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Review Article

Inquiry-Based Education for Students with Visual Impairment

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The purpose of the study presented here was to identify and synthesize studies of evidence-based practices for working with students with visual impairment in the science classroom. Expanding a comprehensive literature search conducted in 1992, 10 empirical reports were found and reviewed. A synthesis of the results showed strong support for inquiry-oriented approaches to science instruction for children with disabilities. Evidence also was found that knowledge of science pedagogy for children with disabilities is continuing to increase; however, the literature to support evidence-based methodology for students with visual impairment in the science classroom is sparse. This critical review is a call for research that provides support for inquiry approaches in science education for the learner with a visual impairment.

1. Introduction

Science education reform necessitates purposeful and planned instruction for all students, emphasizing instruction aligned with the current thinking found in empirical research grounded in theory [1–3]. Knowledge of science pedagogy for children with disabilities is continuing to increase [4–8]. However, the literature in science methodology for learners with a visual impairment is sparse [9–11]. Although the primary interest was to review the literature available in science education for children with a visual impairment, the scarcity of the literature required a broader search with the belief that studies including students with other disabling conditions would provide relevant similarities to the experiences of students with visual impairment in the science classroom. The purpose of this review was to answer the following questions: (a) what recent research has been conducted on science instruction for students with a disability? and (b) what implications does the current research in science education of students with disabilities have for the learner with a visual impairment?

2. The Literature Search Procedures

A systematic search of all the literature was conducted. Modes of searching included reviews of subject related databases and recommended citations and consultation with members of both fields of interest. Learning/visually impaired/experiences, students with a visual impairment/education, science/visually impaired/education, disabilities/science education/visual impairment, and blind/science education were the phrases searched. Authors associated with science education, education of students with a visual impairment, and education of students with disabilities also were searched. Colleagues from three universities were consulted. In addition, colleagues teaching science at two state schools for the blind were contacted for information.

2.1. Early Studies in Science Education for All Students. Mastropieri and Scruggs [12] conducted a comprehensive literature review of science education for children with disabilities. The authors analyzed 66 reports divided into two categories: (a) instructional strategies and (b) science curriculum evaluation or comparison reports. The authors found that activity-oriented science curricula were effective in facilitating knowledge of content, manipulative skills, and science process skills. Activities-oriented curricula also were found to increase both the enjoyment of and motivation for science in children with disabilities.

Of the 66, 14 of the studies included learners with a visual impairment [12]. Researchers studied the use of science activities-oriented curriculum materials or Braille programmed instruction. Curriculum adaptations, materials adaptations, and activities-oriented materials were reported as being successful for students with a visual impairment. However, these seminal studies were conducted between 1967 and 1978.

The search for current literature yielded four empirical studies involving students with low incidence disabilities [7, 9, 13, 14]. A serious gap in the literature exists, and a need to address current thinking in the reform efforts of science education for all students is evident. The search was broadened to include studies in which students with high incidence disabilities were included as participants in the study. Altogether, 10 reports were located and reviewed. A descriptive breakdown of these studies is presented in Table 1.

2.2. The Current Literature (1992-Present). Studies were conducted with children identified with a variety of low and high incidence disabilities (see Table 1). As is typical of studies including students with disabilities, the participant sample sizes ranged from 1 participant to 33 participants, with 30% of the studies having less than 10 participants. Settings were inclusion classrooms (60%) and self-contained classrooms (40%). Both quantitative and qualitative methods were used in 60% of the studies, with 40% of the studies using only qualitative methods. Following the format presented by Mastropieri and Scruggs [12], the studies were grouped into two primary categories: (a) instructional strategies (50%) and (b) curriculum comparisons (50%).

2.2.1. Instructional Strategies. Erwin et al. [9] studied the impact and implementation of Playtime is Science for Children with Disabilities (PSCD). The PSCD curriculum is an approach to activities-oriented science instruction that incorporates science and scientific thinking into the daily routines of children identified with a disability. Through implementation of PSCD, the teacher reinforces the connection between children's play and science learning. Erwin and colleagues adapted the PSCD curriculum to meet the needs of students with a visual impairment. Two classroom teachers and their nine students from the first and the fourth grades participated in the study. The students attended a state funded residential school serving students with a visual impairment. Methods included observation with field notes, student and teacher interviews, and a teacher focus group. Student-related outcomes were identified through analyses of data. Positive peer-related skills, creating meaningful connections about the world, and teacher support of student learning had an impact on the students' knowledge and learning of scientific concepts.

