North Carolina
Council on Technology Teacher Education

TECHNOLOGY EDUCATION JOURNAL

Volume VIII
2006

NCCTTE
Technology Education Journal
Volume VIII, 2006

Table of Contents

Acknowledgments

The *Technology Education Journal, Volume VIII,* is a refereed journal published by the North Carolina Council on Technology Teacher Education. The eighth volume of the publication is the result of the contributions of numerous technology education professionals. Articles included in the journal represent the most current research and insights of the technology teacher education faculty in North Carolina. Uniquely, this is the first volume of the NCCTTE Journal to include international authors. This volume includes scholarly works completed in 2006.

The following authors are recognized for their contributions to this volume:

Dr. Ted J. Branoff, Dr. Aaron C. Clark, Dr Jeremy V. Ernst, Dr. W. J. Haynie, Mr. Richard A. Totten, and Dr. Terri E. Varnado -- North Carolina State University, Raleigh, North Carolina. Also included are: Dr. Klavdiya Kuzovleva, Dr. Natalya Masyuk, and Ms. Alexandra Grichanova – Guest Authors from Russia

Special thanks are extended to the teacher educators and professors who donated their time and expertise in reviewing articles for this volume. Additionally, the Council acknowledges the sustained effort of the reviewers:

Dr. Vince Childress, NC A&T State University
Dr. Bill DeLuca, NC State University
Dr. Richard Peterson, NC State University
Mr. Petros Katsiouloudis, NC State Univeresity
Dr. W. J. Haynie, NC State University
Dr. Aaron Clark, NC State University
Dr. Ted Branoff, NC State University
Dr. Jerianne Taylor, Appalachian State University

W. J. Haynie, III, Ph.D.
Executive Editor

Online Learning: Research, Tools, and Best Practices

Ted J. Branoff and Richard A. Totten

North Carolina State University

Abstract – For years faculty have had the ability to offer courses at a distance through online instruction. Many instructors have taken advantage of online tools to supplement their classroom instruction, but few embrace the full potential of online learning technologies. Some of these tools include course web pages, course management and development tools, and online tutorials. Reasons for not embracing online learning technologies include inadequate training in the necessary tools to develop an online course (Bhattacharya, 2004), perceived lack of interactivity or dialogue between the students and instructor and between students in online courses, lack of technology support at one's institution (Sherry, 1996), costs of implementing distance education technologies (Zirkel, 2004), or time required to develop online materials. In some cases online courses are not developed because face-to-face courses are sufficient to meet student demand. Instructors, especially those in a graphics field, face additional challenges with issues such as finding appropriate ways to demonstrate software, preparing materials that are graphics intensive, and determining adequate methods to evaluate student work. More recently, synchronous communication tools for learning have been developed that allow instructors to communicate with students in real-time. These technologies have increased the level of community within an online course by integrating audio, video, and other means for students to interact (Motteram, 2001).

This paper summarizes research from technology education, engineering and other disciplines related to online instruction, discusses some of the tools available that can be used to deliver instruction synchronously and asynchronously, describes some of the issues related to delivering instruction online, and provides some solutions to issues related to online learning.

Introduction

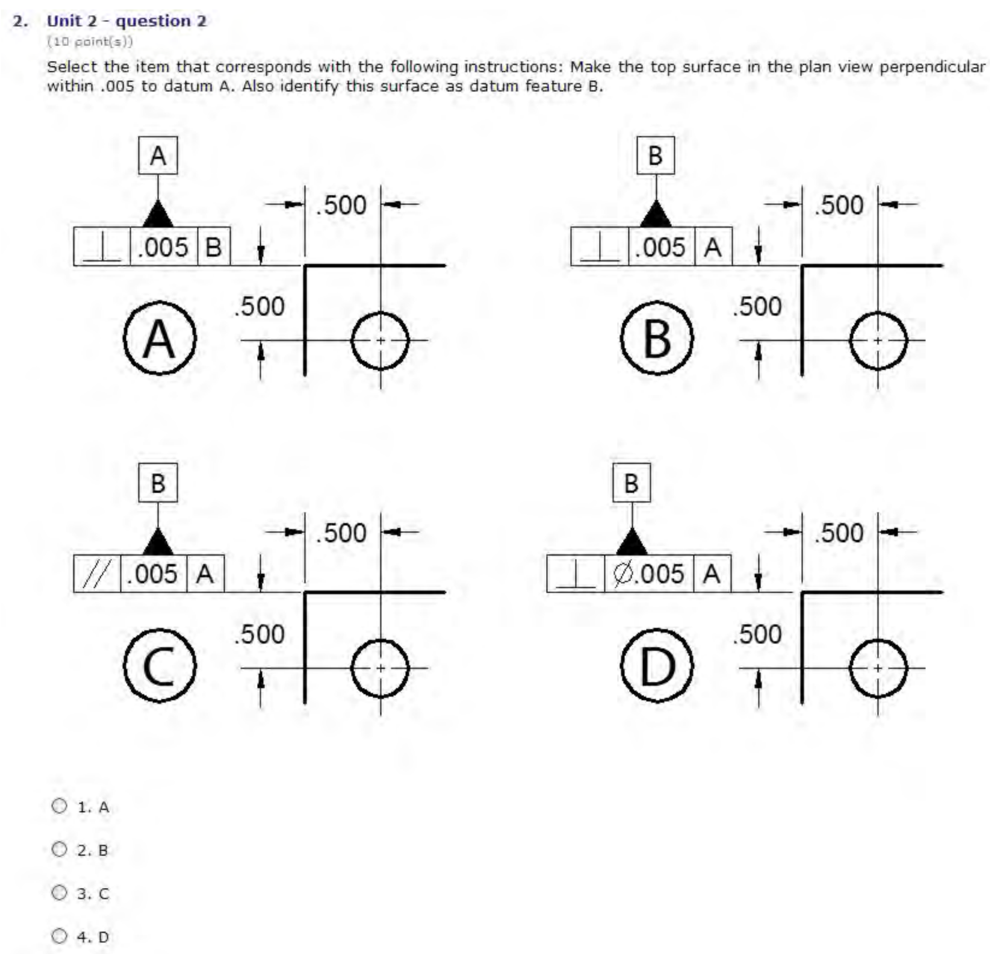
As learning technologies have increased and become easier to use, faculty have found creative ways to offer their engineering courses. We now regularly see courses offered using Distance Learning Management Systems (DLMS). These systems allow the instructor to take advantage of asynchronous technologies (Wheeler & LeMaster, 2005; Howell, 2004), synchronous technologies (Hines, 2005), and videoconferencing technologies (Thai, 2005; Lieu, Bloom, Jang & Won, 2002). Whether these courses are offered for students at a distance or for on-campus students, these tools are giving faculty more options for delivering instruction.

