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Conclusions on Using a Constructivist Approach in a Heterogeneous Classroom

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EDITORS' INTRODUCTION

Valaskey's project provides a unique account of one high school's efforts to de-track its Biology classes. Working in tandem with the special education department, Valaskey and his colleagues use assessment data, interviews, questionnaires, and student work to justify their efforts in providing equitable experiences for all students regardless of age, sex, cultural or ethnic background, or interest and motivation in science. By analyzing attendance rates, examining responses to attitudinal surveys, and interviewing all actors within the project, Valaskey recounts the successes he encountered, while also identifying areas for future study.

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INTRODUCTION

Teachers who, like me, have been in the classroom for more than 30 years and have seen teaching fads come and go are very selective about what new pedagogy and teaching tools they put into practice. Teachers who keep current by reading professional journals and attending professional conventions often pick up good ideas to use in their classrooms. Often these new ideas look good on paper but then don't work well in the classroom. So, as the years of teaching go by, veteran teachers often become leery of new pedagogical practices that come across their paths. Will this one be just another fad or will it endure the scrutiny of those in the trenches?

I was one of those veteran teachers; I taught biology and other sciences for 32 years at an urban public high school attended by approximately 2,000 students. During that time, the high school's minority population more than doubled. Many of these students had high needs because they came from dysfunctional families and poverty. As the school's population continued to change in composition, many perceptive and experienced teachers at this school were finding that they needed to change their teaching methods. Traditional modes of teaching were not engaging many disadvantaged and minority students in the classroom experience. I saw numerous frustrated teachers wondering why they could not get many of their students excited about their curriculum.

In the early 1970s, the school district created special classes to serve students with special needs. Some of those classes still exist today. Ability grouping seemed like the perfect solution, and teachers became experts at imparting knowledge to homogeneously grouped students right at the students' level of understanding.

Why would a biology staff at the public high school described above want to change the practice of homogeneous grouping? All those homogeneously grouped classes were started with the best of intentions and seemed to be working over the years. However, as the minority population continued to increase, it became painfully obvious that the lower-level classes contained a disproportionate number of minorities who were also often tagged as special education students. Apparently, this trend was occurring at many high schools. Black students nationwide are twice as likely as White students to be assigned to special education (Richardson, 1994).

The biology staff felt the need for a new approach to address the school's changing population. Most of the staff attended workshops and several attended summer school sessions on multicultural education. They also studied the new science standards and read professional journals about new constructivist pedagogy that could be used to address the needs of all students. As a result, the biology staff and special education staff made the decision to abandon two lower-level biology classes as well as some special education science classes. Over the years, the staff had come to believe that the changes they would be undertaking were necessary for the benefit of all students.

The decision to group students heterogeneously in Biology I classrooms left us wondering if we would be able to manage all the students in an inclusive environment. To address this concern, more effort was made to give all students opportunities to work together and experience biology in ways meaningful to them and their peers. Teachers used a constructivist approach by giving up some control of the learning process as they spent less time feeding students information and more time interacting with students while guiding them in their quest for knowledge. Students gained scientific knowledge by using the tools and processes of science in their design of laboratory protocols to solve problems while interacting with their peers. Teachers had to adjust to guiding students, because they were accustomed to dispensing scientific knowledge by simply presenting textbook facts obtained by others and offering "cookbook" labs that contained problems already solved by others. Academically talented students also played a part by serving as role models for their peers during the learning process. Would these academically strong students accept the challenge and benefit from it, or would they feel burdened and in the process eventually lose interest in science? Our biology staff embarked on a journey that we hoped would result in lasting and meaningful change for the benefit of all our students.

The following study reflects the experiences of biology staff, special education staff, and students working together on "inclusion" in a Biology I classroom. Because I expected my students to use a format that required showing how they worked with scientific processes, I decided to conduct this study using a similar format to present my findings on inclusion in heterogeneously grouped classrooms. Therefore, this action research paper includes the following processes: question, problem, hypothesis, rationale, materials, procedure, observations, analysis, conclusion, and extension.

THE QUESTION AND PROBLEM

How can the science department and the special education department group a wide variety of students heterogeneously in an inclusive regular education biology classroom and make the experience successful for all students and staff?

Our high school had homogeneously grouped special education science classes and lower-level biology sections with disproportionately high numbers of Black students in them. The lower-level classes were made up of combinations of students who had poor reading scores, discipline problems, poor grades, and/or attendance problems. These special education classes and lower-level classes were formed with good intentions; however, federal studies have found that students of color achieve better in "regular" classes if they receive extra support (Richardson, 1994). These special classes were provided for students with learning disabilities, deficiencies in math and science, and other problems that normally would prevent them from experiencing success in the traditionally taught "regular science" classroom. Students often were absent from the special science classes, and the frequent absences kept students from having a successful science experience. One researcher notes that "creating special science classes frequently leads to a lowering of standards, because teachers of these classes often employ prescriptive teaching and remedial approaches that result in lower achievement" (Heshusius, 1988). All students deserve access to an equal education, and the biology staff realized that access to equal education was never going to happen unless significant changes were made.

HYPOTHESIS

If the biology and special education staffs embrace change by heterogeneously grouping students and by implementing inclusive strategies and other practices consistent with the objectives set forth in the National Science Education Standards, this will result in a successful experience for students and staff as measured by increases in student attendance and grade point averages among lower-achieving students, and increased positive attitudes as reflected by surveys administered to all biology students, the biology staff, and the special education staff.

