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AN EXAMINATION OF INTEGRATION OF ACADEMIC AND VOCATIONAL SUBJECT MATTER IN THE AQUACULTURE CLASSROOM

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Abstract

Many view aquaculture education as an ideal vehicle to facilitate the integration of academic and vocational subject matter when it is infused into secondary or other agriculture curriculum. This national study utilized a mixed methods approach to investigate the extent to which secondary agriculture teachers employ aquaculture as a means to teach and reinforce other content areas. The study also examined the types of activities that occur within various academic areas. Results of the study indicated that approximately one-fourth of all secondary agriculture teachers incorporated aquaculture into their courses of study to some level. Those who integrate work with science teachers more frequently than with teachers in other academic areas, but some teachers have developed strategies to work effectively with areas beyond science. Most integration activities focused on environmental issues. Interviews with agriculture teachers revealed that finding ways to work effectively with other teachers and deal with territorial issues are major barriers for increased integration. Students who participated in interviews indicated that they believe aquaculture has enhanced their academic performance in mathematics and science, and made those areas more relevant for them.

Introduction and Theoretical Framework

Aquaculture is a developing agricultural education program area with potential to increase opportunities for hands-on learning at a fraction of the cost of farm-based programs. When infused into secondary agriculture, aquaculture meets needs for instruction in basic biology, chemistry, and mathematics concepts required of workers in technical jobs (Rosati & Henry, 1991). This study examined integration through the eyes of secondary agriculture teachers and others, specifically those engaged in aquaculture education. The data were collected as part of a larger study commissioned by The National Council for Agricultural Education designed to evaluate its aquaculture education programs in the United States.

Integration of academic and vocational subjects is a strategy for educational reform conceptualized by educators, supported by business, and articulated by policy makers in the Perkins Amendments (Lankard, 1992). Integration is perceived as effective in improving opportunities for youth who will face technologies that demand high-level skills. According to Erickson (1995), integrated curriculum takes thinking to levels of analysis, synthesis, and evaluation and should be used to help students understand concepts, problems, or issues from multiple perspectives, applying what they learn to real-world problem solving (p. 142).

Vocational educators have been criticized for providing "overly specific training" in structures that segregate vocational and academic education (Grubb, Davis, Lum, Plihal, &

Morgaine, 1991). Grubb et al (1991) also stated that academic educators suffer criticism for developing curriculum that lacked opportunities for students to connect learning to "real world" events. Those who study integration have maintained it can address these criticisms by 1) strengthening students' competencies in academic subject areas, critical thinking, and problem solving and 2) ensuring that students learn academic content in ways that are relevant, or by providing other contexts in which the theory has meaning (Lankard, 1992; Lee, 1997; Mabie & Baker, 1996; Meightry, 1992). Yet, in spite of research that supports integration of academic and vocational education, only one-fifth of high schools surveyed in 1994 reported that they have "some" use of integration, and more than half offered no integration at all (Sadowski, 1995).

Part of the problem is a lack of consensus about what integration means. The issue of meaning makes comparisons or evaluations difficult (Vars, 1995), but not impossible. Recent research resulted in the description of degrees of integration (Grubb et al., 1991; Sadowski, 1995) that ranged from time-alignment of instruction about a topic to elimination of subject-area boundaries in an integrated day (Sadowski, 1995). However, all models have one thing in common-teachers incorporate concepts from other discipline(s) into their respective curricula. Recently, the educational research community has focused on how learning in schools might be better contextualized so that students may transfer knowledge to out-of-school settings (Borko & Putnam, 1998). The thrust is not away from integration, but on ways to better characterize how teaching and learning must occur in an integrated setting. While a totally integrated day may be the "ideal," many schools have explored approaches that work best within their individual settings. According to Mabie and Baker (1996), "agriculture is by nature a hands-on discipline" and would seem to be a "perfect match for integration into the science curriculum" (p. 2). This is recognition of the value of agriculture examples in the science classroom as a tool for instruction, but the reverse is also true. Even in traditional areas of secondary programs (e.g., animal science, plant/soil science, mechanics) potential exists for integration with other content areas.