The study by Erwin et al. [9] is important to the field of education of students with visual impairments and to the field of science education. Erwin et al. focused on the impact of inquiry-based instruction for children with a visual impairment and addressed a gap in the literature spanning two decades. Also, the authors concluded that a meaningful learning environment for students with a visual impairment is one in which teachers provide guided opportunities for students to pursue their own interests and answer their own questions. This finding shows the importance of the current reform documents of the NRC in which inquiry-based instruction in science classrooms is promoted [1, 2]. Erwin et al. found that active involvement, peer interaction, discussion, and the use of prior knowledge to construct new knowledge were essential in helping the students understand science concepts.

The small sample size of nine students is a limitation to the Erwin et al. [9] study. Also, because the study was conducted in a residential school setting, comparisons between mainstreamed classrooms including both children with disabilities and children without disabilities cannot be made; therefore, generalizations across students and classrooms are restricted.

Although research on inquiry-oriented approaches in science education for children with visual impairments is limited, the use of inquiry-based instruction in science classrooms has been reported as successful for students with other disabilities. Palincsar et al. [5] and Palincsar et al. [6] studied the engagement and learning of students with learning disabilities as the students participated in the Guided Inquiry Supporting Multiple Literacies (GIsML) approach to science instruction (cf., [15]). This approach is based on the authors' knowledge of research and practice of intentional learning and scientific activity. In GIsML instruction, inquiry is guided by a broad question that includes a general concept (e.g., why do things sink or float?). Students are engaged in inquiry through cycles of investigation. The authors indicated that learning occurs in a socially mediated community of inquiry (cf., [16]), in which small groups of students attempt to answer specific questions and whole groups of students compare and contrast their ideas and findings with the findings of others. In the course of GIsML instruction, students and teachers participate in two forms of investigations. In firsthand investigations, children have experiences related to the phenomena they are investigating. In secondhand investigations, children consult text for the purpose of learning from others' interpretations of phenomena or ideas.

As a second purpose to their study, Palincsar et al. [5] addressed how collaboration was used to help students with special needs realize success in inclusion science classrooms. Through observational methods, the researchers developed five case studies of students with learning disabilities that were used to create a set of claims concerning the engagement and learning of these students. The case study of a 4th grade boy identified with a learning disability was presented. Through the use of field notes from classroom observations, positive student outcomes were revealed (e.g., demonstrating success on inquiry-oriented tasks, seeking assistance in journal writing, engaging in scientific problem-solving, and actively participating in discussions). The authors concluded that science is an instructional environment in which the child with disabilities could demonstrate strengths.

Continuing with the same design as the experiment presented in 2000, Palincsar et al. [6] reported on two phases of their several-year project. Teachers in four 4th or 5th grade classrooms used the GIsML approach to science instruction. In the first phase, the classroom teachers conducted the GIsML program without interventions to support the 22 of 168 students identified with a disability. Researchers collected observational data in the form of video and audio recordings,

Table 1: Disability studies in science education: 1992–present.

