Utilizing the “Engineering the Future” Curriculum as a Social Skills Training Device for Emotionally Disabled Students

By

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This research report, “Utilizing the ‘Engineering the Future’ Curriculum as a Social Skills Training Device for Emotionally Disabled Students” is hereby approved in partial fulfillment of the requirements for the degree of MASTER OF APPLIED SCIENCE EDUCATION.

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Abstract

Utilizing the Engineering the Future Curriculum as a Social Skills Training Device for Emotionally Disabled Students

By Marguerite R. Parino

The purpose of the present research was to determine if the commercial curriculum entitled, “Engineering the Future” could be used to not only teach high school engineering content but also be used to enhance the social skills of emotionally and behaviorally disabled high school students.

The study participants had been identified as being emotionally/behaviorally disabled in their Individualized Education Plans. Participants attended the Alternative Education Center at a suburban Boston, Massachusetts High School. The Alternative Education Center is a substantially separate setting as defined in the Code of Massachusetts Regulations 603 CMR 28:06 (Massachusetts Department of Elementary and Secondary Education, 2007), with students taking more than 60% of their classes outside of the mainstream environment. Emotional disability is characterized by one or more of the following: an inability to learn that cannot be explained by intellectual, sensory, or other health factors; an inability to build or maintain satisfactory interpersonal relationships with peers and teachers; inappropriate types of behavior or feeling under normal circumstances; a general pervasive mood or unhappiness or depression and a tendency to develop physical symptoms or fears associated with personal or school problems.
The study identified 21 students for inclusion; however, only 13 completed the study. This is characteristic of this population that has challenges with school attendance, dropping out and mandated change of placement. Students completed 17 engineering tasks. Data was collected during three of the tasks and assessed participants ability to identify what strengths they brought to the team, their ability to work as a member of a team and their ability to work through the engineering design process. The social skills that were targeted were listening, helping, questioning, respecting, sharing, participating and persuading.

The results indicated that students: 1) stayed on task during the hour-long block with an average of only 1 redirection each and students were able to negotiate the tasks in a safe but competitive manner; 2) students had a difficult time determining what strengths they initially brought to the teams they were assigned; 3) students were honest and fairly accurate in determining their individual strengths and weaknesses as well as the strengths and weakness of the team at the completion of the tasks; 4) students were able to master the engineering content in the curriculum; and 5) students with internalizing and externalizing behaviors differed in the way they approached and carried out social skills tasks.

Recommendations for future study: 1) end of task check-ins with a trained social worker or school psychologist who would be better suited than the science teacher to use the formative assessment model for discussing the social aspect of the tasks; 2) develop a pre and post Survey that determines students’ attitudes and beliefs regarding the seven targeted behaviors; 3) certain tasks need to be re-evaluated to determine if they indeed
involve the engineering design process; and 4) re-determine which behaviors should be included in a safety violation.
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Chapter 1 Context

Introduction

There were twenty-one emotionally disabled (ED) students at Natick High School, Natick, Massachusetts. All were at high risk for dropping out of high school. They had been placed in a substantially separate area of the high school away from Mainstream Students (MS students).

Teaching ED students always involves unique challenges. In the mainstream educational environment, the focus of the teacher is on the subject matter content. In the emotionally disabled setting, the focus of the teacher is on the therapeutic social and emotional needs of the students and it is historically secondary to conceptual understanding. Most Alternative Education students have been assigned to the substantially separated setting through their Individualized Education Programs (IEP’s), and those IEP’s delineate at least one individualized social/emotional goal and one counseling goal that must be addressed and achieved during the IEP period. In Natick, ED students were further divided into two groups: Those that possessed internalizing behaviors that include blank affect, major depression, phobias and who have had histories of hospitalization; those that possess externalizing behaviors which included aggression, defiance, and excessive use of inappropriate language. The above referenced ED students were identified as emotionally/behaviorally disabled and thus were covered under both the Americans with Disabilities Act (ADA) and Individuals with Disabilities Education Improvement Act (IDEA’04). Their disability is characterized as having severe deficits in social competence (Cook et al. 2008).
All of the ED students required practice, remediation and opportunities to engage in positive social interactions while attending a setting that meets both the time on learning and high school graduation requirements. Comparatively speaking, science provides the best classroom opportunity to address these three needs: social skills practice, content and time on learning.

For the most part, all of the ED students were unsuccessful in social situations. There are many social skill training (SST) devices and their effectiveness in increasing the social competence of students with emotional and behavioral disabilities is often questioned (Mathur et al, 1998). SST devices have been used as a course of study in and of themselves. Unfortunately, because of schedule limitations, time on learning and lack of appropriate staff to teach SST, most students will not have the opportunity to engage in such content. What is agreed is that social skills training involves changes in cognition and therefore should be teachable. When students are given the opportunity to participate in activities where social skills are needed and the vocalization of inner speech is permitted, the teacher may be in a better position to address and remediate targeted social behaviors.

In short, there are methods to teach social skills directly and it was believed that the science content curriculum entitled Engineering the Future (EtF) (National Center for Technology Literacy 2008) could teach those same social skills indirectly. The EtF curriculum allows students opportunities to practice appropriate social interaction while learning engineering content that counts towards high school graduation.

Engineering the Future curriculum (EtF) adopts a unique science curriculum delivery method that focuses on the engineering design process. The engineering design
process provides a structure to solve engineering problems. This process is cyclical and can begin or stop at anytime. EtF asks students to define the problem, research the problem, develop possible solutions, choose the best solution, create a prototype, test and evaluate, communicate and redesign. In order to effectively solve engineering design problems students must be able to work together.

Teamwork was embedded into each EtF unit. Just as the design process is spiraled throughout the curriculum, so too are the seven social skills behaviors of the team member: helping, listening, participating, persuading, questioning, respecting and sharing. Within that general framework of the EtF curriculum there are two components to this delivery method. First, the ED students engaged in “hands-on” engineering task(s) that reflected a real life engineering project, which in and of itself requires teamwork and, thus the social skills of an effective team. For example, the ED students designed a cell phone holder in which they worked as a team to discuss what parameters they desired in a cell phone holder, the students built, tested the holder’s functionality and communicated the results to others. While each student maintained their own engineering project notebook that allowed them to keep track of each of their completed units, the success of the unit necessitated working together.

The second component utilized a distinctive textbook that essentially used a “story format”. This format was set-up with first person stories written by engineers, engineering students, and technicians about actual projects they had worked on, the processes involved in the projects and how these projects had assisted society. All of the stories acknowledged, to varying degrees, the importance of team work. For example, Chapter 3 was written by a CAD operator. He discussed working with a team to produce
a design that the prospective client would buy. Only a small portion of the text was
dedicated to science content and theory, unlike a mainstream science class where the
obverse is true.

Further the students were connected to these stories because each of the stories
involved people, places, or things in the Massachusetts area. It was hypothesized that the
EtF curriculum’s delivery method not only delivered engineering content but so
emphasized the necessity of teamwork that students must adjust their social skills to
effectively work in a team to solve an engineering design problem.

The EtF curriculum was driven by group hands-on activities. This gave the
students ample opportunities to practice social skills. Additionally, the teacher had
opportunities to both remediate unwanted social interactions and provide praise or
acknowledgement for the appropriate social interaction. Hands-on activities are essential
for ED students because the vast majority appear to be tactile learners and tactile
materials help these students remain on task.

Each project came with a consumable engineering notebook. The curriculum
designers felt that this notebook mirrored a notebook that an actual engineer might use in
the field. The engineer’s notebook cuts down on the amount of writing ED students
needed to perform. This seems to suit ED students because they lack writing skills and
even moderate demands frustrates them leading to off task behavior.

The EtF curriculum has few on demand tests. The EtF curriculum assesses
students much the way employers assess work based on productivity and the ability to
work well with others. ED students, because of their disabilities, tend to avoid “on
demand” tests by simply not showing up.
Every chapter in the EtF curriculum textbook answers the question, “Why is this important to me?” The text does not emphasize the memorization of vocabulary, definitions and equations. Instead the text presents topics that are related to what students hear on the news, see on television, or witness in their travels and purchases in stores. With these two pieces of information they can share and form opinions about the technology presented in the chapters. Understanding both the needs of the students and the philosophy of the EtF curriculum provided the necessary information to propose a research project that could evaluate EtF as a social skills training device while teaching engineering content.

**Research Questions:**

1. **Content Question**

   Was the Engineering the Future curriculum effective in developing the abilities of alternative education students in solving engineering design problems?

2. **Therapeutic Question**

   Was an engineering curriculum effective in developing the social skills of alternative education students?

**Variable Definition:**

1. **Engineering Design Process**

   A cyclical process with eight components: Define the problem, research the problem, develop solutions, choose the best possible solution, develop a prototype, test and evaluate, communicate results and redesign.
2. Social skills

The seven behaviors described and assessed in the Engineering the Future curriculum: Helping, listening, participating, persuading, questioning, respecting, and sharing.

**Negotiations Necessary to Conduct the Project**

Approval to conduct the project had been obtained from the School District’s Administration. Informed consents were distributed to the students. Prior data indicated that the student population attendance of 75% during the first marking period. It was believed that this attendance might go done because the project would take place over the holidays. The holidays season increases the stress level of the students and their absenteeism increases. It was important to facilitate inclusion into a team when students have been absent for a period of time.

**Statement of Resources**

The EtF curriculum was purchased. Most of the projects involved material readily available at home improvement stores for a minimal charge. The Boston Museum of Science agreed to provide support with the curriculum. Each class had an assigned teaching assistant who was available in collecting some of the data for the project.
Chapter 2 – Literature Review

Students with Disabilities

Federally, there are thirteen categories of special education students: autism, deaf and blind, developmental delay, emotional disability, hearing impairment, mental retardation, multiple disability, orthopedic impairment, speech and language impairment, specific learning disability, traumatic brain injury, visual impairment, and other health disability. National data regarding students with disabilities is gathered by the Office of Special Education Programs (OSEP) and the National Longitudinal Transition Study (NLTS). OSEP collects data from each state, organizes the data to show age data, category data, ethnicity data, socio-economic data as well as a national picture. It also addresses problems that states had in the collection of the year’s data. OSEP then makes an annual report to Congress. The 27th Annual Report to Congress is the last available report and it was presented to Congress in 2005 using 2002-2003 child count data. The report was over 1,000 pages in length. In the fall of 2003, OSEP reported that they were 5,976,558 children covered by special education law (Westat 2004).

Data on how well special education students’ transition after high school is collected and reported by the National Longitudinal Transition Study, which is supported by OSEP. The current NLTS has a sample size of 11,000 (Wagner and Cameto, 2004). It uses interviews, surveys and transcripts to collect data regarding such important topics as attendance, medication use, post secondary education and training, and employment among special education students. It compares this data between special education categories as well as the general population. Both the Congressional and NLTS reports delineate the continuing educational and post-secondary challenges that emotionally
disabled students have struggled with since the inception of Public Law 94-142 in 1975, and currently known as the Individuals with Disabilities Education Improvement Act (IDEA’04).

When people generally think of students with disabilities, their first thoughts go to those students with physical disabilities such as blindness, loss of hearing and impaired physical mobility or cognitive challenges including specific learning disabilities, mental retardation and traumatic brain injury. These students are more likely to receive a great deal of compassion from both the educational community as well as the general population. Students with mental illnesses, however, are not often endearing and receive little compassion outside of those who teach or provide mental health services to them.

Students with mental illnesses are emotionally disabled and nationally represent 8% of all special education students. Nationwide, of the nearly six million students identified as having special needs in the fall of 2003, 483,271 were identified as being emotionally disabled (27th Annual Report to Congress on the Implementation of the Individuals with Disability Act, 2005). This 8% figure has remained relatively unchanged since 1994.

Currently, the special education category mentally ill students are placed in has one of three titles. The term Emotionally Behaviorally Disabled (EBD) is used mostly by teachers and researchers. Emotional Disturbance (ED) is used in Federal documentation related to IDEA and NLTS. Serious Emotional Disturbance (SED) is used by a second
Federal Agency: The Office of Special Education Programs (OSEP). Regardless of the title, the definition for this disability comes from IDEA’04.¹

1. Emotional disturbance means a condition exhibiting one or more of the following characteristics over a long period of time and to a marked degree that adversely affect a child’s educational performance:
   a. An inability to learn that cannot be explained by intellectual, sensory, or other health factors;
   b. An inability to build or maintain satisfactory interpersonal relationships with peers and teachers;
   c. Inappropriate types of behavior or feeling under normal circumstances;
   d. A general pervasive mood of unhappiness or depression;
   e. A tendency to develop physical symptoms or fears associated with personal or school problems.

2. Emotional disturbance includes schizophrenia. The term does not apply to children who are socially maladjusted, unless it is determined that they have an emotional disturbance.

   This last sentence has been the object of much debate. Many educators believe that the distinction between social maladjustment and emotional disturbance overlaps in such a way that adjudicating a student as socially maladjusted leaves that student at further risk for not receiving the educational support until after the children has a significant event and is re-evaluated or the child simply drops out of school.

Additionally, trying to distinguish whether a child is socially maladjusted or emotionally

¹ This review will switch acronyms from EBD, ED, and SED dependent on where the information comes from for example IDEA”04 uses the term ED. Researchers Cook et al. and Quinn et al. use EBD
disturbed may be one of the reasons that unlike other special education categories emotionally disabled students are generally not identified until the age of nine (NLTS 2, 2004).

Late identification is just one of the many notable differences between ED students and other students with disabilities. Thirty-four percent of ED students take psychotropic medication other than stimulants and antidepressant/anti-anxiety drugs. The only group that takes more of this “other psychotropic” medication are students with autism at 38%. The other eleven categories have a combined average of 11% being prescribed “other” psychotropic medications. Seventy-three percent of ED students have been suspended or expelled while only 33% of all other students with disabilities have had this experience. This population is also transient. Forty percent of ED students transfer school five or more times. Their non-disabled peers transfer schools at the ordinary chronology of three times during their K-12 career (NLTS 2, 2004). Often this transfer of schools is a result of manifestation determination hearing. A manifestation determination hearing is held when a student has been suspended for a total of 10 days or more during the school year. The hearing determines whether the behavior resulting in the suspensions is a result of the student’s disability or whether the Individual Education Program was properly written or implemented. The manifestation determination hearing sometimes requires a change of placement. Students are then transferred to a school or program that is better suited to meet the needs of that student (Children’s Law Center of Massachusetts, 2005).