RATIONALE

The biology staff at the high school wanted to test the above hypothesis because we believed that all students, regardless of age, sex, cultural or ethnic background, disability, or interest and motivation in science, should be accountable for meeting higher learning and social standards. The staff was not satisfied with the school's homogeneously grouped lower-level life science classes, which, they thought, lowered standards for students and were comprised of students with poor attitudes toward science and school. The lowered standards also existed in the Project 9 biology classes that were designed for students with low reading skills; however, these students generally had better attitudes about school than did the life science students. Many of the special education students were either in the Life Science class or in a particular science class taught by a special education instructor. The life science, Project 9, and special education science classes contained few students who could serve as role models of motivated students interested in science.

The National Science Education Standards assume the inclusion of all students in challenging learning environments. Excellence in science education embodies the ideal that all students can achieve understanding of science if they are given the opportunity (National Research Council, 1996). The biology staff embraced a constructivist teaching approach, which leads to the type of learning environment that the National Science Teachers Association (NSTA) suggested would benefit all biology students (National Science Teachers Association, 1996).

Most of the biology staff had extensive professional development experience with multicultural science education, in which "cooperative learning" activities were created and the importance of these activities in getting all students involved in the science classroom was emphasized. "Tomorrow's classroom will be a more social place, since teachers will recognize the social component of learning. Collaboration and discourse will be constant components of lessons, as teachers assume the role of leading students in a community of learners" (National Science Teachers Association, 1996). The biology staff also considered Howard Gardner's theory of multiple intelligences in designing curriculum (Gardner, 1993). Traditional teaching strategies and assessment depend either on how well a student uses logic and mathematical intelligence to analyze language and mathematics or on how well an individual can memorize facts. Therefore, students who have mastered analytical skills and who can memorize well get good grades. Grades and test scores may reward only a fraction of the students who should be rewarded. "The more we teach and assess students based on a broader set of abilities, the more racially, ethnically, and socioeconomically diverse our achievers will be" (Sternberg, 1997, p. 22). At times, assessment of multiple intelligences was frustrating to some students and parents because those students who demonstrate logical/mathematical intelligence generally get good grades when traditional school evaluation methods that emphasize test scores are used. The evaluation of new skills as part of overall intelligence means that such students will not always get the top scores in class. One summer workshop placed an emphasis on the "three P's" (problem posing, problem solving, and peer persuasion) of science. The implementation of the three P's can occur when cooperative groups of students propose a problem and construct their own labs to solve a problem. They are generally persuading their peers when decisions are made about what steps to take in problem solving and with the presentation of data. In addition to learning about the topics described above, which were covered in multicultural science summer workshops, some of the biology staff had read about or taken workshops on implementing the learning cycle. "Research supports the learning cycle theory as an effective way to help students enjoy science, understand content, and apply scientific processes and concepts to authentic situations" (Colburn & Clough, 1997, p. 32). Some staff members had also studied brain-based learning. Practices suggested in brain-based learning provide a framework for learning and teaching that moves us away from the methods and models that have dominated education for more than a century. Students are no longer the passive recipients of knowledge, but acquire it actively through collaborative effort by solving problems that have meaning to them. The staff believed that they could take pieces from all these practices and assemble them into a pedagogy that was congruent with the National Science Education Standards (National Research Council, 1996).

A constructivist approach formed the backbone for implementing the National Science Education Standards (National Science Teachers Association, 1996). Fundamental to this approach is a shift from teacher-directed instruction, typically using books and worksheets, to student-centered instruction, where students learn by exploring, predicting, researching, and investigating concepts. The biology staff would help students to see that learning science is something that students do themselves, not something that is done to them by their teachers. The purpose of testing the hypothesis was to evaluate if using this approach in biology would result in better attendance, attitudes, and success for all students.

SOURCES

- The school district database for attendance
- The school district database search for grades
- The school district database search for Wisconsin Student Assessment System (WSAS) science scores
- The school district database search for WSAS reading scores
- Surveys to measure students' and teachers' attitudes
- Middle school teachers' recommendations for student placement into lower-level life science classes
- Special education teachers' recommendations for student placement into life science classes

PROCEDURES

1. In the spring semester before the inclusion model is implemented, meet with a facilitator from the school district's staff development

department to lead the biology staff in discussion and planning for curriculum change.

2. Invite the building principal and a representative member from the special education department to the first meeting. (The biology staff felt a need for support from the administration and input from the special education staff to proceed. The principal provided us with staff development funds for the extra hours when meetings occurred beyond the school day.)
3. Set up ground rules at the first meeting and establish a calendar for future planning.
4. Develop a philosophy statement (Appendix A) that the biology and special education staffs can agree on, and use this statement to guide all future changes.
5. Meet with the special education staff and develop a plan for their regular involvement in planning and for their presence in biology classes.
6. In the spring semester before the implementation of the inclusion model and during the fall semester when the inclusion model was implemented, use extended afternoon meetings once per month for long-range curriculum planning and use weekly morning meetings for updates and assigning of tasks to biology team members.
7. In the spring semester before the inclusion model is implemented, administer a survey (see Appendix B) to students in the current lower-level life science classes.
8. In the fall semester when the inclusion model is implemented, obtain WSAS scores in reading and science for students taking Biology I.
9. Obtain input from the special education staff about students they normally would select for a lower-level life science class.
10. Get recommendations from middle school teachers about the previous year's students whom they would have recommended for lower-level life science courses.
11. Use the information from steps 8, 9, and 10 to identify students in Biology I who would have been in either a Project 9 class or a lower-level life science class. Students with very poor reading scores and good attendance who demonstrated a desire to learn were selected from Biology I students (I will always refer to this group as the heterogeneously grouped Project 9) to compare to the previous year's Project 9 class (I will always refer to this group as the

homogeneously grouped Project 9). Middle school and special education teachers' recommendations along with poor WSAS science scores were used to select from Biology I students (I will always refer to this group as the heterogeneously grouped life science) to compare to the previous year's lower-level life science Class (I will always refer to this group as the homogeneously grouped life science).