Sample	Intervention	Reported results	Design
$N = 1$ 4th MS LD	GIsML	Positive for GIsML instruction	Case study NR: 1 condition
$N = 5$ (3) 4th MS (2) LD, (1) MMH, (1) ED, (1) Multiple	Textbook v/s activities-oriented instruction	SWD: at or above class mean on multiple choice, performance, and verbal fluency tests	Observational Before/after on all measurements NR: 2 conditions
8 schools $N = 172$ 4th MS $N = 33$ LD	Supported Inquiry Science (SIS) v/s Activity-based Science (ABS)	Student gain scores: main effect for group SIS students outperformed ABS students, $F(1, 156) = 40.00$, $P < 0.0001$ Positive results for SWD	Before/after Observational Partial RA: 2 conditions
$N = 14$ 1st–5th SC (6) MMH, (8) LD	FOSS with activities-oriented instruction	Positive results: SWD achieved success	Observational NR: 1 condition
$N = 26$ 6th–8th LD	Inquiry-oriented approach to instruction using FOSS materials	Positive effects inquiry-oriented condition (effect size = 0.42 and 0.49)	Crossover design NR: 2 conditions repeated
$N = 15$ (3) 3rd, 4th, 5th MS (2) HI, (9) LD, (1) VI, (3) physical	Inquiry-oriented activities	7 variables reported as meaningfully associated with success	Observational NR: 1 condition
$N = 16$ 4th–6th (10) LD (6) BD $N = 107$ all students	Discovery teaching versus direct instruction	LD discovery outperformed LD direct instruction (beta = 0.94, $t = 3.44$, $P < 0.001$)	2 × 5 factorial design RA: 2 conditions

Note: ED: emotional disability; NR: nonrandom assignment; VI: visual impairment; PSCD: Playtime is Science for Children with Disabilities; LD: learning disability; EI/ED: emotional impairment/disorder; PDD: pervasive developmental disorder; GIsML: Guided Inquiry Supporting Multiple Literacies; MMH: mild mental handicap; SWD: students with disabilities; RA: random assignment; FOSS: Full Option Science System; HI: hearing impairment; BD: behavioral disorder.

student and teacher interviews, and field notes. Although classroom teachers did not intervene directly, the researchers provided support to the students identified with a disability only if necessary and only as long as the intervention was needed for redirecting the students. The interventions were used to establish guidelines for advanced teaching practices needed to support learners in the next phase. Monitoring and facilitating student thinking, supporting print literacy, and improving group work were a few of the guidelines established.

In phase two, the teachers, participants from phase one, selected specific advanced teaching practices to add to their current GIsML approach to instruction. Students participating included 19 students with a disability of the total 111 participants. Pre and posttest data were analyzed to determine the learning gains of (a) students identified with a disability, (b) students identified as low achieving, and (c) students identified as normally achieving. In two classes, students with a disability made statistically significant learning gains, $P = 0.0129$ and $P = 0.0431$. In a third class, the learning gains of students with a disability approached significance, $P = 0.0679$, and in the fourth class, the students with a disability did not make significant learning gains. Based on data analyses of classroom observations and of the teacher's personal journal, the authors attributed the lack of students' significant learning gains in the fourth classroom to the teacher's limited expectations of what was possible for her students. Overall, Palincsar et al. [6] found that the advanced instructional content represented by guided inquiry science teaching enhanced the learning of students identified with a disability.

In a similar study, Scruggs and Mastropieri [14] investigated how children with disabilities construct scientific knowledge in inquiry-oriented science classrooms. The study was conducted during two academic years with 14 students, six children identified with mild mental handicaps (MMH) and eight children identified with learning disabilities in 1st to 5th grades, and the two special education teachers.

Observational research methods were used to collect data and included video and audio recordings during classroom observations, student and teacher interviews, and student work samples. The classroom teachers used the Full Option Science System (FOSS) approach to science instruction. Students demonstrated difficulty in sorting and classifying, in making inferences, and in drawing conclusions. However, with adaptations such as reduced vocabulary demands, graphic organizers, multiple representations, structured questioning techniques, familiarizing students with science materials, and guided coaching the authors concluded that students with disabilities could participate and be successful in an inquiry-oriented science classroom. A limitation to this study is that student participants met in a self-contained, small-group setting; therefore, results cannot be generalized to an inclusion setting. The authors addressed this limitation in future studies by implementing inquiry-oriented instruction with students in an inclusion setting.

