

Teaching Students with Disabilities in Inclusive Science Classrooms: Survey Results

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ABSTRACT: Inclusive classrooms are becoming the norm in schools, fulfilling the instructional needs of students with disabilities in regular K–12 classrooms. However, little evidence exists describing the experiences, preparedness, and attitudes held by educators who are teaching or who are preparing teachers. The results of a survey of elementary teachers, middle and high school level science teachers, and university science educators are reported in this article. The results indicate that teacher education programs reflect little commitment to preparing or in-servicing science teachers to work effectively with students who have disabilities. This study provides evidence that teachers of science and professors teaching science methods have had little training and experience in teaching students with disabilities, are not aware of the research on best practice as it applies to students with disabilities, and often hold stereotypical views of what students with disabilities can and cannot do. Additionally, they are receptive to receiving additional training in teaching science to students with disabilities. © 1998 John Wiley & Sons, Inc. *Sci Ed* **82**:127–146, 1998.

INTRODUCTION

What are the most difficult aspects of teaching for public school teachers? Ask elementary teachers and secondary teachers what challenges them most each day. The majority will list teaching students with disabilities as one of their primary concerns. Officials of the U.S. Office of Special Education Programs indicate that more than half of all students with disabilities receive instruction in science in regular education classes (U.S. Department of Education, 1991). Science has been considered one of the most valuable subjects taught to students with disabilities (Patton & Andre, 1989). Additionally, teachers identify science as the subject most suited for mainstreaming special

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needs students (Atwood & Oldham, 1985). However, few general education teachers have had training pertaining to teaching students with disabilities, and few special education teachers have had training in science teaching.

Approximately 11% of school-age students have a disability, and reports of the percentages of students with impairments in higher education are similar. The United States Department of Education (1994) *Digest of Educational Statistics* reports that 11.77% of all students in 1991–1992 had a disabling condition reflecting a population of 4,949,000 individuals receiving special services in schools. At the postsecondary level, the percentage of disabled students enrolled is reported at 10.5% deriving a population of 1,319,229 students.

In K–12 schools, approximately 3.6% of the students are identified as having a physical disability or health impairment. The U.S. Department of Education (1994) reports the following: speech impaired—2.37%; hard of hearing and deaf—0.14%; motor/orthopedic impaired—0.12%; other health impaired—0.14%; visually impaired—0.07%; multidisabled—0.24%. In addition, other identified conditions eligible for special education services include: learning disabled—5.31%; mentally impaired—1.28%; and seriously emotionally disturbed—0.95%.

In 1973, the passage of the Individuals with Disabilities Education Act (IDEA) or Public Law 94-142 (P.L. 94–142) impacted all states receiving federal funding for education (Orellove & Sobsey, 1987). The law “brought together many of the judicial principles. . . that had emerged from legal proceedings in the early 1970s” (Reynolds & Birch, 1982, p. 34). Major components of this landmark legislation included the guaranteed rights of all disabled youth to a free, appropriate education in the least restrictive environment. Accountability for this responsibility was to be demonstrated through individualized education plans (IEPs), the use of nondiscriminatory evaluations, support (or related) services, parental involvement, and due process (Gartner & Lipsky, 1987; Schwartz, 1984).

The problem is twofold and is influenced by decisions made by special education teachers, science teachers, and teacher educators. Cawley (1994) states that science teachers generally have little training or experience with disabilities and, in general, special educators have little or no exposure to science. One might expect that students with disabilities receive science instruction from teachers in special education but this clearly is not the case. Special educators perceive their responsibility as accommodating students who are having difficulty learning and who are generally at least two grade levels behind their peers in basic skills. They seldom teach science, and the science they teach is often textbook based. Specialists in adaptations look only at physical accessibility and mobility, not the special needs of the disabled student, which may require adaptations for hands-on science investigations.

Patton, Polloway, and Cronin (1990) in a survey of special education teachers found: (a) 42% of special education teachers received no training in science; (b) 38% of children in self-contained special education classes did not receive any science instruction; and (c) among special educators who did teach science, nearly half devoted less than 60 minutes a week to science, and nearly 90% of the teachers surveyed depended upon a textbook for instruction. Even more alarming, Ysseldyke, Thurlow, Christenson, and Weiss (1987) reported that students with mild disabilities received only 1 minute of science instruction for approximately every 200 minutes of reading instruction!

Studies reflect a continuing lack of responsiveness by science teachers to adjust the learning environment so that students with disabilities feel a sense of success and accomplishment. Secondary science teachers are generally not sensitive to individual needs and are not as inclined to make adjustments in the materials or instructional strategies for their pupils (Lovitt & Horton, 1994). In an examination of science grades for over 400 students with mild disabilities in grades 9–12, Cawley, Kahn, and Tedesco (1989) reported 50–60% of the grades were D's or F's. Donahoe and Zigmond (1988) reported 60% of the grades of students with learning disabilities in ninth-grade science were D or below.

Special education funding has facilitated the provision of new services to 500,000 previously unserved severely disabled students as well as improved services to several million other lesser disabled students (Gartner & Lipsky, 1987; Will, 1986). Among the advancements were the development of instructional strategies, sequenced instructional methodologies, and better methods for evaluating and monitoring student progress. These strategies improved identification of children's instructional entry points relevant to specific learning activities (Will, 1986). The survey reported in this article attempted to discern the degree to which science teachers and science educators are aware of these new developments and to determine the extent to which these practices are evidenced in science classrooms.

A SURVEY OF SCIENCE TEACHERS AND UNIVERSITY SCIENCE EDUCATORS REGARDING TEACHING SCIENCE TO STUDENTS WITH DISABILITIES

As a first step toward helping elementary teachers and secondary science teachers effectively teach science to students with disabilities in inclusive classrooms, an investigation was initiated by the Committee for the Inclusion of Challenged Populations of the Association for the Education of Teachers in Science (now called the AETS Committee for Inclusive Science Education). This investigation focused on the identification of science teacher training, teaching experiences, needs, and attitudes regarding teaching students with disabilities. This undertaking involved an initial 1994 national survey and a 1995 follow-up survey.