Emotionally and Behaviorally Disabled students are at the greatest risk for dropping out of high school and becoming disenfranchised as adults. Data from the 25th
Annual Report to Congress on the Implementation of the Individuals with Disabilities Education Act shows that during the 2000-2001 school year, EBD students had a dropout rate of 65.1%. This is 25 percentage points higher than the average drop out rate for other disabled students. During this same 2000-2001 school year, the National Center for Educational Statistics reported a national drop-out rate for all students under 11% (NCES, 2004). The NLTS2 has a sample size of 1,000 and is weighted to the national population of ED students and reports a 44% drop out rate.

**Intersection of IDEA '04 and NCLB**

Compulsory Education Laws have been in place in the United States since 1918. However, these laws did not cover children with even the mildest of disabilities. For these children there were only two options: stay at home or be institutionalized. Even as late as 1970, United States public schools educated only 1 in five students with disabilities. Some states went as far as to pass laws that prohibited the public education of deaf, blind, mentally retarded and emotionally disabled students (U.S Department of Education, 2007). That, however, did not stymie the Federal Government response. The push for training special education teachers began in 1959, when federal monies were set aside train teachers to educate mentally retarded students (U.S. Department of Education, 2007).

Besides the specialized teaching that is required for students with disabilities, teachers need to be fluent in a vocabulary of acronyms and numbers based on legislation designed to provide equal access to education in order that the teachers can best advocate for their students. This vocabulary includes: IDEA: Individuals with Disabilities Education Act; IDEA ’04: Individuals with Disabilities Education Improvement Act;
The attention both No Child Left Behind and IDEA have generated over the last few years, make it appear as though these laws are products of the very late twentieth century.

Both, however, began as one unified law, and can be traced to Public Law 89-10 signed in 1965. Then known as The Elementary and Secondary Education Act (ESEA), this law was written to address the educational inequalities of economically disadvantage students and it is the statutory basis from which all early special education law is written. The reauthorization of ESEA has occurred every five years since 1965. Currently the law is more commonly known as No Child Left Behind (NCLB).

In 1975, Public Law 94-142 entitled The Education of All Handicapped Children Act was passed. It was at this time that special education law was separated from ESEA. Public Law 94-142 had four distinct purposes:

1. “to assure that all children with disabilities have available to them…a free appropriate public education which emphasizes special education and related services designed to meet their unique needs;"
2. to assure that the rights of children with disabilities and their parents…are protected;
3. to assist States and localities to provide for the education of all children with disabilities;
4. to assess and assure the effectiveness of efforts to educate all children with disabilities” (U.S. Department of Education, 2007).

The Education for All Handicapped Children was the first law to mandate free and appropriate education for disabled students in the least restrictive environment. It also mandated that individualized education programs be prepared and that the educational objectives listed in the IEP be carried out. This law has also been reauthorized on a regular basis and in 1990 it was renamed IDEA. In short, IDEA acknowledges special education students’ individual needs. NCLB makes certain that the delivery of instruction based on those individual needs still produces a student that has had the same educational experiences as their non-disabled peers and thus disabled students will need to pass the same high stakes standardized tests.

Now after more than thirty-five years IDEA and NCLB intersect at a major crossroads: Assessment. In 1997, many national leaders felt that disabled students were being given “watered down” curriculums and that these students were held at lower standards. Striving to close the achievement gap, IDEA’97 mandated disabled students have access to, participate in and progress in the general education curriculum. It was this reauthorization that stated that students with disabilities would be included in state and district wide testing (2 NEA, 2004 p.2). Unfortunately, many states including Massachusetts chose to ignore the new regulations and the status quo was maintained. All of that changed with the 2001 passage the next iterant of NCLB. Instead of having a four year head start in preparing teachers, schedules, and creating remediation opportunities that would assist disabled students in passing state and district testing, special education departments found themselves under the gun trying to meet the
mandates of NCLB that are directly tied to a district’s ability to obtain funding from the federal government.

Parents and advocates argue that disabled students will not be able to pass the examines and that all special education students are lumped into one category. The most salient argument, however, seems to be about annual yearly progress. Disabled students should be able to make annual yearly progress, but that does not translate into these students being at grade level or even being exposed to expectations or objectives being offered in their age related grade. Therefore, the goals and objectives stated in the students Individualized Education Program may or may not be similar to the objectives in the high stakes tests. Nonetheless the U.S. Court of Appeals for the 7th Circuit ruled in 2008 that NCLB in fact trumps IDEA because NCLB is the newer statute (Board of Education of Ottawa Township High School District 140, et al. v. Margaret Spellings, Secretary of Education, et al., 517 F.3d 922 (7th Cir. 2008)) No argument regarding the needs of disabled students was heard.

What NCLB fails to consider is that these students have only recently been given access to subject area curricula with teachers who are highly qualified or on their way to being to highly qualified in the subject areas they teach and who are also willing to rebuild curricula so that the curricula meet the needs of the special education student while still covering state curriculum frameworks. To reiterate, what was written earlier in this section, if the mandates of IDEA’97 had been followed students who graduated high school in 2007 would have to have meet the higher standards of testing requirements of NCLB beginning when they were in elementary school and not have been “thrown under the bus” so to speak as they tried to pass exit exams as high school students. The
need for special education to catch up is even more apparent on a day to day basis. Disabled students, especially in the substantially separate classrooms, are taught by special educators who do not need to be proficient in subject areas. For example, in Massachusetts a special education teacher that teaches at the high school level is highly qualified to teach emotional disabled students all of the science subjects if she has passed the Foundations of Reading exam, the General Science exam for grades 5-8, has 100 instructional hours in special education and 150 hours supervised teaching high school aged emotionally disabled students. Mainstream teachers need to pass the high school science subject area exam for each science subject area they teach (Massachusetts Department of Elementary and Secondary Education 2009).

Many times it was the special educator or the paraprofessional who would take the work given by the science teacher and then present subject area material that she may not understand to the special education student whom was already going to have difficulty with it. The best case scenario is that both the special educator and the student would stumble through the work together. This is problematic for special education students across the board because in Massachusetts traditionally disabled students are pulled out of science classes. This means that the special education student does not have the same amount of time on learning science as her peers. It is quite a feat for the special education student to show annual yearly progress in science when she has not had time on learning as her non-disabled peers.

Further, NCLB does not include any provisions on the proficiency of special education teachers. Students with disabilities must participate in science assessments in the grade level in which they are enrolled once in grades 3-5, 6-9 and 10-12.
Finally, it is traditional that it is in the elementary grades that science students have the most access to hands-on materials. It is here that they can make the most of the benefits of learning in a social context. Students learn, with various levels of success, to share science materials, assign and accept roles in science experiments and touch a variety of learning material. By the time special education students reach high school they have had significantly less time on learning in science and now find themselves needing to pass a science exit exam.

**Time on Learning**

Time on Learning refers to the amount of time a student must be engaged in structured learning. It is defined in the Code of Massachusetts Regulations 603 CMR 27.04 (Massachusetts Department of Elementary and Secondary Education, 2007). High School students must have 990 hours of structured learning in core subjects during a school year. This works out to 5.5 hours of contact hours per day in the 180 day school year. The statute excludes from time on learning activities such as homeroom, lunch and time passing between classrooms. In school services like counseling and social emotional activities are specifically excluded from Time on Learning. Additionally, the statute makes clear that students in Alternative Education Centers, like the center describe in this study, must also meet the 990 contact hours. The focus of this research is to determine if the commercial engineering curriculum for high school students entitled Engineering the Future (EtF) (National Center for Technological Literacy, 2008) can be utilized to teach both the content of the engineering curriculum and provide the emotional supports and interpersonal skills often found in commercial social skills training curriculums. Thus meeting social-emotional goals set in an IEP, provide content material related to the
curriculum frameworks and provide social skills training needed to encourage successful interpersonal relationships without interfering with the required contact hours.

In the United States, not only are public schools the largest providers of education for children aged 3-21, they are also the largest distributors of mental health services to children and adolescents. And in fact, students identified as having special needs in the school setting have the highest rates of emotional disorders and receive more services within the school setting than in mental health centers. (Hoagwood and Johnson, 2003).

This creates a paradox between what the student needs for mental health services as written in the IEP’ and the set amount of hours school is in session. Students require mental health services and they must also have state and federally mandated time on learning. At the secondary level this creates scheduling conflicts. ED students have the poorest school attendance, should be included in as many inclusion classes as possible, must have the minimum number of contact hours per subject which, again, in Massachusetts is 990 contact hours and receive mental health services that removes them from core subject classes or elective classes which then reduces their number of available credits needed for graduation. When ED students are in school, they must be given opportunities to learn core subject matter content while their emotional needs are addressed. Often there is insufficient time during the school day to address this corundum.

Emotional needs have in the past been addressed by involvement in many social programs in school. These programs includes behavior management programs, behavior intervention programs, mental health services, anger management training, case management, social skills training and social work services. These services are provided
to ED students at a much higher rate than other disabled students. Interestingly enough, the only social program that ED students and other disabled students take at nearly the same rate is substance abuse programs at rates of 45% and 39%, respectively. The demands of No Child Left Behind has eliminated both the time available to address the emotional needs of the students during the school day as well as limit the number of professionals accessible to these students. Scheduling a professional to meet regularly with the ED student is further compromised by the professional needing to render crisis intervention protocols and the number of students requiring counseling as part of their IEP’s. Further, in Natick, Massachusetts counseling services are awarded credit at half the rate as other elective classes and students are pulled out of core subject areas to meet with their counselors or simply wait for their counselors to a free minute both of which decrease available credit opportunities.

**Social Skills Training**

Social Skills Training (SST) devices are available commercial curriculums designed to *teach* specific social skills that will assist students in their ability to negotiate social interactions that ED students have difficulty managing. SST devices are created around three theoretical approaches. The social learning approach involves the leader coaching and modeling appropriate behaviors and interactions. This method is not very successful with adolescents because students, regardless of whether they have a disability or not, are at the age when they are trying to find their own way, and they are not readily willing to copy or model adult positive behavior. The operant conditioning model which works best with students between preschool and pre-adolescents relies solely on positive reinforcement. The cognitive learning approach is supported by scripted interactions that
involve problem solving. This final approach is seen to be most successful with adolescents because it requires more thinking and reaching one's own conclusions. Nonetheless, most commercial materials intertwine all three theoretical approaches in their curriculums as well as four basic objectives that combine to emphasize the acquisition, performance, generalization/maintenance of pro-social behaviors and reduce or eliminate the competing problem behaviors (Cook, Gresham, Kern, Barreras, Thorton and Crew 2008).

Social skills training is most often delivered in a group setting and the duration is often limited to twice weekly sessions lasting for twelve weeks and intensive sessions which meet for several hours per day for one or two weeks. Many researchers and intervention specialist have found that this limited time does provide short term gains, but does not provide enough instruction for generalization or maintenance. Scheduling and school credit also becomes a problem and intensive sessions are most often delivered in a hospital setting. Nonetheless, a 1999 meta-analysis conducted by Quinn, Kavale, Mathur, et al. found, however, that duration of training appeared to have little impact on effect size.

Effect size is a social science statistic used to determine the impact of the independent variable. It is the difference between two means and then divided by the standard deviation. Thus it is represented as a percent or decimal that falls within a scale postulated by J. Cohen in 1988. The effect size is said to be small at .2, medium at .5 and large at .8.

In 2008, Cook et al. published a review and analysis of the meta-analytic literature regarding social skills training. In their analysis they were able to find five
meta-analysis studies published between 1980 and 2006. To match the criterion for their “mega analysis,” Cook et al. included only analysis that involved group studies of secondary EBD students, who had been randomly assigned to either the control or treatment group where the primary focus was on the analysis of social skills training utilizing either one or a combination of the three theoretical approaches: social learning, operant conditioning or cognitive learning. This resulted in the meta analysis of 77 studies and approximately 5,000 students. When analyzed, a medium size effect was found. This meant that a noticeable effect should be seen between the treatment and control group. The success rate for EBD students went from 34% to 66%.

The researchers felt that the internal and external validity of their project was maintained with all students having been randomly assigned in their respective studies and that the individual studies had representatives across the EBD population which included students with both internalizing and externalizing behaviors. A student was deemed EBD if that student had been assigned an EBD placement through her IEP. In studies where the populations were separated externalizing students showed a smaller effective size of .20 compared to the effective size of internalizing behaviors which was .40. However, the researchers did conclude that more research was needed to determine the effectiveness of the training and whether it is generalizable, feasible, and cost effective. In large part, this mega-analysis was completed to answer effectiveness questions raised in a meta analysis completed by Quinn et al. (1999).

Using thirty-five studies with 1,123 participants with an average IQ of 94, Quinn et al. found a much smaller effective size of .199. This can be compared to Cook et al. with a mean effective size of .30. Further, they found that in one fourth of the studies
students were better off without the Social Skills Training. Finally, as with the Cook et al. analysis students with externalizing behaviors had even less success than students with internalizing behaviors with an effective size of only .119.

Quinn et al. listed many concerns regarding social skills training which seem pertinent. First, because of the differing definitions of EBD it may be that the studies tested varied populations. Subjects may have met the inclusion parameters of the study they were in, but would have been excluded in other studies. Terms found in the EBD definition are subjective. They include words and phrases such as “a long period of time”, “marked degree”, “general”, “pervasive”, and “tendency”. Secondly, in commercial social skills training curriculums, the individual needs of each student are often not met. These commercial programs have more of a global outlook e.g. what are the situations most EBD students need remediation? Instead of what are the situations that this EBD student need remediation. Third, addresses the issue of duration. Can a significant change be seen in any subject area where there is a severe deficit after 30 hours of instruction over a 12 week period?