Since the 1988 publication of Understanding Agriculture: New Directions for Education, agricultural educators have promoted science credit for agriculture courses (Johnson, 1966). In fact, Dormody (1993) reported that 34% of all agriculture teachers taught at least one course for science credit. In a study of Arkansas agriculture teachers, most believed that offering agriculture courses for science credit would positively impact on students and programs, but recognized that the science content of their curricula must be strengthened (Johnson, 1966). Johnson (1996) also stated that the objective of any such initiative should be to use agriculture to increase student interest and achievement in science. De-emphasizing the production focus and developing courses to appeal to the total school population may be the best way to accomplish this (Gray, 1993). A serious problem in granting science credit is also an identified barrier to integration-agriculture teachers may not have strong academic backgrounds or may feel inadequately trained to teach academics (Gray, 1993). Gray also found that another barrier to integration is the physical isolation that exists between the agriculture teacher and others. Wendt (1994) found that when teachers worked together, cooperation and resource sharing increased.

Aquaculture, as an area of agriscience, is one example of where hands-on experiences complement theory in science and a variety of other disciplines. Information about the types of activities that are being used for integration in aquaculture classrooms could be useful for the development of integration models in other curricular areas of agriculture, specifically those

courses targeted for science credit.

Purpose and Objectives of the Study

This article is based on a study commissioned by The National Council for Agricultural Education to evaluate aquaculture education. Objectives for this portion of the study were to 1) Determine how many aquaculture teachers integrate their curriculum with other areas, 2) Identify examples of integration, 3) Describe integration as related by teachers and students, and 4) Identify how it is being implemented and its success. Integration activities were defined as those involving joint use of facilities, team teaching, guest lecturing, and curriculum alignment.

Methods of the Study

This study utilized a multiple methods approach-surveys, interviews, and focus groups-to allow for a more holistic understanding of aquaculture as a means to integrate academic and vocational subject matter. The population for the study was all United States agriculture teachers, with an accessible population of 9,747 members of the National Association of Agricultural Educators (NAAE). A random sample of 750 teachers was drawn (Krejcie & Morgan, 1970) for use with a survey focused on aquaculture. Dr. G. Wingenbach, West Virginia University, authorized adaptations of one of his surveys for the fixed-response portion of this study (Wingenbach & Gartii 1997). A panel of experts determined content and face validity; a pilot test was conducted and suggestions incorporated into the final document. Since scaled items were not used as a group for any analyses, internal consistency was not calculated.

The revised instrument was mailed to participants with follow-up mailings sent to nonrespondents. Nineteen undeliverable surveys reduced the accessible sample to 731; a total of 406 returned surveys yielded a 55.8% response rate. Follow-up calls to 25 randomly selected nonrespondents (Gall et al, 1996; Tuckman, 1994) yielded no significant differences between them and respondents on selected items (Yrs. taught, t=-1.2; yrs. known about aquaculture, t=-.473; mean, meets needs to teach science, t=-.234; mean, helps learn science, t=.247).

Interviews and Focus Groups

A total of 161 persons were interviewed. Maximum variation sampling (Patton, 1991; Seidman, 1991) was used to select sites and participants for one-on-one interviews with teachers and students. The sampling was based on geographical location, program size, presence or absence of aquaculture industry in the area, and extent to which aquaculture was a part of the curriculum. Sites included Arizona, Indiana, Louisiana, Texas, New York, and Washington. Interviews of 28 adults and 10 students used open-ended questions and the standardized open-ended interview process (Gall et al, 1996) to inquire about their experiences in and perceptions of integration and ways in which it occurred. Four additional students-all seniors planning on entering postsecondary education in an aquaculture related field-also participated in an informal conversational interview held as a group discussion. They were purposefully sampled (Gall et al, 1996; Patton, 1991; Tuckman, 1994) based on their postsecondary plans.

One hundred students attending the 1997 National FFA Convention were interviewed as to how aquaculture is related to mathematics, science, or other subjects. The interviewees were randomly selected from students walking by a booth at the career show. They responded to short, open-ended questions with responses recorded on paper by the interviewers. This site was selected to have access to a large pool of agriculture students from across the country.

Two focus groups conducted during the AAAE/NAAE Eastern Region Conference, included 11 teachers, two college faculty, one industry representative, and one state education department employee. There are limitations to using data from one region and it is not assumed that participants in the Eastern Region represented those on the national level; however, interviews conducted with persons in other regions did not reveal any differences in opinions. Four Regional Aquaculture Learning Center (RALC) directors participated in a focus group held at the 1997 National Aquaculture Inservice. They were purposefully sampled (Gall et al, 1996; Patton, 1991) due to their unique position as both teachers of aquaculture and RALC directors. While four participants are not considered sufficient for most focus group situations, this number represented 80.0% of all RALC directors and results, therefore, provided sufficient depth from their perspective as representatives of that group (Gall et al, 1996; Patton, 1991). All interview data were sorted and analyzed for emerging themes or constructs using a reflective analysis process (Gall et al, 1996). Trustworthiness of the data was ascertained through triangulation; maximum variation, purposeful and random sampling; a detailed audit trail; cross-member checks; and juxtaposition with the quantitative data.