Distance Learning Management Systems

The DLMS are available to meet the needs of all experience levels of faculty. Whether the instructor is just trying to add a small amount of course material online or has a desire to offer a course at a distance, systems exist at all price ranges. These systems typically include both asynchronous and synchronous learning tools. Asynchronous tools can be used to deliver online instruction with some time delay between an instructor's action and when the learner accesses the instruction and responds. With synchronous online tools, participants are engaged in real time activities such as text chat, audio, and/or video.

Asynchronous Tools

Asynchronous tools involve instruction through a "different time-different place" mode. Examples of asynchronous tools are discussion boards, blogs, email, online quizzes, streaming audio and video, narrated slideshows, learning objects, and website links. The main advantage of these tools is that participants can access the instruction at their own convenience (Ashley, 2003). Figure 1 illustrates an example of an online test that was be used to check students' understandings of material related to geometric dimensioning and tolerancing. Students were given a window of time within which they must have completed the quiz.



<u>Figure 1. Example of an Online Test within WebCT Vista.</u>

Synchronous Tools

Synchronous tools involve instruction through a “same time-different place” mode. These tools allow the instructor and students to engage in activities in real-time. Examples of synchronous tools are application sharing, audio conferencing, text chat, web conferencing, white boarding, and video conferencing (Ashley, 2003). These activities tend to facilitate the building of “community” in the online environment better than the asynchronous tools. Figure 2 illustrates an application sharing example of a web browser. Application sharing allows the instructor to present material, demonstrate software, or turn control of the software over to participants.

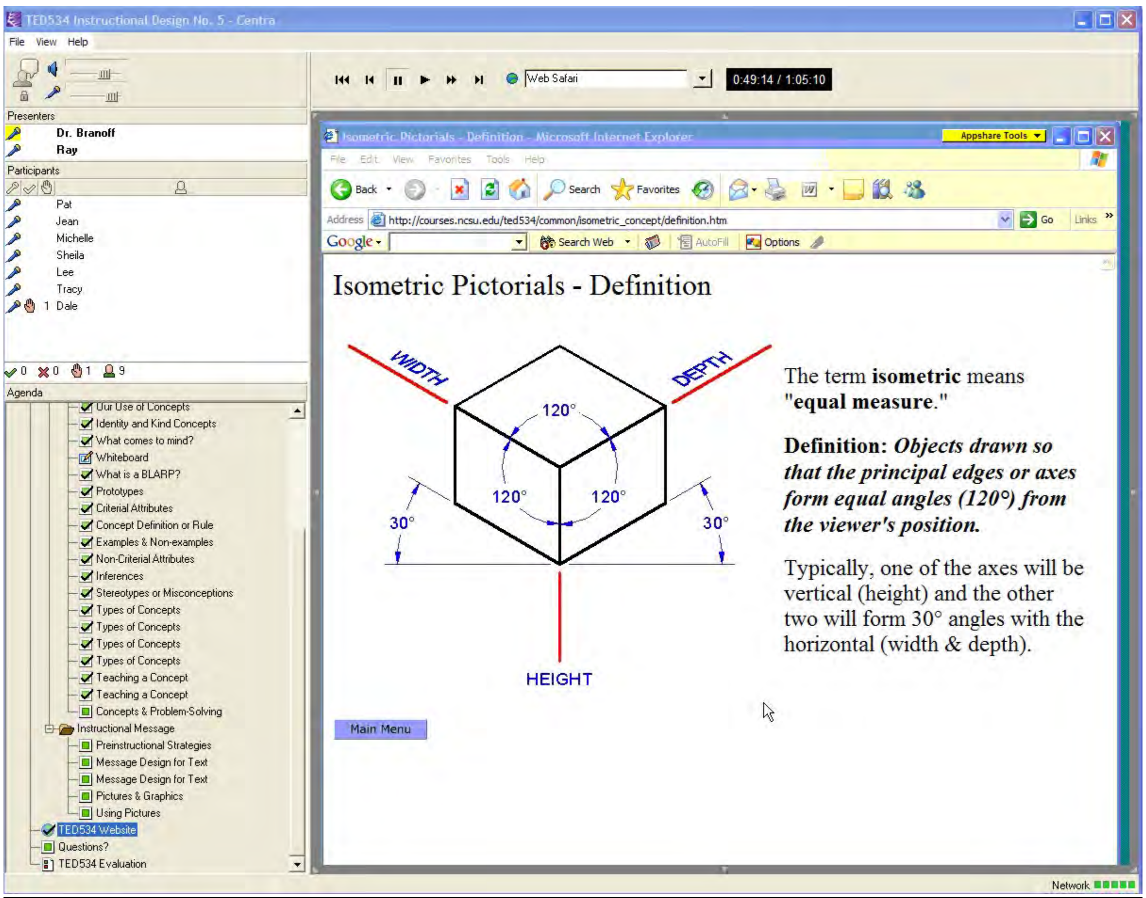


Figure 2. Example of Application Sharing in Centra Symposium.

Experiences Using DLMS in a Technology Education Graduate Course

In addition to teaching undergraduate engineering graphics courses, the author also teaches instructional design graduate courses at a distance for technology education students and community college instructors in the STEM areas (science, technology, engineering, and mathematics). In the instructional design course, a combination of WebCT Vista and Centra Symposium is used. Students are required to complete readings and respond to discussion postings asynchronously. In addition, synchronous sessions are held once or twice each week in Centra Symposium to present material, hold real-time discussions (as a group or in break-out rooms), conduct student presentations, and demonstrate web design tools. Figure 3 illustrates an example of using the whiteboard to conduct brainstorming activities. With the whiteboard tool, all participants can add information to the screen simultaneously.

