The Impact of a Working Conference Focused on Supporting Students with Disabilities in Science, Technology, Engineering, and Mathematics (STEM)

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Abstract

This paper examines the effects of a two-day working conference on attitudes and dispositions of educators and other professionals who have a responsibility to students with disabilities. During this professional meeting, participants shared their experiences and suggested strategies to better educate students with sensory and mobility disabilities. The purpose of this working conference was to stimulate dialogue to (a) improve attitudes toward, (b) investigate ways to better support, and (c) plan accommodations/supports for students with disabilities who have interests in science, technology, engineering, and mathematics (STEM) in secondary and postsecondary settings. Speakers and participants examined ways to support students transitioning from high school to postsecondary education, shared ideas to ease transitions from community colleges into STEM majors in four-year institutions, explored options for resolution of issues, and advanced recommendations for improving the quality of STEM education. A group of 66 professionals from a Midwest state and 159 upper division preservice students in teacher education participated as collaborative partners with speakers from exemplary programs during this working conference. Workshop participants had more positive attitudes toward teaching science for each of the four areas investigated: attitudes toward students, work-related dispositions, postsecondary dispositions, and work-related performance. The evidence indicates that a short-term working conference can significantly impact educators' preparedness, responsiveness to make accommodations, and attitudes toward including students with disabilities.

Keywords: working conference, inclusion, disabilities, professional development, attitudes, accommodations

The purpose of this study was to examine the effects of a working conference focused on science, technology, engineering, and mathematics (STEM) for students with sensory and mobility disabilities on educators' attitudes related to inclusive science education. This investigation contributes to the professional literature by determining the efficacy of this unique mode of professional development, which is neither a workshop nor a traditional conference. A *working conference* is a meeting during which expert professionals and stakeholders of the community (in our case, instructors, parents, students with disabilities, support personnel, administrators, and preservice teachers) combine their knowledge, experience, and perspectives to work collaboratively on a pressing and often controversial issue (Boody, Esveld, & Else, 1997). Time and structure are provided to stimulate true dialogue between the parties. Ideas are recorded so that the results may be made public and built upon during future work. In this article, we: (a) review the literature on the efficacy of different professional development models, (b) examine the instrument used to measure participant attitudes toward students with disabilities who are pursuing coursework or careers in STEM fields, (c) describe our working conference and its outcomes related to participant discussions, (d) analyze pre- and post-test results of participant attitudes, and (e) draw conclusions regarding the efficacy of this form of professional development.

Efficacy of Professional Development Models

Professional development practices in the field of education constantly change as new models emerge. However, past practice is often abandoned on the

basis of just a few studies that demonstrate a more effective professional development model. A pertinent example of this is the adherence to a single model of long-term professional development predicated on criticisms of short-term professional development supplied by Joyce and Showers (1995). We argue that there are many factors in addition to "duration of professional development" that determine the effectiveness of such efforts. Ongoing evidence-based research is needed to continually examine approaches for efficacy in producing responsiveness to change among educators. Unfortunately, as Richardson and Placier (2001) remark in their review of the literature on teacher change, there are still "significant gaps in our understanding of change processes and our abilities to facilitate change" (p. 938).

In the past decade, some researchers have concluded that short-term staff development models involving theory and demonstration were ineffective in improving skills and their application to the workplace. Speck and Knipe (2001) stated, "Researchers have reached a clear consensus that one-time workshops for teachers are ineffective. The content is not transferred to the classroom, nor does it affect student achievement" (p. 84). They based that statement on the seminal publication of Joyce and Showers (1995) who emphasized the importance of practice, feedback, and coaching. Darling-Hammond, Ancess, and Falk (1995) similarly reported that teachers' individual isolated efforts did not provide the power to significantly improve student achievement. They suggested that limited professional impact occurred without sustained long-term, district-wide initiatives and the inclusion of coaching. Joyce and Showers are often cited as reporting that only 5% of teachers applied a principle following presentation of the theory, while 10% were able to incorporate this idea in their teaching when modeling was included in the presentation, and up to 15% if practice and feedback were a part of the professional development session. Joyce and Showers claimed that when coaching during instruction was added, 80-90% of the teacher participants applied the theory.

Lumpe (2007) concurred with earlier authors' conclusions, stating "one shot, workshop-based professional development is passé" (p. 125). He suggested the adoption of research-based professional development models that emphasize professional learning communities, which are based on a culture of collaboration and shared beliefs. Science teachers need to be at the forefront of science education reform for inclusion of all students because they are the change agents in the classroom. Therefore, teacher belief systems need to be addressed as these personal convictions guide their actions (Haney, Lumpe, Czerniak, & Egan, 2002). Although intensive, longer-term, collaborative professional development is desirable because it often results in more substantial and lasting educator change, we believe that short-term efforts to stimulate awareness, examine beliefs, and promote collaboration can serve an important role in education reform.

