)

Because this course was research-based, there were no organized lessons per se. But the skills involved in researching an animal and in presenting a final presentation fit the standards quite nicely. The NRC (1996, p. v-14) standards list Science as Inquiry as a major heading under Content and outline two basic skills:

1. abilities related to scientific inquiry
2. understanding about scientific inquiry.

These two skills are essential in researching a topic in science and can be applied to other hands-on science investigations. The students in Ms. Foster's class investigated several factors about their animals, including population, animal characteristics, habitat, predator/prey relationships, adaptation, and other interesting characteristics, all of which are considered age-appropriate topics by the NRC standards. Ms. Foster also expected students to be able to use or document the following aspects in their reports and presentations:

> Vocabulary, such as hibernation, nocturnal, adaptation, migration, predators, prey, habitat, and the names of diseases as they apply to their chosen animal. To name at least two roles that are played by Maine state biologists and game wardens in relation to their chosen animal. Explain laws that protect the animal they have chosen to study. Report on the economic value of that animal to the state. Describe what is entailed in game management. (Documents, January, 1995)

This detailed investigation concerning one animal per student, meets several standards from the NRC, in addition to Science as Inquiry. Under Unifying Concepts and Processes, the NRC lists, order and organization, evidence, explanation, and form and function. These are skills that are of concern in all academic disciplines, and the Maine Animals research project required students to utilize them. Ms. Foster directed the nature of the inquiry through her questions, so that part of the research was focused in areas other than life science. The social nature of the questions concerning the animal/human interaction also addresses the NRC standards. The animal/human relationship is consid-

ered important by middle level students, as evidenced by an interview with an eighth-grade boy.

> In Ms. Foster's class, on our animals that we had to research, we had to find out what the predator was and most of it was man, like destroying wilderness and stuff. (Interview, January, 18, 1995)

This student's comment illustrated the importance of allowing student research to involve the formation of their own opinions and ideas concerning the world. The social questions in the Maine Animals course also involved students in several social studies topics, such as economics and occupations. By including the work of biologists and game wardens in the research, Ms. Foster created a course component that enabled students to see science as a human endeavor, a concept stressed in the NRC standards.

At Solon, I observed several students giving their presentations in the Maine Animals class. The animals ranged from a wolverine to a skunk. Each of the students stood up in front of the class and presented his or her findings. For example, Armand, an eighth-grade boy, gave a presentation on the bobcat.

> Armand gave a very thorough report outlining the natural history of the bobcat. He had prepared two visuals to go along with his report. One was a large map of the bobcat's range and territory. The map was about four feet long and about a yard wide. Armand also brought with him an oil painting of a bobcat he had made as part of the visuals requirement. His information was accurate and addressed all of the issues required. He was proud of his work and that was obvious. (Field notes, January 6, 1995)

Watching Armand present his findings provided a great deal of insight into student participation. From my own science teaching experience, I judged his work to be of high quality. Oral presentations seemed an essential part of Solon's learning environment and allowed students to practice skills and concepts traditionally associated with the language arts. By doing so the teachers help students see the role of science in the everyday world.

Another lesson that provided a fine example of alignment of Solon's courses with national standards, was the Animal Classes course. This course was team taught by Ms. Foster and Ms. Boyer, each taking turns with a different animal group. The first two animal groups covered were birds and mammals. Ms. Foster taught a lesson about mammals, where she broke the class into four-person groups. The lesson concerned animal records.

> Ms. Foster had prepared four sheets of paper, each one with 3-4 animal records listed on it, for a total of 12 animals. She had a package of the four sheets available for each group. Every student in each group received an individual sheet that he or she was responsible for reading and explaining to the other group members. Ms. Foster gave them about 15 minutes to read and discuss the records. After 15 minutes Ms. Foster got the students' attention by asking them to think as a group about the following question: How has this ability helped an animal adapt or survive in the environment? (Field notes, December, 20, 1994)

The children began to discuss each animal at their tables and Ms. Foster allowed several minutes for them to develop their hypotheses. When she felt enough time had been spent, she went to the board and wrote the following headings: Animal, Record, and Adapt for Survival. She then asked the students to give each animal's name, its record, and their hypothesis about how the record helps the animal survive in the wild. Once an animal was listed and its record written down, the students from all the groups discussed the adaptation until one hypothesis was agreed upon, and that was written on the board. The list was completed as follows:

| Animal | Record | Adapt for Survival |
|---|---|---|
| Sperm whale | Hold breath | Must go to the ocean floor |
| Cheetah | Fastest runner | Get food (short run) |
| Prong horn | Fastest runner | Defense from animals |
| Killer whale | Fastest swimmer | Catch prey |
| Weddell seal | Hold breath | Get food and maybe defense |
| Kangaroo | Jumping | Defense |
| Giraffe | Tall | Food |

(Field notes, December, 20, 1994)

After the students and Ms. Foster spent 10 minutes putting this list together, they moved on to the next activity. Ms. Foster asked the students to create their own mammal that would exhibit a combination of some of the traits of the record holders. Students spent time thinking and then drew their mammals. I observed one 8th-grade girl create a concept web outlining the different parts of her animal before she started to draw. Some of the creatures that students came up with were quite amusing. One was a combination of a cheetah and kangaroo, with a cheetah's head and a kangaroo's body. The newly-created mammals went on display in the classroom when they were finished.