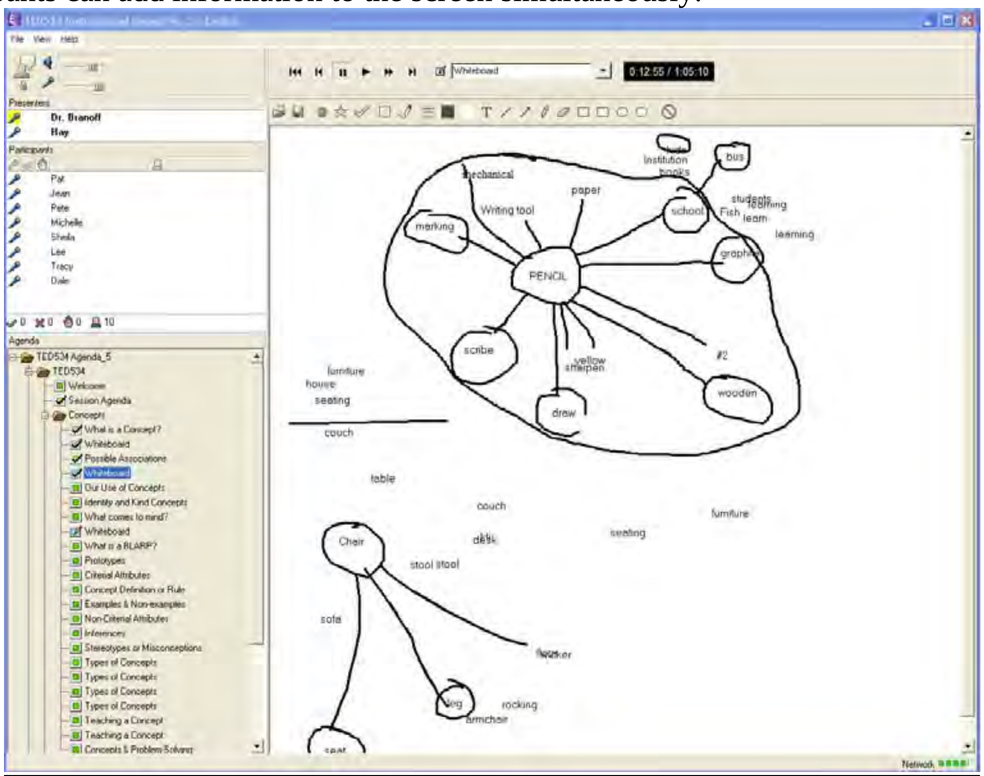


Figure 3. Brainstorming Activity Using the Whiteboard in Centra Symposium.

As part of a National Science Foundation project to study the effects of an online graduate certificate program for community college teachers, data have been collected at the end of each Centra session for both the community college educators and for traditional technology education graduate students (Branoff, Wiessner, & Akroyd, 2005). Figures 4-7 present data regarding where and how students connected to the session and the effectiveness of Centra to deliver the instruction. Figure 4 illustrates that the community college instructors either connected from home or work, while the technology education graduate students were equally divided between home, work, and school. Most students used high bandwidth connections (Figure 5). Their opinions about using Centra in the future were similar, however, some of the technology education graduate students did not care for the online environment (Figures 6 and 7).

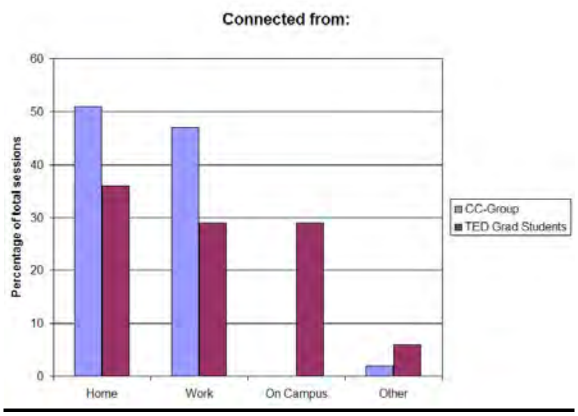


Figure 4. Location from which Student Connected.

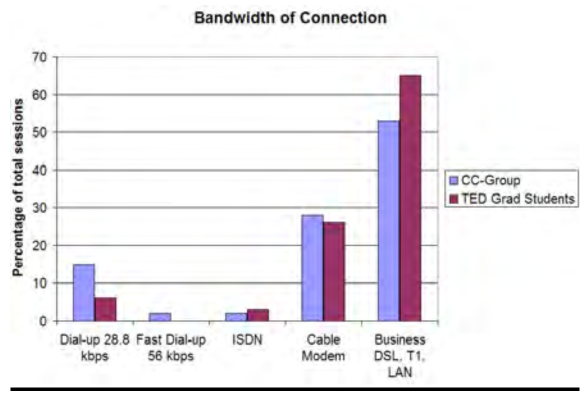


Figure 5. Bandwidth of Students Connection.

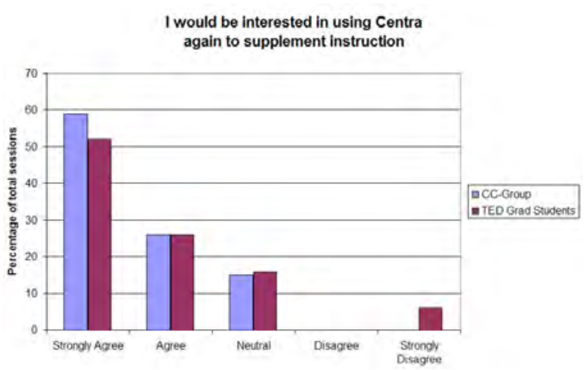


Figure 6. Interest in Using Centra again.

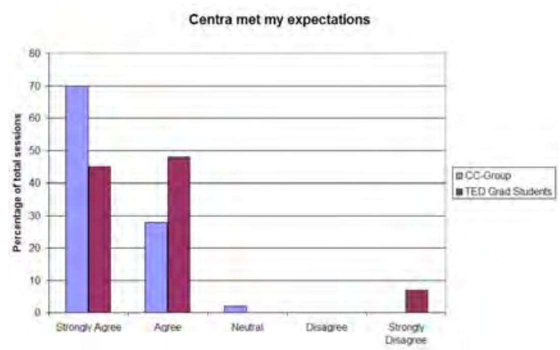


Figure 7. Did Centra Meet My Expectations?

In addition to the online evaluations, data are being gathered for the community college instructors through self-assessments of their technology skills, phone interviews with an external evaluator, assessing samples of work, and summative surveys after each course. Although the first cohort is just finishing the fifth course, preliminary data give some indication of the effectiveness of the program. Comments here are organized based on the year-three goals of the program (Hsiang, 2006).

"Does the program meet the educational needs of adult and distance learners from diverse backgrounds and cultures?" Comments made by students in post-course surveys indicate that the program is meeting the needs of community college instructors. The demographic data indicate that the program is meeting the needs of instructors from rural and suburban areas, however, better strategies are needed to recruit participants from South Carolina and to recruit individuals of color.