Continuing their efforts to provide guidelines for science instruction with students with disabilities, Scruggs and Mastropieri [14] conducted a three-year collaborative project to identify variables associated with successful inclusion of learners with a disability in an inquiry-oriented science classroom. In the first two years of the study, researchers met with administrators, special educators, and other specialists to develop and refine guidelines for including students with disabilities in science classrooms. In the third year of the study, classrooms were targeted for observational research to provide support for the guidelines. Three classroom teachers and 16 students identified with disabilities, representing 3rd, 4th, and 5th grades, participated in the study. Data gathered included field notes from classroom observations, student and teacher artifacts, video recordings, curriculum materials, and student interviews about their inquiry experiences.

Through data analyses, common variables were identified as meaningfully associated with mainstream success of students with a disability in science classrooms: administrative support, special education personnel support, an accepting and positive classroom atmosphere, appropriate curriculum and adaptations, effective general teaching skills, peer assistance, and disability-specific teaching skills. The authors concluded that the students with disabilities in this study appeared to be generally representative of many students with disabilities in other schools. However, characterizing the teachers as generally representative would be difficult because the teacher participants were selected based on their prior experience and success with teaching students with disabilities in the mainstream classroom. Even with this limitation, the important evidence about how students with disabilities can be included in science classes is a contribution to the education field.

2.2.2. Curriculum Comparisons. Two major curricular approaches to science instruction include the traditional textbook-based approach and the activities-oriented approach. Scruggs et al. [17] compared the effectiveness of inquiry-oriented versus textbook-based science curriculum materials in promoting science learning of 26 students identified with a learning disability (LD) enrolled in four self-contained classrooms. Students in both conditions were taught units on electricity and rocks and minerals. In the inquiry-oriented condition, the classroom teacher provided student-centered activities designed to encourage student thinking and problem solving to uncover scientific principles. The Full Option Science System (FOSS) curriculum materials were used. In the textbook based condition, the classroom teacher provided exactly the same content information but used direct teaching strategies rather than inquiry-approaches to instruction.

A crossover design was used in which all students received instruction under both conditions. Students in the inquiry-oriented condition learned and recalled more information on immediate and delayed recall tests (effect size = 0.42 and 0.49) than the students participating in the textbook based condition. In interviews, virtually all students expressed preference for inquiry-oriented materials over textbook materials. The sample size of only 26 students and the self-contained setting are considered limitations to this study.

To determine the effectiveness of mainstreaming students with a disability into the general education science classroom; Mastropieri et al. [13] conducted a study of three 4th grade classrooms. Participants were all students in the selected classrooms, which included two students with LD, one student with mild mental handicap (MMH), one student identified as emotionally disturbed (ED), and one student with multiple disabilities. Students participated in either a textbook-based condition or an activities-oriented condition. Additionally, all students were measured with pre/postmultiple-choice tests, comprehension/performance tests, and verbal fluency tests. Overall, the students participating in the activities-oriented approach demonstrated statistically significant growth on all three measurements, $F(1, 65) = 4.8$, $P = 0.032$; $F(1, 65) = 68.35$, $P = 0.000$; and $F(1, 65) = 104.59$, $P = 0.000$, respectively. Students with disabilities collectively scored above or at the class mean on the same measurements. The authors concluded that the inquiry-based approach to instruction was beneficial to students identified with a disability in the general education science classroom.

An important limitation of the Mastropieri et al. study is that students with a disability only participated in the activities-oriented classroom and did not participate in the textbook-based condition. Therefore, comparisons could not be made between students with disabilities in a textbook-based approach to instruction and students in an inquiry-based approach to instruction. In addition, the presence of the special education inclusion teacher within the activities-oriented classroom may have contributed to treatment effects.

In a similar study, Bay et al. [18] compared the effect of direct instruction and discovery teaching on the science achievement of students with mild disabilities and students without disabilities. Discovery teaching was described as instruction in which students were engaged in gathering data, generating and implementing solutions, and observing consequences. Direct instruction was defined as teacher-focused processes and presentation and demonstration of specific skills or concepts. The researchers found neither method had a direct impact on immediate achievement; however, students' retention after two weeks was higher for those who participated in discovery instruction.

