Using a Thinking Skills System to Guide Discussions during a Working Conference on Students with Disabilities Pursuing STEM Fields

Audrey C. Rule and Greg P. Stefanich
University of Northern Iowa

Abstract

Students with sensory or motor disabilities are often dissuaded from pursuing science, technology, engineering, or mathematics (STEM) careers. They are frequently underprepared to succeed in post-secondary STEM coursework because of inadequate high school preparation and limited post-secondary accommodations. A two-day working conference stimulated dialogue to improve attitudes toward, to better support, and to plan accommodations for students with physical disabilities in STEM areas. Discussion questions during the five small group dialogue sessions that followed panels of speaker presentations were based on Edward de Bono's (2000) CoRT ten Breadth thinking skills. These thinking skills broaden perception so that thinkers might see beyond the obvious, immediate, and egocentric. These ten strategies encouraged conference participants to consider all factors (CAF), rate the plus, minus, and interesting aspects of ideas (PMI), think about other people's views (OPV), generate alternatives, possibilities, and choices (APC), list aims, goals and objectives (AGO) and then prioritize them (FIP), determine rules (Rules), consider consequences and sequels of actions (C & S), make a plan (Planning), and come to decisions (Decisions) in the context of the issues addressed by the conference. The CoRT Breadth thinking skills provided a robust structure for guiding meaningful discussions and are recommended for generating discussion questions for future working conferences. The ideas that were generated during discussions are reported so that readers who are secondary or post-secondary STEM instructors might consider implementing them in their classrooms and programs.

Introduction

The Challenge of Changing Perspectives and Priorities

Professional development program organizers face a steep challenge in changing educators' dispositions and behaviors regarding students with disabilities (Cook, Tankersley, Cook, & Landrum, 2000; Stumbo, Hedrick, Weisman, & Martin, 2011). Students with sensory and motor disabilities have long been underprepared for pursuing science, technology, engineering and mathematics (STEM) careers (Brownell & Thomas, 1998; Kimmel & Deek, 1999). Preservice general educators' perceptions of including students with disabilities in their classrooms are generally neutral, improving only slightly after a course in special education (Shippen, Crites, Houchins, Ramsey, & Simon, 2005). Teachers involved in inclusive school programs exhibit more positive attitudes toward students with disabilities than teachers at schools with pull-out programs—programs in which students are removed ("pulled" out) from the regular classroom to receive instruction in a resource room by a special educator (McLeskey, Waldron, So, Swanson, & Loveland, 2001). Additionally, highly effective teachers show more tolerance toward students with disabilities than typical teachers (Treder, Morse, & Ferron, 2000), indicating that much progress in this area can be made. However, teachers report that they lack the knowledge and skills to make appropriate accommodations for students with disabilities (Stefanich, Gabriele, Rogers, & Erpelding, 2005; Yuen, Westwood, & Wong, 2004), which points to the need for professional development.

The Conference

The authors of this article organized a professional conference to deliver a two-day professional development program that actively involved secondary school and college level faculty, administrators, special educators, disability specialists, students with disabilities, and their parents in thinking about and applying ideas for supporting and accommodating students with sensory and motor disabilities in STEM fields. A well-accepted system of thinking skills was employed to guide discussion questions: the CoRT Breadth thinking skills. This article describes the ten thinking skills and shows how they were applied to stimulate thinking about students with disabilities. Participant responses are analyzed here to show how they mesh with ideas from the speakers' presentations. These ideas may help STEM instructors better meet the needs of students with disabilities in their courses. Finally, a summary of the

findings with recommendations for future use of this technique are provided.

The Framework of de Bono's Thinking Skills

The CoRT (Cognitive Research Trust) thinking skill lessons, developed by Edward de Bono and applied to an extensive variety of problems in business, education, and personal lives since 1970, are the most widely used materials for the direct teaching of thinking. This system is used in schools in countries across the globe including America, the United Kingdom, Ireland, Canada, Australia, New Zealand, Israel, Malta, and Venezuela. The ten simple, practical thinking skills that comprise the Breadth series are intended for students aged four through adult. De Bono's thinking skill systems have been embraced by business (Michalski, 2005); for example, 3M used de Bono's skills to determine the unusual ways people employ duct tape, designing new products related to those uses (Gardyasz, 2007). Innovation is a critical factor in determining whether an organization will thrive or perish in the global business climate; similarly, nations need creative ideas to function well. For example, President Gorbechev made de Bono's book on conflict resolution required reading in the Russian Politburo (Waller, 2007).