"Does the Program develop and enhance knowledge and skills for understanding the diverse ways and settings in which adults learn?" Community college faculty are incorporating the knowledge and techniques learned in the certificate program into their own classroom practices. Participants indicated that studying adult learning theory and instructional design methodology has helped to evaluate how and what they teach and design more effective instruction in their face-to-face and online courses.

"Does the Program prepare individuals and enhance instructors' abilities to research, design, implement, and evaluate distance learning and classroom instruction?" Most participants had interacted in an online environment before enrolling in the program. Their ability to use tools like Centra, WebCT, and file manipulation tools has increased significantly.

Engineering Graphics Courses at NC State University

In North Carolina State University's Graphic Communications program in the department of Mathematics, Science and Technology Education, several types of systems are being used to deliver engineering graphics instruction to students. In addition to regular web pages (see Figure 8), WebCT Vista is being used to supplement face-to-face instruction in three courses. In the introductory engineering graphics course, several instructors are using the DLMS to provide basic course information (syllabus, calendar, assignments, etc.), present content, and provide links to other resources (see Figure 9). In the second and third level computer-aided design courses, the software is being used for online testing. Students are required to complete readings and workbook activities and then take short quizzes to test their knowledge before coming to class. This has been quite successful in the upper level CAD course. In the spring 2004 semester, students were required to read the assigned material, view voiced-over slides streamed over the Internet (Wiebe, 2002), and then take the midterm and final exams that were based on the material. During the spring 2005 semester, the instructor also required that the students take an online quiz for each reading assignment. Figure 10 shows exam scores before and after using the online quizzes.

Figure 8. Delivering Information, Content and CAD Tutorials Through Web Pages.

Figure 9. WebCT Vista Interface for GC120.

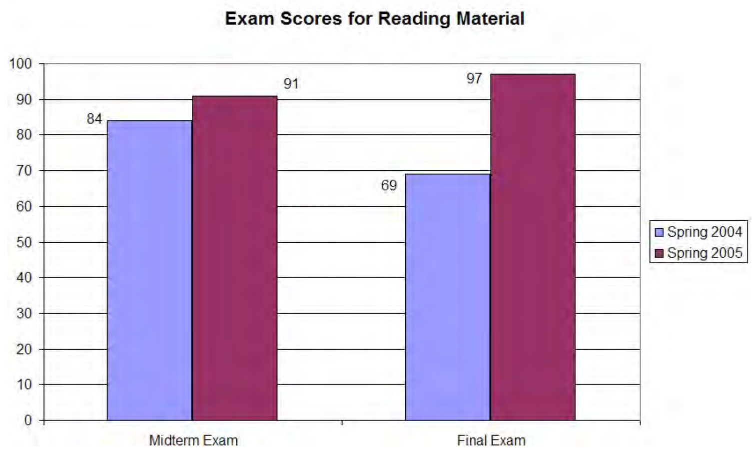


Figure 10. GC450 Mean Exam Scores Before and After using Online Quizzes.

Reflections and Recommendations

As the result of feedback from participants, the project team has instituted a one day orientation session on the campus of North Carolina State University. Goals of this session are to acclimate individuals to the course management tools (WebCT and Centra Symposium), give them a chance to meet the instructors as well as other participants, collect relevant information from the students, and allow them to make a final decision about whether the program is right for them. Moving some parts of a course or an entire course to an online format can be a daunting task for some faculty. Distance Learning Management Systems offer a wide range of asynchronous and synchronous tools that allow instructors to explore alternative ways of delivering instruction. Implemented properly, the online tools can be just as effective as face-to-face courses in most situations. For those who are skeptical about these tools or not totally confident about delving into these technologies, several recommendations are offered.

1. Talk to someone at your institution that is currently using these tools or systems and get their advice. They may be willing to provide you with template files to get you started with creating web documents.
2. Find out if you have support staff at your institution that can provide training in the various distance learning tools.
3. Start out small. Moving an entire course to an online format can be overwhelming if you have never taught using DLMS tools.
4. Visit an online session. If you know faculty who are using tools like Centra Symposium, ask them if you can virtually “sit-in” on a session. It will give you a good feel for the types of things you can do in that environment.

References

Ashley, J. (December 2003). Synchronous and asynchronous tools. *ASAE & The Center for Association Leadership*. Retrieved November 29, 2005, from http://www.centeronline.org/knowledge/article.cfm?ID=2587

Bhattacharya, B. (2004). *Distance education through technology mediated learning: The engineering education scenario in India.* Paper presented at the Third Pan-Commonwealth Forum on Open Learning, Dunedin, New Zealand.

Branoff, T. J. Wiessner, C. A., & Akroyd, D. (June 2005). *Professional development for community college teachers: An online graduate certificate program for community college teachers.* Proceedings of the 2005 Annual Meeting of the American Society for Engineering Education, Portland, Oregon, June 12-15, 2005.

Hines, J. W. (2005). Teaching while on travel: Technology alternatives. *Proceedings of the 2005 Southeastern Section Meeting the American Society for Engineering Education*, Chattanooga, Tennessee, April 3-5, 2005.

Howell, S. K. (2004). *Engineering design graphics across the Atlantic: An experience using asynchronous and synchronous technology*. Proceedings of the 59th Annual Midyear Meeting of the Engineering Design Graphics Division of the American Society for Engineering Education, Williamsburg, Virginia, November 21-23, 2004. 93-97.

Hsiang, M. (2006, April). *Community college teaching certificate program: Year three evaluation report*. Research Triangle Park, NC: RTI International.

Motteram, G. (2001). The role of synchronous communication in fully distance education. *Australian Journal of Educational Technology, 17*(2), 131-149.

Lieu, D. K., Bloom, R., Jang, G. H., & Won, J. (2002). *Conducting a class, live over the Internet*. Proceedings of the 57th Annual Midyear Meeting of the Engineering Design Graphics Division of the American Society for Engineering Education, Indianapolis, Indiana, October 27-30, 2002. 99-104.

Sherry, L. (1996). Issues in distance learning. *International Journal of Educational Telecommunications, 1*(4), 337-365.

Thai, C. N. (2005). Development of an extended-classroom IT infrastructure for engineering instruction. *Proceedings of the 2005 Southeastern Section Meeting the American Society for Engineering Education*, Chattanooga, Tennessee, April 3-5, 2005.