Still as Quinn and others point out, not offering some type of social skills training whether a commercial product, an individual session or group session, will only help perpetuate the continuing struggles that students have with the interpersonal lives. The data is quite clear that these students are at the greatest risk for being disenfranchised as adults. Social remediation must be addressed, if not as a subject area then, as an integrated focus of the regular school day.
Summary

The Education for All Handicapped Children was a giant leap for students with disabilities. However, as the decades progressed, special education teachers were not becoming more skilled in the core subject areas as were their general education counterparts. This meant that one of the original intents of Public Law 94-142 could not be achieved, namely that special education students would be held to the same state standards as general education students. NCLB, while intimidating, ensures that all special education students are adequately educated. Research regarding EBD students appears hindered on two basic fronts. First, professionals and agencies appear not to be able to decide on a simple name for the disability and this may include and exclude students who are affected by the disability and secondly that while all suffer from mental illness it appears that students with externalizing and internalizing behaviors respond differently to different treatments.

The literature shows that all EBD students struggle with interpersonal relationships while at school, are at the greatest risk for dropping out of school and in fact suffer from a disability that will impact their ability to be responsible adults and citizens. With increased high school graduation, and time on learning requirements, the social programs that once took precedence in an EBD students’ school day has now taken the back burner. As a result, it would appear that curriculums that integrate core subject area content should be combined with social skills training in order to best utilize the time that these students are available to learn, and they can earn sufficient credit as not to be penalized for their disability.
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Chapter 3 – Methods

Subjects and Setting

Alternative Education in Natick, Massachusetts

Natick High School, located in a Boston, Massachusetts suburb, has one of the oldest continuous Alternative Education Centers in the Commonwealth. The need for Alternative Education in Natick arose from the number of “street kids” congregating in the Town’s Center who were not attending school or having many of their basic needs met. These students would fall through the educational cracks and be left without a high school diploma. The Center was conceived by Dr. Joseph Keefe, Superintendent of Schools in 1983, at that time the Center was housed in a separate building away from other Natick Public School students. Dr. Keefe was very proud of the Alternative Education Center and he provided continuous support which included coming by the Center weekly. He also made a yearly appearance at the Center’s annual banquet where the graduating Alternative Education Class was honored and other Center Awards were distributed. Although Dr. Keefe retired as superintendent over fifteen years ago, his expertise in education and commitment to Natick Public Schools, saw him serve as interim superintendent for Natick Public schools on several occasions. He retired for the final time at the end of the 2007-2008 school year.

Over the past two and half decades, the role of the Alternative Education Center has changed. At the time of the Center’s conception, the majority of the students came from troubled homes and many of them lived in shelters or abandoned living spaces. Besides the lack of basic needs most students had substance abuse problems.
While the center still has a small group of feral adolescents, the majority of the students live with at least one family member. Most of the students have been diagnosed with having a severe emotional disability and are prescribed psychotropic medications. The students require a high level of emotional support in an education environment that is safe, can meet the individual educational needs of each student, and is extremely lenient on school attendance. Students are able to receive educational services at the Center until they reach the age of twenty-one or accept their high school diploma. It is realistic to believe that students attending the Alternative Education Setting would have little to no chance of graduating high school without this alternative setting.

The Center also accepts tuitions from other districts. Educating an emotionally behaviorally disabled student is extremely expensive. When placed out of district in a private placement, a student with externalizing behavior would require a tuition that would be roughly $30,000. A student with internalizing behaviors tuition would be nearly doubled that. Natick has a limited amount of spaces for students from other districts. The town currently charges $17,000 per non resident student with externalizing behaviors and does not accept out of district students with internalizing behaviors.

**Students and Classroom Environments**

There were twenty-one students enrolled in the study. Students ranged in age from fourteen to nineteen. There were eleven males and ten females. These twenty-one students had already been divided into three classes in a non-rotating block type school schedule. As part of their Individualized Education Plans, each student’s intelligence had been measured during the previous three years. Students had been given either the Wechsler Intelligence Scale for Children (WISC) or, for students over the age of sixteen,
the Wechsler Adult Intelligence Scale (WAIS). Students’ full scale scores (FSIQ) ranged from 75, which is considered borderline of having an intellectual deficiency, to 131, which is considered as having very superior intelligence. Despite this wide range of intelligence, the students were not classed by intellectual ability, rather they were grouped by how their disabilities manifested in classroom settings. That is, again, students with internalizing behaviors regardless of intellectual capacity were grouped together and the same was true with those with externalizing behaviors.

In part, many students had been identified as having internalizing or externalizing behaviors based on results from a second diagnostic test called the BASC-2 (Behavior Assessment Scale for Children). This 20 minute instrument involves rating scales completed by the student, parent, and teacher. It assesses the behavioral, emotional and developmental status of the student.

The first block class met from 7:35 until 8:29 and had an enrollment of one male and five females. These students were enrolled in the Compass program. The Compass program is designed for emotionally/behaviorally disabled students who possess internalizing behaviors. Although these students are served by the Alternative Education Center they are housed in a separate classroom away from the students with externalizing behaviors. The Compass students’ classroom is an old child-development room. This room was chosen because it is very large. It has separate bathrooms, a small kitchen, a small counseling room and separate telephones.

These students are school phobic, depressed and during the first three months of school two students exhibited suicidality which led to those two students being
hospitalized at different times. The Compass students had the poorest attendance of the
three classes during the study period.

The second block met from 8:40 to 9:39. This class served five students. It
contained four males and one female. All of these students were over the age of eighteen
and had been identified as being emotionally behaviorally disabled with externalizing
behaviors. Their behaviors included aggression and belligerence. Two of the students
had a co-morbidity on the Autistic Spectrum Disorder (Asperger’s). During the study
this class experienced three suspensions: one for inappropriate sexual behavior and two
for extreme verbal abuse of staff. The class was held in the science room of the
Alternative Education Center. This room, while smaller than mainstream classrooms, is a
good size for the limited number of students. The Alternative Education Office is
adjacent to the classroom and allows access to water and a telephone. The third class in
the study also met in this classroom. This group contained eleven students. Four
students were females and seven were males. Two of the students, one boy and one girl,
did not have an emotional disability diagnosis. They had been assigned to the Alternative
Education Center because they were at high risk for dropping out of school even though
they were seniors. Another student had completed all of his graduation requirements
during the 2007-2008 school year; however, his parents refused to accept his diploma
because they felt he was not ready. He also presented with a co-morbidity of Asperger’s.
This student proved to be the most dangerous of all of the alternative education students.
Massachusetts Law permits regular education students to attend with students assigned to
substantially separate settings under section 11b of the statute. Therefore, this group is
designated as the 11b group. By state law, each of the classes was staffed with one
teacher and one assistant. Data from the two non-disabled students was not included in the study. And due to the small sample size data from the three classes were combined.

**Units**

Students were given the opportunity to participate in two Engineering the Future units (EtF). Unit I was entitled Design the Best Organizer. Unit II was entitled Design a Building of the Future. Unit I contained eleven sub-tasks two of which were design challenges. Beginning with the second design challenge, students completed teamwork assessments. These teamwork assessments would provide the data as to how well students perceived their individual and team performance with the seven behaviors, that are the basis for measuring social skills in this project.

The EtF curriculum suggested that the sub-task entitled “What is Engineering?” precede the sub-task “Design a Cell Phone Holder”. However these sub-tasks were reversed so that the first task could be an inquiry task. By building the cell phone holder first the students could demonstrate what they already knew about working with a team and designing a product. The students intuitive knowledge about engineering became the foundation for the key terms, concepts and behaviors needed to complete the engineering project.

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2 The EtF curriculum uses the term “Projects”. The word Project has been replaced by Unit to avoid confusion.
**Table 1. Design the Best Organizer**

<table>
<thead>
<tr>
<th>Day Numbers</th>
<th>Sub-Task</th>
<th>Description</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 – 3</td>
<td>1. Design A Cell Phone Holder</td>
<td>Examine needs, sketch possible ideas, create mock up and estimate costs.</td>
<td>2 and 3</td>
</tr>
<tr>
<td>4 and 5</td>
<td>2. What is Engineering?</td>
<td>Students discuss ideas, views and then watch video about designs and innovations.</td>
<td>1</td>
</tr>
<tr>
<td>6 and 7</td>
<td>3. Engineering Drawing</td>
<td>Distinguish and draw oblique, perspective, orthographic and isometric views.</td>
<td>4</td>
</tr>
<tr>
<td>8 and 9</td>
<td>4. Define the Problem</td>
<td>Define the problem to be solved. Include criteria and constraints. Form teams.</td>
<td>5</td>
</tr>
<tr>
<td>10 and 11</td>
<td>5. Research the Problem</td>
<td>Identify competition and customers.</td>
<td>6</td>
</tr>
<tr>
<td>12</td>
<td>Develop Possible Solutions</td>
<td>Brainstorm and Sketch possible solutions. Share ideas with other members.</td>
<td>-</td>
</tr>
<tr>
<td>13 and 14</td>
<td>6. Choose the Best Solution</td>
<td>Analyze solutions as a team utilizing both the criteria and constraints of the project.</td>
<td>7</td>
</tr>
<tr>
<td>15 -20</td>
<td>7. Create a Prototype</td>
<td>Complete Hazard Sheet Construct Prototype.</td>
<td>8</td>
</tr>
<tr>
<td>21-22</td>
<td>8. Test and Evaluate</td>
<td>Evaluate against the criteria and constraints. Suggest a manufacturing process.</td>
<td>9</td>
</tr>
<tr>
<td>23</td>
<td>9. Communicate</td>
<td>Teams prepare and present design solution.</td>
<td>-</td>
</tr>
<tr>
<td>24</td>
<td>10. Redesign</td>
<td>Teams and Audience suggest improvements</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>11. Project 1 Assessment</td>
<td>First Unit Test</td>
<td></td>
</tr>
</tbody>
</table>

The cell phone holder task was an inquiry task that introduced both the engineering and team work objectives that were utilized through the 43 day study. Students were divided into teams and were given a class period to build a cell phone.
holder. After the build, the teacher elicited responses about how the students completed the task and how they interacted with their team members. This information was recorded on one half of the white board. Then the teacher initiated a discussion on the actual components of the engineering design problem. This was the first time students heard about the eight components.

Figure 1. 8 Components of Engineering Design Process (Engineering the Future 2008, National Center for Technological Literacy, California p 39).

During the next class, students watched a twenty minute video that showed a diverse engineering team at the IDEO Corporation as they went through each component of the engineering design process to build a better shopping cart. The teacher asked students to list behaviors that the IDEO team members engaged in. The behaviors were written on the board. The teacher then tried to connect what students reported to the
seven behaviors identified in the EtF curriculum of a team member: Helping, listening, questioning, respecting, sharing, persuading, and participating.

**Figure 2: 7 Behaviors of a Team Member (Engineering the Future 2008 National Center for Technological Literacy, California p. 44)**

Sub-task 3 was the content portion of the challenge and students practiced four types of engineering drawings. This carried the students into the next challenge which delineated each of the eight components as well as provided content knowledge.

Sub-task 4 in this challenge series presented a fictional story of a company on the verge of going out of business unless they were able to engineer an organizer that would sell. This then became the *define the problem* component of the engineering design process. After some discussion of the problem, students were put into teams. Individually, they answered the question, “What strengths do I bring to the team?” Thereafter they spent two minutes interviewing other members of the team and recorded their fellow team members’ strengths. Sub-task 5 was the *research the problem* component. Students identified who buys organizers and what those customers are looking for in an organizer.
Sub-Task 6 was a brainstorming session where students decided what type of organizer they were going to build. Once ideas were gathered students were then asked to declare what strength they would bring to the construction of the prototype. These ideas were recorded. Students then interviewed their teammates to discover the strengths that team members brought to the construction process.

Students used the engineering drawing content to create sketches of possible organizers. Sub-task 7, *choose the best solution*, asked the students to commit to an idea, its criteria and constraints as well as the drawing.

These sub-tasks collectively lead to the design challenge: *Build a Prototype of the Best Organizer.* After the prototype was finished three assessments were completed: The Team Assessment, Individual Assessment, and Teacher Rubric (See Table 4, 5, and 6 respectively on pages 38 and 39. The teacher also compared her rubric to the students’ rubric as part of a discussion with the students in an attempt to delineate the strengths and weakness of the team. The content component of the task continued with sub-task 9: *test and evaluate* their prototype. Does the prototype look like the drawing? Has it met both the criteria and constraints of the challenge? Sub-task 10, *communicate results* present their prototype to the class and sub-task, *Redesign*, communicate what they would do differently to make a better product. Once the Unit was completed in its entirety, the teacher lead a discussion on the seven behaviors, helping, listening, sharing, participating, persuading, questioning and respecting, that a team member should possess to be successful in a team. Teacher asked students to order the seven behaviors from the behavior that they believe is their strengths to the behavior they see as their weakness.
The information was tallied on the board and recorded by the teacher. Finally students completed the content assessment for this Unit (see Appendix C).

Unit II began with a review of engineering design process, teamwork and a repeat of the seven behaviors of a team member (Figures 1 and 2).

Table 2: **Unit II: Design a Building of the Future**

<table>
<thead>
<tr>
<th>Day Numbers</th>
<th>Sub-Task</th>
<th>Description</th>
<th>Chapter</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>1. Define the Problem</td>
<td>Students examine the problem of urban sprawl and possible solutions</td>
<td>10</td>
</tr>
<tr>
<td>27 and 28</td>
<td>2. Identify Loads</td>
<td>Calculate live and dead loads. Explore load transfer to structure members</td>
<td>11</td>
</tr>
<tr>
<td>29- 32</td>
<td>3. Use Failure Analysis</td>
<td>Design and load a tower to analyze forces that affect a structure</td>
<td>12</td>
</tr>
<tr>
<td>33-36</td>
<td>4. Test Construction Materials</td>
<td>Test and compare materials under tension and compression</td>
<td>13</td>
</tr>
<tr>
<td>37-39</td>
<td>5. Describe Mechanical Properties</td>
<td>Test a variety of construction materials</td>
<td>14</td>
</tr>
<tr>
<td>40-42</td>
<td>6. Experiment with Concrete</td>
<td>Test the compression strength of concrete</td>
<td></td>
</tr>
<tr>
<td>43</td>
<td>7. Project 2 Assessment</td>
<td>Second Unit Test</td>
<td></td>
</tr>
</tbody>
</table>

Sub-task 1 asked students as a class to identify problems associated with Urban Sprawl. Next the class was instructed in taking measurements. Finally students were broken into teams and asked to come up with the criteria and constraints necessary to build a multi-purpose building.