Although the de Bono CoRT thinking skills have been in use in hundreds of schools for several decades and are well-known in the field of gifted education, only a few empirical studies have been published that document their success (e.g., Barak & Doppelt, 1999; Melchior, Kaufold, & Edwards, 1988; Rule & Barrera, 2006, 2008). This is unfortunate, as their adoption by so many education systems is actually based on local successes with this approach that are often described on de Bono's website (2009). We hope to add to the existing body of professional literature with this documentation of a successful working conference guided by the de Bono CoRT Breadth thinking skills.

Changing Perceptions

This article applies de Bono's CoRT Breadth thinking skills to the context of a working conference focused on students with disabilities pursuing STEM coursework and careers. The purpose of these strategies is to broaden perception so that thinkers can see beyond the obvious, immediate, and egocentric (de Bono, 2000). The Breadth skills form the foundation of de Bono's lateral thinking, a creative thinking approach that involves the generation and perception of new ideas that may not be obtainable by traditional step-by-step logic (Carter, 2007). De Bono finds it important for individuals to know *how* they learn as well as *what* they are learning. He explains, "It's all about improving perception, because research at Harvard shows that 90 percent of the areas of thinking are about perception and not logic at all. CoRT wholly teaches humans frameworks for changing their perception, seeing more broadly into the future and into people's minds" (Carter, 2007, p. 21).

This change in perception is precisely the type of thinking needed during working conference discussions focused on helping students with sensory and mobility disabilities who are pursuing STEM careers. Students with these disabilities have often been stereotyped as incapable, facing both physical obstacles and perceptual barriers from teachers, peers, administrators, potential employers, and even themselves. Skills that help conference participants to imagine possibilities and consider ideas in new ways are valuable. Therefore, we chose to organize the group discussions at the conference reported here around these ten de Bono CoRT Breadth thinking skills.

The Working Conference

A working conference differs from a workshop or a typical conference of a professional organization in fundamental ways. Instead of a skilled professional delivering techniques and asking participants to practice them, and instead of participants listening to expert papers from conference speakers without organized and focused dialogue among attendees, a working conference involves participants in active discussions of information presented by experts with the goal of synthesizing ideas from both speakers and participants to solve problems related to the main goal of the meeting (Boody, Esveld, & Else, 1997). This objective, in the case of the working conference reported here, was to identify ways to improve attitudes toward, support, and plan accommodations for students with sensory or motor disabilities enrolled in STEM courses or pursuing careers in STEM at the secondary and post-secondary levels. A working conference is the first link in a chain of professional development; it defines the problems in a specific area and outlines solutions, building a greater sense of awareness in participants and readying them for action. The professional development that follows may take many forms, as detailed by Lang and Fox (2004), such as action research, collection and discussion of case studies, coaching, cur-

riculum development, journaling and reflection, formation of networks, mentoring, portfolio development, and study groups.

Rather than focusing on working with diverse learners *in general*, as many successful working conferences such as the Wingspread conference (Dieker, Voltz, & Epanchin, 2002) have reported previously, our conference addressed a population of students with sensory or physical disabilities pursuing coursework and careers in science, technology, engineering or mathematics. The focus of our conference included examining ways to support students with STEM interests transitioning from high school to post-secondary education, transitioning from community colleges into STEM majors in 4-year colleges and universities, or transitioning to careers; it also included advancing recommendations for improving the quality of STEM education for students with disabilities. Students with sensory or motor disabilities in the geographic area served by this conference (Iowa and neighboring states of Wisconsin and Illinois) are often isolated in rural school districts with scarce funding and few specialists who are aware of resources for accommodations in STEM subjects; hence the need to prepare educators (high school and college instructors, disability services personnel, and preservice teachers) and support personnel in meeting their needs.

Quality of life is often determined by the opportunity to work and achieve success. Work, consuming about a third of the time for waking living, provides some of the most intense and satisfying moments of life. The fulfilling psychological condition of flow in which people use well-developed skills to meet strong challenges is most often encountered at the workplace (Csikszentmihalyi, 1997); therefore, work contributes significantly to the quality of a person's life. Unemployment rates for persons with disabilities in America are near 70%, but persons with disabilities who are knowledgeable in STEM areas fare much better in wage-earning, with only about 11% being unemployed in 2006 (National Science Foundation, 2008). These data also show that the employment rate for those whose disability occurred before age 25, rather than afterward, is better. The structures and supports provided early in life enable individuals to secure and maintain employment as adults. Therefore it is important to assist secondary and post-secondary students with disabilities so that they may reach their work potential.