A better understanding is needed of how the goals of a professional development initiative, the context of the professional development experience, and professional development strategies work together to effectively produce specific changes in the educational experiences for students. The working conference model allows for a rich exchange of ideas among a diverse group of professionals addressing a common goal through dialogue. Additionally, there is evidence that educators can, and do, change their practices with brief, targeted professional development experiences. Duffrin (2002) showed that when teachers feel a need and a readiness to learn something, they are more likely to choose to participate in professional development opportunities. Participants of a working conference may similarly seek additional professional development after sharing their insights and discussing issues with professional colleagues.

Exclusive use of long-term, district-wide professional development programs limits input from outside experts who may only be available for brief appearances. An advantage of the working conference format is that it connects knowledgeable professionals beyond the school district with those inside a particular institution, thereby providing a broader range of viewpoints for school reform. Lieberman and Miller (1999a) reported the critical need to balance the use of inside and outside expertise and accompanying research that informs professional school practice. Educators in that study reported that experiencing out-of-school professional development with colleagues convinced them to adopt new approaches, resulting in greater student participation and success (Lieberman and Miller, 1999b).

Research (Schumm & Vaughn, 1995; Stefanich, Gabriele, Rogers, & Erpelding, 2005; Yuen, Westwood, & Wong, 2004) has indicated that teachers of students in inclusive classroom settings report they lack the

knowledge, skill, and confidence to make instructional adaptations for students with disabilities. Additionally, researchers have observed that adaptations were not consistent, systemic, or as frequently implemented as the circumstances required. Therefore, changing classroom practices to accommodate students with disabilities is a needed but challenging task that requires motivation. For educators to be persuaded to improve their instructional skills and change their performance, they must be professionally involved in improving practice. The format of a working conference provides educators with an opportunity to provide input and take a more active professional role in the planning of change in practice. Blandford (2000) identified six elements of effective professional development: providing role models of good practice and attitude, arranging specific guidance/training, encouraging reflection, delegating with sensitivity, promoting developmental initiatives, and providing information and developmental opportunities. Although a short-term working conference cannot address all of the elements noted by Blandford, it can address many of them and provide a stimulus to implement the other elements.

Goals of the Working Conference

The working conference targeted specific beliefs and attitudes towards inclusive science education through speaker presentations and discussion questions. These goals can be grouped into categories with specific attitudinal outcomes (Stefanich et al., 2005) as shown in Table 1. A questionnaire was designed and administered to determine the effects of the working conference on these specific beliefs and attitudes.

Method

Organization of the Working Conference

The presentation and discussion sessions of the working conference occurred over a two-day period. There were three sets of presentations by panels of speakers each day that were followed by conversation among the eight participants seated at each of multiple tables in response to given questions. The third panel presentation on the second day (poster presentations of assistive technology devices created by engineering students) was followed by a summary and wrap-up by the conference hosts rather than table discussions. A detailed schedule of speakers and presentation topics has been provided in Rule, Stefanich, Haselhuhn, and Peiffer (2009), but is summarized here. The five sessions addressed the following main topics: (a) community college STEM programs along with disability support services; (b) support services for students with disabilities at state institutions that focused on students pursuing STEM careers along with first-hand experiences and insights from a student with mobility impairments who majored in biology; (c) internships and mentorships for students with disabilities, together with information about disability services in adjoining states and department of education supports; (d) assistive technology programs, transition services to work, and funding opportunities; and (e) transition services, assistive technology, and supports for students with sight, hearing, and motor impairments. During an evening banquet on the first day, high school teachers, parents, and students with vision impairments discussed their experiences in STEM classes. Additionally, a keynote address at the start of the second day focused on challenges and supports in STEM careers for students with disabilities.

Discussion Response Data Collection

Data were collected during the group discussions that followed each panel of speakers. Conference attendees discussed two types of question sets after each set of panel presentations as volunteers typed responses into a Google Document through a laptop at each table. One set was based on de Bono's CoRT thinking skills (de Bono, 2000), such as determining the pluses, minuses, and interesting aspects of a statement (PMI) or listing the factors that affect a situation (Consider All Factors or CAF). Participant responses to the de Bono questions are discussed in Rule and Stefanich (in press). The other set consisted of two questions that were repeated for conversation after each panel presentation: "What new understandings or insights do you have about students with disabilities or services for students with disabilities pursuing STEM subjects, now, since the panel presentation?" and "What connections can you make between the information you just heard and what you already know, especially connections that lead to ways to help students with disabilities succeed in STEM subjects?" Responses to these questions are reported and qualitatively analyzed here using the constant comparison method in which similar responses were grouped and then further categorized by major trends shown (Charmaz, 2006; Richards, 2005).