METHODOLOGY

The survey instrument used in the study was prepared by members of the AETS Committee for the Inclusion of Challenged Populations. After undergoing several revisions between January and April 1994, the pilot instrument was mailed to five national leaders in science education in June 1994, requesting that they complete the survey and make recommendations for improvement. The instrument was further modified to reflect the input of these individuals and the final survey instrument was completed in September 1994.

In October 1994, the survey instrument was mailed to 100 elementary teachers, 100 middle level teachers, 100 high school teachers, and 100 science methods professors in higher education. The sample population for the survey was obtained from the following documents: the 1994 National Science Teachers Association Directory, the Association for the Education of Teachers in Science Directory, 1993 Presidential Award Winners for Excellence in Science Teaching, and the 1994 NSTA National Convention Program. Returns from the initial mailing were collected until December 20, 1994.

Because of the manner in which the names were selected several of the instruments were returned due to insufficient addresses. There were also several respondents who chose not to complete the instrument because they did not feel their present assignment allowed them to provide valid input. In January 1995 a follow-up survey was mailed to nonrespondents. Individuals who did not receive the survey or did not complete the survey were replaced with additional names taken from the 1994 NSTA Convention Program. Returns on the follow-up survey were collected until July 1, 1995.

The survey returns, from the initial mailing in the fall of 1994 and follow-up mailing in the spring of 1995, were compiled and analyzed in the fall of 1995. They represent the data base for this report. The percentage of respondents to the survey was: elementary teachers, 43%; middle level science teachers, 54%; high school science teachers, 46%; and science educators, 46%. The overall return was 47.25%. A return rate of 47% for a mail survey is considered an acceptable response rate.

SURVEY RESULTS

Results of the survey indicate that today's public school elementary, middle, and high school science teachers are experiencing the inclusion of students with many types of disabilities in their classrooms. Because students with learning disabilities and emotional/behavioral disorders are often the focus of teachers' concerns regarding teaching students with disabilities, this paper focuses on survey results pertaining to teaching students with these types of disabilities. The summary tables include survey results pertaining to teaching students with various types of disabilities.

Current Practice: Students with Disabilities in General Education Science Classrooms

Elementary teachers, middle and high school science teachers, and university science educators reported learning disabilities and emotional/behavioral disabilities as the categories of students with disabilities most frequently represented in their classrooms. Overall, 69.7% of the educators reported having students with learning disabilities in their classes and 56.9% of the educators reported having students with emotional/behavioral disabilities in their classes. Table 1 shows the percentages of students with disabilities in the classes of the four groups of respondents. The group with the highest percentages of teachers that reported students with learning disabilities (reported by 88.9%) and students with emotional/behavioral disabilities (reported by 79.6%) was middle school science teachers. Not surprising, the group with the smallest percentages of educators reporting students with learning disabilities (32.6%) and students with emotional/behavioral disabilities (9.7%) in its classes was university science educators. The overall percentage of K–12 teachers who reported having at least one student with a cognitive impairment was slightly over 25%. This number is likely to increase as inclusion becomes more prevalent in our schools.

It would appear that the older students are, the less information is available to educators about their learning needs. Perhaps this could be attributed, in part, to the reality that, as students age, they spend less time with each teacher. As school time becomes more fragmented at the secondary level, teachers have less time to observe students and work with them individually to ascertain their needs. Or, perhaps, documentation of a student's past records has not received appropriate attention

TABLE 1
Percentages of Educators Who Reported Students with Disabilities in 1994–1995 Classes

Type of Disability	Elementary Teachers	Middle School Teachers	High School Teachers	University Educators	Overall
Physical or health impairments	37.2	53.7	37.0	28.3	39.0
Motor/orthopedic impairments	25.6	33.3	23.9	13.0	23.6
Visual impairments	25.6	29.6	26.1	15.2	23.6
Hearing impairments	20.9	35.2	37.0	15.2	26.7
Learning disabilities	86.0	88.9	67.4	32.6	69.7
Emotional/behavioral disabilities	74.4	79.6	58.7	8.7	56.9
Cognitively impaired	27.9	25.9	21.7	8.7	20.5
Do not have sufficient knowledge to respond	2.3	3.7	8.7	34.8	12.8

at the secondary level. It is especially disheartening that a large percentage (34.8%) of the university science educators do not have sufficient knowledge of their students' learning needs to respond.

Undergraduate Preparation: Students with Disabilities

Teachers reported information about both undergraduate teacher education programs and graduate teacher education programs regarding training pertaining to students with disabilities, science for students with disabilities, recommended adaptations, and required teacher education courses. University science educators reported information on their teacher education programs. Findings are presented for undergraduate teacher education programs only. A limiting factor is due to the random sampling and voluntary return of the questionnaires: teachers who reported information on their teacher education programs were not, except by coincidence, from the same teacher education program as the university science educators who reported information. Therefore, in all probability, teachers and university educators reported information on different programs.

Table 2 reveals an alarming discrepancy between the perceptions of university educators and those of elementary and secondary teachers with regard to the disability categories for which they received some (even minimal) academic instruction in their undergraduate academic program. University educators perceived that elementary and secondary teachers had opportunities to receive instruction far more often than the teachers themselves reported. For example, 46.5% of elementary teachers reported that they received training regarding students with learning disabilities, but 73.9% of university educators reported that elementary teachers received training pertaining to this group of students. Additionally, 17.4% of high school teachers reported having received training pertaining to students with emotional/behavioral disorders, and 67.4% of university educators reported that high school teachers received this type of training.