Setting

The working conference addressed in this article was titled, "Planning for success in STEM for students with disabilities: A working conference," and was held on April 1–2, 2009, at the campus of the authors in a Midwestern state. Two groups comprised the conference attendees. The first group was composed of 66 professionals from community colleges, regent institutions within the state (state-funded and managed institutions) and from neighboring states, the state department for the blind, area education associations, and middle or high schools. These professionals were high school teachers, college instructors, disability support specialists, school-to-work specialists, administrators, state department of education personnel, and parents. The second group consisted of 159 preservice teachers who were enrolled in senior level science methods courses. Most of the latter group attended one or two sessions on the second day of the conference, although a few attended sessions on the first day.

The two-day conference was organized into five panel presentations, each of approximately one-hour duration with 3–4 presenters, followed by fifteen-minute audience discussions. These five panels presented information on the following topics: 1) community college STEM programs and disability support services; 2) support services for students with disabilities at regent institutions with a focus on students pursuing STEM careers, along with first-hand experiences and insights from a student with motor disabilities who majored in biology; 3) internships and mentorships for students with disabilities, together with information about disability services in adjoining states and department of education supports; 4) assistive technology programs, transition services to work, and funding opportunities; and 5) transition services, assistive technology, and supports for students with sight, hearing and motor impairments. A keynote address at the opening of the second day of the conference (before the fourth panel of presenters) focused on the challenges students with disabilities face in STEM careers and approaches that mitigate these. A sixth and final panel presentation during which senior university engineering students presented posters of their adaptive devices for persons with motor disabilities was not followed by small group discussion, but rather questions for presenters and a wrap-up summary of discussion responses from the previous day along with closing remarks.

During the conference, audience participants were seated in assigned groups of eight and provided with a volunteer recorder who typed responses through a laptop into an online Google document. Assigned seating was changed for each of the five panel presentation-discussion sessions so that participants would mix for better exchange of ideas. Group discussion questions were provided to all participants and were of two types: 1) repeated questions that were addressed during each discussion; and 2) questions based on the de Bono CoRT thinking skills. The repeated questions were, "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?" The CoRT questions, one for each of the ten thinking skills, addressed a variety of aspects of the central ideas of the conference. During each discussion, half of the discussion tables were directed to answer the repeated questions first, while the remaining tables were asked to begin by responding to the two CoRT questions designed for that portion of the program. Not all questions were answered by participants at each table; sometimes participants continued to discuss interesting ideas related to one or two questions for the entire fifteen minutes. A summary of conference evaluation results (Rule, Stefanich, Haselhuhn, & Peiffer, 2009) provides participant responses to the repeated questions along with conference ratings and comments about panel presentations. This article focuses on the use of CoRT Breadth thinking skill questions to facilitate discussions.

Results of the Discussions Using the CoRT Questions

In the following sections, we explain each of the ten thinking skills, noting its applicability to broadening perceptions of secondary or post-secondary STEM situations for students with disabilities. We also present and analyze participant responses recorded during these discussions.

CAF—Consider All Factors

This thinking skill involves an exploration of all of the variables or factors involved in a situation. It is most effective to consider all possible factors and then to determine which are most important. Having the points of view of many people in a discussion group helps in capturing all relevant factors, which is important because leaving out a crucial factor may make a wrong decision seem correct at the time. After listening to a panel of presenters talk about community college STEM program offerings and support systems for students with disabilities, we asked conference participants to "Identify as many factors as possible that affect the success of a student with disabilities in STEM subjects. Group these as helpful, not helpful, or both." Table 1 shows participant responses to this exercise.

One of the points of emphasis of the panel presenters was the importance of self-advocacy of the student for his/ her accommodation needs. Self-advocacy not only involves meeting one's needs that are specific to one's disability, but doing this without compromise of one's dignity or that of others (Skinner, 1998). One presenter suggested that students with disabilities become experts on their disabilities by conducting literature reviews. Another presenter mentioned that a recurring problem was the reluctance of some entering community college students to request accommodations in their courses. Often, the students only

Category of Factor	Factor
Helpful factors	Healthy self-esteem, positive attitude of student. Strong motivation and task commitment of student. Self-advocacy, self- awareness of needs of student. Teachers with high expectations and who understand a "case-by-case" approach to reasonable accommodations. Teachers who use universal instructional design strategies. Teachers who have intense training for meeting specific needs of students. Professional development updates for teachers. Hands-on lessons, manipulatives. Tutoring services, academic support, student learning team with peer tutors. Text support and Braille. Assistive technology, talking calculators, Smart boards. Parental involvement and realistic but high expectations. Exam accommodations. Lab assistants who assist in making the work accessible but do not complete the work for students. More materials and programs. Transition services from high school to work or high school to college or college to work.
Factors that are Not Helpful	Students' failure to disclose the disability and the need for accommodation. Lab equipment that is inaccessible. Poor self-esteem of student. Prejudice of teacher or belief that all disabilities are the same. Assumption that a student with a disability asking for an accommodation is trying to get away with something. Assistants who do too much for the student and don't allow the student to experience and learn. Limited time management skills of some students with disabilities.
Factors that can be both helpful and not helpful	The idea that all students can learn at the same rate and in the same way. Assistive technology that can only be used at school (and not at home). Attitudes of instructors.