Table 1

Attitudinal Goals of the Working Conference

General Category	Specific Outcome
Attitudes Toward Students	To help participants recognize that students with disabilities have equal rights to develop to their full potential. To recognize that, with appropriate accommodations, students with disabilities can attain and succeed like all other students. To instill an awareness that students with disabilities can, and should, actively participate in laboratory activities and do not pose any additional risks for teachers or other students. To understand that high quality science instruction plays an important role in preparing students for future learning in all aspects of life.
Postsecondary Dispositions	To develop in participants readiness to teach all students in the science classroom. To familiarize participants with resources, strategies, possible specific accommodations, and specialized methods for meeting the needs of all students. To develop a familiarity with best practice research and the temperament to apply the correlates of effective schools in their teaching. To familiarize participants with teacher responsibilities under legislative mandates (IDEA, ADA, etc.), and to instill in them a commitment to comply with these legislative initiatives and policies. To instill an awareness of educators' safety and legal responsibilities in science classroom, laboratory, and/or field settings.
Work-related Dispositions	To instill in participants an awareness that meeting the needs of students with disabilities in a science setting is not providing something "extra," but simply providing an equivalent opportunity previously afforded to all other students while excluding or marginalizing those with disabilities. To develop a temperament to collaborate with others, especially those with academic preparation, in meeting the needs of students with disabilities. To be accepting of all individuals in their teaching, professional, and personal interactions. To communicate with students and guardians to help students establish and assume responsibility for high expectations and high levels of personal accomplishment. To create a commitment in participants to make learning-related adjustments to provide students with disabilities equivalent educational experiences in science.
Work-related Performance	To instill in participants a commitment to sustained physical and mental effort to obtain high learning outcomes for all students. To exercise creative talent and expend creative effort to select, design, and modify learning tasks so all students can attain learning outcomes commensurate with their talents and abilities in science. To adhere to a pattern of support, encouragement, and cooperation when working with students who are not responding to instructional opportunities. To modify instructional practices, management strategies, teaching practices, and time allocations to best serve the learning needs of all students. To help students develop meta-cognitive skills that promote positive decision-making and learning independence.

Participants

There were two main groups of conference participants—practicing education professionals and preservice teachers. The practicing professional participant group included individuals from community colleges, regent institutions within the state and from neighboring states, the state department for the blind, area education associations, business and industry, middle schools, and high schools. These professionals were teachers, college instructors, disability support specialists, school-to-work specialists, administrators, state department of education personnel, and a few parents and students with disabilities. The second group consisted of preservice teachers who were enrolled in senior level science methods courses. The preservice student participants did not attend all of the program sessions. Most attended one or two speaker panel presentations with its following discussion. However, all participants were asked to complete the pre- and post-tests. Data analysis was conducted using the pre- and post-conference survey assessments completed by participants. The questionnaires were coded enabling us to match the individual pre-test and post-test responses. Complete responses were received from 31 of 63 (49.2%) professional participants and 82 of 159 (51.6%) preservice teacher participants. Demographic information about ethnicity, gender, professional capacity, or length of time teaching was not collected from the respondents.

Instrumentation

A 44 item questionnaire (Stefanich et al., 2005) was administered with eleven questions addressing each of these four areas, as elaborated in Table 1: attitudes toward students, work-related dispositions, postsecondary dispositions, and work-related performance. The questionnaire had 22 questions with a negative direction in which disagreement was the most desirable outcome and 22 questions with a positive direction in which agreement was the most desirable outcome (see Appendix). Working conference participants were asked to respond on a five-point Likert scale ranging from "strongly agree" to "strongly disagree." For questions stated in a negative direction, a value of five was assigned to strongly disagree down to one for strongly agree. Opposite values were assigned to questions stated in a positive direction; five to strongly agree down to one for strongly disagree. Overall, mean scores in each category were tabulated for the statistical analysis.

Validity and reliability evidence for this questionnaire were gathered from a previous study (Stefanich et al., 2005). Content validity evidence for the survey questionnaire was obtained from written comments provided by practitioners, critiques of the questionnaire by authorities with STEM backgrounds, and feedback from multiple workshop recipients. Internal consistency estimates of reliability (Coefficient alpha) for the entire instrument (.96) and each of the sub-scales (Attitudes toward Students = .85, Work-Related Dispositions = .84, Postsecondary Dispositions = .85, and Work-Related Performance = .91) were uniformly high.

Analysis of Surveys

Questionnaire responses were scanned into electronic format and then analyzed using the Statistical Package for the Social Sciences (SPSS). Each item was examined individually and indices were created for total score and the four sub-scales. Analysis focused on (a) changes from pre-test to post-test, (b) differences between participants who were practicing professionals and those who were still preservice, and (c) interaction between the two independent variables. These three analyses were carried out using two-way ANOVAs for total score as well as the four sub-scale scores.

Results and Discussion

Qualitative Analysis of the Participant Discussion Responses

After each panel presentation, participants, seated in groups of eight, were asked to discuss a set of given questions. Two questions were repeated for each discussion: "What new understandings or insights do you have about students with disabilities or services for students with disabilities pursuing STEM subjects, now, since the panel presentation?" and "What connections can you make between the information you just heard and what you already know, especially connections that lead to ways to help students with disabilities succeed in STEM subjects?"