How could this vast gap have occurred? Perhaps the noted instruction had been added to teacher preparation programs in recent years, and therefore, the teachers responding to the survey would

TABLE 2
Percentages of Educators Who Reported Undergraduate Teacher Education Programs that Included Instruction on Categories of Disabilities

Disability Instruction	In Elementary Teacher Programs (According to)		In Middle School Teacher Programs (According to)		In High School Teacher Programs (According to)	
	Elementary School Teachers	University Educators	Middle School Teachers	University Educators	High School Teachers	University Educators
	Physical or health impairments	23.3	63.0	24.1	58.7	6.5
Motor/orthopedic impairments	11.6	58.7	9.3	54.3	6.5	58.7
Visual impairments	20.9	54.3	13.0	47.8	6.5	52.2
Hearing impairments	27.9	54.3	14.8	50.0	8.7	52.2
Learning disabilities	46.5	73.9	40.7	69.6	21.7	76.1
Emotional/behavioral disabilities	37.2	65.2	20.4	63.0	17.4	67.4
Cognitive impairments	37.2	60.9	13.0	56.5	13.0	65.2

already have been in the field. Possibly the instruction was embedded within the curriculum of one course, perhaps taking a day or two on the syllabus without timely reinforcement, and thus was so minimal that the responding teachers did not recall it. Perhaps the courses noted by the university educators were available as electives, but not required for teacher preparation. Whatever the case, the people who most need the training in meeting the needs of students with disabilities—those currently working with students every day—had not received it.

Undergraduate Preparation: Teaching Science to Students with Disabilities

There were discrepancies in the reports of topics pertaining to teaching students with disabilities that were included in undergraduate teacher education programs. The percentage of teachers who reported that they received training on topics related to teaching students with disabilities was quite a bit lower than the percentage of university science educators who said these topics were taught in their teacher education programs. Recalling that the teachers and university educators who completed the surveys were not (except by chance) from the same institution, it is very possible that they remembered and reported accurately. Or perhaps the university educators assumed students were receiving instruction on these topics in other classes.

Table 3 contains the percentages of elementary, middle school, and high school teachers who reported having received training in their undergraduate teacher education programs on specific topics related to teaching students with disabilities. This table also contains the percentages of university science educators who reported training related to teaching students with disabilities as a part of their teacher education program. Thirty-two and six-tenths percent (32.6%) of elementary teachers reported that they received training on mainstreaming, but 63.0% of university educators reported that elementary teachers received training on mainstreaming. Four and seven-tenths percent (4.7%) of elementary teachers reported that they received training on inclusion, but 65.2% of university educators reported that elementary teachers received training on inclusion.

TABLE 3
Percentages of Educators Who Reported Undergraduate Teacher Education Programs that Included Instruction on Specific Topics Related to Teaching Students with Disabilities

Topics Instruction	In Elementary Teacher Programs (According to)		In Middle School Teacher Programs (According to)		In High School Teacher Programs (According to)	
	Elementary School Teachers	University Educators	Middle School Teachers	University Educators	High School Teachers	University Educators
	Mainstreaming	32.6	63.0	25.9	67.4	17.4
Inclusion	4.7	65.2	9.3	65.2	4.3	52.2
Safety and legal concerns regarding students with disabilities	23.3	58.7	16.7	65.2	15.2	69.6
Resources for information on teaching science to students with disabilities	14.0	60.9	11.1	56.5	4.3	60.9
Professional associations representing types of disabilities	16.3	32.6	11.1	37.0	2.2	39.1

The results were similar for middle school and high school teachers regarding training on mainstreaming and inclusion: 25.9% of middle school teachers reported having had training on mainstreaming and 67.4% of university educators reported that middle school teachers had such training; 9.3% of middle school teachers reported training on inclusion and 65.2% of university educators reported that middle school teachers had this training. The discrepancy between what teachers and university educators reported was even greater for high school: 17.4% of high school teachers reported having had training on mainstreaming and 71.7% of university educators reported high school teachers had this training. Four and three-tenths percent (4.3%) of high school teachers reported having training on inclusion, but 52.2% of university educators reported these teachers had inclusion training. Comparing the information reported by teachers and university educators, similar reports were obtained from teachers and university educators for other topics pertaining to teaching students with disabilities: safety and legal concerns; resources which provide information on teaching science to students with disabilities; and professional associations representing the different disability areas.

Undergraduate Preparation: Courses Concerning Teaching Students with Disabilities

University educators reported the type of methods courses in which students with disabilities were addressed:

1. *Introductory special education course.* Forty-seven and eight-tenths percent (47.8%) of the university educators said a course of this type is included in the elementary program; 39.1% of the university educators said such a course is included in the elementary program; 39.1% of the university educators said such a course is included in the middle school program; and 45.7% said one is included in the high school program.
2. *General methods course on teaching students with disabilities.* Thirty-seven percent (37.0%) of the university educators said a course of this type is included in the elementary program; 26.1% said one is included in the middle school program; and 30.4% said one is included in the high school program.
3. *Specific methods course on teaching science to students with disabilities.* Forty-five and two-tenths percent (45.2%) reported such a course in the elementary program; 4.3% said one is included in the middle school program; and 4.7% said it is included in the high school program.

The percentages of the various courses reported by university educators were, in almost all cases, very different from percentages reported by teachers. For example, 11.6% of elementary teachers reported a general methods course on teaching students with disabilities, compared with 37.0% of university educators who reported such a methods course in the elementary program. Sixteen and seven-tenths percent (16.7%) of the middle school teachers reported a general methods course on teaching students with disabilities, but 26.1% of the university educators reported such a course in the middle school program. Additionally, 15.2% of the high school teachers reported a general methods course on teaching students with disabilities, and 30.4% of the university educators reported similarly. There are several explanations for this difference. Students may not recall the specific elements of the coursework they have taken, or there may be a presumption on the part of the university educators that these elements are being addressed in required courses other than the ones they teach. Another explanation is that marginalized groups may now be receiving greater attention in teacher training than was given at the time the teachers completed their teacher education programs. In some teacher education programs, students take “generic” methods courses, rather

than science methods, and the omission of the “generic” university educators could have distorted the accuracy of the data.