12. At the end of the fall semester, gather the previous year's first semester data from the lower-level, homogeneously grouped life science classes to compare attendance and grade point average (GPA) data from this year's heterogeneously grouped life science students in Biology I.
13. Gather previous year's first semester GPA data from the homogeneously grouped Project 9 class to compare to GPA data from this year's heterogeneously grouped Project 9 students in Biology I.
14. Compare the attitudes of the homogeneously grouped life science students toward conventional labs (see Appendix B) to how it might have changed the following year with heterogeneously grouped life science students doing constructivist labs in Biology I.
15. Administer a survey on student attitudes toward project activities as learning experiences (see Appendix C).
16. Have students who had an "A" average in biology at the end of the semester identify themselves on the survey to get insights into the attitudes of these students toward constructivist labs and cooperative learning.
17. Conduct a survey of the special education staff and the biology staff to determine the level of support for the curriculum changes and the staff members' perceptions of the impact of this philosophy on students (see Appendix D).
18. Revisit the philosophy statements developed in step 4 to see if the special education and Biology I staffs still feel that they apply.
19. Analyze the impact of curriculum changes (independent variable) on the attendance, attitudes, and success of inclusion of all students (dependent variable) in Biology I.

OBSERVATIONS

The first-semester data for the heterogeneously grouped life science students in Biology I were compared to actual data from the previous year's first-semester, homogeneously grouped life science classes. Table 1 displays the results.

Attendance data from the school district's database for the previous year of the homogeneously grouped life science classes shows students absent 9.5 percent of the time (see Table 1.). The heterogeneously grouped life science students in Biology I were absent 5.8 percent of the time. The grade point average of the heterogeneously grouped life science students in Biology I was 1.74, which was slightly higher than the 1.71 grade point achieved by the homogeneously grouped life science students. That is significant, since students in the homogeneously grouped life science classes were given passing grades if they showed up on a somewhat regular basis, regardless of their classroom performance. Approximately 45 percent of the heterogeneously grouped students in Biology I who were used for the comparison were from a minority population, which was similar to the minority makeup of the homogeneously grouped life science classes.

The heterogeneously grouped life science students in Biology I had a 16 percent failure rate, as compared to the 19 percent failure rate for the homogeneously grouped life science classes. The homogeneously grouped and heterogeneously grouped Project 9 students attended class regularly and demonstrated a desire to learn; however, their WSAS reading scores were very low compared to their peers. Table 2 displays the first-semester GPA data for the heterogeneously grouped Project 9 students in Biology I compared to the first-semester GPA data from the homogeneously grouped Project 9 classes.

One of the heterogeneously grouped Project 9 students failed Biology I. However, the GPA of all heterogeneously grouped Project 9 students in Biology I was 2.06, which was slightly higher than the 1.94 GPA of all students in the homogeneously grouped Project 9 classes.

A large part of the Biology I class experience involved constructivist labs. The special education staff administered a survey to the Biology I students (see Appendix B) to find out how they felt about some of the constructivist lab activities done in cooperative groups as compared to conventional labs done in groups where roles were not assigned. Table 3 displays the results.

Biology I "A" students were asked to identify themselves. Table 4 displays the results for these students.

All students preferred the constructivist labs, in which each student had a cooperative and interdependent role, to the conventional labs. When students participated in constructivist labs, they worked in cooperative groups to define problems and they designed lab protocols to solve those problems. Students working in cooperative groups strongly supported the

Table 1 Data on Biology I students who would have likely been in lower-level life science classes versus actual data on lower-level life science students from the previous year

Number of Students	*Ethnicity*	*WSAS* Average Science Score (out of 7)*	*1st Semester Average GPA in Life Science (out of 4.0)*	*1st Semester Average GPA in Biology*	*1st Semester Absences in Life Science*	*1st Semester Average Biology I Absences*
17	White	5.82	1.69	1.64	8.20	5.59
7	African Am.	4.14	1.59	1.57	3.52	0.86
4	Asian	4.00	2.49	2.50	4.53	2.25
1	Native Am.	4.00	1.33	2.00	1.17	0.00
2	Hispanic	5.50	0.84	1.50	9.67	7.50
Overall Avg:		**5.1**	**1.71**	**1.74**	**6.54**	**4.03**

*WSAS = Wisconsin Student Assessment Proficiency exam

Table 2 Data on Biology I students who would have likely been in a Project 9 class versus actual data on Project 9 students from the previous year

Number of Students	*Ethnicity*	*WSAS* Reading Score Average (out of 7)*	*1st Semester GPA Average in Project 9 (out of 4.0)*	*1st Semester GPA Average in Biology I*
8	White	3.75	2.18	2.25
4	African Am.	3.00	1.29	1.50
3	Asian	2.33	2.39	2.33
1	Native Am.	4.00	1.33	2.00
Overall Avg:		**3.31**	**1.94**	**2.06**