Sub-task 2 was a mathematical lesson found in the textbook readings.
Sub-task 3 had the students working in the teams to complete a design challenge. Team members were required to utilize the engineering design process to build a tower that would hold the largest load and meet both the criteria and constraints of the problem. During the design challenge the teacher or assistant again recorded engagement and at the end of the design challenge the three assessments were given as well as the discussion comparing the teacher’s rubric to the students’ self and team assessments.

Sub-tasks 4 and 5 for this unit were content related. In both tasks students assessed construction materials. These tasks were completed as classroom activities.

Sub-task 6 was a design challenge where teams were asked to determine the best mix of concrete. After defining the problem, the parameters of the task were discussed and the seven behaviors reviewed, students were divided into teams and again asked the question, “What strengths do I bring to the team?” Thereafter they spent two minutes interviewing and recording other team members’ strengths. During the design challenge the teacher or assistant again recorded engagement and at the end of the design challenge the three assessments were given as well as the discussion comparing the teacher’s rubric to the students’ self and team assessments. A second Unit assessment was given to the students that measured their success with the content of the curriculum (Appendix D).

In summary, students will be given the opportunity to participate in Two Engineering the Future Projects. Project I is entitled Design the Best Organizer, and it is divided into eleven tasks. It will yield six sets of data that tally students’ engagement (See Table 2), one set of data that yields perceived strengths as a team member and one set of behavior data which includes the three assessments represented in Tables 4,5 and 6. Project II is entitled Design a Building of the Future. It will yield four sets of data that
tally students’ engagement, three sets of data the describe students perceived strengths and three sets of behavior data which includes the four assessments. Appendixes J and K reconcile what data was taken during what tasks.

The Engineering the Future curriculum continues with two more Units. However, these projects were outside of the study time-limits. Data from the two completed Projects were analyzed and a conclusion about the effectiveness of the Engineering the Future curriculum regarding both research questions can be found in Chapter 5.

Data Collection Instruments

Data was collected regarding the engagement level of each student, the student’s perceived strength question, student team work assessment, student self-assessment, the teacher’s assessment each team’s success and the students success with the content of the curriculum. The teacher modified each of the Unit tests provided by in the EtF curriculum. Unit tests can be found in Appendixes C and D.

Student Engagement

Table 2 shows the data sheet that was filled out during EtF tasks. The sheets contained the student’s name, quarter of the teaching block and engagement level. Data regarding student engagement began as soon as students entered the classroom. The assistant or teacher then began recording every 15 minutes how engaged students were during the class. Students received a (1) if they were fully engaged. A (2) if there was engagement with one redirection. A (3) if students were moderately engaged with more than 1 redirection. A (4) if there was no engagement and a (5) if there was a safety violation. This data was collected in addition to behavior data that was collected on students every 15 minutes as part of the Alternative Education Centers policies and procedures.
Table 3. Engagement Data Example of Teacher Journal

<table>
<thead>
<tr>
<th>Name</th>
<th>15 minutes</th>
<th>30 minutes</th>
<th>45 minutes</th>
<th>59 minutes</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description of task</td>
<td>15 minutes</td>
<td>30 minutes</td>
<td>45 minutes</td>
<td>59 minutes</td>
<td>Total</td>
</tr>
<tr>
<td>Engagement</td>
<td>15 minutes</td>
<td>30 minutes</td>
<td>45 minutes</td>
<td>59 minutes</td>
<td>Total</td>
</tr>
</tbody>
</table>

Strength Statement

The Engineering the Future curriculum provided several different teamwork assessment instruments. After the brainstorming portion of each project students were asked to answer the question, “What strengths do I bring for this project?” (National Center for Technological Literacy, Engineers Notebook, p.43) They then were given two minutes to individually interview other members of the team and record the strengths of the other team members. These statements were recorded in each of the pre-printed Engineering Workbooks. This open-ended data was used to determine whether there was a change in the type of attributes the students felt they brought to the team and the type of positive information they garner from other members of the team. This data and the following data were important because EBD students in particular have a perception of themselves and others that is not entirely accurate.

Behavior Assessments

The curriculum provided three behavior assessments (See Appendixes A and B) that are directly linked to the seven behaviors that should be displayed by the members of the team. These assessments were found in the EtF teacher’s guide.
a. Teamwork Assessment

First, the teamwork assessment form was a seven item rated scale that was completed by each team member and measures the perception of the success of the team as a whole. Table 4 provides an example of one of the seven questions. Students rated their team’s performance as excellent, good, adequate, poor or none for each question. For the example a rating of 1 or excellent meant that the team fully cooperated with each other.

Table 4. Behavior Assessment: Example of Teamwork Assessment Question

<table>
<thead>
<tr>
<th>The group cooperated Everyone played a role and carried it out</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>excellent good adequate poor none</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

At the end of this assessment there was an open-ended question that asks, “What do you think the team could do to be more effective?”

b. Student Behavior Self-Assessment

The second assessment, found on the same page was a four item rated scale individual assessment form. As the name implies, this device assessed the student’s perception of her success as a member of the team. Table 5 provides an example of one of the questions. In this case a score of 1 or excellent meant the student perceived that she fully participated in group discussions and group work.

Table 5. Behavior Assessment: Example of Individual Assessment Question

<table>
<thead>
<tr>
<th>I actively participated in group discussions and group work</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>excellent good adequate poor none</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Again there was a reflective open-ended question that asked the student to think about the way she could have been a more effective member of the team.

c. Teacher Assessment of Team Success

The third behavior assessment seven questions that responded to each of the seven behaviors identified as a teamwork skill. It measured the teacher’s perception of the success of the team. As an assessment instruments it allowed the teacher to identify and explore with the students teamwork behaviors that needed additional work. This assessment could also be used to give the students a teamwork grade. Table 6 provides an example of one of the questions found on the assessment. A score of 4 or always meant that the students frequently helped each other or offered assistance to one another.

Table 6. Behavior Assessment: Example of Teamwork Rubric Question

<table>
<thead>
<tr>
<th>Name</th>
<th>4 Always</th>
<th>3 Most of the time</th>
<th>2 Some the time</th>
<th>1 Never</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Name</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Helping Students on your team frequently offer assistance to each other

Timeline and Summary

The EtF curriculum contains four units. For the purposes of this study two of the four units were completed. Tables 1 and 2 delineate the time line for each unit. These tables include the numbers of days spent on the each task and the corresponding chapter that students read in a teacher directed group.
The inquiry task was completed in November, 2008 for Unit I. Beginning with the Design the Best Organizer the students completed the strengths page, the design challenge, and the assessments. Unit II– Design a Building of the Future began after discussing the Teamwork Assessment from the previous unit. Unit II included spiraling of the seven behaviors, planning the design of the building, completing the strengths page, building a tower and analyzing forces, and completion of the three assessments. Unit II contained 17 hours of lessons as described in the curriculums Gantt Chart and was completed by the beginning of March, 2009. Data was examined and a final report was delivered to the Research Committee by April, 2010.

In summary, three groups of emotionally/behaviorally disabled students worked through two engineering Units. Unit I entitled Design the Best Organizer contained eleven tasks that were completed over a period of 23 days. It yielded six sets of data that tallied students’ engagement (See Table 7), one set of data that generated perceived strengths as a team member, one set of behavior data which included the three assessments represented in Tables 4, 5 and 6 and a unit assessment that measured content. This data was the baseline and it was compared to the data collected in Unit II. Unit II was comprised of six tasks presented to students over 17 classroom hours. It yielded two sets of strength data, two sets of engagement data, two sets of behavior data as well as content assessment data.
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Chapter 4 – Results

Data Sets

There were six sets of data collected during the project: 1) engagement data, 2) strengths data, 3) team assessment, 4) individual assessment, 5) teacher rubric and 6) content assessment. A discussion of each set of data is provided in tables as well as a narrative below.

All data was affected by student attendance during the 43 day project. However, since attendance is a defining characteristic of the emotionally and behaviorally disabled student it is important to understand the movement of these students during the project period and therefore it is included herein.

Attendance and IEP Mandated Change of Placement

It was known before the project began that attendance and the students’ ability to remain in the alternative education setting was going to be a significant issue in gathering data. This proved to be very true. As mentioned in Chapter 1, three classes were chosen for the project. Block 1 students had been identified as being emotionally disabled and having internalizing behaviors. The class began with 5 girls and 1 boy. Data was collected over a 43 day period. Data, however, could only be collected on 2 girls and 1 boy. One girl dropped out of school before day 10. A second girl was assigned to a hospital program and a third girl was rescheduled to receive “respite” during block 1. The three remaining students had attendance records during the project of 62%, 68%, and 73%. Additionally, the three students attended class as a full compliment only fifteen of the 43 project days. The averaged number of missed days from the project was 14.3.
Block 2 students were defined as being behaviorally disabled with externalizing behaviors. The study began with 5 students participating. This group lost 2 students on manifestation determinations 3 weeks into the study which coincided with the end of the semester. However, three behaviorally disabled students from Block 3 were moved into Block 2 at that same time. Therefore data was collected on 6 students: 4 boys and 2 girls. Attendance in this class averaged 80.66%. Individually these students had attendance during the project of 66%, 75%, 77%, 84%, 91%, and 91%. A full compliment of students was achieved on only 18 of the 43 days. The average number of missed days from the project was 8.16.

Block 3 was a combined group of drop out prevention students and behaviorally disabled students. This class was identified as the 11b class more information about their status in the Alternative Education Center is again, provided in Chapter 1. Nevertheless, this group started out with 11 students and finished with 6 students. Two behaviorally disabled students dropped out of school. The make up of the class, therefore included 2 regular education students (drop out prevention) and 4 behaviorally disabled students. While data was collected on the two regular education students, they have been excluded because they did not fit the criteria as emotional/behaviorally disabled students. This class had the best attendance missing an average of 6.5 days. A full classroom compliment was reached on 24 of the 43 days. The students’ respective attendance were 81%, 84%, 86%, and 91%.

In short, 21 students were originally planned for the study. However, only 13 students are included in the data. During the project, three out of the original 21 dropped out of high school, 3 had a change of placement and 1 was rescheduled to rest during
science class. Of the remaining 13 had they been in regular education classrooms or mainstreamed special education classrooms only 6 students would have been able to receive credit based on their attendance. The small sample size indicates that the data for the groups should be combined and the group labeled Alternative Education Students, hereinafter referred to as AE Students. However, as the conclusion in Chapter 5 indicates that it was clear from the data collected in each class that the internalizing and externalizing students carried out the tasks quite differently and there was a significant difference in self-perception in carrying out and successfulness of the tasks.

**Engagement Data**

Poor attendance, dropping out, and change of placements are all characteristics of Emotionally/Behaviorally disabled students. One of the greatest challenges in meeting the educational needs of these students is to keep them on task when they are in school and available to learn. The data indicates that these students were engaged for the majority of each block. The last 15 minutes of each class required the most redirection. This can be attributed to remaining on task during clean-up and preparing for transition to the next class. Each student worked the most diligently during the middle portion of the block.

Engagement was assigned a numerical value between 1 and 5. One indicated full engagement, 2 engagement with 1 redirection, 3 moderately engaged with more than 1 redirection, 4 was no engagement and 5 was a safety violation. In this instance, the average of all of the students’ engagement sheets was found. The numbers provide a snapshot of what was happening in the classroom during each of the 15 minute fragments. Table 7 shows that the students were nearly fully engaged and required less than one
redirection during each of the first three measured time frames. The data shows that the students were most engaged during the time period from 30 minutes into the class to 44 minutes into the class. They required more than one redirection from the time period 46 minutes to 59 minutes.

It is important to realize that these students have been placed in substantially separate classrooms because of their behaviors. Within these classes there are generally 2 adults for seven students. Adults in the classroom are fully trained in restraining these students when they become violent. Physical removal of students from classrooms happens on a daily basis. That these students required little re-direction shows that they were able to maintain their behaviors and respond to a classroom setting much the way their non-disabled peers would.

**Table 7: Engagement Data**

<table>
<thead>
<tr>
<th>Time in Block</th>
<th>15 minutes</th>
<th>30 minutes</th>
<th>45 minutes</th>
<th>59 minutes</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>ED Students</td>
<td>1.92</td>
<td>1.56</td>
<td>1.65</td>
<td>2.74</td>
<td>1.96</td>
</tr>
</tbody>
</table>

**Strengths**

The design challenges each began with a summary of the problem the team members would be exploring. After reviewing the problem as a group, students were asked to think about the problem independently and how they would interact as a member of a team trying to solve the problem. A simple question was provided in the engineer’s notebook which asked them to record what strengths they would bring to a team trying to solve the problem. Once the students had the background information needed to complete the tasks they were asked to record what strength they believed they could bring
to the activity as an individual. The “strength” listing activity was the first activity to be completed in each of the tasks. It provided information regarding both the content research question and the therapeutic question. First students were able to identify where in the engineering design process their strengths would be most needed. This “forced” them to think about the engineering design process before each of the tasks. Secondly, the strength question had the students stop and think about previous successes and failures before heading into the task. This is an important factor in teaching social skills. Students should identify how they have been successful in the past. This needs to be a taught behavior for emotional and behaviorally disabled students. Stating strengths can also be said to help boost self-esteem, traditionally a lacking quality in these students.

Table 8 indicates the perceived strengths for each group of students. It should be noted that students did not have a “drop down” list to choose from and that the responses are solely student generated.