Preparedness: Teaching Science to Students with Disabilities

Teachers and university science educators answered questions regarding their preparedness to teach science to students with different types of disabilities and their preparedness to accomplish tasks related to teaching students with disabilities. They rated their preparedness using a scale of: 1 = not prepared; 2 = somewhat prepared; and 3 = adequately prepared. Only items rated as 3 (adequately prepared) are presented and discussed. Table 4 reveals an unexpected pairing in that university and elementary educators overall felt the most prepared to teach science to students with disabilities. University educators felt most prepared to teach students with visual, hearing, and cognitive impairments, whereas elementary teachers felt best prepared to deal with physical/health, motor/orthopedic, learning, emotional, and behavioral disabilities. Overall, teachers felt least prepared to teach students with visual impairments and most prepared to teach students with learning disabilities.

The findings from Table 4 lead one to question the characteristics of teacher preparation. What is it about elementary teacher preparation that yields a higher comfort level in teaching students with disabilities? Perhaps it is the emphasis on developing a wide range of instructional strategies. This flexibility in instruction would make it easier to adapt for specific disabilities. At the university level, educators have access to more sophisticated resources and technology, enabling them to better meet the needs of their students. Possibly, in the attainment of advanced degrees, teaching students with disabilities is given more complete coverage.

When comparing the data from teachers at the middle and high school levels to data from teachers at the elementary school level, it is clear that middle and high school teachers feel much more limited in their preparedness to accomplish tasks relating to accommodating instruction to students with disabilities. These findings are quite alarming. At the secondary level, it is traditional to focus teacher preparation more on content than on instructional delivery. Perhaps this focus on what to teach rather than how has contributed to those feelings of inadequacy in how to teach students with disabilities.

TABLE 4
Percentages of Educators Who Felt Adequately Prepared to Teach Science to Students with Specific Disabilities

Type of Disability	Elementary Teachers	Middle School Teachers	High School Teachers	University Science Educators ^a
Physical or health impairments	23.3	5.6	13.0	6.5
Motor/orthopedic impairments	20.9	3.7	6.5	6.5
Visual impairments	9.3	5.6	10.9	10.9
Hearing impairments	18.6	11.1	10.9	17.4
Learning disabilities	44.2	27.8	10.6	10.9
Emotional/behavioral disabilities	27.7	9.3	10.9	4.3
Cognitively impaired	18.6	5.6	13.0	13.0

^a University science educators—percentages denote adequate preparedness to provide training for preservice teachers on teaching students with the indicated disabilities.

Preparedness: Accomplishing Tasks Related to Teaching Students with Disabilities

Teachers rated their preparedness to accomplish specific tasks related to teaching students with disabilities. These tasks included: (a) designing, selecting, and modifying activities; (b) modifying assessment strategies; (c) modifying testing and assessment formats; (d) working with parents and professionals in planning programs; (e) working with metacognitive strategies; and (f) feeling comfortable communicating with students. Thirty-four and nine-tenths percent (34.9%) of elementary teachers, 13.0% of middle school teachers, and 17.4% of high school teachers reported that they were adequately prepared to design, select, and modify activities for students with disabilities. When university educators reported their preparedness to help preservice teachers develop the knowledge and skills to design, select, and modify activities for students with disabilities, less than 20% said they were adequately prepared. Similar responses were reported from teachers and university educators regarding the other tasks.

These results, shown in Table 5, reveal that elementary school teachers feel more prepared to teach science to students with disabilities than secondary or university educators. One cannot help but wonder if the more student-centered approach in elementary teacher preparation, rather than the more content-oriented approach in secondary teacher preparation, has influenced these results. Less than a quarter of the university science educators felt prepared to educate preservice teachers about performing all of the tasks related to teaching students with disabilities except for communicating with students with which 35.5% of the science educators felt comfortable. If so many university educators feel inadequately prepared to address teaching science to students with disabilities with preservice teachers, where will the preservice teachers gain this important training?

It appears that all educators are most uncomfortable assisting students with metacognitive strategies. Perhaps this vital area does not receive proper attention in teacher preparation programs. Another area of weakness is comfort in working with parents in planning appropriate educational programs for students with disabilities. It seems that parent communication is an area that could benefit from more attention in teacher education programs as well. Many teachers expressed dif-

TABLE 5
Percentages of Educators Who Felt Adequately Prepared to Perform Tasks Related to Teaching Science to Students with Disabilities

Tasks	Elementary Teachers	Middle School Teachers	High School Teachers	University Science Educators ^a
Design, select, and modify activities	34.9	13.0	17.4	19.6
Modify assessment	34.9	14.8	15.2	19.6
Modify testing and assessment formats	39.5	13.0	15.2	19.6
Work with parents in planning programs	20.9	9.3	21.7	10.9
Work with professionals in planning programs	39.5	14.8	21.7	17.4
Work with metacognitive strategies	20.9	3.7	4.3	19.6
Feel comfortable communicating with students	55.8	22.2	30.4	34.8

^a University science educators—percentages denote adequate preparedness to help preservice teachers develop knowledge and skills to accomplish the indicated tasks.

faculty in modifying assessment formats and strategies for students with disabilities. This could be due to a lack of knowledge about appropriate accommodations for specific disabilities—the teachers simply may not know what options are available and appropriate. Also, teachers may not have experience creating or modifying assessments if they use the ones provided by the science textbook “as is.”

A disheartening factor that needs to be addressed is the low number of teachers who report feeling comfortable communicating with students with disabilities. Often, the disabilities that students have are barriers to the communication process. Teachers need strategies to overcome those barriers so that the student and teacher can communicate with each other about the student’s needs.

Needs: Training to Teach Science to Students with Disabilities

Teachers and university science educators rated the need for training by themselves, by their peers, by teachers at other levels, and by university instructors pertaining to teaching science to students with disabilities. The results are shown in Table 6. It is interesting that the teachers reported less need for themselves to receive considerable training in teaching science to students with disabilities than they perceived others needed. Table 6 clearly reveals the perception that considerable training is needed to effectively teach science to students with disabilities, when in fact well-designed training may only need a few workshops to put teachers on the right track.