Wheeler, E. & LeMaster, R. (2005). Effective delivery of on-line engineering courses: The nuts and bolts of success. *Proceedings of the 2005 Southeastern Section Meeting the American Society for Engineering Education*, Chattanooga, Tennessee, April 3-5, 2005.

Wiebe, E. N. (2002). *Moving outside of the box: Alternative instructional delivery methods in engineering graphics*. Proceedings of the 57th Annual Midyear Meeting of the Engineering Design Graphics Division of the American Society for Engineering Education, Indianapolis, Indiana, October 27-30, 2002. 99-104.

Zirkle, C. (2004). Distance education programming barriers in career and technical teacher education in Ohio. *Journal of Vocational Education Research*. *29*(1). http://scholar.lib.vt.edu/ejournals/JVER/index.html

Technology Education in Russia

Klavdiya Kuzovleva
Far Eastern State Technical Fisheries University
Vladivostok, Russia

W. J. Haynie
North Carolina State University
Raleigh, NC

Natalya Masyuk
Ivanovo State Textile Academy
Ivanovo, Russia

AND

Alexandra Grichanova
Georgia Perimeter College
Atlanta, GA

North Carolina Council of Technology Teacher Education

April 2006

Technology Education in Russia

In November of 2005 Dr. Klavdiya Kuzovleva, a chemistry professor, came to the USA from Russia with full support as a Senior Fulbright Scholar. As a faculty member, Professor of Chemistry, and Department Head at Far Eastern State Technical Fisheries University in Vladivostok, Russia, she had read empirical articles on the effects of testing on learning by Haynie and had applied for the Fulbright funding to come study with him to develop a similar research protocol in her discipline in Russia. The length of her USA visit was six months. This presented a unique opportunity for Haynie to learn from her about how Technology Education is presented in Russia and for her to be a co-presenter and co-author with him at NCCTTE. Hence, the format of this article is questions and answers in interview style. The other authors were involved due to their expertise in answering some of the questions, for help in translation of Russian documents, and to insure both clarity and completeness. The basic manuscript outlining the questions was written in mid December of 2005 to allow a search for currently accurate answers. Then, following consultation, the answers were formulated and the final manuscript was prepared in March of 2006. A presentation was made at the April NCCTTE Conference which allowed for further questions from the audience.

Question 1: Introduce yourself more fully and tell briefly about your university and the courses that you teach.

Klavdiya Kuzovleva is Associate Professor at the Far Eastern State Technical Fisheries University (FESTFU), Vladivostok, Russia. She graduated from Far Eastern National University in 1975 (Diploma – equivalent of Bachelor's and Master's in USA) and St.-Petersburg State Technological University, St.-Petersburg, Russia in 1987 with the Candidate of Chemistry degree (Ph.D. equivalent). She teaches Analytical Chemistry and Instrumental Methods of Quantitative Analysis. Educational measurements are the main region of Klavdiya Kuzovleva's scientific interests. She is the author or co-author nearly 70 scientific papers. Her scientific and teaching work in the field of educational testing was supported by grants of RSS Program of the Open Society Institute (1999); the Eurasia Foundation, the USA (1999); program 'Educational measurements in Russia' of the Centre of Testing of the Ministry of Education of Russia (2001); 2005 - Fulbright Program, the USA (2005). Now she is a Senior Visiting Fulbright Scholar at North Carolina State University, conducting research under supervising Dr. William J. Haynie, Associate Professor and Coordinator Technology Education, Mathematics, Science and Technology Education, College of Education, North Carolina State University.

Natalya Masyuk is Vice-President and Head of Finance Chair, Professor of Economics at Ivanovo State Textile Academy (IGTA), Ivanovo, Russia. She graduated from Ivanovo Textile Institute, Ivanovo, Russia (1978, Diploma of Engeneer); Institute of Textile and Light Industry, Leningrad, Russia (1982, Kandidat of Science); Ivanovo State University (2002, Doctor of Science). She teaches Industrial Economy, Bases of Business, Financial Management, Marketing and Insurance. She is the author or co-author nearly 200 published scientific works, including 4 monographs. Now she is a Visiting Fulbright Scholar at the University of North Carolina at Greensboro. The theme of her project is connected to research of availability of services of Higher Education, including Technology Education, for the different social groups of the population. She conducts the research under supervising Dr. Bert A. Goldman, Professor of the Department of Educational Leadership and Cultural Foundations.

Alexandra Grichanova has bachelor's and master's degrees in Library Science from St.-Petersburg State University of Arts and Culture (St.-Petersburg, Russia) and an associate degree in journalism from Georgia Perimeter College (Atlanta, GA). For several years she worked as a librarian in the human rights society "Memorial" and as a journalist in St.-Petersburg Customs Newspaper in Russia. Currently she works as a librarian in Georgia Perimeter College in Atlanta, the USA.

Background for Questions Concerning Technology Education

Technology Education in the USA developed over a long time with roots in and influence from many sources. These include the earliest form of education—apprenticeships, and many influences in Europe such as special trades schools and arts and crafts movements. In the USA there is a distinction between "General Education" intended for all people and specialized segments of education intended for unique groups of people. Among those specialized segments two are particularly important: "Academic Education" and "Vocational Education". The Academic Education prepares students in middle and high school to go on to college or university for further education prior to entering the workforce in (mostly) professional careers. The Vocational Education enables a student to enter the workforce directly after high school (or perhaps after a couple of years in a junior technical or community college). Our discipline, Technology Education, is unique in that it partially has its feet in both General Education and Vocational Education. Modern Technology Education evolved most recently from the previous curriculum known as "Industrial Arts Education" (1950s-1980's) which had itself grown out of earlier programs with names such as: "Manual Training", "Manual Arts" and "Industrial Education". For funding reasons, Technology Education must maintain its close ties to Vocational Education, but many of us in the profession more closely identify our role as a part of General Education—we feel that the classes we offer in the middle and high schools are valuable for all people regardless of whether they grow up to be "professionals" (doctors, lawyers, engineers, and such) or "trades people" (mechanics, carpenters, health assistants, homemakers, etc.). Though there are some low level technical skills involved in most of the Technology Education courses, that is not their prime essence. They attempt to develop "technological literacy" among people including consumer knowledge, understanding of the workings and impacts of technology (broadly), career awareness, and other General Education understandings rather than the specific job skills taught in the Vocational Education courses. There must be some sort of Vocational Education in Russia developing from one of its early roots at the Imperial Technical School at Moscow in the 1860's under Victor Della Vos, which (according to Bennett, 1926) was one of the early influences on Vocational Education in the USA. Most of the rest of this interview concerns the nature of current Vocational and Technology Education in Russia and its relationships to Vocational Education, General Education, and Academic Education in your country.