Table 1. Factors affecting the success of students with disabilities in STEM subjects generated by conference attendees.

recognized the need for accommodation when they began to fail, a situation difficult to reverse. These ideas were reflected in the responses from participants.

Another point made by a speaker and noted by participants during discussion was the role of paraeducators or laboratory assistants who can be tremendously helpful in making science labs accessible, but who sometimes do too much for students, preventing them from experiencing and learning themselves. A published study expressed a similar idea: Werts, Harris, Tillery, and Roark (2004) found that a majority of parents viewed their children's paraprofessionals positively, but that some voiced concern about student overreliance on adult help.

PMI—Plus, Minus, Interesting

Instead of engaging in the natural inclination to like or dislike an idea, this thinking skill guides the user in considering the good points (pluses), the bad points (minuses) and the ideas that are neither good nor bad but perhaps lead to interesting connections or possible consequences (interesting items). This operation guards against thinkers becoming so enamored with an idea that they overlook its negative aspects. Similarly, this operation forces participants to examine the positive points of disliked ideas. We provided two statements related to the topic of providing accommodations for students with sensory/ mobility disabilities for conference attendees to discuss using a PMI. Conducting a PMI analysis may be helpful because sometimes an idea initially perceived as bad is rejected on emotional impulse before its good points are examined. Therefore, one can decide whether one likes an idea after exploring its pluses and minuses, rather than before such an investigation.

We chose two statements for this PMI analysis. The first was chosen because of the positive effect of hands-on learning and its potential benefits for students with a variety of disabilities. Montessori believed that the hand leads the mind—touching and moving objects motivates learners (Lillard, 2005) and focuses attention on learning (Sobe, 2004). Besides sparking interest and helping students with attention deficits, hands-on programs benefit tactile learners and those with sight impairments. The second statement centered on the crucial role of classroom teachers in implementing accommodations for learners with disabilities (Mastropieri & Scruggs, 1992). Such accommodations include instructional variables such as text alternatives through assistive technology, portable note-taking devices (Supalo, 2005), and scientific apparatus changes to make laboratory work accessible (Lunsford & Bargerhuff, 2006; Rankel, Amorosi, & Graybill, 2008). Tables 2 and 3 show the results of the discussions. Encourag-

Rating	Statement: A completely tactile science program should be developed and used with all children
Plus Ideas	What's designed for students with a certain issue helps all. This supports universal design of instruction, providing another component to help students learn. This makes concepts more meaningful because students can see and feel them through multi-modalities. This approach holds students' interest and provides more information. This is hands-on, motivating, and exploratory. Great for tactile students - allows the use of another sense that is not used so much. An example of alternate programs trying to get all kids involved - good to try new ways. All students benefit from an all-sensory approach. All students - including students who are blind or hearing-impaired are using it and learning. Accessibility to information for those who are sight or hearing impaired or who need tactile stimulation to maintain focus. Three- dimensional approach sparks more interest.
Minus Ideas	The teacher may not be informed on this new program and may not implement it well. It takes time – perhaps more time than other typical programs. Some kids can't be tactile and so could not participate. Not enough space to use a lot of materials or store them. Managing all children when they are engaged in hands-on activities is a challenge. Lumping all the students into one group to use tactile materials may not differentiate for those who need something else. A program that is completely anything is trouble. Hard to find the materials and difficult to create such a set of materials on your own. Difficult and costly to manufacture such a set of materials.
Interesting Ideas	Students may learn awareness of disabilities. Visual learners may thrive on this also. Students may catch on better. May be a higher demand for accuracy of teaching materials because they are tactile. Gives new perspectives on a science unit that is usually taught a different way. Learning style differences might be addressed in a new way. All students can work together with classmates and be involved in the same activities.

Table 2. Results of PMI Discussion on completely tactile science programs.