**Student Strengths**

**Table 8: Students’ Strengths**

<table>
<thead>
<tr>
<th>Student Number</th>
<th>1.11 Build Organizer</th>
<th>2.3 Build a Tower</th>
<th>2.6 Concrete Samples</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>listen</td>
<td>Manage</td>
<td>Manage</td>
</tr>
<tr>
<td>2</td>
<td>Draw</td>
<td>Good Ideas</td>
<td>Following directions</td>
</tr>
<tr>
<td>3</td>
<td>Good Ideas</td>
<td>Good Ideas</td>
<td>Communicate Ideas</td>
</tr>
<tr>
<td>4</td>
<td>Entertainment</td>
<td>Build</td>
<td>Measure</td>
</tr>
<tr>
<td>5</td>
<td>Draw</td>
<td>Record Amounts of materials</td>
<td>Keep up right</td>
</tr>
<tr>
<td>6</td>
<td>Draw</td>
<td>Draw</td>
<td>Crush/Strength</td>
</tr>
<tr>
<td>7</td>
<td>Build</td>
<td>Build</td>
<td>Build Crusher</td>
</tr>
<tr>
<td>8</td>
<td>Ideas</td>
<td>Draw</td>
<td>Keep Track</td>
</tr>
<tr>
<td>9</td>
<td>Bust Heads</td>
<td>Build</td>
<td>Line up/Crush</td>
</tr>
<tr>
<td>10</td>
<td>Smartest Student</td>
<td>Work as a Team</td>
<td>Make Crusher/Follow directions</td>
</tr>
<tr>
<td>11</td>
<td>Keep it Real</td>
<td>Work as a Team</td>
<td>Cut pieces/make</td>
</tr>
</tbody>
</table>
### Summary of Strength Data

The teacher needed encourage students to identify strengths that they could bring to the tasks. Over the three tasks it can be seen that students took the question more seriously and could develop positive ideas regarding being a team player. Students’ answers may not have represented strengths but did state what aspect of the project the students’ felt they would have the most best chance of completing successfully and how they could best support the team in these staged social situations. It was apparent that some students had reflected on their failures and successes in previous projects when listing strengths for the next project. Regarding content, the teacher was able to determine whether the students understood the gist of the projects and how the engineering design process would be utilized. As such, the strength questions provided a pre-assessment for the engineering tasks. Students were also able to demonstrate that they understood the concepts and vocabulary presented before each project began.

### Student Assessments

At the completion of each design challenge students completed two short assessments regarding the social interaction that had occurred while the students completed the engineering tasks. First students completed a rated four item assessment on how they individually interacted in their groups. Thereafter students completed a seven item assessment on how the group interacted. Students were also asked to make a
comment on what they could have done to be more effective and what the team could have done to be more effective.

On the surface it appeared that no real trends could be gleaned for the comments or responses to the individual and teamwork questionnaires completed by the students. To assist in determining if any useful information could be found Tables 9-16 were created to find the average of rating of each response. To do that each rating: Excellent, good, adequate, poor and absent were each given a numerical value. A response of excellent received 5 points, good; 4 points, adequate; 3 points, poor; 2 points and absent; 1 point. These points were then multiplied by the frequency of their occurrence. From there an average was found to determine how the students and teams perceived their performance for each rated item and that number was re-translated into the corresponding perception rating.

Student comments were also studied to determine students’ highlight students’ perceptions. Overall, the teacher felt that the students had given sufficient thought in answering the assessments. Further, the teacher was impressed with the students written comments that again showed that they had reflected on the targeted behaviors.
Table 9  Individual Assessment Form: Build the Best Organizer

<table>
<thead>
<tr>
<th>Item 1: I followed directions and listened carefully to instructions.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rating</td>
</tr>
<tr>
<td>Frequency</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 2: I actively participated in group discussions and group work.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rating</td>
</tr>
<tr>
<td>Frequency</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 3: I stayed on task during all activities and did my part of group work to the best of</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rating</td>
</tr>
<tr>
<td>Frequency</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 4: I interacted well and respected others at all times.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rating</td>
</tr>
<tr>
<td>Frequency</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

When the item totals are averaged together the student rating gives a score of 3.71 with a standard deviation of .29. This average would be between the responses adequate.
and good. Student comments were very honest in reporting what they could have done better as a team member. And there was a full range of emotions. Students reported that they would have worked better in the team if they themselves had not had been “crazy” or if they could have not gotten so “mad” or been open to other peoples ideas. Other students felt they had done a superb job with comments like, “I was awesome”. Still others understood that they needed to participate more stating, “I could have talked more” and “not let others tell me what to do”.

Table 10 looks at the same project, Build the Best Organizer, but asks the students to rate the performance as a team. Again the students responses were given a numerical value. Those numerical values were averaged and then the average of the averages was found. Also, following the table, there is a synopsis of student comments on how the team could have better performed.
## Table 10: Teamwork Assessment Form: Build the Best Organizer

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Rating</th>
<th>Frequency</th>
<th>Total</th>
<th>Number</th>
<th>Average</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 1</td>
<td>The group cooperated. Everyone played a role and carried it out.</td>
<td>5 4 3 2 1</td>
<td>3 3 5 2 0</td>
<td>15 12 15 2 0</td>
<td>13</td>
<td>3.38</td>
<td>1.05</td>
</tr>
<tr>
<td>Item 2</td>
<td>Everyone contributed to the discussion.</td>
<td>5 4 3 2 1</td>
<td>2 4 5 2 0</td>
<td>10 16 15 4 0</td>
<td>13</td>
<td>3.46</td>
<td>.97</td>
</tr>
<tr>
<td>Item 3</td>
<td>Everyone’s opinion was valued.</td>
<td>5 4 3 2 1</td>
<td>2 3 3 3 2</td>
<td>10 12 9 6 2</td>
<td>13</td>
<td>3</td>
<td>1.35</td>
</tr>
<tr>
<td>Item 4</td>
<td>The group was organized.</td>
<td>5 4 3 2 1</td>
<td>5 5 0 3 0</td>
<td>25 20 6</td>
<td>13</td>
<td>3.92</td>
<td>1.19</td>
</tr>
</tbody>
</table>
Item 5: Materials and resources were gathered, distributed and shared.

Rating  5 4 3 2 1  number average sd
Frequency 8 3 2 0 0
Total  40 12 6 0 0 13  4.46  .77

Item 6: Problems were addressed as a group.

Rating  5 4 3 2 1  number average sd
Frequency 2 3 4 2 2
Total  10 12 12 4 2 13  3.07  1.32

Item 7: All parts of the assignment were completed within the time assigned.

Rating  5 4 3 2 1  number average sd
Frequency 7 2 3 1 0
Total  35 8 9 2 0 13  4.15  1.06

Students felt that they did a good job in being organized, materials were
distributed well and they did a good job in completing the assignment. However, when
the ratings are averaged, (3.65 with a standard deviation of .20), the overall rating once
again falls between good and adequate. Student comments indicated that many students
felt their teams were very effective. Other teams had personality conflicts that are
represented with comments: “We could have made different teams.” and “We could
have liked each other more.” Several students also commented that there was insufficient
communication within their groups.
Table 11: Individual Assessment Form: Build a Tower to Failure

Item 1: I followed directions and listened carefully to instructions.

<table>
<thead>
<tr>
<th>Rating</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>number</th>
<th>average</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>10</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>50</td>
<td>4.77</td>
<td>.44</td>
</tr>
<tr>
<td>Total</td>
<td>50</td>
<td>12</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td>4.77</td>
<td>.44</td>
</tr>
</tbody>
</table>

Item 2: I actively participated in group discussions and group work.

<table>
<thead>
<tr>
<th>Rating</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>number</th>
<th>average</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>8</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>0</td>
<td>40</td>
<td>4.38</td>
<td>.87</td>
</tr>
<tr>
<td>Total</td>
<td>40</td>
<td>8</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td>4.38</td>
<td>.87</td>
</tr>
</tbody>
</table>

Item 3: I stayed on task during all activities and did my part of group work to the best of my ability.

<table>
<thead>
<tr>
<th>Rating</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>number</th>
<th>average</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>11</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>55</td>
<td>4.85</td>
<td>.38</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>13</td>
<td>4.85</td>
<td>.38</td>
</tr>
</tbody>
</table>

Item 4: I interacted well and respected others at all times.

<table>
<thead>
<tr>
<th>Rating</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>number</th>
<th>average</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency</td>
<td>7</td>
<td>4</td>
<td>0</td>
<td>2</td>
<td>0</td>
<td>35</td>
<td>4.23</td>
<td>1.09</td>
</tr>
<tr>
<td>Total</td>
<td>35</td>
<td>16</td>
<td>0</td>
<td>4</td>
<td>0</td>
<td>13</td>
<td>4.23</td>
<td>1.09</td>
</tr>
</tbody>
</table>

The Tower Project had students working in two and three member teams.

Students rated their performance squarely between excellent and good. Students enjoyed
the competitive nature of this project. Since students needed to rely on one or two other people to complete the task, lack of attendance became a key comment: “I should have called “J” to come to school”, “I could have come to school more often.”. Students also presented the idea that they needed to do more planning before starting. This is a content comment that showed the students could identify with why the engineering design process is needed. Out of the three tasks, the Tower task showed the greatest difference between individual behavior and group behavior. Individually, students felt that their work as a team member was firmly between good and excellent with an average of 4.55 and a standard deviation of 0.34. However they felt the team functioned again between good and adequate with an average score of 3.83 with a standard deviation of 0.17. This demonstrates students’ appreciation that it is harder to work as a member of a team than it is to work by oneself.
### Table 12: Teamwork Assessment Form: Build a Tower to Failure

<table>
<thead>
<tr>
<th>Item 1: The group cooperated. Everyone played a role and carried it out.</th>
<th>Rating</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>number</th>
<th>average</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency 5</td>
<td>Frequency 3</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total 25</td>
<td>Total 12</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>13</td>
<td>3.53</td>
<td>1.56</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 2: Everyone contributed to the discussion</th>
<th>Rating</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>number</th>
<th>average</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency 4</td>
<td>Frequency 2</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total 20</td>
<td>Total 8</td>
<td>9</td>
<td>6</td>
<td>1</td>
<td>13</td>
<td>3.38</td>
<td>1.39</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 3: Everyone’s opinion was valued.</th>
<th>Rating</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>number</th>
<th>average</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency 4</td>
<td>Frequency 4</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total 20</td>
<td>Total 16</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>13</td>
<td>3.46</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 4: The group was organized.</th>
<th>Rating</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>number</th>
<th>average</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency 7</td>
<td>Frequency 1</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total 35</td>
<td>Total 4</td>
<td>3</td>
<td>6</td>
<td>1</td>
<td>13</td>
<td>3.77</td>
<td>1.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Item 5: Materials and resources were gathered, distributed and shared.</th>
<th>Rating</th>
<th>5</th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>number</th>
<th>average</th>
<th>sd</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frequency 9</td>
<td>Frequency 2</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total 45</td>
<td>Total 8</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>13</td>
<td>4.30</td>
<td>1.31</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Item 6: Problems were addressed as a group.

Rating  5  4  3  2  1  number  average  sd
Frequency  8  1  1  1  2
Total  40  4  3  2  2  13  3.92  1.6

Item 7: All parts of the assignment were completed within the time assigned.

Rating  5  4  3  2  1  number  average  sd
Frequency  10  1  0  2  0
Total  50  4  0  4  0  13  4.46  1.12

Group dynamics certainly paid an important role in how students rated their teamwork for the Tower Project. Rated responses consistently run from excellent to poor. Many cases the students “absent” rating had to do with the very fact that their teammates were absent. The overall performance was rated close to good. Students were for the most part able to say that, “Problems were addressed as a group.”

Comments: What do you think your team could do to be more effective?

Use a little more communication so we could have built the tower straighter. Students’ comments addressed absenteeism. Students also stated that they felt they needed extra time to “redesign” their towers and that their first “prototypes” could have been improved. From the content point of view it was clear that students were becoming more comfortable with the language of the engineering design process and could appreciate learning from their first prototype.
**Table 13: Individual Assessment Form: The Best Mix of Concrete**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Rating</th>
<th>Frequency</th>
<th>Total</th>
<th>Average</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 1</td>
<td>I followed directions and listened carefully to instructions.</td>
<td>5</td>
<td>10</td>
<td>50</td>
<td>4.53</td>
<td>0.97</td>
</tr>
<tr>
<td>Item 2</td>
<td>I actively participated in group discussions and group work.</td>
<td>5</td>
<td>5</td>
<td>25</td>
<td>3.77</td>
<td>1.24</td>
</tr>
<tr>
<td>Item 3</td>
<td>I stayed on task during all activities and did my part of group work to the best of my ability.</td>
<td>5</td>
<td>6</td>
<td>30</td>
<td>3.77</td>
<td>1.3</td>
</tr>
<tr>
<td>Item 4</td>
<td>I interacted well and respected others at all times.</td>
<td>5</td>
<td>5</td>
<td>25</td>
<td>4.07</td>
<td>0.86</td>
</tr>
</tbody>
</table>

During the project, many students commented that the Concrete Project was not about Engineering but instead was a science experiment. These students felt so strongly about this differentiation that they included the fact in the comment section of their individual performance. They stated, “I shouldn’t have argued about what we were
doing”, “I shouldn’t have gotten so angry about this.” This demonstrated that they could apply the knowledge gained from the text the identified what engineering looked like and what science looked like. Other students were disappointed in their performance. The concrete in the project was an unforgiving medium that required some attention to detail. Students stated, “I should have looked at the concrete before it dried.” “I could have asked for help.” However, more than half of the students stated that there was nothing they could have done to be a more effective team member, “I did all my jobs”. This was replicated in the average rating of good for individual performance. Still students rated their individual performance as good: 4.03.

### Table 14: Teamwork Assessment Form: The Best Mix of Concrete

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Rating</th>
<th>Frequency</th>
<th>Total</th>
<th>Average</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Item 1</td>
<td>The group cooperated. Everyone played a role and carried it out.</td>
<td>5 4 3 2 1</td>
<td>9 2 1 1 0</td>
<td>45 8 3 2 0</td>
<td>13</td>
<td>4.46</td>
</tr>
<tr>
<td>Item 2</td>
<td>Everyone contributed to the discussion.</td>
<td>5 4 3 2 1</td>
<td>5 3 5 0 0</td>
<td>25 12 15 0 0</td>
<td>13</td>
<td>4</td>
</tr>
<tr>
<td>Item 3</td>
<td>Everyone’s opinion was valued.</td>
<td>5 4 3 2 1</td>
<td>6 3 3 0 1</td>
<td>30 12 9 0 1</td>
<td>13</td>
<td>4</td>
</tr>
</tbody>
</table>
Item 4: The group was organized.

Rating 5 4 3 2 1 number average sd
Frequency 6 3 1 1 2
Total 30 12 3 2 2 13 3.80 1.53

Item 5: Materials and resources were gathered, distributed and shared.

Rating 5 4 3 2 1 number average sd
Frequency 8 4 0 1 0
Total 40 16 0 2 0 13 4.46 0.88

Item 6: Problems were addressed as a group.