*WSAS = Wisconsin Student Assessment Proficiency exam

Table 3 All Biology I students surveyed on constructivist lab activity

Survey Question	*% Agree*	←→			*Disagree*
I prefer constructivist labs over conventional labs.	34	20	23	11	12
I prefer working in lab groups versus individually.	63	19	9	5	4
I like groups made up of students with various skill levels.	45	16	23	11	5
Everyone is learning when peers help peers.	49	19	19	7	6
Students get to know each other better in constructivist lab groups.	55	27	11	5	2
Students should evaluate other students.	59	14	11	8	8
Group work results in less classroom conflict.	42	20	25	5	8
I use cooperative skills during constructivist lab activities.	70	20	7	2	1
Everyone in my group carries out their role.	47	23	18	5	7

opportunity for evaluating the effort of each group member and they believed that group work resulted in less conflict. While students preferred constructivist labs to conventional labs, the "A" students seemed to prefer them more. All students in the biology classes in general felt they used cooperative skills during constructivist lab activities; however, "A" students seemed to use them less.

Students made a variety of comments on their surveys. A distillation of some of the more important statements includes: students would like to have some input on the selection of groups; they said it was a good way to meet and get to know new people; peer evaluation seemed to be one of the

Table 4 Students with "A" grades in Biology I were identified

Survey Question	*% Agree*		←→		*Disagree*
I prefer constructivist labs over conventional labs.	15	57	21	7	0
I prefer working in lab groups versus individually.	36	29	21	14	0
I like groups made up of students with various skill levels.	22	7	57	14	0
Everyone is learning when peers help peers.	36	14	29	14	7
Students get to know each other better in constructivist lab groups.	29	50	14	7	0
Students should evaluate other students.	72	14	7	0	7
Group work results in less classroom conflict.	65	14	14	7	0
I use cooperative skills during constructivist lab activities.	28	22	29	21	0
Everyone in my group carries out their role.	36	32	21	4	7

more popular choices; group activities can work well, but group members did not always listen; and students enjoyed working in groups as long as everyone worked.

In addition to constructivist activities, the Biology I students completed more projects than biology students did in previous years. These projects were often done in cooperative groups. Interdependence was created within the groups, because all group members were assigned different roles. Students were encouraged to be creative with their projects. Groups created models, produced videos, performed skits, and wrote songs and poems, to name just a few of the activities.

To obtain feedback on project activities, the Biology I staff decided to have Biology I students complete a survey (see Appendix C) that looked at a specific project completed during the unit on cell structure and function. Table 5 displays the results.

One response on the project survey that stood out above all others was that students felt they used cooperative skills with project activities. Students also seemed to feel comfortable with guidance they got from their teachers and thought that there were adequate resources to complete projects and that they could not have earned a higher grade if they had done the projects individually.

The survey in Appendix D was administered to the special education and biology staffs after they had worked for two semesters on curriculum changes. Table 6 displays the results.

One of the six biology teachers felt strongly that not all students learn well in a heterogeneously grouped environment, which lowered the

Table 5 Biology I students were surveyed on a project activity

Survey Question	*% Agree*		⟷		*Disagree*
I enjoyed doing this activity.	36	35	21	6	2
I learned a lot during this activity.	47	22	23	6	2
I learned a lot from other groups on the subjects they presented.	31	35	25	8	1
I used cooperative skills during this activity.	70	17	10	2	1
I could find the information I needed to complete the project.	58	25	13	3	1
My teacher provided enough guidance.	62	19	15	2	2
Everyone in our group contributed to the success of the project.	40	25	19	13	5
There was enough time to complete the activity.	40	23	24	8	5
I could not have gotten a higher grade doing the project myself.	47	15	19	5	14

average for this statement to 2.67. All the other biology teachers felt that students learn well in a heterogeneously grouped environment.

At the end of the first semester, the biology and special education staffs revisited the philosophy statements (see Appendix A). All staff members felt that the philosophy statements were still appropriate. The three statements that everyone believed were the most appropriate were:

1. All students, regardless of educational or ethnic background, have the ability to learn and be successful in an integrated Biology I classroom.
2. Biology should be an active, hands-on process that includes the three P's of problem posing, problem solving, and peer persuasion.
3. All students need to learn the skills of working together successfully in group settings.

The three statements that were the least appropriate include:

1. If teachers plan and work together, Biology I will be a quality experience for all.
2. Students learn in diverse ways, therefore need diverse assessment strategies to measure diverse learning styles.

Table 6 Biology I and Special Education staff feelings on Biology I program

	Average for Survey Question Agree (5) to Disagree (1)	
	Bio	*SpEd*
I feel that heterogeneous grouping is a good idea.	5.00	4.75
I feel that students of all ability levels should learn to work together.	5.00	5.00
Students learn the subject matter better if they are guided into finding the information themselves rather than the teacher presenting to them.	3.67	4.50
Students working in cooperative groups tend to get more out of labs than if they work individually or in pairs.	3.67	4.25
Learning is going on by all heterogeneously grouped members	2.67	4.00
Students tend to prefer constructivist labs over conventional labs.	3.00	3.75
Students should have the experience of evaluating peers.	4.00	4.50
Student groups should be made up of students with various ability levels.	4.83	4.75
Placing special education students in a regular classroom is a good idea.	5.00	5.00
Placing special education instructors in the classroom to team with a regular education teacher is a good thing to do.	4.83	4.75
I believe we are headed in the right direction with our Biology I program.	4.83	4.75

3. Parents need to serve as partners in the education of their children, and therefore need to be involved in the assessment of their children.