It is clear from the data in the tables, that classroom teachers at all levels feel inadequately prepared to meet the needs of students with disabilities. It is also clear that university science educators do not feel they have adequate skills to prepare new teachers in these skill areas. The problem continues to be perpetuated with little evidence that there is any concerted effort to address concerns relating to providing instruction in science that is adapted to meet the unique needs of students with disabilities in science classrooms.

TABLE 6
Percentages of Educators Who Reported the Need for Considerable Training Related to Teaching Science to Students with Disabilities

Training Needed in Teaching Science to Students with Disabilities	Reported by Elementary Teachers	Reported by Middle School Teachers	Reported by High School Teachers	Reported by University Science Educators
Considerable training needed for self	23.3	29.6	28.3	26.1
Considerable training needed for elementary teachers	44.2	48.1	45.7	47.8
Considerable training needed for middle school teachers	46.5	57.4	41.3	41.3
Considerable training needed for high school teachers	48.8	51.9	58.7	39.1
Considerable training needed for university science methods instructors	48.8	61.1	56.5	41.3
Considerable training needed for university science content instructors	48.8	57.4	47.8	41.3

Attitude Statements

In the final section of the survey, teachers and university science educators were asked to agree or disagree with statements regarding educating students with disabilities. The percentages of each group of educators that agreed with the statements are shown in Table 7. The results of the study demonstrate that some prejudicial and emotional barriers exist as far as teaching students with disabilities. Over half (55.9%) agreed that disability categories are too often used as an excuse for failure, and almost one third (32.8%) felt that too much money is spent to address the unique needs of students with disabilities. Ten and two-tenths of the respondents reported that they wish they did not have to teach science to students with disabilities at all. Over one-fourth (26.7%) of the respondents reported feeling more comfortable in a setting where there are no people with visible disabilities, whereas almost one-fourth (23.6%) reported that they actively seek direct involvement with persons with disabilities when choosing service commitments. Over three-fourths (78.9%) agreed that teachers need special training to overcome prejudices and emotional barriers in working with students with disabilities. These attitudes can be tremendous obstacles for teachers and students to overcome in ensuring that students with disabilities have equitable opportunities to learn science.

The results of this study also reveal some misconceptions about students with disabilities, which can also be a barrier to effective instruction. Forty and four-tenths percent (40.4%) of the respondents felt that students with disabilities should not be given unrealistic goal expectations because they will inevitably be frustrated in their search for employment. Over one-fourth (28.6%) felt it is unrealistic to expect a blind student to be a chemist, when there are in fact many blind chemists here in the United States. It is encouraging, however, that only 13.7% of the respondents felt it would be unfair to encourage persons with severe motor/orthopedic disabilities to pursue careers involving active field study like marine biology or geology. Only 1.8% of the respondents agreed that the majority of students with physical disabilities also have cognitive impairments, and less than 1% (0.9%) agreed that all students with disabilities should receive passing grades regardless of performance. It appears that, although some misconceptions about students with disabilities have been eradicated, others still stand as barriers to science achievement.

Teachers express some concerns about inclusion, according to Table 7. One-third (33.3%) felt that students with severe disabilities should not be in science classes with regular students. Almost half (46.2%) of the respondents were concerned that the attention given to students with disabilities detracts from teaching the rest of the students. Safety issues were a concern as well with almost half (47.5%) of the respondents expressing that students with disabilities are at risk in terms of safety in lab settings, and one-third (33.6%) responding that students with disabilities increase the risk to others in lab settings. However, safety issues do not appear to concern elementary science teachers as much as secondary and university educators. It is possible that this could be due to the increasing sophistication of equipment, materials, and responsibilities as students get older.

Table 7 reveals strong support for active, hands-on participatory science for students with disabilities. Almost all (98.3%) of the respondents agreed that special needs students gain self-confidence through science activities and that outdoor field trips are excellent opportunities to enhance the experiences of students with disabilities. Fourteen percent (14.0%) of the responding teachers expressed that it is impossible to expect a student with a physical disability to be an active participant in all science laboratory exercises. Only 9.9% of the teachers reported agreeing that disabled persons should serve as observers rather than active participants when conducting a science investigation. There is a significant difference in opinion between levels on this issue however. Although less than 5% of the elementary and middle school teachers agreed, 20.7% of the high school teachers felt it was best for students with disabilities to be observers. Perhaps the perceived level of difficulty in science investigations during high school is more rigorous, but only 10.3% of the university educators agreed, and surely college level science investigations are more rigorous than high school.

As far as accommodations are concerned, almost all (99.1%) of the teachers expressed that they

TABLE 7

Percentages of Elementary School Teachers, Middle and High School Science Teachers, and University Science Educators Who Agreed with Attitude Statements Concerning Teaching Students with Disabilities

Statements	Percentages of Educators Who Agreed:				Overall
	Elementary Teachers	Middle School Teachers	High School Teachers	University Educators	
Teachers need special training to overcome prejudices and emotional barriers in working with students with disabilities	74.4	83.3	74.5	93.2	81.4
Too much money is spent to address the unique needs of students with disabilities	26.2	34.0	44.4	14.3	30.2
Students with severe disabilities should not be in science classes with regular students	26.8	43.8	51.2	30.2	38.2
Students with disabilities are at risk in terms of safety in science laboratories	26.2	50.0	59.1	45.0	45.5
Students with disabilities increase the risk of other students in terms of safety in science laboratories	16.7	37.3	44.4	33.3	33.3
In the majority of cases, it is best if peers conduct a science investigation with the disabled person as an observer	7.0	5.6	17.8	7.0	9.2
It is unreasonable to expect science laboratories to be open extra hours to allow the disabled student extra time for lab investigations	23.1	14.8	28.3	18.6	20.9
Disability categories are too often used as an excuse for student failure	61.9	64.2	53.2	46.3	56.8
The attention given to students with disabilities detracts from teaching the other students	53.7	53.8	39.5	33.3	55.5
The regular classroom teacher should not be expected to make major adjustments to serve the special needs of students with disabilities	31.0	58.9	51.2	29.3	44.0
The primary responsibility for communication concerning students with disabilities should rest in the hands of the special education teacher	42.5	46.2	62.8	35.7	46.9
Special needs students gain self-esteem and confidence through science activities	95.1	98.1	100.0	100.0	98.3

TABLE 7 (Continued from previous page.)