This lesson involved several features that were congruent with the NRC standards, particularly in the Life Science section. Diversity and Adaptations of organisms, Structure and Functions, Evolution and Equilibrium were all included in the lesson. The NRC standards, because they focus on skills and concepts as well as content seem to provide a framework that fits Ms. Foster's students very well.

As a final example, the lesson on bird migration, also from the Animal Classes course, illustrates the integrative nature of the curriculum, as well as its alignment with NRC standards. This lesson started with Ms. Foster asking the students to draw a map of the western hemisphere. Several students had a difficult time with this activity, particularly sixth graders, who were nervous about their maps being perfect. Other students had difficulty because they were not sure what countries were included in the western hemisphere. After the maps were drawn, students were given a handout that contained directions for a specific bird's migration route. Each person in a group received a different bird so students could share their findings. The handout mentioned several stops that each bird would make along their route. This activity was taken from the Ranger Rick Nature Scope series and the birds chosen all had long migration routes. The students were to map out the route for their birds, by locating the towns, cities, states, provinces, and countries provided in the handout and marking them on the map. When their maps were completed, students determined how far their bird had flown to reach its southern destination. The bird migration activity included several parts that met national standards, including measurement, the study of diversity, adaptation, and change. This activity also provided Solon students significant experience with map making, geography, and math. Its integrative nature allowed students to work with interrelationships of several disciplines, a common practice at the Solon School.

## Final Thoughts

It seems safe to conclude that Solon's integrative curriculum program had no trouble aligning itself with the life science standards of the NRC and that Beane's strategies are well suited for the implementation of an integrative middle level program. The data collected through classroom observations, interviews, and documents at Solon, revealed how the people involved, students and teachers alike, shaped the curriculum at the school. Although the story of Solon's middle level program is unique to the setting and individuals who participated in its creation, this report does offer several insights concerning the implications of integrative units as a middle level curriculum.

To start with, integrative curriculum takes a great deal of time and an intensive work commitment on the part of teachers. The faculty at Solon were very dedicated to the use of Beane's model and put forward an effort to make their program successful. They were intimately involved with the academics of the school's curriculum because they believed they could meet content standards and standardized assessments while still involving students in the integrative process (Hicks, 1996). The National Middle School Association (1994), in its initial position paper on middle level curriculum, supported the use of integrative experiences based on the concerns and questions of adolescents, because the experiences directly involve students in the process of education, stress learning process and educational skills, allow for individual differences in learning style, and still allow students to learn relevant content and skills.

If the Solon teachers had not trusted the students' abilities to develop sound themes or topics for courses, Beane's (1990) integrative planning process would not have worked. When faculty modification for an integrated unit is based on student-generated questions, the student is placed directly into the educational decision-making process. By doing so the curriculum takes on a whole new meaning for both teachers and students. As is evident from the Solon examples, students begin to see themselves as an integral part of the school's academic program and teachers begin to see students as copartners in the learning/teaching experience.

Most educators would admit that teaching young adolescents is hard work. The Solon experience shows that there is much more needed in the education of 10- to 14-year-olds than learning content. When educators are pressured to stick to the separate-subjects, content-driven curriculum because they believe that it is the only way to meet the national standards or that their options are limited because of geographical location and school size, then little change in curriculum will occur. Schools who choose to maintain the traditional separate-subjects model and its pedagogical format have very little time left in the school day to address the other concerns of adolescent education. Skills such as developing decision-making abilities, developing abilities of inquiry, learning to be effective problem solvers, learning to build positive relationships with peers and adults, developing the attitudes of life-long learners, and becoming responsible individuals are often times not considered. Yet, many of these skills are needed to facilitate a science program that meets the NRC standards and are essential skills students need for future employment opportunities.

If it is essential to teach children these skills, then it is time for communities and school systems to start looking at alternative curriculum models to facilitate this effort. This study strongly suggests that Beane's model, as employed by Solon's middle level program, would allow students opportunities to learn educational skills, practice applications of content, and at the same time generate effective

course work capable of meeting national standards. Although an integrative program requires an incredible amount of energy on the part of teachers, the middle level program at Solon was successful in meeting the academic and social needs of its students. The concept of integration seemed to offer this school a challenging and exciting avenue for curriculum development that was not hampered by their small size, geographical location, and sparse resources.

It seems clear that as a starting point for schools to explore alternative curricula, Beane's integrative curriculum planning strategies hold great promise for providing a solid base for the middle level curriculum.

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