In addition to responding to the statements in Appendix A, the biology and special education staff members made these paraphrased comments:

1. It is important to take responsibility for the learning of all students.
2. Ensuring participation by all group members is a challenge.
3. Roles need to be clearly defined for each cooperative group member.
4. Students claim they have to work too hard with constructivist labs.

5. Some ninth graders are not ready for self-evaluation and peer review.
6. Some students with involved learning and behavior problems may interfere with the learning of their peers.
7. Some special education students do not like the stigma of being seen with their special education teacher in an inclusive classroom setting.
8. Staff time is needed to communicate and plan.

In general, the observations that the students and the biology and special education staffs made about the program were very positive.

ANALYSIS

Our principal handed out a survey designed to get input from the entire high school staff on what issues needed attention in next year's school improvement plan. The number one issue the staff identified was attendance. Every teacher knows that students will not be successful if the students are absent on a regular basis.

One of the major problems with the homogeneously grouped life science classes was poor attendance. The attendance for the first semester of the homogeneously grouped life science class was actually much better than for the second semester, but data collected was only for the first semester. There were days during last year's second semester when more than half of the students in the homogeneously grouped life science classes were absent. This seldom happened with the heterogeneously grouped life science students in Biology I. In fact, the data collected showed that the heterogeneously grouped life science students in Biology I were in biology classes almost twice as often as the average attendance for their other classes at school. There were too few students in the homogeneously grouped life science classes who could serve as positive role models for other students, and this may have been responsible for the many negative behavior issues in those classes.

A possible reason that the heterogeneously grouped life science students in Biology I attended classes regularly is because they felt psychologically safe and felt included in the classroom. Our data showed that all students, especially "A" students, felt that group work resulted in less conflict. Group activities in which roles were assigned made students feel as though they were a part of the classroom action. Students said they got to know classmates better, and used cooperative skills, when they worked in groups on constructivist labs and projects. Our data indicated that students believed that everyone was learning when peers helped peers. It makes sense that the general population of students would feel more positive about peer tutoring than "A" students; however, even the majority of "A" students agreed with the benefits of peer tutoring for all students. The biology staff believed that thinking is clarified and learning is reinforced in "A" students if they take the time to explain material to a peer. "A" students often need to work on interpersonal relationships. They may gain as much or more from this part of the experience than do the students who get lower grades.

Another possible reason for improved attendance was the peer pressure that took place in cooperative groups. Students felt pressure to attend when they were placed in cooperative groups, because of the interdependence created by group roles. There were some days when I had ill students in my class tell me they would not even be in school if it were not for the work they needed to share with their group so that the group could complete a lab or project. When students had more ownership in a laboratory exercise or project and experienced the pressures brought about by group dynamics, attendance generally improved.

Success as measured by overall grades was an area everyone was concerned about when the Project 9 students, who were previously homogeneously grouped, and special education students were included in Biology I. Remember that the Project 9 classes were made up of students who were not only failing biology after 6 weeks, but were also identified with poor reading scores. After the curriculum changes in Biology I, only 6 percent of students with poor reading scores failed. More than 80 percent of the heterogeneously grouped Project 9 and life science students earned a B or C grade in Biology I, and only 15 percent failed. This happened in spite of the higher standards they had to meet.

All special needs students benefited in Biology I, because the special education teachers worked not only with special education students but also with any students who needed extra help. The teachers would be at the laboratory stations offering assistance to whoever needed it. The teachers also offered reading help on exams to all students who had reading problems. Forty special education students took Biology I. Those with the most need were placed in classes where a special education teacher was often present. No more than four special education students were generally put into any one class. Most of the special education students were learning-disabled, and only five of these students did not pass biology.

Our data also showed that most students liked peer evaluation. The staff was less comfortable than the students with peer evaluation, perhaps because they were used to having control of evaluation for most of their teaching years. Robert McGarvy, of *Entrepreneur* magazine, has written that "multirater feedback is rapidly replacing the traditional boss-to-employee performance review. Multirater feedback gives employees information from peers and subordinates as well as the boss. The best systems include ratings by at least three coworkers and three subordinates. That preserves raters' anonymity and gives the employee considerable information" (McGarvy, 1998, p. 15). Students should be exposed to peer evaluation before entering the workplace, where such evaluation is a more common practice.

The biology staff members had different approaches to evaluation. All used some form of peer evaluation, but some did not use it as much as others. Those teachers who used peer evaluation at least once per week felt more comfortable with this practice, and their students seemed to appreciate the opportunity to use peer evaluation. Half the staff used student self-evaluation on a regular basis. They believed it was a good way to get students to reflect on their past work in order to improve on future work. I used an end-of-semester portfolio in which a rubric was used for self-evaluation, peer evaluation, and parent evaluation of the students. This explains why most staff members did not give alternative assessment and parent assessment as high a priority as the other staff philosophy statements when revisiting the staff philosophy at the end of the year. It is difficult for some teachers to share control of the grading process.

Two of the surveys (see Appendixes B and C) showed that all students felt positively about constructivist labs and projects. The number one complaint about constructivist labs was that they were too difficult; however, "A" students generally appreciated that challenge. Some students would rather have others do their thinking for them, and constructivist labs forced them to think fully about the problems with which they were working.