Question 2: Basically explain the general structure of the Russian school system. At what age do children enter school, how many levels or grades do they attend, and are there special types of education for different groups of children or one general education program for all students?

The education system in Russia is multilevel. Practically from birth and until very old age every Russian citizen can receive education at these consecutive stages: Preschool education; general education (primary, basic, general secondary (complete)); vocational education (initial, secondary and higher); supplementary education (for adults and children); post tertiary professional education (post-graduate school, so called 'aspirantura', doctorate, continuing education and retraining). Thus, the state realizes its principle of continuous lifelong education. In response to an editorial request, this work will concentrate on describing the general education (primary, basic and general secondary (complete)), and the place of vocational education in it, as well as on describing forms of vocational education in Russia on the secondary school level. Other education levels are described briefly or only mentioned. All figures on numbers of students, lengths of education, etc. are taken from the official websites "Russian Education. Federal Portal" at http://www.edu.ru and The Russian Federation Ministry of Education and Science, Federal Agency for Education at http://www.edu.ru.

Preschool education is given in preschool institutions (kindergartens), intended for children from two months to seven years of age, but usually children start attending them at the age of two or three years. Preschool institutions, regulated by Standard Regulations for Educational Institution for Preschool and Early School Age Children, are divided by form of ownership into state, municipal, and private. In state and municipal kindergartens parents usually pay only part of tuition, the rest being paid by the founder (the state). Every Russian kindergarten, unlike any other in the rest of the world, provides children not only with basic care, upbringing and education, but also with board and medical care. At the end of 2001 the number of preschool educational institutions in Russia was about 50 thousand, and the number of students attending them was over 50 million, which is about 56% of all children at the ages from one to six. Preschool education is not compulsory, but it is recommended that, in order to level the initial abilities of children of different social backgrounds, before starting the first grade of school they receive preschool education for one year.

General education includes primary (grades 1-4), basic (grades 5-9) and secondary (complete) (grades 10-11) education. At the present time the length of education in general school is 11 years. Children start attending school at the age of 6 or 7 and graduate, in general, at 17.

According to the Constitution of Russian Federation and the Federal Law of Russian Federation 'On Education' primary general and basic education are compulsory, equally accessible and free; and the secondary (complete) education is also equally accessible and free, but not compulsory.

Depending on level and contents of education, all general schools are divided into primary, basic, secondary general; secondary general schools with profound study of some subjects (math, physics, foreign languages, etc.); gymnasiums (offering educational programs on basic and secondary (complete) general levels with profound study of humanities) and lyceums (offering educational programs on basic and secondary (complete) general levels with profound study of technology and science). Present day general schools are regulated by Standard Regulations for General Educational Institution. In the 2004-2005 school year there were more than 61 thousand general schools in Russia, attended by more than 16 million children. The scope of general education in Russian Federation is one of the highest in the world and constitutes 81% of all population at the ages of 7 to 17 inclusive.

The curriculum content of general education in Russia is for the most part standardized and is defined by specific documents adopted in the late nineties, which establish the list of core subjects and their contents, so called 'compulsory minimum contents', for every stage of education. According to these documents, for primary schools the core subjects are: *Russian Language, Reading, Math, Environment (Natural History and Social Studies), Art, Music, Vocational Studies, Physical Education.* For basic school the subjects are: *Russian Language, Literature, Foreign Language (English, German, French, Spanish), Art, Music, World Art, History of Russia, World History, Social Studies, Geography, Physics and Astronomy, Chemistry, Biology, Math, Computer Science, Physical Education, Basics of Life Safety, Technology*. For the level of Secondary (Complete) General Education the subjects are: *Russian Language, Literature, Foreign Language (English, French, German, Spanish), Math, Computer Science, History, Social Studies, Geography, Economics, Biology, Physics, Chemistry, Ecology, Physical Education, Basics of Life Safety, Technology.*

The turbulent period of reforms, resulting from drastic changes in Russia after the fall of USSR, did not bypass the education system. During the last decade the contents of education have changed and started allowing different options, non-state schools emerged, teachers were allowed to choose programs and educational materials independently. The contents of humanities subjects went through major changes; there appeared elective (non-compulsory) social-economic subjects - Political Science, Sociology, Economics, Law, and others. However, the social-economic crisis of the system in the nineties significantly slowed down positive changes. The state to the large extent abandoned the education system, which was forced to find the means to survive on its own, distancing itself in the high degree from the true needs of the country. At the present stage of development of Russia in the conditions of its transformation into a democratic and lawful state with free market economy, education, becoming a major force of economic development, can not remain in the enclosed and self-sufficient state. Realizing the need for educational reform, the government of Russian Federation adopted in 2001 'The Concept of Modernization of the Russian Education for the Period until 2010', which defines priorities and means of realization of the general, strategic line for the next decade - modernization of education. The goal of modernization of education is to create the mechanism of consistent development of the education system, which presumes not only large scale structural, institutional, organizational and economic changes, but in the first place regeneration of educational contents, primarily those of general education, and tailoring them to the modern standards. The most important condition for achievement of this goal is introduction of a state standard of general education – a combination of standards, defining mandatory educational contents for every stage of general education, graduates' training requirements, maximum allowed study workload, as well as basic requirements for the educational process.

The State Basic Educational Standard includes three components: Federal Component (determined by Russian Federation), Regional Component (determined by a subject of Russian Federation), and Educational Institution Component (determined by an educational institution). The Federal Component, covering from 80% (in primary school) to a half (in senior grades) of study time, is the major part of the state standard of general education, mandatory for all educational institutions of Russian Federation with state accreditation. The federal component defines this list of core subjects for primary school: *Russian Language, Literary Reading, Foreign Language, Math, Environment, Computer Science and Information Technologies, Art, Music, Technology, Physical Education*. For basic school the current subjects are: *Russian Language, Literature, Foreign Language, Math, Computer Science and Information Technologies, History, Social Studies (including Economics and Law), Geography, Natural History, Physics, Chemistry, Biology, Art (Fine Art and Music), Technology, Physical Education*. As one can see, the new state standard for general education has significantly broadened the list of core subjects for the first and second stages of general education.