Percentages of Elementary School Teachers, Middle and High School Science Teachers, and University Science Educators Who Agreed with Attitude Statements Concerning Teaching Students with Disabilities

Statements	Percentages of Educators Who Agreed:				
	Elementary Teachers	Middle School Teachers	High School Teachers	University Educators	Overall
It is impossible to expect a student with a physical disability to be an active participant in all science laboratory exercises	19.0	21.2	15.6	15.0	17.9
I wish I did not have to teach science to a student with a disability	2.4	15.1	6.5	9.5	8.7
I feel inadequate in my preparation for teaching science to a student with a physical disability	37.5	62.3	65.2	62.8	57.7
The majority of students with physical disabilities also have cognitive impairments	10.3	10.2	2.4	2.2	6.3
It is unrealistic to expect a blind student to be a chemist	36.8	26.5	40.5	18.6	30.2
It is unfair for a science teacher to encourage a person with a severe motor/orthopedic disability to pursue study in a career which involves active field study like marine biology or geology	13.2	11.5	18.4	18.6	15.4
Care should be taken to not give students with disabilities unrealistic goal expectations which will inevitably result in frustration when they try to find employment	32.4	54.7	46.5	38.1	44.0
Outdoor field trips are excellent opportunities for increasing the experience of students with disabilities	100.0	96.2	97.8	100.0	98.3
Care must be taken not to frustrate students with physical disabilities in science because they are more likely to become frustrated and give up	28.2	46.0	38.6	20.9	34.1
All teachers of science should be required to participate in training on teaching science to students with disabilities	90.0	78.8	72.7	95.2	83.4
I am more comfortable in a setting in which there are no people with visible disabilities	20.0	36.5	23.3	22.7	26.3

Continued

TABLE 7 (Continued from previous page.)

Percentages of Elementary School Teachers, Middle and High School Science Teachers, and University Science Educators Who Agreed with Attitude Statements Concerning Teaching Students with Disabilities

Statements	Percentages of Educators Who Agreed:				Overall
	Elementary Teachers	Middle School Teachers	High School Teachers	University Educators	
All students with disabilities should receive passing grades regardless of performance	3.4	2.0	0.0	0.0	1.2
All state and national science conferences should have a section which includes programs on science teaching for students with disabilities	92.7	93.8	91.1	85.0	90.8
When choosing my service commitments, I will actively seek out direct involvement with persons with disabilities	32.4	15.2	30.6	25.6	25.2
I would be receptive to suggestions for making changes in my classroom environment and my teaching method to accommodate a student(s) with a disability	97.6	98.1	100.0	100.0	98.9
It is inappropriate to expect all science methods instructors in higher education to include topics and model lessons in teaching science to students with disabilities	15.0	18.9	28.9	19.0	20.6
Methods of teaching science for K–12 students with disabilities should be taught by faculty in the area of special education	32.4	46.5	45.5	24.4	37.6
Teaming and collaborating in the teaching of science methods between special education professors and science methods professors is unrealistic	0.0	11.3	2.2	7.0	5.5
There is no need for specialized methods instruction in teaching science for students with disabilities in a preservice teacher preparation program	5.0	4.1	2.2	12.2	5.7
There is no need for specialized methods in teaching science for students with disabilities as a separate graduate course offering	15.0	10.4	16.7	25.0	16.5

would be receptive to suggestions for making changes in their classroom environment and teaching methods to accommodate students with disabilities, yet two-fifths (41.4%) of the respondents felt that the regular classroom teacher should not be expected to make major adjustments to serve the special needs of students with disabilities, and one-fifth did not find it reasonable to keep science labs open extra hours to allow students with disabilities extra time for lab investigations. In addition, almost half (45.7%) of the respondents felt that the primary responsibility for communication concerning students with disabilities should rest in the hands of the special education teacher rather than the regular classroom teacher. It appears that teachers may be open to suggestion, but essentially do not seem to feel compelled to act on those suggestions.

Table 7 reveals strong support that training in teaching science to students with disabilities is needed although there is some disagreement as to who should be responsible for that training. Over half (61.2%) of the respondents reported feeling inadequate in their preparation for teaching science to students with a physical disability, and a majority (81%) supported required training for all science teachers. Many responding teachers (80.3%) supported the notion that it is appropriate to expect all science methods instructors in higher education to include topics and model lessons in teaching science to students with disabilities. Most (92%) of the respondents expressed a need for specialized methods instruction in teaching science for students with disabilities in a preservice teacher preparation program, with 80.7% supporting a separate graduate course offering in specialized methods. Over one-third (36.9%) felt that methods for teaching science to K–12 students with disabilities should be taught by special education faculty, whereas 92.4% felt it would be realistic for science methods instructors and special education instructors to collaborate and team teach. For continuing education, 89.8% of the respondents reported that all state and national science conferences should have programs on science teaching for students with disabilities.

COMMENTS FROM TEACHERS AND SCIENCE EDUCATORS

Each teacher was asked to list three major concerns regarding teaching science to students with disabilities. The concerns most often mentioned by elementary, middle school science, and high school science teachers included the following:

1. Inadequate preparation and training regarding teaching science to students with disabilities.
2. Limited knowledge about methods and adaptations for students with disabilities.
3. Lack of time for planning and individualized instruction for students with disabilities.
4. Large class sizes and inadequate space and materials.
5. Classroom management and discipline, especially with students with emotional disabilities and behavior problems.
6. Safety and liability issues.
7. Support from administrators and other teachers, especially special education teachers.
8. Expectations, assessment, and grading for students with disabilities.