Some comments made by students and staff suggest areas that the biology team should include as topics for future discussion. These include:

1. When groups are chosen, students would like to have some input into the selection of people who are placed in their groups. To facilitate success for all students, teachers need to walk the fine line between listening to their students and maintaining some control over group composition. In a survey, the students did say that all ability levels should be represented in the groups.
2. Some students would like to see more equalization of the work required of each group member to complete a particular task. An effort should be made to make roles as equal and fair as possible. What also has to be taken into consideration is that some students have the ability to handle more complex tasks, and more should be expected from these students for successful completion of a group activity; however, equal effort should be anticipated of everyone.

CONCLUSION

This research project set out to look at the hypothesis: "If the biology and special education staffs embrace change by heterogeneously grouping students and by implementing inclusive strategies and other practices consistent with the objectives set forth in the National Science Education Standards, it will result in a successful experience for students and staff as measured by increases in student attendance and grade point averages among lower-achieving students and increase positive attitudes on surveys administered to all biology students, the biology staff, and the special education staff." The majority of our research supports this hypothesis. The data clearly showed higher attendance rates for the heterogeneously grouped life science students in Biology I than for students who were previously in homogeneously grouped life science classes. While the grades for the heterogeneously grouped life science and Project 9 students in Biology I were not significantly higher than the grades of the homogeneously grouped life science and Project 9 students, many of the special education and biology teachers were still pleased that the grades were not lower, given the new tougher expectations. Guidance counselors normally would have steered students with poor grades in middle school away from Biology I, because it was considered a difficult course for freshmen. Certainly, the attitudinal surveys indicated that the majority of students, special education instructors, and biology instructors favored the curriculum changes.

Parents and students gave lots of feedback in addition to the data collected in this study. The majority of this feedback was positive, and the data certainly supports that feedback. The biology and special education staff members also commented positively on a regular basis.

EXTENSION

This study had some potential for experimental error. One source of error in a scientific study is the existence of an independent variable that has the potential to be inconsistent. In this study, one such potential inconsistency concerned the fact that the homogeneously grouped students who took lower-level life science and special education classes one year could only be compared to similar students who were heterogeneously grouped in Biology I the following year. There was no way that the same students could be used both years. Another potential inconsistency concerned the fact that the attendance data collected was based on the daily scan sheets completed by the teachers. There may have been days when scan sheets were not turned in, but an assumption had to be made that the overall attendance data was reasonably accurate.

I continue to have a number of questions to which I did not get answers:

1. How many heterogeneously grouped Project 9 or lower-level life science classes in Biology I were not included in the data because they either dropped out of school or were dropped from class before the end of the semester?
2. How would the number in (1) above compare to the number that started out in the homogeneously grouped life science classes and dropped before the end of the semester? The teacher who taught the homogeneously grouped life science classes for many years felt that the dropout rate in these classes was normally substantially higher.
3. What was the primary reason that the heterogeneously grouped life science students dropped Biology I this year and the homogeneously grouped life science classes last year? Was it because of family and personal problems, the curriculum, or something else?
4. What kinds of information do parents receive from their sons or daughters regarding curriculum changes? Students involved with group work might place the blame on others if the group was not successful. The biology staff shared stories about how parents often complained that the group was dragging down their child's grade. However, students commented in the surveys that they could not have done as well individually as they did in these cooperative group activities.
5. Do the Project 9 and heterogeneously grouped life science students in Biology I have other classes as difficult as Biology I? The GPA for the heterogeneously grouped students in Biology I was slightly higher than the same students' overall GPAs. In other years, biology grades tended to bring down grade point averages.
6. Will the changes made in the biology curriculum have an impact on the number of minority students found in the advanced science classes? Currently, while there seems to be an equal representation of males and females in advanced science classes, the number of minorities taking these classes is not representative of the school's minority population.

The study could have revealed a more accurate picture on attendance if we had compared attendance sheets at the beginning of the semester to attendance sheets at the end of the semester, to find out how many of the heterogeneously grouped Project 9 and life science students dropped Biology I. The grade point averages and attendance data might have been inflated because the students having the greatest problems were no longer in the class. However, the sample size used in the study was probably large enough to give some accurate results in spite of only using data from the end of the semester.

From the data collected in this action research, there is evidence to show that with the pedagogy presented, inclusion can successfully take place in our schools. Using a constructivist approach rather than primarily teacher-directed activities is important in any classroom, but it is essential in an inclusive classroom. Grouping together students of different abilities and interests is an important part of the inclusive-classroom environment; however, simply putting students together in groups to complete activities would be disastrous. Teachers need to have their students practice good cooperative learning skills if grouping is going to be successful. Teachers also need to create roles for each student so that all students can be engaged within their groups. Students need to practice skillful reflection and self-evaluation of these activities. Teachers must use a variety of assessment instruments, and students need to be involved in evaluating the effort of their peers. Ensuring that peer evaluations have credibility requires skillful guidance by teachers.

EPILOGUE

I was happy with the results of the changes we made in our biology classrooms. The data we collected shows that there was an increase in attendance and in grade point averages of minorities and special education students, which suggest that the changes made were very beneficial to these populations. While grade point averages and attendance improved overall, the students also learned how to solve problems and developed skills to work cooperatively. The entire Biology I population had a more enjoyable classroom experience in this environment. This model was held up within the high school and within the district as evidence that inclusive classrooms can work. Teachers throughout the school district came to our classrooms to learn more about our model because they also were attempting to embed inclusive teaching practices in their classrooms.