Results

Objectives 1 and 2 were addressed utilizing a survey to determine how many aquaculture teachers integrated as well as to identify examples of activities. Of the 406 respondents, 96 (23.6%) taught aquaculture, 15 (3.7%) stated they had taught it in the past, and 189 (46.6%) indicated an interest in teaching it for a total of 300. This group responded to Likert-scaled statements about factors related to decisions to teach/interest in aquaculture; two statements were related to how aquaculture could help meet goals related to science instruction (Table 1). Table 1 reveals that both statements were rated important in considering aquaculture as a program offering in terms of its usefulness to teach more science and whether it might help students learn more science than other agricultural content areas.

The 96 aquaculture teachers indicated they had known about aquaculture, on average, 7.3 years and had taught it for an average of 5.3 years. They also indicated that aquaculture has created interest in their programs--combined enrollments totaled 7,565 students and 21,539 non-agriculture students toured their facilities in the 1996-97 school year to view their tanks and fish.

Integration of Aquaculture and Other Content Areas

Persons teaching aquaculture were asked whether they worked with other teachers in their districts to 1) create opportunities for other teachers/students to use their facilities to present academic/other content in an applied way, 2) team-teach with members of other departments using aquaculture as the theme, and 3) present guest lectures on aquaculture to other classes. They were also asked to identify departments with which they conducted activities. Forty-one teachers (42.7%) stated they worked with other teachers to integrate in some way. Of these, 16 (16.7%) indicated that others, primarily biology teachers, used their facilities regularly to teach. However, chemistry and environmental science teachers also used their facilities (Table 2). Teachers provided specific examples of efforts to integrate aquaculture with other teachers (Table 3) and all indicated they expected to expand their integration activities.

Emergent Themes from the Qualitative Data

An analysis of the interviews resulted in the emergence of three themes: 1) levels on which integration occurs, 2) levels of success of activities, and 3) benefits to students. These themes will be used to describe activities and

Table 1. How Aquaculture Can Help Meet Program Goals Related to Integration

		Teachers' ranking (n=300)	
	N	m	SD
Aquaculture education meets the need to teach more science.	295	3.21	0.81
Aquaculture helps students learn more science than many other agriculture content areas.	297	3.00	0.77

Note. Scale: 1=Not Important, 2 = Somewhat Important, 3 = Important, 4 = Very Important
Note. Total of 300 participants reflects those teaching aquaculture (n=96), those who have taught it in the past (n=15), and those who are interested in teaching aquaculture (n=189).

Table 2. Integration of Aquaculture with Other Content Areas

Type of reported integration	N[a]	%[a]	Courses (# teachers)
Other teachers/students use my facility on a regular basis (six or more times per semester).	16	16.7%	Biology (15), chemistry (6), envir-onmental science (3), general science (3), math (1), physics (1), marine biology (1)
Other teachers/students use my facility some throughout the year (< six times per semester).	24	25.0%	Biology (21), chemistry (8), general science (4), earth science (2), environmental science (2), physics (1), math (1), biotechnology (1)
I team-teach with members of other departments using the aquaculture facilities.	13	13.5%	Biology (11), chemistry (2), general science (2), math (1), physics (1), environmental science (1)
I present guest lectures on aquaculture to other students in other departments.	14	14.6%	Biology (10), chemistry (2), elementary science (2), environmental science (2), math ((1), general science (1)

[a]Total respondents=96; individual teachers may be listed as participants in more than one level of integration.

Table 3. Integration Activities

Department	n	%	Example activity (# teachers)
Science	26	27.1%	Water quality testing (9), dissection labs (4), pond and stream restoration (2), wetland fish management project (1)
Language arts, English	5	5.2%	Debate teams (3), term papers (2), public speaking (2)
Elementary	5	5.2%	Tours of facility (2), fish projects (2), wildlife assembly (1), set up' aquarium (1)
The arts	2	2.1%	Fish print/anatomy project (1)

Note. Total participants=96; some participants identified activities with more than one department.

strategies related by teachers and students to identify how it is implemented and its success in various settings (Objectives 3 and 4).