University science educators had many of the same concerns, and some additional ones:

1. Lack of training related to teaching students with disabilities in undergraduate programs for preservice teachers.
2. Overcrowded methods courses and science teacher education programs leave little time for additional topics and coursework.
3. Lack of space, materials, equipment, and funds to use in teaching students with disabilities.
4. Limited research regarding science instruction for students with disabilities.
5. Need for university faculty in-service training and time to work in special education and inclusive classrooms.

6. Need for field experiences in inclusive classrooms for preservice teachers;
7. Need for modeling of science lessons for teaching students with disabilities.

Specific comments from teachers were eye-openers. Although elementary teachers have dealt with greater numbers of mainstreamed children than middle school or high school teachers, some of their comments were worthy of extra attention: “Teachers are *not* trained to work with students with disabilities. I have *no training. Train us!!!*” From another elementary teacher: “Special children take valuable teacher time away from the other 20–30 children in the room. Their education should not be so casually compromised. Lower class size will be needed—a costly item!”

Middle school science teacher comments were equally as revealing: “More effort needs to be put in training of teachers to prepare them for teaching students with disabilities.” Another middle school teacher stated “More funding needs to be available for staff development, science materials, and additional staff to meet the needs of students with disabilities.” And another: “There’s an inadequate amount of time to collaborate with on-staff colleagues to get assistance in obtaining methods to provide a quality education for all students.” Such wisdom we obtain from the teachers in the classroom with K–12 students: “Sometimes the special-ed teacher should be in the science classroom to deal with the nonscience problems. Just as the science teacher would not expect the special-ed teacher to be a science specialist, the science teacher shouldn’t be expected to be a specialist for students with disabilities.”

Many high school teachers were concerned with time, support, and funds: “Time and support—Help! Will this be in to everything else? Where will the money come from? We don’t have what we need for regular students.” From one of the high school teachers who voiced concerns about safety “Students who lack motor skills cannot manipulate lab equipment properly, and pose a hazard for themselves in the case of spills.” There were also controversial comments, such as “There is too much ‘worry’ about so-called special students; the mainstream kid doesn’t exist anymore.” Ending on a more positive note, one teacher stated “A lot of energy is often invested in students with disabilities and I don’t find them any different from my other students.”

University science educators voiced their own concerns: “Every student is different and it is unrealistic to expect precious time to be devoted to a broad preparation for all ‘special’ circumstances. Time is limited and there is so much to do as it is now. What do we omit? I’m not willing to discuss add without subtract.” Another science educator stated “Many university educators lack knowledge and experience regarding students with disabilities.” Another carried the idea further: “Funds are needed to provide college faculty in-service training and time to work in special-ed and inclusive classrooms.”

CONCLUSIONS AND RECOMMENDATIONS FOR PRACTICE

The purpose of this study was to gain information through the experiences and perceptions of K–12 science teachers and science educators about preservice preparation and the ability of classroom teachers in science education to teach students with disabilities. The study was limited in that the survey sought perceptions of teachers, which are personal, not verifiable realities. They are the result of individual feelings and experiences. In addition, teachers and university educators were not necessarily associated with the same teacher training program. Generalizations to the population of science teachers and science teacher educators must be made with caution. However, given the limitations, we believe that this study presents important new information worthy of consideration as practitioners design programs to adequately prepare classroom teachers to work with a diverse population of students in science.

The present study confirmed findings from previous research and further clarified issues and concerns regarding the inclusion and instruction of students with disabilities in science classrooms. Similar to the findings of Kearney and Durand (1992) and Lyon, Vaassen, and Toomey (1989),

feedback provided by the participants in this study indicates that teacher education programs reflect little commitment to preparing or in-servicing teachers to work effectively with students who have disabilities. There is considerable evidence that the majority of science teachers are not even aware that they can improve students' learning through adaptation and modification of instructional procedures. Atwood and Oldham (1985) indicate that, when asked to describe why students with disabilities have problems learning, teachers report: (a) language skills of reading, writing, following directions, recording data, and verbal expression; (b) concepts and new terminology; and (c) behavior problems. Science teachers expect that others will provide special education assistance, medical assistance, and technical assistance for students. The majority of individuals teaching science methods courses and most classroom science teachers have had little or no background, either academic or experiential, in teaching science to students with disabilities. They look at accommodation as being the responsibility of special educators.

Participants in this survey support the views of others: that classroom teachers are not adequately prepared to meet the needs of students with disabilities in general education classrooms (Vaughn, Schumm, Jallad, Slusber, & Saumell, 1996). The study provides evidence that teachers of science and professors teaching science methods:

1. Are not knowledgeable of the forms of physical and health impairments and how these impairments may affect student learning.
2. Have had little or no direct experience in teaching disabled students.
3. Are not aware of the research on best practice as it applies to students with disabilities.
4. Do not provide modeling in their classes on how to accommodate students with disabilities.
5. Do not expose the students in methods classes to instructional strategies best suited for participation by all students.
6. Have a very limited awareness of resources and agencies available to provide information and assistance in meeting the needs of students with disabilities.
7. Have a very limited awareness of facilities, equipment, and safety adaptations for students with disabilities.
8. Are not aware of networking opportunities to link students with similar disabilities and are not aware of networking opportunities to link students with disabilities with practicing scientists and other professionals in scientific fields.
9. Often hold stereotypical views of what students with disabilities can and cannot do.
10. Are receptive to receiving additional training in teaching science to students with disabilities.

Several previous studies reveal that elementary and secondary teachers do not make specific adaptations for students with special needs (Baker & Zigmond, 1990; Schumm et al., 1995; Ysseldyke, Thurlow, Wotruba, & Nanaia, 1990). Similar to the findings of Leyser and Abrams (1986), comments from respondents in this study indicate a need for more training in the rationale for mainstreaming instruction and assessment strategies, and classroom management.