During my last semester of teaching before retiring, Dr. Sharon Derry, an educational psychologist at the University of Wisconsin–Madison, came into my classroom for an entire topical unit of study to create a videotape of successful practices used in constructivist teaching. She conducted several large, theory-based instructional technology research and development projects in several different schools focusing on individual and collaborative problem solving. I recall how amazed the video crew chief was at the amount of collaboration that took place in my classroom among students of diverse abilities. The second summer after I retired from teaching high school students, I presented a summer workshop at UW–Madison to science teachers who were interested in the constructivist approach to science teaching. Many of the attendees found this workshop useful, because many of them were under pressure from their school districts to create inclusive classrooms.

Recently, I went back to my former high school to talk to members of the biology team who had worked with me to make the significant curriculum changes used in our inclusive classrooms. They said that the model we developed is still working, but that it is being threatened by change. Before starting to use inclusive classrooms, the administration offered support by paying our biology staff beyond the school day to sit down with a coordinator from the central office to set goals and prepare a philosophy on which we could all agree. Partial support from the administration came in the form of keeping class sizes to 24 or fewer students, for classrooms in which special needs students were included. The special education department assigned several special education instructors to the biology staff to help modify curriculum and evaluations, as well as to provide some classroom support for activities and projects. They also assigned no more than four special education students to a class. This did not mean that there were not other students in the classroom who required special attention, but the special education students were to be divided among 20-plus sections of biology, with no more than four to a class. The biology staff met a couple of times a week before school and once a month for several hours after school to strategize and share ideas for working with students in their diverse classrooms. Members of the special education staff met with the biology teachers to give their insights on the pedagogy being discussed. There was a concerted effort to make inclusion work.

A number of changes have occurred since the early years of implementing the inclusion model that, I believe, are threatening its success. Several of the biology team members who took the lead for making changes in our biology curriculum have retired, and the newer teachers do not appear to have the same level of commitment to this model. The current staff does not hold regular team meetings to continue this work; team meetings are necessary if new staff members are going to be properly grounded in the model. Members of the staff are no longer compensated for participation in planning sessions that take place outside of required hours. Some teachers have established a reputation for doing a good job of dealing with needy students, and so the special education department is no longer equally distributing its students among all the Biology I sections. Now there may be twice as many special education students in some classrooms and fewer in others. This can be a real problem for student-group dynamics. The special education department, which has had staff cuts, offers less help. Now parents of regular education students complain more often about their children not receiving enough attention in classes with high numbers of special education students. Class sizes are also increasing. Two new head principals and many changes in the administration have resulted in lack of awareness of the history of the model by current school administrators. As a result, some biology teachers have many special education students in their classes, and those classes often exceed the old limit of 24. Class size is crucial to the success of the model.

I still believe that the biology department's model for inclusion is a very effective model that promotes a fair and equitable education for all students—more than what one might see in a traditional classroom. As budget and staff cuts erode quality education, the overall effectiveness of any kind of teaching will be diminished. For "no child to be left behind," good educational practice has to be properly funded and supported.

APPENDICES

Appendix A: Philosophy Statements Created by the Biology I Staff

Appendix B: Student Attitudes on Constructivist Labs Versus Conventional Labs

Appendix C: A Project Activity as a Learning Experience

Appendix D: Survey of Biology I and Special Education Staffs on Curriculum Change

APPENDIX A: PHILOSOPHY STATEMENTS CREATED BY THE BIOLOGY I STAFF

1. Biology should be an active, hands-on process that includes the three P's of problem posing, problem solving, and peer persuasion. This will allow students to experience the true nature of what science is and how it can be used to solve everyday problems.

2. All students, regardless of educational or ethnic background, have the ability to learn and be successful in an integrated Biology I classroom.

3. All students, regardless of educational or ethnic background, should be challenged through high expectations in an integrated biology classroom.

4. Biology will be more relevant if it is taught with an interdisciplinary approach that allows students of varying interests to participate more enthusiastically, and make connections to relevant use of science in the larger world.
5. All students need to learn the skills of working together successfully in group settings.
6. All students can make a significant contribution to an integrated Biology I class through their talents and interests.
7. Students should be taught to understand and use science, not memorize it.
8. If teachers plan and work together, Biology I will be a quality experience for all.
9. Students should reflect on past experiences and use this information to improve future performance.
10. Students need a clear definition of levels of achievement in order for all students to be successful.
11. Students learn in diverse ways; therefore, diverse assessment strategies are needed to measure diverse learning styles.
12. Parents need to serve as partners in the education of their children, and therefore need to be involved in the assessment of their children.
13. Since science uses technology of all types at a very high level, the most current technology available should be used whenever possible.
14. Students need to put their own work in perspective through self-evaluation and peer review.

APPENDIX B: STUDENT ATTITUDES ON CONSTRUCTIVIST LABS VERSUS CONVENTIONAL LABS

Directions: Laboratory experiences are of two basic types. The conventional labs give you a hypothesis and you follow procedural step by step instructions to completion, while the constructivist labs ask you to come up with the hypothesis and you create the procedure. Circle the number that you feel best represents your attitude on the statements. Then comment on why you responded the way you did, and if your score was less than 5, then state what you believe it would take to make your rating a 5.