Levels on Which Integration Occurs

Analysis of the interview data revealed a dual nature to the integration of aquaculture with academic subjects. It occurred on both structural and instructional levels. One teacher reported after-school and summer programs in which instructors from various disciplines- language arts, math and science-meet with 25 students in the aqualab for work and instruction. This structural change overcame contract issues and resulted in more integration in the overall school. Others provided insight into structural integration within their schools/ communities:

> Aquaculture has become the core vehicle for instruction and integration within our total Schools-to-Career Program. Our facility was built with that in mind.

> All the schools in my district now offer aquaculture as a science as well as vocational class, so students can earn a vocational credit or a science credit.

Integration also occurred at the instructional level as verified by both the quantitative and qualitative data. Science departments were the primary partners in integration efforts for aquaculture teachers, yet teachers were very aware of other opportunities:

> The math teacher has a class in statistics. . . he has his kids come down and monitor the growth of the fish weekly. They plot their findings and project growth rates. . . In our district we've looked at what students need to go on to higher education.. . all of them have to have certain work skills... we can teach these in aquaculture.

The most insightful discussion of the thematic nature of aquaculture for integration came from a teacher who expressed that aquaculture is a tool for teaching about a lot of different things, citing math, science, social interaction, economics, and entrepreneurship. Echoing this, RALC Directors stated their programs are integrated with most departments in their schools. Home economics teachers provided instruction on nutrition related to fish, business students maintained financial records, and graphics arts students created promotional materials, as examples. This total school focus required both structural and instructional levels of integration.

It is interesting to note several differences between teachers who felt successful at integration vs. those who did not. Those who did indicated they were inadequately trained to teach scientific aquaculture, and they often sought assistance from science teachers. They also felt they have relied on their academic counterparts to enhance the rigor of their courses, expressing a lack of knowledge about teaching science and math.

Students also had a lot to say about the instructional integration of aquaculture with other areas. Most of them cited mathematics and science, particularly biology, as the major areas of instruction in which they saw integration occurring as evidenced by two students:

> In biology we learned about parasites that could kill the fish in our aquaculture system. We used math in a very practical way. You have to do water testing . . takes math, and you have to do the science, too.

They were also aware that the complement worked both ways; one student indicated, "math and science couldn't really be separated from

aquaculture and vice versa."

Levels of Success of the Integration Activities

All teachers interviewed indicated that integration with science has the greatest potential, and most activities occurred with science departments in their schools. This supported the quantitative data outlined in Tables 1 and 2. However, teachers had varying levels of success integrating with other disciplines. Teachers felt that two things--territoralism and time--most impacted success. General consensus was that there aren't enough hours in the day to work, take care of tanks, and discuss lesson plans with others. One teacher related, "Integration with math in the school is the hardest thing I've ever dealt with." Another supported this by sharing, "Everybody has this little ring around him or her. . . it's hard to step inside." However, it appeared integration may also be influenced by the personalities of individuals and was not necessarily discipline-specific. This is evidenced by the fact that some teachers, in contradiction to the above statements related to math, have found their math departments to be cooperative.

Teachers felt that a change from the traditional vocational emphasis resulted in more ability to develop cross-curricular opportunities. One teacher shared that once he changed focus from production, opportunities to integrate with the total school program became available:

> Our desire in aquaculture is to give kids an opportunity to get exposure to raising fish... to a field that uses writing and mathematics. We still want to produce fish, but we're more concerned about learning processes than the end product. . .

The level of success with instructional integration was related to structural integration. In schools where teachers felt they had administrative support, or where aquaculture was a theme for integrated instruction, time and other issues related to integration and planning were at least partially resolved. In schools where this level of support was not evident, teachers were only as successful as their individual efforts and those of others involved, often at their own expense.

Benefits of Integration to Students

Students and teachers alike stated that aquaculture was an important vehicle to enhance their (students') understanding of mathematics and science principles. With few exceptions, student interviewees believed that tasks they performed in aquaculture labs improved their performance in science and mathematics. Students interviewed at one school all felt they did better in math and science classes because of what they were learning in aquaculture:

> Practical math problems in aquaculture make you care about learning math. It helps you relate to other subjects.. . the [chemistry teacher] really had us hooked.. . it was something we liked.. . and we already knew it.

Both teachers and students perceived aquaculture as beneficial beyond academics, particularly when considering life skills-those non-content skills necessary for successful adulthood (e.g., SCANS). Students expressed an appreciation for the responsibility they gained as part of their aquaculture classes, relating the level of care they provided to fish survival. The aspect of caring for another living thing had dramatic impact on students as related by one teacher:

> I had this one kid ... Mom didn't want him; dad didn't want him. . . he kept getting kicked out of school and that sort of stuff. Then he got involved in taking

> care of the fish. Right now he is working at a waste treatment plant and he can explain the biology of what is going on the system. He flunked biology three times, but he can explain nitrification in an aquaculture system to you.