Table 2 shows new understandings from the first three panel discussions held on the first day of the conference. Participants indicated new understandings at the end of the first half of the conference in several areas:

- STEM teachers are generally not aware of the possibilities of assistive technologies enabling

students with disabilities to succeed.
- Community colleges in the Midwest seem to be leading the way in terms of educational support and career services.
- The psychological environment of students with disabilities needs to be addressed through improving self efficacy and through professional development of teachers and support staff.

Table 3 shows connections participants reported making on the first day of the conference. Insights made by participants include:

- Accommodations need to be provided early (preschool or elementary) for students and continue as long as needed.
- Students need to be self-advocates.
- STEM subjects are important for all students – students with disabilities should not be pulled out of science classes to address deficits in reading and mathematics.

Table 4 shows some new understandings reported at the end of the second day of the conference:

- Amazement at the variety of resources available to assist students with disabilities was expressed.
- Expectations should remain high but students with disabilities often require additional time to meet those expectations.
- It is important for students to assume responsibility for self-disclosure of disabilities and education of instructors in their needs.

Table 5 tells additional insights of participants on the second day of the conference:

- Educators need to address stereotyped attitudes and work collaboratively to connect students to needed resources.
- Assistive technologies are available for a variety of disabilities that allow full participation in STEM.

The data in Tables 2, 3, 4, and 5 indicate that conference attendees gleaned important information from the panels of speakers, much of it attitudinal in nature. For example, during discussions on the second conference day, participants stated their realization that disabilities are a pervasive part of the human condition; we all have disabilities in some areas. On the first day, attendees mentioned that they had connected "individualization" to the current discussion because students with disabilities need to have their needs and accommodations considered individually. Participants also became more aware of the broad range of services and supports available to students with disabilities as evidenced in comments during dialogue both days of the conference. In comments that spanned the entire conference, they noted that it is important to start early in developing interests and preparing students with disabilities for coursework or careers in STEM fields. In addition, participants noted the importance of providing assistance when students struggle so they do not get behind or become discouraged in their work.

Recorded remarks on both days show conference participants suggested that teachers and support personnel teach self-advocacy to students with disabilities, encourage students, and provide role models of others with disabilities who have succeeded. Affective issues that surfaced during the conference included the idea that teachers should maintain high expectations for students with disabilities and involve them in science inquiry. Participants noted that they were now aware of mentorship and internship programs that are available, providing important experiences for students with disabilities. Additionally, attendees remarked about their new awareness of how assistive technology at school, work, and home expands the quality of life for students with disabilities; therefore teachers, employers, and support personnel need to know more about it. They also referred to the ideas presented by speakers with disabilities who discussed accommodations that worked best for them in science classes.

Attitude Survey Data Results

Workshop participation effects on educators' attitudes. Table 6 provides the descriptive statistics (means, standard deviations, statistical significance) for attitude scores pre- and post-workshop in the four goal areas and overall. To examine the effects of workshop participation on educators' attitudes toward disability and inclusion, five two-way ANOVAs were performed on the four attitude sub-scales, and the overall total score. These ANOVAs were of 2x2 mixed design, including one between-groups factor (group: professional or pre-service) and one within-subjects factor (time: pre-test

Table 2

New Understandings Reported by Participants During the First Day of the Conference

Generalized Concept	Examples of Supporting Responses
Starting earlier to assist students with disabilities in STEM fields is better	Look at STEM careers earlier in K-12 so that students can set goals. Teach self-advocacy earlier.
Better teacher/ instructor preparation	Teachers are unaware of the possibilities for assistive technology. Schools aren't making use of everything that is available. Teachers need more professional preparation to improve services.
Range of services offered	Some schools make accommodations and some don't. Many STEM career options at community colleges. Community colleges offer more support and assistive technologies than high schools. Temporary disability services may be given while a student is obtaining documentation.
Philosophies	High schools make modifications; colleges make accommodations but not modifications of course requirements. Students need to know requirements for being hired so they can choose careers in which they can succeed. Self efficacy and self advocacy are very important.
Mentorships/ internships	Having a mentor makes a student more comfortable about approaching new life experiences. Anyone can apply for mentorships and camps.
Cognitive and Psychiatric disabilities	Surprised at the large percentage of mental compared to physical disabilities. Schools are now focused on accommodating these invisible disabilities. Instructors need professional preparation to understand how to help students with mental disabilities succeed in their courses.
Science class accommodations	We can learn a lot from students with disabilities about what works for them. A clearer picture of the types of accommodations that can be made in science labs.
Science inquiry	Used to be reserved for honors students, but now for all students. Most students did rote textbook work in science class. If teachers are struggling with teaching it, how can they begin to make accommodations?