In a study to compare the development of conceptual understanding of electricity concepts in an inquiry-based condition to an activity-based condition, Dalton et al. [19] observed eight 4th grade classrooms enrolling 172 students in which 33 students were identified with LD. In the Supported Inquiry Science (SIS) condition, teachers took an active coaching role in the classroom; they guided students in recursive processes of experimenting and processing for meaning to promote conceptual change in students. In the activity-based science (ABS) condition, teachers engaged the students in a series of hands-on activities. However, in the ABS condition, little attention was given to students' conceptual understanding or to the social processes that mediate learning such as sharing of student findings, peer evaluation of projects, and group discussions to facilitate the development of meaning.

The study was conducted over a two-month period. A before/after questionnaire, a diagram test, and a pre/postconcept test were used to collect important information regarding the learning gains of the students. An ANOVA of students' gain scores on the questionnaire administered before and after instruction yielded that a main effect for group was found with the SIS students outperforming the ABS students, $F(1, 156) = 40.00$, $P < 0.0001$. The SIS students had an average gain of 18.05 points, approximately twice that of the ABS students' gain of 9.41 points. A main effect for learner status was also found, $F(3, 156) = 6.90$, $P < 0.0002$. As a group, students identified with LD demonstrated less conceptual growth than their peers without disabilities. Additionally, the SIS students obtained higher concept gain scores than the ABS group with a main effect for group found in each concept area (simple circuits, $F(1, 156) = 30.23$, $P < 0.0001$; conductivity, $F(1, 156) = 32.65$, $P < 0.0001$; series circuits, $F(1, 156) = 17.01$, $P < 0.0001$; parallel circuits, $F(1, 156) = 12.73$, $P < 0.0005$). The positive effect of SIS instruction was consistent for students with diverse abilities, indicated by the lack of interaction effects. The authors concluded that all students showed greater attainment of conceptual understanding in the inquiry condition, and the students with a learning disability benefited from the challenging SIS curriculum.

McCarthy [7] conducted a study comparing textbook-based instruction to hands-on, inquiry-based instruction with 18 middle school students identified with serious emotional disorders in a self-contained, partial hospitalization setting. Most of the students also had secondary disabilities. The students were assigned to one of two conditions based on current classroom enrollment. Overall, the author reported statistically significant gains in achievement for students participating in the hands-on approach, $F(3, 16) = 15.77$, $P = 0.000$. Several measurements were used in the analyses of data including pre/postmultiple-choice tests, short answer tests, and performance assessments. No significant differences were obtained on the multiple-choice tests; however, on both the short answer and the performance assessments, students in the hands-on group outperformed the text-based instruction group, $F(1, 16) = 50.11$, $P = 0.000$ and $F(1, 16) = 7.27$, $P = 0.016$. The author concluded that the inquiry-oriented approach to instruction was more effective for students identified as emotionally disturbed than was the textbook-based instruction.

Teacher participants in the McCarthy study may have had an impact on the treatment effects. The teachers had specialized training in the education of students with behavior and emotional disorders and applied strong behavioral-management strategies in the classroom. Therefore, the experiences and training of the teachers may not be reflective of teachers working with students in other settings, including special education and regular education settings.

3. Limitations of Studies Reviewed

General limitations to the studies reviewed should be discussed. First, most studies had a small number of students participating, which is typical of studies including students with disabilities. Small sample sizes do not allow for generalizations across similar situations. However, insight into the unique characteristics of children with a disability and the knowledge gained about how children with a disability learn and are best supported in an inquiry-oriented approach are beneficial. Next, many of the teachers participating in the studies were selected because of their exceptional teaching skills and their experiences working with children with disabilities. The strategies and skills employed by the teachers may be unlike those of the general teaching population; therefore, generalizations across teachers would be difficult. Also, as previously stated, only two of the studies included children with visual impairments as participants, indicating a strong need for research in the area of science learning for children with a visual impairment.

Inquiry-oriented approaches to science instruction and learning for a child with a visual impairment have shared characteristics. Learning through use of the senses, exploring concrete objects to further understanding, questioning discoveries, and testing the discoveries become a natural occurrence to the learner with a visual impairment. Using these commonalities for instruction in science classrooms will increase the students' understanding, spark further interest, and provide new avenues for the students' futures.