This sentiment was echoed by an administrator who related that aquaculture has "provided us an avenue for a lot of kids, and we do have a lot who stay here to work to make a living." This administrator saw aquaculture as assisting students, particularly those who would not leave the community for further education, to develop the life skills necessary to become productive. It is important to note that this belief was held even though the specific community has no aquaculture industry-the skills were transferable to other workplace situations.

Conclusions, Recommendations, and Implications

The quantitative portion of this study can be generalized to the entire population. The researchers will follow the examples of Sandra Wilson and Lee Cronbach and place the responsibility for generalizing the results of the qualitative data analysis on the readers of this study so they can determine the applicability of the findings in their own situations (Cronbach, 1976; Gall et al, 1996; Wilson, 1979). Most secondary agriculture teachers who offered aquaculture were not integrating their course content with other teachers in their schools. The teachers who were involved in integration worked in a variety of contexts and content areas-primarily science, but also in mathematics, language arts, the arts, and elementary school science. The teachers interviewed as part of this study all agreed that integration is desirable, as did the majority of those surveyed, and most believed it is possible. Participants believed that aquaculture also generated interest and visibility for them, and may have lead to the increased likelihood of integration through enhanced interactions with other teachers and students.

There is much potential for agriculture teachers to integrate academic and vocational subject matter, but it is hard to do. Curricular integration as it has been identified through an analysis of both the quantitative and qualitative data, consisted largely of teachers and students getting together to conduct activities over the course of the year. While some argued that even this superficial approach to integration is worthwhile, some perceived it to have disadvantages. Specifically, agriculture may still be the "vocational ag" class at the end of the hall that "has a fish tank that we can use once in awhile." It is only in a few locations where aquaculture was utilized as a theme to link instruct among several curricular areas or throughout the entire school that there was joint planning and development of outcomes and assessments. It was also evident that where structural barriers to integration were removed integration is multi-disciplinary in approach and effective. Teachers, students, and administrators also viewed aquaculture as having potential to address workplace skills and promote youth development.

The results of this study support prior research (Johnson, 1996; Miller & Gliem, 1996; Miller & Gliem, 1993) that indicated agriculture teachers might not have the necessary academic backgrounds to teach other subjects to some level of depth. Teacher education programs should examine program requirements to determine if their graduates have the prerequisite skills to address the needs of the integrated classroom as well as the technical agriculture industry. Ways to incorporate the pedagogy of teaching science, as well as how to revise materials to include scientific principles, should also be explored. Research into these issues will be necessary to determine how to do this and integration with other teacher education programs may be appropriate. In addition, we should partner with colleagues in

educational administration to conduct research focused on elimination of structural barriers to the integration.

Agricultural educators have known for some time that they can develop programs to integrate economics, computer skills, and other areas into their curricula. As one example, aquaculture provides experiential science and mathematics education to help meet demands for cross-curricular integration. The more important implications of this study may be those derived from an examination of when and how integration worked, and development of ways to replicate those situations in a variety of agriculture classrooms. The key to effective integration did not lie with aquaculture; rather, successful integration was possible when individual teachers made it happen. The more support received at the administrative level, the more successful the integration was likely to be. It is likely that any thematic approach, when taken seriously and utilized for interdisciplinary outcomes and assessments, would yield the same successful results as those reported by the agriculture teachers who integrate using aquaculture (Erickson, 1995).

Why is integration important? Caine and Caine (1991), in their book titled Teaching and the Human Brain, differentiated between surface and meaningful knowledge. For knowledge to be meaningful, students must be able to perceive relationships and patterns to make sense of information, activities classified as "brain-based learning." Erickson (1995) contended that integration supports and enhances brain-based learning as it is a way to facilitate the brain's search for patterns and connections. An integrated curriculum also develops depth of understanding by presenting a message through a variety of contexts and disciplines.

Implications also exist for teacher education in agriculture that has, traditionally, remained isolated from teacher education in the academic disciplines. Current efforts such as the National Council's Reinventing Agricultural Education for the year 2020 initiative must give attention to pedagogical reforms which may be critical for success of future teachers including the "how to" of integration. Also, removing structural barriers at the college level may be a necessary precursor to removal of barriers that exist in the public schools.

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