	Agree				*Disagree*
1. I prefer constructivist labs over conventional labs.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					
2. I prefer working in lab groups rather than doing a lab required individually.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					
3. I like groups made up of students with various skill levels.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					
4. Everyone is learning, even when one student is explaining and others are listening.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					
5. When we work in groups, students get to know each other and feel comfortable with one another.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					
6. Students should be asked to evaluate other students as part of their grade for a lab activity.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					
7. When we work in groups, there is less conflict within the classroom.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					
8. I used cooperative skills during this activity, such as facilitating, evaluating peers, recording, consensus building, etc.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					
9. Everyone in my group carried out their role and participated in the required activity.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					
10. I enjoyed doing this activity.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					

APPENDIX C: A PROJECT ACTIVITY AS A LEARNING EXPERIENCE

Directions: Circle the number that you feel best represents your attitude on the statements. Respond to each statement based on your experience with the unit on cell structure and function, where your project was the creation of a cell model. Then comment on why you responded the way you did, and if your score was less than 5, then state what you believe it would take to make your rating a 5.

	Agree				Disagree
1. I enjoyed doing this activity.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					
2. I learned a lot during this activity.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					
3. I learned my group's subject matter doing this activity and I learned the subject matter presented by other groups.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					
4. I used cooperative skills during this activity, such as facilitating, evaluating peers, research, art work, consensus building, etc.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					
5. I could find the information I needed to complete the project.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					
6. My teacher provided our group with enough guidance during the activity.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					
7. Everyone in my group contributed to the success of the project.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					

	Agree				Disagree
8. There was enough time to complete the activity.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					
9. If I had completed this project myself, I would not have received a higher score than I got for the group project score.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					
10. I like learning through projects and constructivist activities better than with traditional lectures and worksheets.	5	4	3	2	1
Required comments: What would it take to make this a "5"?					

APPENDIX D: SURVEY OF BIOLOGY I AND SPECIAL EDUCATION STAFFS ON CURRICULUM CHANGE

My current assignment is:	Regular Ed.
Special Ed. ______	LD CD ED (circle one)
Directions: Please complete the following questions. They are intended to gather data concerning cognitive, attitudinal, and affective issues related to the biology curriculum. Part I. Beliefs Related to Student Success In Biology—The following beliefs last year were considered essential to curriculum change. Please indicate how you feel now by placing either a 5, 4, 3, 2, or 1 in the square provided and also indicate how important you feel the statement is to the success of the biology curriculum by ranking each statement either a 5, 4, 3, 2, or 1 in the square provided.	

(Continued)

(Continued)

High Agreement			*Low Agreement*		*High Rank*				*Low Rank*
5	*4*	*3*	*2*	*1*	*5*	*4*	*3*	*2*	*1*

Agreement	**Rank**	
☐	☐	1. All students, regardless of educational or ethnic background, have the ability to learn and be successful in an integrated Biology I classroom.
☐	☐	2. All students, regardless of educational or ethnic background, should be challenged through high expectations in an integrated Biology I classroom.
☐	☐	3. Students need a clear definition of levels of achievement in order for all students to be successful.
☐	☐	4. All students can make a significant contribution to an integrated Biology I class through their talents and interests.
☐	☐	5. Biology should be an active, hands-on process that includes the three P's of problem posing, problem solving, and peer persuasion. This will allow students to experience the true nature of what science is and how it can be used to solve everyday problems.
☐	☐	6. Biology will be more relevant if it is taught with an interdisciplinary approach that allows students of varying interests to participate more enthusiastically, and make connections to relevant use of science in the larger world.
☐	☐	7. All students need to learn the skills of working together successfully in group settings.
☐	☐	8. Since science uses technology of all types at a very high level, the most current technology available should be used whenever possible.
☐	☐	9. Students learn in diverse ways; therefore, diverse assessment strategies are needed to measure diverse learning styles.
☐	☐	10. Students should reflect on past experiences and use this information to improve future performances.
☐	☐	11. Parents need to serve as partners in the education of their children, and therefore need to be involved in the assessment of their children.
☐	☐	12. Students need to put their own work in perspective through self-evaluation and peer review.
☐	☐	13. Students should be taught to understand and use science, not memorize it.
☐	☐	14. If teachers plan and work together, Biology I will be a quality experience for all.

Part II. This is similar to the questionnaire given to our students.—Circle the number that you feel best represents your attitude on the question asked. You may comment on why you responded the way you did in the space provided after each question and at the bottom of the last page.

	Agree				*Disagree*
1. I feel that heterogeneous grouping is a good idea.	5	4	3	2	1
2. I feel that students of all ability levels should learn to work together.	5	4	3	2	1
3. Students learn the subject matter better if they are guided into finding the information themselves rather than the teacher presenting to them.	5	4	3	2	1
4. Students working in cooperative groups tend to get more out of labs than if they work individually or in pairs.	5	4	3	2	1
5. Learning is going on by all heterogeneously grouped members.	5	4	3	2	1
6. Students tend to prefer constructivist labs over conventional labs.	5	4	3	2	1
7. Students should have the experience of evaluating peers in the classroom.	5	4	3	2	1
8. Student groups should be made up of students with various ability levels.	5	4	3	2	1
9. Placing special education students in a regular classroom is a good idea.	5	4	3	2	1
10. Placing special education instructors in the classroom to team with a regular education teacher is a good thing to do.	5	4	3	2	1

Part III: Bottom Line—Are we headed in the right direction with our Biology I program?

_____I strongly believe we are _____I believe we are _____I am not certain _____I don't believe we are _____I strongly believe we are not	COMMENTS:

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