Table 3

Connections made by participants between ideas presented by speakers and other areas on the first day of the conference

Generalized Concept	Examples of Supporting Responses
Insights connecting multiple grade levels	No matter the grade level or age of the students with a disability, the accommodation is similar. Need to start early in elementary grades to provide meaningful, engaging STEM activities so interest is there in high school. A student's accommodations may change across grades even though the disability remains. Students need to work on self-advocacy from early ages – they need to become experts in their disabilities. Parents should know about this also.
Connections to individualizing	Students with disabilities need to be considered on a case-by-case basis. Go with each student to the disability office the first year at college to get students started. Hire a teaching assistant familiar with the curriculum to help students with disabilities in the classroom.
State core curriculum	The core curriculum will have appropriate accommodations for students. This core curriculum is a big shift for educators in the way it focuses on inquiry in all subjects. Students with special needs usually get pulled out of science rather than out of math or reading, but with the core curriculum they will no longer be able to be pulled out from science.

and post-test). Table 6 shows significant improvements for conference participants in all four goal areas and overall at the 0.01 level of significance.

Table 7 displays the data separated by groups (professionals and preservice teachers). First, for the sub-scale "Attitudes toward Students," professionals did not score significantly higher than preservice students $F(1, 104) = 3.61$, $p > .05$; attitudes improved significantly from pretest to posttest $F(1, 104) = 32.84$, $p < .001$, effect size (d) = .45; with no significant interaction $F(1, 104) = 2.14$, $p > .05$. Cohen's d is a commonly used effect size that measures the magnitude of a treatment effect (Cohen, 1988).

For "Work-Related Dispositions," professionals scored higher than preservice students $F(1, 104) = 5.78$, $p = .018$; attitudes improved from pre-test to post-test $F(1, 104) = 24.44$, $p < .001$; and there was a significant interaction $F(1, 104) = 4.65$, $p = .033$. This interaction was produced by the professionals improving their attitude (effect size (d) = .60) more than did the preservice teacher candidates (although their attitude did increase as well, effect size (d) = .27).

For "Postsecondary Dispositions," professionals scored higher than preservice students $F(1, 104) = 7.68$, $p = .007$, effect size (d) = .56; attitudes improved from pre-test to post-test $F(1, 104) = 33.31$, $p < .001$, effect size (d) = .53; with no significant interaction $F(1, 104) = 3.26$, $p > .05$.

For "Work-Related Performance," professionals scored higher than preservice students $F(1, 104) = 5.79$, $p = .018$, effect size (d) = .31; attitudes improved from pre-test to post-test $F(1, 104) = 23.02$, $p < .001$, effect size (d) = .38; with no significant interaction $F(1, 104) = 2.97$, $p > .05$.

Table 4

New understandings from the second day of the conference

Generalized Concept	Examples of Supporting Responses
Available resources and services for students with disabilities	Surprised at the vast amount and variety of resources for students with disabilities. Amazed at the resources available from the University of Iowa through the ICATER system. Know students with disabilities and now I know who to contact to help them.
Home/school/work assistive technologies	Interesting to see services, devices, and technologies that are not just in school. Can use devices at school, but also allowed to take them and use them at home.
Disabilities are part of the human condition	We all need to work together to see similarities and differences, because all humans have disabilities in different areas. People with disabilities need to be able to have fun even if it involves some risk. There are services so that college students with physical disabilities can lead a more independent life on campus.
Encouragement and self esteem are important	Students with disabilities sometimes need help, but won't ask for it. Knowing expectations and requirements for various careers helps when encouraging students. People who are blind have succeeded in many STEM fields: physics, chemistry, marine biology. Students with disabilities need think time for transitions. Expectations should be kept high for students with special needs. Help students when they first begin to struggle in a subject, so that they don't get far behind.
Professional development for teachers concerning assistive technologies	Assistive technology devices can be loaned to teachers so they can take them home for a few days to see how they work. ICATER does trainings on-site that are hands-on.
Self-advocacy	Students with disabilities should write research paper on own disability to increase understanding. Self-reporting and self-disclosure of disabilities should be encouraged. Encourage more self-advocacy for students with disabilities.

Table 5

Connections made by participants between ideas presented by speakers and other areas on the second day of the conference

Generalized Concept	Examples of Supporting Responses
Affective issues	Helping students earlier, as soon as they are beginning to learn to read, so that they don't get behind. Encouraging more self-advocacy. Assistive technologies can really expand the quality of life for persons who are blind. Believing in the students - getting rid of stereotypes
Importance of knowing about resources	Connecting some of my students with the resources they need. As a parent- useful to know about resources and who to contact for help.
Preparing teachers	Need to feel comfortable with assistive technology - teachers need to have time to try it. Important to keep up with new technologies. Show teachers success stories of students with disabilities using assistive technology. All teacher preparation institutions need to have assistive technologies available.