Rating	Statement: Teachers who consistently make accommodations for students with disabilities in science should be identified in some formal way
Plus Ideas	These teachers can serve as a resource for other teachers and others can learn from them. This may encourage others to make more accommodations and be more sensitive to student needs. Important to recognize people who do a great job and put a lot of effort into their work. It's great to have someone on staff that is good at accommodating students with disabilities – the school can be proud. Raise awareness and set an example for other teachers.
Minus Ideas	Could cause intimidation for other teachers. Students may just be sent to accommodating teachers rather than everyone learning how to accommodate them. Risks for students of being labeled as needing accommodations that go with being placed in such a teacher's class. Students who are placed in this class are automatically labeled. These teachers will always get put on IEP teams - unfair work load. Could place too much emphasis on something that should already be happening. Need to have that expectation for teachers of all students.
Interesting Ideas	All teachers need to do their jobs. Judging goes both ways - teachers performing exceptionally well and also very poorly. Rewards might be provided for good teachers. The teachers may not feel qualified although they are recognized.

Table 3. Results of PMI discussion identifying teachers who accommodate students with disabilities.

ing classroom teachers to accommodate and teach students with special needs is important, as McGinnis (2002) found that science teachers reported considerable reluctance in this area.

An interesting comment appeared through discussion of the second statement—that teachers may not feel qualified although they are recognized as qualified. This aspect was brought to life when one of the conference organizers asked teachers involved with students who were visually impaired to talk to conference attendees after the banquet that occurred on the first evening of the conference. Few teachers, although they had been working with students with disabilities all year, wanted to speak about the accommodations they had provided. Intensive, long-term professional development with direct classroom assistance (Coombs-Richardson, Al-Juraid, & Stuker, 2000; Kimmel, Deek, Farrell, & O'Shea, 1999) is needed before teachers experience confidence.

OPV—Other People's Views

Considering a problem from different perspectives sheds light on different aspects and factors that affect the outcome. The situation is enlarged by considering multiple points of view. Other people may have different objectives, priorities, and ideas that are essential in understanding the solution to the problem. Whether one agrees with another person's point of view or not, it is helpful to understand the mechanisms that lead to that perception. Different people have different values because of their personal histories and positions – sometimes these perspectives can lead to new or more effective solutions.

The second panel presented support services for students with disabilities at four-year colleges and regent universities. To help participants analyze the ideas put forward by this panel, we asked participants to consider as many different points of view of other people as possible regarding students with disabilities studying STEM subjects. We also asked them to then classify these points of view as helpful or not helpful to students with disabilities. The results are shown in Table 4. The concept of universal design for learning was addressed by one of the speakers and appeared in the discussions. This involves providing multiple means of representation, expression, and engagement (Center for Applied Spatial Technology [CAST], 2008) that benefit all learners (Hitchcock & Stahl, 2003). Ideas about the importance of self-efficacy were repeated here, showing that conference attendees were remembering and applying ideas from previous speakers to the task at hand.

APC—Alternatives, Possibilities, Choices

This thinking skill focuses on deliberately trying to find alternatives to help solve a problem. Sometimes, a situation seems to have few alternatives, but when one takes time to seek other possibilities, they can usually be found. Having a discussion group determine possible choices is particularly effective because the many points of view lead to new ideas. We asked participants to generate possible ways they could personally help in improving the transition for students with disabilities from the community college to a four-year STEM major at a four-year institution. The results are shown in Table 5.

AGO—Aims, Goals, and Objectives

Knowing exactly what one is trying to achieve aids in aligning actions to achieve that end. Our third panel discussion centered on internships and mentorships for students with disabilities interested in STEM careers. Therefore, we asked participants to generate a list of possible aims, goals, or objectives of a mentoring program in STEM careers for students with disabilities.

Rating	Points of View of Other People Regarding Students with Disabilities in STEM subjects
Helpful	Teachers who consider all students of the class when conceptualizing the design for the course.
	Teachers who post PowerPoint presentations online so everyone has access to notes.
	Office of student disabilities personnel who want accommodations to be made for students and those instructors who assist in this.
	Instructors who believe that students with disabilities can succeed in STEM fields.
	Mentors who want to encourage students with disabilities in STEM fields.
Not Helpful	An instructor's attitude of "You can't read, so you can't do it."
	Instructors who rate students' abilities on what they can physically do.
	Students with disabilities who have poor self-efficacy and low motivation.
	Students with disabilities who do not ask for accommodations when they really need them.
	Instructors who discourage students from STEM fields just because they have a disability.

Table 4. Different points of view regarding students with disabilities studying STEM subjects.