Rating 5 4 3 2 1 number average sd
Frequency 4 0 1 4 4
Total 20 0 3 8 4 13 2.69 1.70

Item 7: All parts of the assignment were completed within the time assigned.

Rating 5 4 3 2 1 number average sd
Frequency 7 2 2 2 0
Total 35 8 6 4 0 13 4.07 1.19

It is interesting to compare Item 1, “The group cooperated” to Item 6, “Problems were addressed as a group.” The majority of students felt that everyone in their group cooperated, yet they felt less strongly that problems were addressed as group. This might
be explained again by many students commenting that everyone worked well and nothing could have been done to improve the effectiveness of the group. Some students did, however, in their comment section states what specific problems they ran into,” We could have checked others work,” “Could have dealt with problems and started over,” “Could have made sure that everyone’s tubes were the same”. And here again, some students used the opportunity to state that this activity was not an engineering problem, but a science problem: “We didn’t build anything.” “We could have come up with our own problem.” “We didn’t need to work as a team everyone had a job and did it.” The students’ rated the effectiveness of the teams at 3.92 and a standard deviation of 0.31.

Summary of Assessments

The teacher was impressed by how serious students took these assessments. While the value of self-assessment can be limited, the students took the opportunity to reflect on their behaviors and on what went well and what did not. This time for reflection built directly into the curriculum can be seen as a way to develop social skills to aid in the practice of thinking before acting and realizing that behaviors have consequences. Social skills are difficult to measure, “What does a team player look like” and “How can effective team membership be measured.” Traditionally social goals on Individualized Education Program read, “During the current IEP period, student will be able to work with a group 4 out of 5 trials”. Students do not necessarily have to opportunity or direction to reflect on their performance of these trials outside of the counseling venue.
When the project is looked at as a whole, it is discovered that throughout the tasks students felt that their teams possessed less teamwork skills in items 2, 3 and 6. It is telling that the students felt strongly that ‘not everyone’s opinion was valued’. For example in the concrete task students felt that the teamwork skill found in item 6, “Problems were addressed as a group,” was nearly absent. These may require more student sophistication and more direct teaching and perhaps more interaction from the teacher to complete group process activities as the tasks were being completed.

Skills that the students felt more confident in were, the sharing of the task materials, finishing the task on time and organization. These appear to be more elementary social skills and encompass activities that are more readily aligned to the students being able to be engaged in the tasks. Engagement is rudimentary to being able to work in a group.

Table 15 summarizes each of the individual assessment items. In the scale a 1 is that the skill was absent and a 5 was excellent. Interestingly enough students perceived individually that the only adequately participated (Item 2). On the contrary the teacher felt that the students all did participated fully. The highest score with an average of 4.46 and a standard deviation of 0.36 was Item 1. Item 1 states, “I followed directions and listened carefully to instructions.” The teacher also felt that the students did nearly an excellent job in listening and following directions.
Table 15 Individual Assessment Items Over Three Design Challenges

<table>
<thead>
<tr>
<th>Item</th>
<th>Organizer</th>
<th>Tower</th>
<th>Concrete</th>
<th>Average</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>4.07</td>
<td>4.77</td>
<td>4.53</td>
<td>4.46</td>
<td>0.36</td>
</tr>
<tr>
<td>2.</td>
<td>3.39</td>
<td>4.38</td>
<td>3.77</td>
<td>3.84</td>
<td>0.5</td>
</tr>
<tr>
<td>3.</td>
<td>3.54</td>
<td>4.85</td>
<td>3.77</td>
<td>4.05</td>
<td>0.7</td>
</tr>
<tr>
<td>4.</td>
<td>3.85</td>
<td>4.23</td>
<td>4.07</td>
<td>4.05</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Table 16 summarizes how students perceived the team’s success for item. Students rated their team performance as good for items 5 and 7. These are basic teamwork skills. Material were gathered (Item 5) and the assignment was completed on time (Item 7). This shows that the students could get organized for the design challenge and stay on task so that the challenge could be completed in the time allotted. Items that students perceived as not being strengths were items 6, 3, and 2. Item 6 was the most challenging for the students and is a more evolved social skill (Problems were addressed as a group) Item 3 (Everyone’s opinion was valued) and Item 2 (Everyone contributed to the discussion) can also be thought of as requiring more social sophistication and therefore more difficult for the EBD students to negotiate.

Table 16 Teamwork Assessment Items Over Three Design Challenges

<table>
<thead>
<tr>
<th>Item</th>
<th>Organizer</th>
<th>Tower</th>
<th>Concrete</th>
<th>Average</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>3.38</td>
<td>3.53</td>
<td>4.46</td>
<td>3.79</td>
<td>0.59</td>
</tr>
<tr>
<td>2.</td>
<td>3.46</td>
<td>3.38</td>
<td>4</td>
<td>3.61</td>
<td>0.34</td>
</tr>
<tr>
<td>3.</td>
<td>3</td>
<td>3.46</td>
<td>4</td>
<td>3.48</td>
<td>0.5</td>
</tr>
<tr>
<td>4.</td>
<td>3.92</td>
<td>3.77</td>
<td>3.80</td>
<td>3.83</td>
<td>0.08</td>
</tr>
<tr>
<td>5.</td>
<td>4.46</td>
<td>4.3</td>
<td>4.46</td>
<td>4.4</td>
<td>0.09</td>
</tr>
<tr>
<td>6.</td>
<td>3.07</td>
<td>3.92</td>
<td>2.69</td>
<td>3.22</td>
<td>0.62</td>
</tr>
<tr>
<td>7.</td>
<td>4.15</td>
<td>4.46</td>
<td>4.07</td>
<td>4.22</td>
<td>0.2</td>
</tr>
</tbody>
</table>
Table 17 summarizes how the students scored themselves in each of the design challenges. The table demonstrates that students consistently felt their performance was above adequate and that they felt that their teams did not perform as well as they performed as individuals.

**Table 17 Rated Task Performance**

<table>
<thead>
<tr>
<th></th>
<th>Individual</th>
<th>Team</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organizer</td>
<td>3.71</td>
<td>3.65</td>
</tr>
<tr>
<td>Tower</td>
<td>4.55</td>
<td>3.83</td>
</tr>
<tr>
<td>Concrete</td>
<td>4.03</td>
<td>3.92</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>4.09</strong></td>
<td><strong>3.8</strong></td>
</tr>
</tbody>
</table>

**Teacher Rubric**

The teacher rubric consisted of seven items each of which addressed one of the seven behaviors of a team member. The curriculum creators developed a scale that gave each rating a numerical value. This allowed the teacher to give the students a team work grade. Items were rated as Always (earning 4 points), Most of the Time (3 points), Some of the Time (2 points) and Never (1 point). At the bottom of the rubric was a space for the teacher to write her comments. This scale was used in the curriculum so that the teacher could give the students a teamwork grade. Each item was worth a total of 4 points. Since there were three design challenges the total number of points for each question was 12. When the points are added for each item and then divided by 12 the
average score for all items results in a score of 67%. The teacher felt these average scores shown in Table 18 did not demonstrate the teamwork success that students had with the project. In fact, mathematically, with an average of only 67%, it would appear that the students did not engage in the positive behaviors required of a team member and by extension the students did not engage in pro-social behaviors. The teacher felt that this did not accurately portray the behaviors that were seen in the classroom.

**Table 18 Team Combined Scores Behavior Items**

<table>
<thead>
<tr>
<th>Behavior Item</th>
<th>Organizer</th>
<th>Tower</th>
<th>Concrete</th>
<th>Average</th>
<th>SD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Helping</td>
<td>1.33</td>
<td>2.83</td>
<td>1.66</td>
<td>1.94</td>
<td>0.79</td>
</tr>
<tr>
<td>Listening</td>
<td>2.33</td>
<td>2.83</td>
<td>2.67</td>
<td>2.61</td>
<td>0.26</td>
</tr>
<tr>
<td>Participating</td>
<td>2.33</td>
<td>3.5</td>
<td>3.16</td>
<td>3.0</td>
<td>0.6</td>
</tr>
<tr>
<td>Persuading</td>
<td>3</td>
<td>3.16</td>
<td>2.33</td>
<td>2.83</td>
<td>0.44</td>
</tr>
<tr>
<td>Questioning</td>
<td>2.67</td>
<td>2.83</td>
<td>1.83</td>
<td>2.44</td>
<td>0.54</td>
</tr>
<tr>
<td>Respecting</td>
<td>3</td>
<td>3.5</td>
<td>3.16</td>
<td>3.22</td>
<td>0.26</td>
</tr>
<tr>
<td>Sharing</td>
<td>2.33</td>
<td>2.33</td>
<td>3.33</td>
<td>2.66</td>
<td>0.58</td>
</tr>
</tbody>
</table>

**Summary of Teacher Rubric**

To review, a score of 1 meant that the targeted behavior never occurred. A score of 2 meant the targeted behavior sometime occurred. A score of 3 meant the targeted behavior appeared many times and 4 meant that the targeted behavior always occurred. Looking at the three tasks as a whole the students scored the highest on the respecting (occurred many times) item and the lowest on the helping item (less than sometime
occurring. This is interesting since each student was very understanding of one another’s absence and respected their choice not to come to school, however, the students were not inclined to help each other catch up. Helping may have also received a low score since lab based activities are still new to the students and all wanted to participate. Participating was in fact their second highest score. Both respecting and participating were initially evident in the good level of engagement recorded in Table 7 (see page 45). This engagement showed the students were on task and not involved in aggressive behavior towards one another. Positive engagement is also evident in the success students had in persuading. This developing social skill takes the place of bullying, whining and off task behavior. Persuading goes hand and hand in with listening and respecting. It can be seen that these students while perhaps still demonstrating beginning skills were able to package skills together. That is by listening to others they could also persuade others and these behaviors show a level of group respect.

Content

Besides working on social skills, the teacher needed to assess how students were successful with the content found in the curriculum. The Engineering the Future curriculum provides assessments to be completed at the end of the each Project Unit. Thus two written assessments were given to the students. Both were modified so that skills that were emphasized could be assessed and other test items could be dropped. Additionally the teacher was able to make informal assessments based on how the students were working on their tasks.

Assessments 1 and 2 are attached as Appendixes C and D. Students did very well with Assessment 1 with all students passing and the average score received was a 86%.
This assessment checked students’ ability to define and identify technology, explain why each part of the engineering design process is important, match vocabulary from the readings to terms, identify the main work completed by engineers and use the engineering design process to solve a problem.

Assessment 2 again saw all of the students passing with an average score of 77%. This assessment was longer and more diverse and in retrospect should have been divided into two smaller assessments. The device tested objectives that had students identify the components of concrete, state the variable in an experiment, find mechanical advantage, put the steps of the engineering design process in order, identify the work done by engineers, identify tensile strength, the properties of materials and compare torsion compression and tension.

Given the test averages, an 86 on exam one and 77 on exam two and no student failing, the ability of the students to use the proper terms during the project tasks, observations made by the teacher during the building processes and the quality of the tangible product produced in of each task completed the teacher felt confident that the students had in fact understood the content of the material. Table 19 provides a glimpse on how well the students did on the exams as well as the standard deviation on how the did as a group. The highest scores were achieved by the students in the internalizing group. With the internalizing group eliminated, the higher scores went to older students. The fourteen year old students consistently did the poorest with this mainstream high school curriculum. Older students may have done better just because of their exposure with the outside world.
Table 19  Student Assessment Scores Assessment 1 and 2

<table>
<thead>
<tr>
<th>Student</th>
<th>Grade level</th>
<th>Test 1</th>
<th>Test 2</th>
<th>Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>11</td>
<td>100</td>
<td>93</td>
<td>96.5</td>
</tr>
<tr>
<td>2.</td>
<td>11</td>
<td>100</td>
<td>83</td>
<td>91.5</td>
</tr>
<tr>
<td>3.</td>
<td>9</td>
<td>100</td>
<td>93</td>
<td>96.5</td>
</tr>
<tr>
<td>4.</td>
<td>12</td>
<td>92</td>
<td>83</td>
<td>87.5</td>
</tr>
<tr>
<td>5.</td>
<td>11</td>
<td>92</td>
<td>83</td>
<td>87.5</td>
</tr>
<tr>
<td>6.</td>
<td>11</td>
<td>83</td>
<td>83</td>
<td>83</td>
</tr>
<tr>
<td>7.</td>
<td>11</td>
<td>83</td>
<td>70</td>
<td>76.5</td>
</tr>
<tr>
<td>8.</td>
<td>10</td>
<td>85</td>
<td>65</td>
<td>75</td>
</tr>
<tr>
<td>9.</td>
<td>10</td>
<td>83</td>
<td>70</td>
<td>76.5</td>
</tr>
<tr>
<td>10.</td>
<td>11</td>
<td>83</td>
<td>83</td>
<td>83</td>
</tr>
<tr>
<td>11.</td>
<td>10</td>
<td>75</td>
<td>70</td>
<td>72.5</td>
</tr>
<tr>
<td>12.</td>
<td>9</td>
<td>75</td>
<td>70</td>
<td>72.5</td>
</tr>
<tr>
<td>13.</td>
<td>9</td>
<td>70</td>
<td>65</td>
<td>67.5</td>
</tr>
</tbody>
</table>

Average 86  Average 77  Average 82  SD = 9.09  SD = 9.87  SD= 9.87
Chapter Five - Conclusions

Overview of Research Results

The project aimed to determine if using the commercially available engineering curriculum: Engineering the Future was an effective device for teaching both engineering content and social skills. As such, two research questions were defined: Is the Engineering the Future curriculum effective in developing the abilities of alternative education students in solving engineering problems? And secondly, is an engineering curriculum effective in developing the social skills of alternative education students?

The project was subdivided into four engineering design challenges. The first challenge was an inquiry challenge. Each subsequent task required that the students synthesize the engineering content they were taught in order to produce a product. Further, each task was designed to require some measure of teamwork. The teacher assessed the students’ ability to utilize the engineering content and work affectively as a team member. Each design challenge was assessed using five instruments. Additionally, two formal assessments were given.