This study substantiated recent findings without specific respect to science (Scruggs & Mastropieri, 1996) which indicate that general education teachers agree with the general concept of mainstreaming, and are willing to implement strategies in their classroom identified to best serve students with special needs. Several investigators (e.g., Dileo & Meloy, 1990; Leyser & Lessen, 1985; Stone & Brown, 1987) have indicated that preservice teachers improve their attitudes toward mainstreaming students with disabilities when provided with information about children with disabilities. There is enormous variation within the population of students with disabilities. Disabilities can assume many forms and each disability requires some specific and unique implications for instruction. Many impairments, particularly in the case of health impairments, may require many different adaptations from day to day depending upon the effects of the disability itself (i.e., acute occur-

rences, progressive diseases, or incapacitating conditions), the effects of the medication used in treating the disability, and changing conditions of the learning environment.

The lack of knowledge specific to students with disabilities examined in this study is evidence of the need to revise or expand the content of many of our teacher training programs to allow prospective and in-service teachers an opportunity to acquire the knowledge and skills necessary to work with a diverse population of students. Given that almost all teachers have students with disabilities in their classrooms, the classroom teacher must possess a variety of skills that must include accommodating the physical environment, modifying instructional materials, altering the modes of presentation, adjusting assessment strategies, and providing encouragement to students with special needs.

We must find ways to educate preservice teachers about the issues they will face in the classroom when they graduate. A serious barrier to this goal has been the dual system of regular education and special education maintained in higher education. Johnson, Pugach, and Delvin (1990) contend that the "interface between general and special education is one of the most pressing issues facing educators in the 1990's (p. 11). Thousand and Villa (1995) maintain that colleges and universities share a major responsibility for preparing teachers to both expect diversity in the classroom and develop the skills to respond to students' differing learning styles and needs.

The following recommendations are based on the concerns and attitudes expressed by the participants in this study, as well as our collective experience, and research about inclusive education and teaching science to students with disabilities:

1. Develop a "yours, mine, and ours" approach to designing programs to include students with disabilities. It is important to remember that we are all accountable, in some way, for the success of these students in the classroom. No one can be expected to know everything about every disability or do everything necessary to meet the academic and social needs of all students. However, educators should collaborate to bring their expertise to the arena where teachers learn to teach students with many diverse needs. An interdisciplinary, collaborative, or consultative approach among teacher educators in science and special education should be developed. Vehicles for establishing these relationships need to be explored.
2. Require general education preservice teachers to include coursework in special education and a field-based experience in inclusive settings as a part of their program of studies. Educating teachers in the rationale for mainstreaming, accommodations, instructional strategies, and behavior management will likely improve attitudes and a willingness to teach students with special needs.
3. Seek professional development opportunities to learn more about special needs students. Increasingly, presentations at professional conferences include sessions in which model programs are described, and best practices identified. Additional resources are available through videotapes, books, and journals.
4. When planning science methods courses, reach out to special educators, master teachers in whose classes students with disabilities are integrated; utilize community guest speakers to help bring awareness, compassion, and practical approaches to beginning classroom teachers. Encourage teachers to do action research specific to science and students with disabilities.
5. Employ strategies that emulate the principles of inclusive education (e.g., outcome-based education, multiple intelligence theory, constructivist learning, cooperative learning, use of technology in the classroom, peer-mediated instruction [Udvari-Solner & Thousand, 1995]). Reform initiatives in special education are paralleling similar efforts in general and higher education, often referred to as restructuring. Educators are raising the fundamental questions regarding best practice for teaching all students. What we do know about science and students with disabilities is that researchers have argued the merits of activity-oriented science for disabled, as well as nondisabled children (Atwood & Oldham, 1985; Coble, Mattheis, & Vizzini, 1982; Hoffman & Ricker, 1979; MacDougall, Schnur, Berger, & Vernon, 1981).

Advantages of teaching science to students with disabilities include: (a) concrete, hands-on learning activities; (b) less need for language skills such as reading and writing; (c) high level of group interaction and participation; (d) provision for individual differences and success; and (e) encouragement of interest and inquisitiveness (Atwood & Oldham, 1985).

6. Identify model programs where collaborative relationships have been developed and where coursework integrates science and special education.
7. Science education research should be conducted in the public schools and in university teacher education programs to obtain baseline data on current practice and its effectiveness, and subsequently to implement improved methodologies that prepare teachers of science to address student diversity in the science classroom.

The survey on Science for Students with Disabilities has raised some critical issues as we begin to address the challenges of educating students with disabilities in inclusive classrooms and schools. Can we develop teacher training programs that prepare teachers to meet the needs of students with disabilities in inclusive classrooms? More specifically, can science educators and special educators work together to ensure that all teachers are trained in science and that students with disabilities are included and engaged in science learning experiences?

Unfortunately, inclusion of students in general education classrooms often precedes the establishment of appropriate training and assistance for teachers and support personnel. Additional in-service training and opportunities for teachers in general and special education to work together as collaborative teams becomes necessary to deliver appropriate services to all students. Colleges and universities must create training programs to better prepare teachers to maximize learning for all students and to assume new collaborative roles in schools. Preservice education classes should prepare special education and regular education teachers together. In-service workshops should be offered in which special educators and science educators learn to work in teams.

Courses on teaching students with disabilities should be required of education majors in all teacher preparation programs. A focus should be on expanding teachers' repertoire of instructional methods and to accommodate a greater diversity of students' rates and styles of learning. Science and science methods courses should be required for all preservice teachers, including elementary school teachers.

It is the responsibility of both groups of educators, science and special educators, to work together for improved opportunities for all students with special needs. Instructors of science methods must broaden their skills to model appropriate strategies to accommodate students with disabilities in their classes if we are to bring about change in current practice. Science teachers must have the skills and a willingness to accommodate instruction and adjust the learning environment so all students can achieve success and all students can be active participants in the learning process. They must become accustomed to teaching fewer concepts with richer insights, deeper understanding, greater attention to application, and more relationships. Further research should be conducted in inclusive science classrooms, focusing on all aspects of science teaching and learning, and the classroom environment.

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