Possible Actions to Support Students with Disabilities transitioning from the Community College to a Four-year institution
Work with students prior to the transition to prepare them for differences between the two environments. Understanding all program expectations, professional standards, and career demands so students can make good decisions early.
Talk to the students to ensure classes transfer.
Must communicate with both the 2 year and 4 year colleges because both need to be on the same page.
As an instructor at a four-year institution, I can talk to students with disabilities about their experiences and make accommodations for them.

Table 5. Possible actions that conference participants could take to better support students with disabilities in STEM classes in transitioning from community colleges to four-year colleges.

Table 6 shows the ideas that were produced. Note that these goals were then prioritized, as described in the next section.

FIP—First Important Priority

Some aspects, factors, or objectives of a situation are more important than others. Often, after determining a list of goals, it is effective to prioritize them. It is necessary to determine the order of importance so that one may attack the most essential areas first. Additionally, it is important to know the reasons something is given high priority. Items not given the highest priority are usually still important, but not as important as those items that are prioritized. Table 6 shows the frequency of prioritizing different goals of mentorships for students with disabilities in STEM subjects.

The goals listed by conference attendees reflected many of the points made by speakers as they described their school-to-work programs and the exciting mentorships with industry that they were able to offer. The fact that psychological aspects were prioritized is a reflection of previous speakers emphasizing the role the student has in self-advocating. Learning about the STEM field and gaining valuable experience were also prioritized. These aspects of both internships and mentorships are important for students with disabilities and also other typical students.

Frequency of being chosen as high priority	Goals of a mentorship program for students with disabilities in STEM fields
5	Motivation, self confidence, anxiety reduction in school.
5	Learning about the career and current practices in that field.
5	Improving employability through knowledge and experience.
4	Understanding the social culture of the career.
4	Networking with others in the field.
2	Gaining practical experience.
2	Obtaining a broader comprehension of the world.
1	Changing the perception of the disability for both the students and the employer.
1	Choosing a career that fits.
1	Gaining knowledge that helps in school.
1	Making the school-to-work transition easier.

Table 6. Prioritization of goals of a mentorship program for students with disabilities.

Rules for Instructors and Personnel
Document solutions/accommodations put in place for a student so that it can be referenced at a later date if a student with a similar disability requires accommodation in the future.
A professor/instructor who receives specialized training in assistive technology can share the training with other faculty at in-service or faculty development sessions.
Faculty need to be notified prior to start of the semester if a student requires accommodation.
Accommodations need to be provided in a timely manner; especially at a college/university where courses are taught in a semester format.
Provide up-to-date websites to gain information about services.
Provide captioning services for students. Have an outline for each lecture.
When using voice recognition software, synchronize the voice of the user with the system in advance so that it works properly during lesson activities.
Use universal design- what helps one may help many others.
More hands-on, cooperative thinking, problem solving activities in classes.
Pairing up students benefits all people involved.

Table 7. Rules for instructors or other personnel using student disability services to better provide support for students with disabilities taking STEM courses.

Rules

Rules are invented to organize procedures and to make life easier for a majority of people. Rules should be purposeful and should work for the benefit of those who need to follow them. From time to time they should be examined and updated.

The fourth and fifth panels focused on assistive technologies for students with visual or hearing impairments and motor disabilities. Also addressed were transition and grant opportunities, along with special programs such as the Iowa Braille School and the Iowa Center for Adaptive Technology Education and Research (ICATER). To help participants synthesize their learning thus far, we asked participants to develop a set of rules for instructors or other personnel using student disability services to provide better support for students with disabilities taking STEM courses. Table 7 shows the rules that were generated.

The ideas recorded in Table 7 show both valuable ideas mentioned by speakers and effective practices inferred by participants. The statements made by participants articulate the need for forethought and planning in making instruction accessible to all learners. The importance of communicating in advance, allowing the instructor to acquire methods and plan ahead, was noted. Also mentioned is a need for recording solutions and accommodations so ideas can be referenced and applied in the future. Several rule statements referred to assistive technology, a particularly important support for students with disabilities. One of the speakers for this session from the ICATER program explained how preservice teachers and other participants in classes offered across the state could actually try out various devices so that they would better understand their uses. This hands-on experience allows educators to better select, implement, and evaluate assistive technology in their classrooms (Judge & Simms, 2009).

C&S—Consequence and Sequel

The CoRT skill of consequence and sequel guides learners in looking ahead to see the effects of some action in different time frames: immediately, short term, and long term. This

thinking skill focuses attention on the future to enlarge the view beyond immediate outcomes. The immediate effects of an action may seem favorable or acceptable, but consideration of the long-term effects may reveal negative consequences that overshadow short-term benefits. Table 8 shows the discussion results of considering the immediate, short term, and longer-term effects of participant attendance at the working conference. Conducting a consequence and sequel analysis of a situation with others may be helpful because others may be able to see the consequences of an action more easily than you do. Some other aspects of consequences that should be considered are whether they are reversible and whether they affect various groups in different ways. To help conference participants begin to internalize their learning on this second day of the conference, we asked them to determine the possible immediate, short-term, and long-term consequences and sequels to attendance.