Thirteen out of the twenty-one available students completed this research project. As predicted the project was punctuated by attendance and changes of placement of the participants. As a result of their attendance only six of the thirteen students would have been able to earn high school credit in a mainstream setting. The average attendance was 73.1% or attending thirty days out of the forty-three day project. Since, the attendance reported herein was in line with national patterns, for this student population, the project accurately reflects what the attendance would be in similar projects.
As mentioned previously, six different assessment devices were utilized in answering the two research questions. Most examined whether gains could be made with regard to social interaction.

**Social Interaction**

**Engagement**

The engagement data (Table 7) showed a high level of student engagement especially during the middle of each class. This means that the students were available to learn the content of engineering and were not engaging in off task behavior. The teaching assistants, whose functions were to help manage deviant behaviors that occurred during the class periods, spent most of their time collecting data and providing encouragement and assistance during the completion of tasks. Since teacher and assistant time was not being utilized to manage behaviors, the adults in the classroom were able to positively interact with students providing facilitation and role modeling.

On task behavior is further demonstrated by the 100% completion of the tasks each of which required the eight components of the engineering design process. Significant behavior disruptions occurred on only three days of the 43 day project. Each disruption was extreme and resulted in three separate suspensions. Those behaviors were limited to only second block students. Further the incidents all occurred during reading tasks as opposed to hands-on tasks.

Teachers often assume that EBD students require shorter class periods. The results, however, indicated that these students could be well engaged throughout an hour long block. This does require an intense curriculum that offers the opportunity for students to be extremely busy with interesting hands-on work. The finding that
engagement lacks towards the end of the period is no different from regular education classes that are often seen standing by the door waiting for a bell to ring.

**Attitude**

The second piece of assessment measured students’ attitude before the design challenge began. Students needed to state what strengths they brought to the design challenge. This measures self-confidence for the task and helps students to internalize what is expected of them. After some initial hesitation, responses to the strength data indicated that the students understood the relationship between the task and the engineering content. And they could provide in writing one good thing about themselves in relation to the task.

**Ability**

Assessments three and four queried how students perceived their individual ability and that of their team when it came to the seven behaviors of a team player. These assessments were self-rated scales. The teacher felt the students responses were honest and for the most part accurately reflected the teams’ dynamics. Students had more success working in larger groups than with a single partner. This can be contributed to attendance simply because a member could not rely on his partner in attending the next day. While it cannot be said that the students’ increased their ability to use the 7 behaviors, it can be said that the students were much more cognizant of the behaviors and how they related to the team’s success. Responses further indicated that student’s took ownership of their behaviors and intended to remediate that behavior for the next design challenge.

Students were consistent with which behaviors they felt were the easiest and which they had the most difficulty. Students consistently rated items 7, 5 and 1 with high
values. These items can be said to assess beginning teamwork skills. Item 7, “All parts of the assignment were completed within the assigned time. Item 5, “Materials and resources were gathered, distributed and shared. “ Item 1, “Everyone cooperated. “

Items that required more sophistication received poorer ratings. Students consistently gave items 6, 3 and 2 low ratings. Item 6, “Problems were addressed as a group.” Item 3, “Everyone’s opinion was valued.” Item 2, “Everyone contributed to the discussion.” This data reflects that students could complete tasks on time with group organization and group participation. It also reflects that the higher level group skills require instruction as well as practice.

Teacher Perception

The fifth measured assessment was a rubric completed by the teacher. This assessed how the teacher perceived students working through the seven behaviors of a team player. Again what is noted is that higher skills received lower scores. Table 18 reveals that the teacher students had the most difficulty helping each other. This can be seen as a specific skill that requires instruction. The teacher perceived that the students were more successful in respecting and participating. In that students allowed others to work but they were not going to help them. The teacher perceived participation is attributed to 1) the still newness of completing hands-on engineering tasks and 2) the ability to be successful in those tasks. Respecting and participating can be seen as easier social skills perhaps requiring the least interaction of the seven behaviors as a whole.

Content Attainment

Knowledge Gained

The final assessment measured knowledge gained in the content of the two units. A unit test was given to the students at the completion of each unit. These two
assessments were a combination of the provided EtF content assessments as well as supplementary teacher written questions. EtF questions that were not relevant to the three design challenges or readings were deleted from the EtF tests. Despite low attendance students did well on the two exams.

Students did better on the first unit test than on the second. The first unit exam tested students knowledge of the differences between science and engineering/technology. Students could state why each step in the design process was necessary. Students could recognize information from the readings. And students could provide a solution for an engineering design problem. The average score was an 86% or a B+

While on the surface the second exam did not appear any more difficult than the first it received a lower average score. The average score was still a C+. The device tested objectives that had students identify the components of concrete, state the variable in an experiment, find mechanical advantage, put the steps of the engineering design process in order, identify the work done by engineers, identify tensile strength, the properties of materials and compare torsion compression and tension.

**Differences between Disabled Groups**

The three scheduled blocks represented three different diagnoses. And while chapter four of this report combines the data of all diagnosis it is important to comprehend that the blocks did not respond to the project in the same manner. Throughout the study differences between the three groups were noted. The internalizing group which is often seen as more educationally capable had more off task behavior than
both the externalizing group and the group that included regular education and special education students (11b group).

The internalizing group also required much more prompting in answering the strength questions and filling out the teamwork assessments. These students were more likely to believe that they worked as hard as they could and they were an effective team. The most interesting observation to note was that the internalizing group could not talk and complete a task at the same time. These students did not socialize while they were building. In addition, where the externalizing group could socialize and come to agreements on design changes quickly, the internalizing students stopped what they were doing entirely and then would discuss as a team how to proceed. The externalizing students were more likely to make quick design changes. For example, both the externalizing students’ entertainment center and the internalizing students’ desk originally called for doors. As the prototype was being built both groups realized functional doors with hinges were going to be more difficult to replicate than they had originally planned. The externalizing team met and decided to forego the doors. The internalizing students chose to press on and worked on their two doors two full class periods. This was seen as each group knowing their limitations and how to avoid inappropriate behaviors. The externalizing group would have probably become extremely frustrated with the doors leading to anger so they decided to redesign. The internalizing group had more patience, and once they have decided on something trudged on without regard to time.

During the tower project differences were again noted between the two groups. This was a smaller project that required more fine motor skills. The externalizing and
11b students had an easier time manipulating tape, straws and paper. It was noted that the internalizing students did not have the same motor control. Based on this project one of the internalizing students was referred to occupational therapy.

The purpose of the 11b grouping was to save the district money. For the twenty-five years previous to the study the regular education students assigned to the third block would have been assigned to their own classroom, with a different curriculum and a different teacher. Under IDEA the EBD students had been placed in substantially separate classrooms so that they could best access education. Though this study was limited, it supported the idea that EBD students are better served in a homogeneous groupings. Unlike the other two groups, the 11b group felt they performed both individually and as team best during the concrete task. In fact, even though this task contained the least social interaction they rated their team performance between good and excellent. This was indicative of the difficulty this group of regular education and special education had in working with each other.

**Educational Implications**

It was noted, in Chapter One, that finding a name for this group of disabled students has been difficult with different agencies relying on different names. It appears that the two groups: Those with internalizing behaviors and those with externalizing behaviors respond to educational stimulus differently and that it may be in these students’ best interest two categorically separate internalizing behaviors from externalizing behaviors.

What can also be seen from this project is that all EBD students, when available to learn, do in fact learn and reflect on what they have done. Students were successful in
completing the unit knowledge assessments. However, it was evident in the unit II knowledge assessment that students had a difficult time holding onto such a breadth of information and the Unit II knowledge assessment should have divided into two exams.

In small classes, regular education students may not be able to be role models when there is such a significant difference in social skills. EBD students can participate in lab based science and this fact would dictate that more teachers be trained concurrently in science and special education to deliver instruction that is content specific.

The teamwork data clearly demonstrated that students could with relative ease master the basic social skills necessary to work in a group. However more sophisticated social skills need to be directly taught so that the students can go on to the next level. Here it may be useful to incorporate group process into the design challenges. Instead of the teacher becoming a facilitator as the students proceed with the task, she should stop the team from proceeding and complete a group process activity. In this manner all of the students would be able to state their opinions, contribute to discussions and all be involved in problem solving as a group. This would meet the mandate of researchers to teach the social skills lacking in EBD students directly.

Some measure of social skills training is inherently included in the Engineering the Future curriculum. The curriculum provides an excellent platform to teach the seven behaviors directly. It may prove worthwhile for environments that service this disabled population to find other curricula that can deliver content and social skills as well. If students practice direct social skills throughout their school day they may be able to generalize said skills more readily.
Another topic noted in the literature review of this project was the amount of medication these students are prescribed. It was evident to the teacher that the internalizing students’ progress in the tower project and concrete project was hindered because of the amount of uncontrollable shaking in their hands and fingers. These students should be given additionally opportunities to develop fine motor control.

**Recommendations**

Four recommendations to improve this project have been identified. First, no safety violations were noted; however, during the tower design there was some pushing and inappropriate behavior. A better list of what a safety violation is, needs to be compiled and reviewed with staff recording the data. Second, an instrument needs to be developed that measures students’ attitudes and beliefs regarding the 7 behaviors of a team player prior to instruction. Third, the concrete mix task needs to be re-evaluated for inclusion. Students identified this task as a science task and not an engineering task that required teamwork. Fourth the question being explored was whether or not a content engineering class could also be used to teach social skills. While the hypothesis was not disproven it was obvious that a sound relationship between the teacher and school psychologist and or social worker (support staff) is paramount and the teacher needs to be trained in directing conversations about social skills development. Students talked about their experiences with their individual counselors. Additionally, the teacher got some feedback from the support staff as well. It would benefit the students if there was some regular involvement in the classroom by support staff. This could take place once each design challenge and behavior assessment is completed and be presented as a consultation by the support staff to the engineering teams. At this time, support staff is
better trained to explore the social behaviors of the students than is the teacher.

However, the teacher being part of these consultations would, in time, be better able to lead behavior discussions and a truly didactic blend of content and social skills could be achieved.

References

Board of Education of Ottawa Township High School District 140 et al. v. Margaret Spellings, Secretary of Education, et al., 517 F.3d922(7th Cir. 2008).


# Appendix A  Teamwork and Individual Assessments

## Teamwork Assessment Form

Your name:  

Names of group members:  

Name of project:  

Check the box with the appropriate rating for each aspect of your team’s work.

<table>
<thead>
<tr>
<th>1 is excellent; 2 is good; 3 is adequate; 4 is poor; 5 is absent.</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspect</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>1. The group cooperated. Everyone played a role and carried it out.</td>
<td></td>
</tr>
<tr>
<td>2. Everyone contributed to the discussion.</td>
<td></td>
</tr>
<tr>
<td>3. Everyone’s opinion was valued.</td>
<td></td>
</tr>
<tr>
<td>4. The group was organized.</td>
<td></td>
</tr>
<tr>
<td>5. Materials and resources were gathered, distributed, and shared.</td>
<td></td>
</tr>
<tr>
<td>6. Problems were addressed as a group.</td>
<td></td>
</tr>
<tr>
<td>7. All parts of the assignment were completed within the time assigned.</td>
<td></td>
</tr>
</tbody>
</table>

**Comments:** What do you think your team could do to be more effective?

## Individual Assessment Form

Check the box with the appropriate rating for your individual work.

<table>
<thead>
<tr>
<th>1 is excellent; 2 is good; 3 is adequate; 4 is poor; 5 is absent.</th>
<th>Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aspect</td>
<td>1 2 3 4 5</td>
</tr>
<tr>
<td>1. I followed directions and listened carefully to instructions.</td>
<td></td>
</tr>
<tr>
<td>2. I actively participated in group discussions and group work.</td>
<td></td>
</tr>
<tr>
<td>3. I stayed on task during all activities and did my part of group work to my best ability.</td>
<td></td>
</tr>
<tr>
<td>4. I interacted well and respected others at all times.</td>
<td></td>
</tr>
</tbody>
</table>

**Comments:** What do you think you could do to be a more effective team member?
### Appendix B Teacher Rubric

**Teamwork Rubric**

<table>
<thead>
<tr>
<th>Name:</th>
<th>Title of work:</th>
<th>Date:</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>4</th>
<th>3</th>
<th>2</th>
<th>1</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Helping</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students on your team frequently offer assistance to each other.</td>
<td>Always</td>
<td>Most of the time</td>
<td>Some of the time</td>
<td>Never</td>
<td></td>
</tr>
<tr>
<td><strong>Listening</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students listen to each other’s ideas respectfully.</td>
<td>Always</td>
<td>Most of the time</td>
<td>Some of the time</td>
<td>Never</td>
<td></td>
</tr>
<tr>
<td><strong>Participating</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Each student contributes to the project.</td>
<td>Always</td>
<td>Most of the time</td>
<td>Some of the time</td>
<td>Never</td>
<td></td>
</tr>
<tr>
<td><strong>Persuading</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The students exchange, defend, and rethink their ideas.</td>
<td>Always</td>
<td>Most of the time</td>
<td>Some of the time</td>
<td>Never</td>
<td></td>
</tr>
<tr>
<td><strong>Questioning</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The students discuss each other’s ideas, and pose questions to each other.</td>
<td>Always</td>
<td>Most of the time</td>
<td>Some of the time</td>
<td>Never</td>
<td></td>
</tr>
<tr>
<td><strong>Respecting</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Students encourage and support each other’s ideas and efforts.</td>
<td>Always</td>
<td>Most of the time</td>
<td>Some of the time</td>
<td>Never</td>
<td></td>
</tr>
<tr>
<td><strong>Sharing</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The students offer ideas and report their findings to each other.</td>
<td>Always</td>
<td>Most of the time</td>
<td>Some of the time</td>
<td>Never</td>
<td></td>
</tr>
</tbody>
</table>

**Overall Comments:**

---

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Assessment Tools 339
Project 1.0 Final Assessment

1. Read through the following list of definitions. Choose the one that provides the broadest definition of the term technology.
   A. Any man-made device that helps machines run more efficiently.
   B. A process that involves using computers in the work that people do.
   C. Any device that has a computer or an engine that allows it to do work.
   D. Changes made to the world to satisfy human needs or wants.
   E. A machine that is used to solve a problem.