4. Implications for Practice

The studies reviewed were focused on science education and instruction for children with a variety of disabilities. Because the authors reported positive findings for inquiry-oriented approaches, one may conclude that students with a disability can achieve success in the science classroom with appropriate adaptations and accommodations. One also may conclude that the use of inquiry-oriented approaches in science education can be an effective method to use with students identified with a disability. All but one study [9] was focused on accommodations and adaptations to the general science education curriculum, again indicating that students with a disability can be successful with appropriate supporting techniques such as the facilitation of student thinking, guided coaching, and multiple representations of content and processes [1–3].

Collectively, these studies can provide educators with important information regarding inquiry-oriented approaches to science instruction for students identified with a disability. Support for the value of inquiry-based approaches is evident. Students with a disability demonstrated knowledge construction in both special education classrooms and in mainstreamed classrooms. Knowledge construction was facilitated by the meaningfulness of materials presented, by active participation and exploration, and by building these experiences into the students' prior knowledge. Personal construction of knowledge is a fundamental philosophy of the social constructivism models of teaching emphasized in current science education reform efforts [20–22].

Many positive outcomes were demonstrated in the reviewed studies connecting the effects of inquiry-oriented approaches in science and students with a disability. First, science was an instructional context in which the child with a disability could demonstrate strengths. Adaptations such as reduced vocabulary demands, graphic organizers, and multiple representations of content materials gave the students with a disability ways to verbally engage in the science classroom. Structured questioning techniques were used to guide and facilitate students' thinking, demonstrating that the child with a disability can exhibit higher thinking skills and cognitive processes to work through a problem. The teacher's guided coaching strategies provide the students with a disability the opportunity to build upon prior knowledge and experiences and to create new knowledge of the materials presented.

An additional positive outcome of the inquiry approach to science instruction in virtually all student interviews conducted is that the students expressed a preference for inquiry-oriented activities over textbook-based instruction. The preference for inquiry-oriented activities is not surprising given that students learn best by doing [1, 2].

What implications do the studies reviewed have for the learner with a visual impairment? Object interaction and firsthand experiences were critical in facilitating the construction of knowledge in the learner with a disability, as demonstrated in the studies reviewed. The learner with a visual impairment builds knowledge of the world in the same manner, and many researchers in the field of visual impairments have noted the importance of direct experiences. For example, Barraga [23] emphasized the need for a child with a visual impairment to develop a relationship with the immediate environment, concluding that experiences with the immediate environment would further facilitate a relationship between the child and the world around him. Similarly, Landau [24] found that a child with a visual impairment could not develop concepts when relevant experience was deficient, and if the child's concepts are deficient, the child's learning and understanding of word meanings also will not develop. Although Landau's study was about the language development of children with a visual impairment, the relationship between experiences and learning is evident. In a related study, Andersen et al. [25] found that the language demonstrated by children with blindness appropriately "reflected their experience-specific conceptualizations of objects obtained through touch and other non-visual senses" (p. 662), again indicating the importance of experiences in helping to facilitate learning in the child with a visual impairment.

The unique social needs of students identified with a disability were not discussed in the studies reviewed. However, social interaction is an essential component of learning. Inquiry-oriented approaches can facilitate the development of social skills of students identified with a disability because peer interaction is promoted in the learner-centered environment. Arguably, social interaction to promote learning is essential for all students. However, students with a visual impairment may need more opportunities for educationally meaningful interaction than students with sight [26–29]. Wolffe and Sacks [30] found that students with a visual impairment spend more time alone than peers with sight. Rosenblum [31] found that children with visual impairments have satisfying and supportive friendships; however, MacCuspie [32] concluded as children with a visual impairment grow older, they participate less in social activities. Participating in a science classroom in which the teacher promotes peer interaction, the sharing of information, and discussions of findings may encourage the learner with a visual impairment to be socially aware and to practice social negotiation in problem solving.