The most serious changes were imposed on the contents of secondary (complete) general education, for which provisions were made to introduce the so-called 'profile education'. Following is a brief description of it. Federal component of state standard establishes the following list of educational subjects: *Russian Language, Literature, Foreign Language, Math, History, Social Studies, Economics, Law, Geography, Biology, Physics, Chemistry, Natural Studies, World Art, Technology, Computer Science and Information Technologies, Physical Education, Basics of Life Safety*. The majority of these subjects are given on two levels – basic (designed for formation of general culture and mostly connected with attitudinal goals of general education) and profile education (selected based on students' personal needs and designed to prepare them for consecutive professional education or professional work). The contents of these two types of education constitute the federal component of the state standard of general education. In addition, there exist mandatory elective courses, implemented on the basis of school component of curriculum, which either "support" study of main profile subjects (for example, the elective course "Mathematical Statistics" supports study of a profile subject "Economics"), or serve for "intraprofile" specialization of education (for example, the course "Chemical Technologies" within the Natural Sciences profile).

The ratio of basic, profile and elective courses is 50:30:20. General schools, based on their resources and educational requests from students and their parents, independently design educational profiles (a certain set of subjects, studied on a profile level), or let every student choose some subjects, studied on general or profile levels. Educational profiles may be: Humanitarian, social-economic, natural-mathematical and technological. For every profile the core subjects on basic level are: Russian Language, Literature, Foreign Language, Math, History (if none of these subjects is selected on profile level), Social Studies (for natural-mathematical and technological profiles), Natural Studies (for humanitarian and social-economic profiles), and Physical Education.

The aim of introducing profile education in senior grades of general school is individualization of education and socialization of students with regard to real demands of the job market. Started in 2003 in 9 regions of the country, the experiment in refining the system of profile education now spans across 30% of schools; its preliminary results show that profiling of education is socially important and is popular among the society.
Introduction of the federal component of the state standard of general education (and profile education for senior grades based on it) is scheduled for the 2005/2006 school year in 9th grades for organizing pre-profile training, and the 2006/2007 school years in 1st,5th and 10th grades. However, depending on the level of preparedness and on decision of a founder, they are allowed to introduce the federal component beginning in the 2004/2005 school year. The multistage period of introducing the standard will end in 2010.

Another way of professional development of a person beginning in childhood is supplementary education. According to the Federal law of Russian Federation "On Supplementary Education", "…students, attendees of educational institutions, as well as other persons no older than 18 years of age, have a right for free supplementary education in state and municipal educational institutions". For 85 years the Russian Federation has maintained a continually developing state system of supplementary (extracurricular) education for children, which has no analogs in the world. It includes 18 thousand institutions of general education (art centers for children and youth, sport schools and clubs, other clubs, studios, design studios, internet-cafes and information centers, museums), established by different departments; employs 440 thousand teachers; and serves 13 million children from 5 to 18 years old. The system of supplementary education gives skills and knowledge outside the mandatory minimum of basic subjects in an array of various types of activities – scientific, sports, art / esthetic, hiking/ local studies, biological/ ecological, military/ patriotic, socio-pedagogical, natural-scientific and other activities – and is one of the determining factors of development of interests, social and professional self-determination of children and youth. In addition, it has a growing importance in providing pastime to children and youth, organizing their socially important recreation, prevention of child neglect, crime, drug abuse, and other asocial behavior among youth.

Students can receive general education not only in general school, gymnasium or lyceum, but also while receiving initial and secondary vocational education (see answer to the next question).

Question 3: Is there some form of Vocational Education in Russia at the middle or high school level (ages 11-18)? Is this free public education or does it cost the students and their families? What trades or vocations are studied?

Vocational education in Russia has three levels in order of increasing qualification: initial, secondary and higher. All these steps are designed to accomplish one, most important goal: To give a person a profession. After completing nine years of compulsory secondary education, students can, depending on their desires and abilities, continue their education in high school, or get primary or secondary vocational education. After attainment of complete secondary general education or secondary vocational education they can continue studying in higher professional education institutions.

Initial vocational education schools prepare skilled laborers and office workers. After applying, students are accepted into state and municipal initial vocational schools on competitive basis in accordance with school statutes and regulations. Length of education in this stage depends on the student's educational level. Those students, who apply after completion of nine years of school, study for two or three years. Those, who have completed 11 years, study for one or two years. Regardless of this fact, some initial vocational schools change their profiles to those of technical colleges (see below). It results in increasing the length of education to three or four years, depending on students educational level. There are two types of attendance - day and evening.

Traditional form of schools at this educational level is PTU (Professional'no-technicheskoe uchilische). A new form of initial vocational schools - Professional Liceums (Professional'ny Litsei), preparing skilled workers at highest levels, emerged during the last few years.

There are state, municipal or non-state schools of initial vocational education. In state and municipal schools of initial vocational education students, receiving their first initial or secondary vocational education, study for free. In addition, they receive grants, dormitory rooms (if they qualify), discounted or free meals and public transportation and other types of benefits and financial assistance. Orphans and children without primary caregivers study under full state sponsorship. Operation of these schools is regulated under Standard Regulations on Primary Vocational Schools.

In the last years of the Soviet Union the list of professions studied in PTUs reached 1400 titles. During a short period of time, the initial vocational education system has gone through significant changes in its specialization. In response to the market quote demand a new, integrated list of professions has been created, and in the present time more than 280 integrated professions are being taught. Demand grew highest for professions in hospitality business, transportation, food service and retail industry. There appeared brand new, clamored for by the society professions of social workers, small business administrators, ecologists and designers, which increase competitiveness of graduates of these schools at the labor market. Meanwhile, the importance of professions of the industrial and construction complex has diminished. The new state initial vocational education standards and basic curriculum were developed. Continuity of educational programs on this level with programs in secondary vocational education grew significantly stronger. Despite the fact that during the last decade there appeared a tendency of decreasing number of students, until now initial vocational schools are an important element in the educational system that allows students to get a profession before graduating from secondary school. Usually, this type of education is popular among youth from partial and troubled families in need of an additional source of income. For children from this social group, when there are no prospects of getting a high school diploma, there is still a chance to continue their education. In the 2004-2005 school year there were more than 3600 initial vocational schools in Russia.

Persons 14 to 18 years of age can also receive vocational education while studying craftsmanship, usually regulated by local authorities [an apprenticeship system of sorts].

Secondary vocational education is designed for preparing practical specialists. It is carried out in two educational programs - basic and advanced. After completing the basic level education graduates receive degrees of technicians. The advanced level of secondary vocational education gives more profound or broader training than the basic level (at the same time the length of education is increased by one year). Graduates with profound training are given degrees of senior technicians and those with broader training receive degrees of technicians with additional training in a selected area (with indication of specific area of education - management, economics, computer science, etc.).