2. Look at the list below. Please circle all that are clear examples of technology.

<table>
<thead>
<tr>
<th>shoes</th>
<th>subway</th>
<th>dandelions</th>
<th>cell phone</th>
</tr>
</thead>
<tbody>
<tr>
<td>oak tree</td>
<td>bridge</td>
<td>television</td>
<td>cup</td>
</tr>
<tr>
<td>parrot</td>
<td>factories</td>
<td>bandage</td>
<td>house</td>
</tr>
<tr>
<td>power lines</td>
<td>bicycle</td>
<td>lightning</td>
<td>books</td>
</tr>
</tbody>
</table>
Below are the steps of the Engineering Design Process. Under each step write one or two sentences stating why the step is important.

1. Define the Problem: WHY do you need to define the problem?

2. Research the Problem: WHY would you research the problem before solving it?

3. Develop many Possible Solutions: WHY should you have more than one possible solution?

4. Choose the Best Possible Solution: HOW do you choose the best possible solution?

5. Create a Prototype. WHAT is a prototype?

6. Test and Evaluate the Solution: WHAT 2 things must the solution meet?

7. Communicate the Solution: WHO do you communicate the solution to?

8. Redesign: Give an example of a product that has been redesigned and what about it has been redesigned.
Match

___Scientists
___Invention
___Gantt Chart
___Engineers
___Patent
___Technology
___Haiti
___micro-enterprise
___engineering design process
___prototype

1. A timeline
2. A government document
3. A developing country
4. A way to solve a problem
5. An object that helps society
6. A full scale working model
7. A mom and pop
8. observer of the natural world
9. brand new idea
10. Civil, Chemical, Structural

Circle the phrase that is the most accurate ending for the sentence:
"The main work of engineers is to...
A. ...use various kinds of machines."
B. ...find out what's wrong and fix things."
C. ...improve technologies or invent new ones.""
D. ...build bridges, buildings, and other structures."

What Do You Think?

Your principal just hired you to help solve a problem for your school. Students are sneaking off campus for lunch because they are so unhappy with the food choices at the school cafeteria. The principal has budgeted only $1,000 to solve the problem, and she really wants it solved this academic year.

How would you use the engineering design process to develop a solution to this problem?

Write two or three sentences for each step detailing how you would accomplish it.

Step 1: Define the problem, criteria, and constraints.
Step 2: Explain how you would conduct your research.
Step 3: Brainstorm at least three possible solutions.
Step 4: Describe how you would choose the best solution.
Step 5: Indicate how you would create a prototype.
Step 6: Show how you would test your solution.
Step 7: Explain how you would communicate your solution.
7. Below are the eight steps of the engineering design process, and they are not in the correct order. Please fill in the blanks with the letter of each of the steps to show the correct order.

A. Communicate the solution  E. Research the problem
B. Create a prototype        F. Choose the best solution
C. Redesign                  G. Define the problem
D. Develop possible solutions H. Test and evaluate

   Step 1  
   Step 8  
   Step 7  
   Step 6  
   Step 5  
   Step 4  
   Step 3  
   Step 2  

8. Is it always necessary to follow these steps in order? Why or why not?

9. Give examples of how three different kinds of engineers use the engineering design process:

   A. Kind of engineer: Example:

   B. Kind of engineer: Example:

   C. Kind of engineer: Example:
Appendix D  Unit 2 Knowledge Assessment

Project 2.0 Final Assessment

1. The drawing below is a plan view of a two-car garage. Assuming each car is 6 ft. wide by 15 ft. long, what is the best estimate for the area of the floor in this garage?
   A. 180 sq. ft.
   B. 400 sq. ft.
   C. 900 sq. ft.
   D. 1,600 sq. ft.

2. The snow on a supermarket roof has a density of 100 kg/m³ and is 0.2 m deep. The roof is 20 m wide and 40 m long. What is the load of the snow on the roof?
   A. 160 kg
   B. 1,600 kg
   C. 16,000 kg
   D. 160,000 kg
3. Which would you use to answer to each question: Building Codes or Zoning Laws? Label each question as either BC (Building Codes) or ZL (Zoning Laws).

<table>
<thead>
<tr>
<th>BC or ZL</th>
<th>Questions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>How tall can I design a building in a given part of the city?</td>
</tr>
<tr>
<td></td>
<td>Can I open a restaurant on the first floor of my apartment building?</td>
</tr>
<tr>
<td></td>
<td>How can I reinforce my home to prevent earthquake damage?</td>
</tr>
<tr>
<td></td>
<td>What is the allowable load for the porch I am adding to my house?</td>
</tr>
<tr>
<td></td>
<td>Where can we plan a new city center to reduce urban sprawl?</td>
</tr>
<tr>
<td></td>
<td>What are the concrete mixture requirements for a house foundation?</td>
</tr>
</tbody>
</table>

4. Look at the school building shown below. In order to indicate whether the elements contribute to live load or dead load of the building, please label each element as either LIVE LOAD or DEAD LOAD.

![School Building Diagram]

<table>
<thead>
<tr>
<th>Live Load or Dead Load?</th>
<th>Item</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Milk Man</td>
</tr>
<tr>
<td></td>
<td>Outside Wall</td>
</tr>
<tr>
<td></td>
<td>Roof</td>
</tr>
<tr>
<td></td>
<td>Second Floor</td>
</tr>
<tr>
<td></td>
<td>Globe</td>
</tr>
</tbody>
</table>
Given the following information, answer the questions below.

<table>
<thead>
<tr>
<th>LADDER</th>
<th>KIMBERLY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Length: 20 ft. long</td>
<td></td>
</tr>
<tr>
<td>Step: 3 in. × 10 in. × 1 in.</td>
<td></td>
</tr>
<tr>
<td>Overall weight: 10 lb.</td>
<td></td>
</tr>
<tr>
<td>Weight of step: 0.25 lb.</td>
<td></td>
</tr>
<tr>
<td>Weight: 5 lb.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CHRISTIAN</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height: 3 ft. 2 in.</td>
</tr>
<tr>
<td>Weight: 60 lb.</td>
</tr>
</tbody>
</table>

5. Kimberly climbs up the ladder carrying the paint can and her radio. What is the live load on the ladder?
   - A. 7 lb.
   - B. 128 lb.
   - C. 135 lb.
   - D. 142 lb.

6. Kimberly gets halfway up the ladder with the can of paint and her radio. If Christian starts to climb up the ladder behind Kimberly, what is the total load?
   - A. 212 lb.
   - B. 202 lb.
   - C. 152 lb.
   - D. 79 lb.

7. The largest expected load of the ladder is about 200 lb. If the ladder is designed with a safety factor of 4, what is the maximum live load the ladder could support before failing?
   - A. 50 lb.
   - B. 204 lb.
   - C. 800 lb.
   - D. 1,000 lb.
8. The diagram below shows a joint comprised of a bolt holding together two parts of a deck. Failure at the joint is most likely caused by:
   A. Compression
   B. Tension
   C. Shearing
   D. Torsion

9. The figure below shows the handle of a spoon that bent while being used to scoop frozen ice cream.

What does the bend indicate about the property of the material in the spoon's handle that made it inappropriate for this use?
   A. It was too brittle.
   B. It was too malleable.
   C. It was too elastic.
   D. It was too dense.

10. The diagram to the left shows a diving board. At what point is the maximum tensile stress when a load is applied to the end of the board?
    A. Point W
    B. Point X
    C. Point Y
    D. Point Z
The picture below shows a tower, secured by two cables. Please answer the questions below:

11. What is the main type of force tower M must withstand?
   A. Compression
   B. Torsion
   C. Shear
   D. Tension

12. What is the main type of force cables L and N must withstand?
   A. Compression
   B. Torsion
   C. Shear
   D. Tension

13. If someone is changing the tire on a car, what kind of force is being exerted if he or she is using a lug wrench to remove the wheel nuts?
   A. Compression
   B. Torsion
   C. Shear
   D. Tension
14. Match each of the following terms associated with materials with the appropriate definition. (Not all definitions will be used.)

A. Point at which a material will not go back to its original shape when stress is removed
B. Ratio of an applied force divided by the area over which the force acts
C. Difference between the tension capacity and the compression capacity of a material
D. Measure of how much a material deforms due to applied stress
E. Ability of a material to be stretched or deformed and return to its original shape
F. Describes materials that do not deform plastically but fracture shortly after reaching their elastic limit
G. Ability of a material to be hammered or rolled to change its shape or thickness

15. Which of the following properties is most important for steel used to make springs?
A. Conductivity
B. Malleability
C. Elasticity
D. Plasticity
Appendix E

Task 1.2 Cell Phone Holder

Overview: In Task 1.2 the students are challenged to build an every day object—in this case, a cell phone holder. The purpose of the task is to engage each student in an inquiry task designed to bring out intuitive knowledge about the engineering design process and the seven behaviors of a team member. The students will share their cell phone holders with the class thus communicating the results.

Time: 3 Class periods

Focus Questions:

How do people use a given technology?

How are technologies redesigned to meet people’s needs?

What is a mock-up and how does it help the design process?

What do industrial designers, engineers and scientists do?
**Materials for each class:**

Several roles of masking tape

Scissors

One manilla folder for each student

Rulers

Students are told to make a cell phone holder. After the cell phone holders have been presented to the class the teacher reflects with the students how they used the engineering design process and the seven behaviors of a team player.
Appendix F

Task 1.8 Best Organizer (Create a Prototype)

Overview: Students have worked through engineering pages entitled, “Define the Problem”, “Research the Problem”, “Develop Possible Solutions” and “Choose the Best Solution”. They are now ready to build the prototype for this design challenge. The students re-design their best solution if necessary and construct a parts list before the begin building their prototype.

Time:

5 Class periods

Focus Questions:

Why is it helpful to make engineering drawings and parts lists before you begin?

What safety and emergency procedures should you know about before using tools?

Objectives: Students will be able to:

- Explain why engineering drawings, scale models, and parts lists are Helpful in the engineering design process.
- Identify proper safety rules and emergency procedures
- Identify criteria and constraints in the building process
- Follow a set of plans to make a prototype.

Materials:

- Several pieces of foam board
- Utility knives
Rulers
T-squares
Pencils
Glue gun and extra glue

Safety:

A safety briefing and the filling out of a hazard sheet is important because Students will be using tools. Highlight how the tools are properly used. Review the safety contract students had signed at the beginning of the school year.

Procedure: Once students have completed their final drawing and made a parts list, the teacher signs off on the project and students begin constructing their prototype. Teacher provides guidance and facilitates any problems using the formative assessment that student might have in building the prototype. Prototypes should be 1:1 scale.
Appendix G

Tower To Failure

Overview: Students will build a tower from paper, straws, paperclips and masking tape and then load it with weights until it fails. Primary emphasis is on the detailed analysis of failure to identify weak point and the kinds of forces that caused the failure using appropriate vocabulary. The activities key message is that by studying failures in the lab, engineers can reduce the chance of catastrophic failures in actual structures.
**Time:**

4 Class periods

**Focus Questions:**

How can you build a tall tower so that it will be structurally sound?

What shapes and materials will you use to handle the load?

What kind of forces cause structures to fail?

How can catastrophic failures be avoided?

**Objectives:** Students will be able to:

- Identify static and dynamic forces that act on structures.
- Explain the difference between tension, compression, bending, torsion and shearing forces.
- Understand how connectors or fasteners allow the members of a structure to work as a whole.
- Recognize failure is not necessarily bad.

**Materials:**

- 500 hundred straws
- 100 sheets copy paper
- 2 rolls of masking tape
- 100 paper clips.

**Procedure:** The criteria states that the minimum height of the tower must be 2 feet. Introduce the vocabulary terms. Use the engineering design process by having develop possible towers and then choose the best solution.
Appendix H

Experiment with Concrete

Overview: This hands-on experience with concrete will allow the students a chance to experiment with actual building materials. The most important concept for students to learn in this task is the method of controlled experimentation for investigating how to make concrete that is as strong as possible with cement, water and aggregate. Failure analysis will again play a major role.

Time:
3 Class periods

Focus Questions:
For what applications is concrete best suited?
What roles do the constituents of concrete play?
What happens if you change the standard formula?
How can the formula for concrete be changed to meet different needs?

Objectives: Students will be able to:
Predict how changes in the formula for concrete will affect its compression strength.

Explain what the different constituents in concrete do.

Perform controlled experiments to test and compare the compressive strengths of actual construction material.

**Materials:**

1. concrete crusher
2. 5 pounds portland cement
3. Mixing dishes
4. Plastic spoons
5. 3 inch lengths of ½ diameter pipe insulation
6. Samples of aggregate fine sand, rough sand, small pebbles
7. Water
8. Safety gloves

**Procedure:** Concrete may become too hard to crush if uses the crusher. Do not allow the concrete to set for more than two days. Limit the amount of water students have access to. Ask students to identify something they have seen made out of concrete. Discuss the task 2.6 in the engineers notebook. Have the students use the internet to find the best formula for concrete. Have students read the instructions on pages 44-46 in their Engineering Notebook. Have students record their formulas.
One at a time put each concrete form into the crusher. Have students put the analogue scale on top part of the crusher. Then have students use their force to see how many pounds are needed for the concrete to fail in compression.
## Appendix I

### Reconciliation of Data Collection Unit 1

<table>
<thead>
<tr>
<th>Unit 1 Task# and Description</th>
<th>What are my strengths?</th>
<th>Engagement Every 15 minutes</th>
<th>Team Assessment</th>
<th>Individual Assessment</th>
<th>Teacher Rubric</th>
<th>Knowledge Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Design a Cell phone holder</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. What is engineering</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Engineering drawing</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Define the problem</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Research the problem</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Develop possible solutions</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Choose the best solution</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Create prototype</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Test and Evaluate</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Communicate</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11. Redesign</td>
<td>X X X X X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>X X X</td>
</tr>
</tbody>
</table>
## Appendix J

### Reconciliation of Data Collected for Unit 2

<table>
<thead>
<tr>
<th>Unit 2 Task# and Description</th>
<th>What are my strengths?</th>
<th>Engagement Every 15 minutes</th>
<th>Team Assessment</th>
<th>Individual Assessment</th>
<th>Teacher Rubric</th>
<th>Knowledge Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Define the problem</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. Identify loads</td>
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<td>3. Use failure analysis</td>
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<td>4. Test construction material</td>
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<td>5. Describe mechanical properties</td>
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<td>6. Experiment with concrete</td>
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<td>7. Knowledge assessment</td>
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