5. Conclusion

The studies reviewed contribute to the literature in several ways. First, inquiry-oriented approaches to science instruction were shown to be effective and successful for children with disabilities. Although direct instruction methods may be useful in some situations, these studies have shown students with disabilities seemingly thrive in inquiry-oriented learning environments. However, additional research is needed to increase the knowledge base about science education for students with a visual impairment. Future research can provide information on the following questions yet unanswered in the current literature. (a) How may the social constructivist models of science learning, prevalent in science reform efforts, promote meaningful engagement of students with a visual impairment in the science classroom? (b) What are the optimal methods for facilitating scientific knowledge construction in students with a visual impairment? (c) What type and amount of support is required by special educators, science teachers, and peers to successfully include students with a visual impairment in the mainstream science setting? Strong support for inquiry-oriented approaches to science instruction for children with disabilities was provided by the studies reviewed. However, this review is also a call for research that provides support for inquiry approaches in science education for the learner with a visual impairment.

Conflict of Interests

The author declares that there is no conflict of interests regarding the publication of this paper.

References

[1] National Research Council, *National Science Education Standards*, National Academy Press, Washington, DC, USA, 1996.

[2] NGSS Lead States, *Next Generation Science Standards: For States, By States*, The National Academies Press, Washington, DC, USA, 2013.

[3] J. Singer, R. W. Marx, J. Krajcik, and J. C. Chambers, "Constructing extended inquiry projects: curriculum materials for science education reform," *Educational Psychologist*, vol. 35, no. 3, pp. 165–178, 2000.

[4] M. A. Mastropieri, T. E. Scruggs, and K. Butcher, "How effective is inquiry learning for students with mild disabilities?" *Journal of Special Education*, vol. 31, no. 2, pp. 199–211, 1997.

[5] A. S. Palincsar, K. M. Collins, N. L. Marano, and S. J. Magnusson, "Investigating the engagement and learning of students with learning disabilities in guided inquiry science teaching,"

Language, Speech, and Hearing Services in Schools, vol. 31, no. 3, pp. 240–251, 2000.

[6] A. S. Palincsar, S. J. Magnusson, K. M. Collins, and J. Cutter, "Making science accessible to all: results of a design experiment in inclusive classrooms," *Learning Disability Quarterly*, vol. 24, no. 1, pp. 15–32, 2001.

[7] C. B. McCarthy, "Effects of thematic-based, hands-on science teaching versus a textbook approach for students with disabilities," *Journal of Research in Science Teaching*, vol. 42, no. 3, pp. 245–263, 2005.

[8] F. J. Brigham, T. E. Scruggs, and M. A. Mastropieri, "Science education and students with learning disabilities," *Learning Disabilities Research & Practice*, vol. 26, no. 4, pp. 223–232, 2011.

[9] E. J. Erwin, T. S. Perkins, J. Ayala, M. Fine, and E. Rubin, "'You don't have to be sighted to be a scientist, do you?' Issues and outcomes in science education," *Journal of Visual Impairment and Blindness*, vol. 95, no. 6, pp. 338–352, 2001.

[10] L. DeLucci and L. Malone, "Science activities for the visually impaired," in *A Teacher's Guide to the Special Educational Needs of Blind and Visually Handicapped Children*, S. Mangold, Ed., American Foundation for the Blind, New York, NY, USA, 1982.

[11] D. E. Hadary, "Science and art for visually handicapped children," *Journal of Visual Impairment and Blindness*, vol. 71, no. 5, pp. 203–209, 1977.

[12] M. Mastropieri and T. E. Scruggs, "Science for students with disabilities," *Review of Educational Research*, vol. 62, pp. 377–411, 1992.

[13] M. A. Mastropieri, T. E. Scruggs, P. Mantzicopoulos, A. Sturgeon, L. Goodwin, and S. Chung, "'A place where living things affect and depend on each other': qualitative and quantitative outcomes associated with inclusive science teaching," *Science Education*, vol. 82, no. 2, pp. 163–179, 1998.

[14] T. E. Scruggs and M. A. Mastropieri, "The construction of scientific knowledge by students with mild disabilities," *Journal of Special Education*, vol. 28, pp. 307–321, 1994.