Table 6

Mean scores, standard deviations, and* t *from respondents on attitude survey*

Category	Pretest Mean	Posttest Mean	*t*	Significance
Attitudes Toward Students	3.64 (0.44)	3.87 (0.51)	5.86	<.01
Work-Related Dispositions	3.91 (0.48)	4.08 (0.55)	4.41	<.01
Postsecondary Dispositions	3.54 (0.38)	3.74 (0.43)	5.65	<.01
Work-Related Performance	3.84 (0.48)	4.02 (0.56)	4.56	<.01
Overall Total	3.73 (0.37)	3.93 (0.44)	6.67	<.01

*Standard deviations shown in parentheses.

Table 7

Mean scores from respondents on attitude survey

Group	Attitude About Students		Work-related Dispositions		Postsecondary Dispositions		Work-related Performance		Overall	
	Pre	Post	Pre	Post	Pre	Post	Pre	Post	Pre	Post
Professionals	3.72	4.08	4.03	4.38	3.61	3.95	3.79	4.21	3.79	4.16
Preservice Teachers	3.59	3.81	3.82	4.00	3.48	3.67	3.77	3.97	3.66	3.86

Finally, for the overall score, professionals scored higher than preservice students $F(1, 104) = 5.79$, $p = .018$; attitudes improved from pre-test to post-test $F(1, 104) = 48.70$, $p < .001$; and there was a significant interaction $F(1, 104) = 5.49$, $p = .021$. This interaction was produced by the professionals improving their attitude (effect size (d) = .86) more than did the preservice teacher candidates (although their attitude did increase as well, effect size (d) = .43).

There was significant improvement from pre-test to post-test for both the professionals and for the preservice teachers in all areas of these results. When considering the four subscales and the total attitude changes, in almost every case, there was a difference between the professional participants and the preservice teachers, with the positive effect on the professionals always being higher. The reason there is an interaction in the total score and in one of the four subscales (work-related dispositions) is likely because professionals improved at a much greater rate than preservice teachers. This is also reflected in the differences in effect size between these two populations in total score: the attitude change of professionals showed a large effect size (0.86) while the attitude change of preservice teachers also showed a substantial but medium effect size (0.43). In contrast, other researchers (Roberts, Henson, Tharp, & Moreno, 2001) who have examined the efficacy of professional development programs of differing lengths (two-to-three weeks versus four-or-six weeks) in improving teacher efficacy for teaching science found only small effect sizes.

Insight can be derived from looking at the analysis of individual questions showing significant changes from pre-test to post-test that are shown in Table 8. For example, the most significant difference was noted on the statement: “Students with special needs are at risk in terms of safety in hands-on science lessons.” Discussion of the results of this item is particularly appropriate because the comments made by blind participants who completed the pre-test prior to coming to the conference and inquired why the question was included. The essence of the conversation was, “Isn’t safety a concern in planning hands-on science for all students?” The implication was, in planning and preparation, professional educators would not look at students with disabilities any differently than students without disabilities. However, the pre-test data of other participants clearly indicate that it is not the case. The conference had a major impact on improving attitudes about including all students in hands-on investigations and making science accessible for all students. The statement with the second-most significant pre-to-post difference closely parallels the previous statement, again reflecting changes in attitude about the importance and need for including students with special needs working with other students in science laboratory activities.

The statement with the third largest pre-to-post change reflected awareness among participants of a need to improve their general strategies to address students with disabilities in a science classroom or laboratory. This can be connected to research results of several stud-

ies (Schumm & Vaughn, 1995; Stefanich et al., 2005; Yuen, Westwood, & Wong, 2004) that showed teachers do not have enough strategies for teaching students with disabilities. Even this relatively short working conference experience helped change this endemic problem.

Finally, the last line of Table 8 shows participants' improved comfort in being in a setting where there are persons with visual disabilities (i.e., low-vision or blindness). This might be a direct consequence of the number of participants who had disabilities at the working conference including three individuals who were blind. Fetters, Czerniak, Fish, and Shawberry (2002) found that teachers' lack of skills led to anxiety when trying to implement a new teaching system of using hands-on science kits, but this situation was ameliorated by in-service work with the materials. In our study that addressed person-to-person interactions rather than use of new materials, hearing the perspectives of students and professionals with sensory and mobility disabilities similarly eased anxiety, increased understanding, and improved attitudes toward including such students in STEM classes.