The effects listed by conference participants support conference goals of changing attitudes toward students with disabilities in STEM fields and showed that attendees expressed awareness of possible ways to take action in breaking down barriers for these students.

Time Frame	What will be the possible immediate, short-term, and long-term consequences and sequels to your attendance at this conference?
Immediate effects	Check for similar services in Illinois - learn about available services in Northeast Iowa Community College (NICC).
	Collaborate more with different organizations- to better support students with disabilities.
	Go to the websites of conference presenters and learn more.
	Now I know where to get information.
	Greater awareness of the disabilities and accommodations and supports that can be put in place.
	Prepare for upcoming students with disabilities by applying ideas learned at the conference.
	Stop giving misinformation on self-advocacy and start keeping high expectations of what students with disabilities need to do.
	Understand technologies already available and utilize these technologies for students with impairments.
	Learn more about terms or other things discussed.
	Learn to make accommodations for students with whom I come into contact.
Short term effects	Attend Iowa Center for Adaptive Technology Education and Research (ICATER) training sessions or other professional development programs for learning about students with disabilities and possible accommodations.
	Goal setting to improve our disability services and accommodations.
	Have the mobile lab come and get trained with other teachers.
	Implement assistive technologies into lessons and activities.
	Inviting an expert on assistive technologies to speak about possible equipment.
	Look into level of demand in our respective states for assistive technology.
	Read articles and research ways to improve what we are doing.
	Provide cooperating teachers with information about students with disabilities during student teaching.
Long term effects	Write grant proposals and obtain funding to improve our programs.
	Inform coworkers about accommodations they can make and use of assistive technology.
	Know how to further create and popularize educational materials that address the needs of students with disabilities.
	Professional development - knowing what is new, current, and available.
	Look into Area Educational Association (AEA) programs for blind students.
	Look into Northwest Community College assessments of assistive technology and expand upon the types of the most helpful assistive technologies used in classrooms.
	Start a math help room with help from grad students.
	Possibly attend additional conferences.
	Push for curriculum changes.
	Seeking help when needed with future teachers.
	Provide mentors for blind students to motivate/ talk to schools.
	The hosting university builds an assistive technology course.
	Using accommodations for a wide variety of disabilities.

Table 8. Consequence and sequel of attendance at the working conference.

Planning

Planning involves thinking ahead to determine the best way to accomplish something in a simple, direct way. Planning should focus on the final objective. It is good to have alternate ideas that can be implemented when things do not go as expected. Considering all the factors involved and the possible consequences of each action can help in developing an effective plan. We encouraged participants to further apply the ideas presented at the conference by formulating a plan for students with disabilities. Table 9 shows planning ideas generated by conference attendees in response to, "Make a plan for assisting and encouraging a student with disabilities who is pursuing a STEM career. List the steps."

The steps listed in Table 9 show that conference attendees were able to articulate major positive ways to support students with disabilities in STEM areas.

Frequency	Planning Step
7	Start encouraging students in STEM subjects at a young age.
5	Explore student interests related to STEM and other fields
3	Teach the student how to be a self-advocate and an expert in his/her disability
3	Teachers need to know about assistive technologies and to be interested and open to making accommodations to help the students.
3	Be realistic determine the services a student needs, and seek appropriate help.
2	Make contact with a STEM mentor for the student.
1	Organize the educational plan so that the student will have the prerequisites for a STEM career.
1	Include transitioning to college and beyond.

Table 9. Planning ideas for assisting a student with disabilities in a STEM career.

Decisions

Decisions are important, as they chart a course of action. As the two-day conference neared its end, we asked our participants to decide what aspects of assisting students with dis-

abilities in STEM fields needed to be changed. Table 10 shows participant responses.

Frequency	Decision of What Needs to be Changed
6	Students need to be assertive and to engage in self-advocacy. Students need to become experts in their own disability and to know all of the services and assistive technology available to them.
4	Change attitudes that are based on prejudices and misconceptions, including low expectations, and the perception that STEM is not a field for students with sensory or motor disabilities.
3	All professionals need to work together as a team, including teachers, administrators, special education support services, vocational rehabilitation, high schools, community colleges, four-year colleges, and employers.
3	All teachers and preservice teachers need professional development in making accommodations for students with disabilities and in using assistive technology.
2	STEM fields need to be emphasized more for students with disabilities in middle and high school.
2	Students need realistic examples of people with disabilities who are succeeding in STEM fields.
2	Students need to be informed of the difference between high school and college with respect to modifications of the curriculum in high school, but accommodations to learn the same curriculum in college.