[15] S. J. Magnusson and A. S. Palincsar, "Learning environments as a site of science education reform: an illustration using interdisciplinary guided inquiry," *Theory Into Practice*, vol. 34, no. 1, pp. 43–50, 1995.

[16] Cognition and Technology Group at Vanderbilt, "Anchored instruction and situated cognition revisited," *Educational Technology*, vol. 33, pp. 52–70, 1993.

[17] T. E. Scruggs, M. A. Mastropieri, J. P. Bakken, and E. J. Brigham, "Reading versus doing: the relative effects of textbook-based and inquiry-oriented approaches to science learning in special education classrooms," *The Journal of Special Education*, vol. 27, pp. 1–15, 1993.

[18] M. Bay, J. R. Staver, T. Bryan, and J. B. Hale, "Science instruction for the mildly handicapped: direct instruction versus discovery teaching," *Journal of Research in Science Teaching*, vol. 29, pp. 555–570, 1992.

[19] B. Dalton, C. C. Morocco, T. Tivnan, and P. Mead, "Supported inquiry science: teaching for conceptual change in urban and suburban science classrooms," *Journal of Learning Disabilities*, vol. 30, no. 6, pp. 670–684, 1997.

[20] J. R. Mergendoller, N. L. Maxwell, and Y. Bellisimo, *The effectiveness of problem-based instruction: A Comparative Study of instructional methods and student characteristics*, 2006.

[21] R. K. Sawyer, Ed., *The Cambridge Handbook of the Learning Sciences*, Cambridge, New York, NY, USA, 2006.

[22] J. Krajcik, C. Czerniak, and C. Berger, *Teaching Children Science: A Project-Based Approach*, McGraw-Hill, Boston, Mass, USA, 1999.

[23] N. Barraga, *Visual Handicaps & Learning*, Exceptional Resources, Austin, Tex, USA, 1983.

[24] B. Landau, "Blind children's language is not 'meaningless,'" in *Language Acquisition in the Blind Child: Normal and Deficient*, A. E. Mills, Ed., pp. 62–76, Croom Helm, London, UK, 1983.

[25] E. S. Andersen, A. Dunlea, and L. S. Kekelis, "Blind children's language: resolving some differences," *Journal of Child Language*, vol. 11, no. 3, pp. 645–664, 1984.

[26] M. Hoben and V. Lindstrom, "Evidence of isolation in the mainstream," *Journal of Visual Impairment and Blindness*, vol. 74, pp. 289–292, 1980.

[27] L. S. Kekelis, "Peer interactions in childhood: the impact of visual impairment," in *Development of Social Skills by Blind and Visually Impaired Students*, S. Z. Sacks, L. S. Kekelis, and R. J. Gaylord-Ross, Eds., pp. 13–35, American Foundation for the Blind, New York, NY, USA, 1992.

[28] L. S. Kekelis and S. Z. Sacks, "The effects of visual impairment on children's social interactions in regular education programs," in *Development of Social Skills by Blind and Visually Impaired Students*, S. Z. Sacks, L. S. Kekelis, and R. J. Gaylord-Ross, Eds., pp. 59–82, American Foundation for the Blind, New York, NY, USA, 1992.

[29] C. G. McGaha and D. C. Farran, "Interactions in an inclusive classroom: the effects of visual status and setting," *Journal of Visual Impairment and Blindness*, vol. 95, no. 2, pp. 80–94, 2001.

[30] K. Wolffe and S. Z. Sacks, "The lifestyles of blind, low vision, and sighted youths: a quantitative comparison," *Journal of Visual Impairment and Blindness*, vol. 91, no. 3, pp. 245–257, 1997.

[31] L. P. Rosenblum, "Best friendships of adolescents with visual impairments: a descriptive study," *Journal of Visual Impairment & Blindness*, vol. 92, pp. 593–608, 1998.

[32] P. A. MacCuspie, "The social acceptance and interaction of visually impaired children in integrated settings," in *Development of Social Skills by Blind and Visually Impaired Students*, S. Z. Sacks, L. S. Kekelis, and R. J. Gaylord-Ross, Eds., pp. 83–102, American Foundation for the Blind, New York, NY, USA, 1992.