Table 8

Mean Scores and t *on statistically significant individual survey questions with* p *less than .01.*

Question	Pretest Mean	Posttest Mean	*t*	*p*
Students with special needs are at risk in terms of safety in hands-on science lessons.*	2.91	3.43	-5.74	<.01
Students with severe special needs should be included in science laboratory activities with regular students.	3.98	4.50	-5.48	<.01
I am aware of general strategies to address students with disabilities in a science classroom or laboratory setting.	3.24	3.63	-4.54	<.01
I am aware of safety and legal issues relating to classroom science instruction.	3.13	3.50	-3.51	<.01
I provide additional laboratory time for students with special needs.	3.56	3.79	-3.38	<.01
Too much money is spent to address the unique needs of students with special needs.*	3.59	3.93	-3.36	<.01
It is impossible to expect a student with a physical disability to be an active participant in all laboratory exercises.*	3.84	4.13	-3.33	<.01
It is unrealistic to expect a blind student to be a chemist.*	3.99	4.29	-3.26	<.01
Special needs students gain self-esteem and confidence through science activities.	4.20	4.42	-3.12	<.01
I am more comfortable in a setting in which there are no people with visual disabilities (i.e., low-vision or blindness).*	3.12	3.39	-3.07	<.01

* Although these statements are phrased as on the original questionnaire (in the negative direction), the scores shown here have been adjusted as if the questions had been phrased positively, so that pretest to posttest movements could be easily compared between questions. Therefore, an increasing score from pretest to posttest on all questions shown here indicates an attitudinal change favoring students with disabilities.

Conclusions

Summary of Findings

The data from this study punctuate the importance of professional development for faculty and staff to improve the participation level of students with disabilities in hands-on science rather than serving as passive observers or marginalized participants. Working conferences such as the one reflected in this investigation can be an important first step in increasing awareness and improving attitudes about the inclusion of students with disabilities in STEM education. The goals of the working conference (shown in Table 1) were supported by the results of this study. As shown in Table 6, there were significant gains in all of the four goal areas. Therefore, this study indicates that a short-term working conference can change STEM-related attitudes towards students with disabilities, postsecondary dispositions, work related dispositions, and performance related dispositions, which were the four goal areas of the working conference.

Participants provided information on their perceptions of the best direction of future professional development. Responses from participants clearly reflected a need for additional professional preparation about resources and strategies to improve their knowledge and skills in making accommodations for students with disabilities in STEM classroom and laboratories. The need for greater collaboration was noted. The conference brought out the existence of limited awareness among professionals of other professional entities that serve students with disabilities, and limited contact between individuals from different agencies. Considerable satisfaction with networking opportunities, and appreciation of the opportunity to interact with other professionals who have different roles but similar desired outcomes for students with disabilities, were reflected in the narrative evaluation statements.

Three of the six elements of effective professional development as identified by Blandford (2000) were directly addressed by this working conference. Role models of good practice and attitude were provided by many conference speakers. For example, directors of offices of disability services discussed exemplary programs, and individuals with disabilities shared their educational and work-related experiences. Reflection was encouraged as participants engaged in discussions and problem-solving related to assisting students with disabilities in STEM education. The conference speakers provided information about resources such as a mobile lab of assistive technology and professional development opportunities during their presentations and in their exhibits. Blandford's remaining three elements (arranging specific guidance and training, delegating with sensitivity, and promoting developmental initiatives) were addressed during discussions as suggestions for future actions.

The working conference employed here appears to be quite effective based on improving attitudes reflected in responses to the survey's questions. Although both groups reflected significant gain scores, professionals reflected significantly higher gains than the preservice teacher participants. Interaction effects were observed between the full-time professionals and the upper-division preservice teachers, which may reflect the lack of experience of preservice teachers and therefore readiness for growth, the shorter time-span of conference participation, or both.

A major finding of the study is that a working conference addressing the needs of science teachers working with students with disabilities produced significant positive changes in attitudes toward students with disabilities and evidence of increased commitment to make appropriate accommodations in consultation with students. In addition to giving participants knowledge and skills, the working conference enhanced collaboration and communication among those committed to improving science education of students with disabilities. Ample quantitative and qualitative evidence is seen in the efficacy of the working conference to positively impact the goal of greater equity in STEM education, contrary to published criticisms of short-term professional development programs. Working conferences such as the one investigated in this study can serve an important role in the continuing professional development of educators.

Limitations

This study is a summary and analysis of attitudes and discussion comments of participants attending a two-day working conference. Several elements in the design of the study are limitations. The participant groups consisted of volunteers and may not be equivalent to a random sample non-participant group. The sample populations were not stratified; therefore, there were not opportunities to compare participants and non-participants considering ethnicity, gender, teaching experiences, or professional expertise. The pre- and post-test intervals were short-term, adminis-

tered at the start of the conference and following the last session; long-term effects were not investigated. The instrument used in the study investigated only perceptions of the participants rather than observations of responsive behaviors to persons with disabilities with STEM career interests prior to and after the workshops. In this study, the attitudinal effects of a working conference in which participants were more fully engaged in problem-solving than typical workshops, was investigated. In our review of the literature, we were not able to locate studies that investigated the effects of conferences in this "working" format on teacher application of learning. The scope of this study did not address this criticism of short-term professional development, which is that teachers often do not apply what they learn at short-term workshops.