Table 10. Decision of what needs to be changed to help students with disabilities succeed in STEM education.

Conclusion

The foregoing discussion presented each of the ten CoRT Breadth thinking skills accompanied by an explanation of the utility of the skill and how it was applied to a discussion question, along with the conference participants' responses during discussion. These questions allowed participants to delve deeply into the concepts presented by speakers. Rather than merely recalling what was said, attendees applied the information just presented in meaningful ways to questions centered on students with disabilities pursuing STEM classes and careers. A synthesis of the ideas that appeared during the CoRT question discussions shows that participants addressed the following nine main ideas in response to the central problem of supporting students with disabilities in STEM courses or careers. 1) Self-advocacy and knowledge of one's disability, along with possible effective accommodations, will help students succeed. 2) Teachers need high expectations for students with disabilities and should encourage their participation in STEM subjects early so that students have appropriate knowledge bases for pursuing STEM. 3) Teachers need to be creative and willing to make accommodations so that students with disabilities can reach the same objectives as other students. 4) Universal design strategies, inquiry, hands-on learning, and real-world applications will benefit all students. 5) Laboratory assistants need to facilitate access and learning. 6) Assistive technology allows students to more fully participate in lessons. 7) Teamwork and sharing between faculty and support personnel of effective practices is needed. 8) Internships and mentorships build confidence, teach knowledge of the field, and help with transitions to work. 9) Transitioning to community colleges, four year institutions, or work can be facilitated by appropriately educated support personnel.

The atmosphere of the conference was relaxed, cordial, and collaborative, similar to that reported in the effective Wingspread conference (Dieker et al, 2002). The most frequent comment on the conference evaluation form was that participants found the conference an ideal situation for professional networking. On a scale of 1 to 6, with "1" being "very dissatisfied" and "6" being "very satisfied," the level of overall satisfaction with the conference reported by participants was 4.7. Participants also indicated that they were very likely to attend or recommend that a colleague attend another similar working conference in the future. Several participants mentioned the discussion times in response to, "Overall, what did you like best about the conference?" on the conference evaluation form. For example, they noted, "The significant interaction among conference participants," "Panels and discussions, moving people around from panel to panel," "I really enjoyed the discussions that took place after the sessions," and "I enjoyed hearing different people's perspectives."

The CoRT Breadth thinking skills provided a robust structure for guiding meaningful discussions in which participants applied concepts to critical issues related to supporting students with disabilities in STEM courses and careers. A pre-to-post 44-item attitude questionnaire documented statistically significant changes with substantial effect sizes in participants' attitudes toward inclusion of students with sensory and mobility disabilities in STEM classes/programs as a result of this two-day working conference (Rule, Stefanich,& Boody, 2011). Therefore, we recommend that other organizers consider using these thinking skills in generating discussion questions for future working conferences that involve the school and community.

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Acknowledgement

The information contained in this article is based upon funding (Grant No. IMSEP25-08-08) from the Iowa Mathematics, Science, and Engineering Partnership (IMSEP) titled, "Planning for success in STEM for students with disabilities: A working conference," and with collegial support from "Midwest" a Regional Alliance supported by the National Science Foundation under Grant No. 0533197. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the Iowa Board of Regents or the National Science Foundation.

Audrey C. Rule is an Associate Professor in the Department of Curriculum and Instruction at the University of Northern Iowa. She earned a Ph.D. in Geology from the University of Wisconsin-Madison and two subsequent Master's degrees in Elementary Education and Gifted Education from the University of Alabama-Tuscaloosa. She teaches science methods courses for preservice elementary teachers and is the coordinator of the Education of the Gifted Endorsement and Master's Programs. Her research interests are broad, including integration of critical/creative thinking skills into the curriculum, curriculum materials development, arts integration, and nature study/appreciation.

Greg Stefanich is a Regents Professor at the University of Northern Iowa. He received his Ed. D. from the University of Montana, MS from the University of Minnesota, and BS from the University of Minnesota, Duluth . His scholarly activity emphasizes science education for students with disabilities. His instructional responsibilities are in science methods. Recent awards include the Lifetime Service Award from the Association of Science Education for Students with Disabilities (2006), election as a fellow in the American Association for the Advancement of Science (2005), and the Hubbard Outstanding Educator Award (2004) from the University of Northern Iowa.