Implications

Short-term programs have a place in the overall toolkit of professional development strategies for the following reasons. A two-day working conference, such as the one described in this article, can provide attitudinal and conceptual change for teachers and professional staff with regard to including students with disabilities in science coursework or careers. Terehoff (2002) reported a dramatic increase in self-concepts when people make a transition from being a learner to a producer or doer. A working conference is more than a lecture or knowledge-dissemination process; it engages participants in discussion and digestion of the issues being addressed. This is similar to longer-term models that actively involve participants in grappling with issues. It is hard for university personnel with cutting-edge academic expertise and practicing professionals with specialized expertise to be involved in long-term intensive professional development projects because of the time commitment. The working conference model provides an opportunity to capitalize on the knowledge and skills of these outside experts.

With the understanding that more research is needed to affirm this investigation, the data and findings in this study challenge the blanket criticism of the ineffectiveness of short-term, one-time programs. Much depends upon the structure of the workshop, the context, and the participants. Although this research investigation did not measure K-12 student effects, the feedback from the participants reflects improved attitudes and greater commitment toward meeting the needs of all students, valuable professional development outcomes.

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Appendix

Survey of Attitudes Towards Teaching Science to Students with Disabilities

Directions: Please indicate the letter (see list below) that best represents your level of agreement or disagreement with the following statements.

A = Strongly Disagree
B = Disagree
C = Neutral, neither agree or disagree
D = Agree
E = Strongly Agree

1. Students with severe special needs should be included in science laboratory activities with regular students.
2. Too much money is spent to address the unique needs of students with special needs.
3. Teachers need special training to overcome prejudices and emotional barriers in working with students with special needs.
4. I am sensitive to teaching through the mind of the learners rather than expecting students to accommodate to my teaching.
5. Students with special needs are at-risk in terms of safety in hands-on science lessons.
6. It is unreasonable to expect a classroom to be open extra hours in order to allow the special needs student as an observer.
7. I feel inadequate in my preparation for teaching science to a student with a physical disability.
8. I put forth more effort to work with students that are not responding to instruction to enlist their support and cooperation.
9. Students with special needs increase the risk of other students in terms of safety in hands-on science lessons.
10. The attention given to special needs students detracts from teaching the other students.
11. All teachers of science should be required to participate in training on teaching science to students with special needs.
12. I engage in additional efforts to design, select or modify activities so that all students can achieve success appropriate with their talents and abilities.
13. In the majority of cases, it is best if peers conduct a science investigation with the special needs student as an observer.
14. The regular classroom teacher should not be expected to make major adjustments in order to serve special needs students.
15. I am aware of sourcebooks for making changes in my classroom environment and my teaching methods in order to accommodate student(s) with disabilities.
16. I modify my testing in assessment strategies and formats to allow greater numbers of students to experience a sense of success or accomplishment.
17. Special needs categories are too often used as an excuse for student failure.
18. The primary responsibility for communication concerning special needs students should rest in the hands of the special education teacher.
19. 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.
20. I work closely with parents or guardians to engage in cooperative efforts to serve the best interests of the child.
21. Special needs students gain self-esteem and confidence through science activities.
22. I wish I did not have to teach science to students with special needs.

23. Faculty in the area of special education should teach methods of teaching science for K-12 students with special needs.
24. I utilize Internet resources to seek out ideas that can help me be more responsive to addressing the needs of all students.
25. It is impossible to expect a student with a physical disability to be an active participant in all laboratory exercises.
26. Outdoor field trips are excellent opportunities for increasing the experiences of students with special needs.
27. There is no need for specialized methods of instruction in teaching science for students with disabilities in pre-service teacher preparation programs.
28. I modify my management strategies to make them more appropriate for the student diversity in my classes.
29. The majority of students with a physical disability also have cognitive impairments.
30. Care must be taken not to really challenge students with physical special needs in science because they are more likely to become frustrated and give up.
31. There is no need for specialized methods in teaching science for students with special needs in staff development programs or graduate classes.
32. I provide additional laboratory time for students with special needs.
33. It is unrealistic to expect a blind student to be a chemist.
34. I am more comfortable in a setting in which there are no people with visual disabilities (i.e., low-vision or blindness).
35. I am aware of general strategies to address students with disabilities in a science classroom or laboratory setting.
36. I am accessible to students with special needs outside of regular classroom instruction to respond to their individual needs.
37. It is unfair for a science teacher to encourage a person with severe motor/orthopedic special needs to pursue study in a career that involves active study like marine biology or geology.
38. I am accepting of student diversity in my own teaching.
39. I am aware of safety and legal issues relating to classroom science instruction.
40. I collaborate with other professionals in planning strategies for meeting the needs of all my students.
41. Care should be taken not to give special needs students unrealistic goal expectations which will inevitably result in frustration when they try to find employment.
42. I am comfortable in interacting with human diversity in my personal relationships.
43. I apply my knowledge of best practice research to improve my own teaching.
44. I work with my students to develop meta-cognitive skills (self-awareness, self-questioning, self-monitoring, self-reinforcement) to assist them in decision-making processes.