The curriculum content of secondary vocational education programs is regulated by State Educational Standard of Secondary Vocational Education, consisting of two parts: the federal component, which sets statewide standards for basic curriculum and graduates training level, and national regional component. There are various forms of secondary vocational education: full-time, part-time, distance, external on the basis of basic education (nine years of general school), or secondary (complete) basic education (11 years of general school). In state and municipal schools of secondary vocational education students, receiving their first degree, study for free. They also get grants, dormitory rooms and other forms of benefits and financial assistance. The length of full-time basic secondary vocational education on the basis of secondary (complete) basic education is two or three years depending on type of training. The length of part-time and distance education is a year longer than that of full-time education. It takes one year longer to get secondary vocational education on the basis of basic education, than on the basis of secondary (complete) basic education.

There are two main types of secondary vocational education schools: technical college (technicum) and college. Technical colleges offer major educational programs on the basic level of secondary vocational education; colleges - major educational programs on the basic and advanced levels. Secondary vocational education programs may also be carried out in institutions of higher education. Schools on this level are regulated under Standard Regulations on Secondary Vocational Schools.

There are more than 300 specialties of secondary vocational education. In the last years a few dozens of new specialties were added - mainly in social work, hospitality services and new information technologies. The secondary vocational education system includes 2600 state and municipal secondary vocational schools and university subdivisions that give secondary vocational education. More than 25 ministries and departments along with subjects of Russian Federation regulate secondary vocational schools. Every year about 11% of basic school graduates and about 23% of secondary (complete) school graduates enroll into secondary vocational schools. In the 2004-2005 school year there were 2.6 millions students in the secondary vocational education system.

As was mentioned above, after receiving secondary vocational degree students can continue their education in the higher professional schools: universities, academies and institutes. Moreover, they receive fast-track degrees on the basis of secondary vocational education. Any type of higher education institution may offer basic initial, basic, basic secondary (complete), initial vocational and secondary vocational education programs, as well as additional vocational education if they have appropriate licenses. Russian higher professional education system, which went through drastic changes in the last years, is beyond the subject of this article, and we would only mention that in the 2004-2005 school year there were about 6.8 millions students in more than 1300 Russian higher education institutions, regulated by the Federal Law on Higher and Post Tertiary Level Professional Education and by Standard Regulations on Higher Professional Education (Higher Education Institution).

Question 4: Is there specialized schooling for those 11-18 year old students intending to go to college or university for professional careers? What types of subjects do they study? Is this college preparatory education also free?

The Russian education system has two principally different ways of preparing senior-grade school students for entering universities or colleges. Pre-college education may be realized in preparatory faculties of higher education institutions, financed from the federal budget, or in commercial preparatory courses. Depending on the length of studies, such courses may be 1,3,6,8 or 10 months long.

The first form of pre-college education, offered only by state educational institutions, and financed by the government, was very popular in 1960-1980s. Preparatory faculties of universities and institutes were created in 1969. Their main goal was to raise the educational level of working and rural youth and military reservists in order for them to be accepted into higher education institutions. In the soviet times, as a rule, mostly men who served two or three years in the military were accepted into preparatory faculties. They were prepared to the necessary level, and their final examinations, held in June, were considered their entrance exams if they did well.

It is important to note that before being admitted into the faculty, most students had significant breaks in their studies. Considering this fact, the studies were organized in the best way possible to allow students to refresh their knowledge received in general school, prepare for final exams and later to successfully study at the faculties of their choice. During their studies at preparatory faculties students were receiving financial aid and those from out of town were given rooms in dormitories. At the end of their studies students had final examinations and, if they passed them successfully, they were enrolled as freshmen at the corresponding faculties.

Beginning in 1991 the policy of enrolling students into preparatory faculties has undergone significant changes. The earlier rule of accepting students depending on their prior occupation and work experience has been lifted. Preparatory faculties have ceased to be only “military” and now persons who did not serve in the army, but have basic general or basic vocational education are also accepted.

At the same time, higher education institutions have been allowed to add new categories to the classification of persons accepted into the faculties with regard to social-economic needs of their regions. All these changes, together with difficulties in state financing of education, and new laws, allowing colleges and universities to offer commercial education, resulted in transformation of many preparatory faculties into commercial preparatory courses, and by the end of 1990 in termination of free education for preferential categories of students.

Presently the majority of preparatory faculties in Russian higher education institutions are closed, because they are not receiving any funding from the state budget. Only a few schools in Russia still have preparatory faculties sponsored by the government. The Ministry of Education of Russia has developed recommendations for reorganizing the work of preparatory faculties of higher professional education institutions.

Earlier one of the requirements for being accepted into preparatory faculties was two years of work experience. Today there is no such restriction. Moreover, candidates into institutions of higher education who did not pass their entrance exams are often given preference when applying for preparatory faculties. State establishments usually consider results of final exams at preparatory faculties as those of their entrance exams .

Preparatory faculties are an alternative variant for students without complete high school diplomas or with grade point average lower than required for acceptance into certain faculties. At preparatory faculties students study such basic subjects as math, physics, chemistry, English (German, French) language, history, and other subjects necessary for further studies at the faculties of students' choice.

There are also preparatory faculties in colleges, which offer necessary courses for those who do not have high school diplomas or want to raise their GPA.

In cases when there are more applicants to preparatory faculties than they can accept, students are admitted on a competitive basis (contingent on the results of interviews, conducted in accordance with high school curricula, or the results of entrance examinations into the given school).

Preparatory faculties, financed by the government, were created in order to help those who have financial or social difficulties in preparing for institutions of higher education. Students attending these faculties are sponsored by the government—that is why there are no provisions for introducing commercial education in preparatory faculties. In addition, full-time students, attending preparatory faculties at state and municipal institutions of higher education, receive the same amount of financial aid as freshmen.

More popular today is the second method of preparing for college--commercial preparatory courses. Their length, number of classes offered, forms of attendance and cost of attendance are determined by schools themselves.

Following is an example of organizing preparatory courses in Ivanovo State Textile Academy. Currently it has eight, six, three months, one month and two weeks duration preparatory courses. Courses are offered in regular and distance learning modes. Small groups of fast-track and individual learning are also available.

Taking these courses allows students to systematize their knowledge received in general school, raises their preparation level to that of other college students, develops their skills in creative solving of the most complicated problems, helps to adopt these skills to specifics of entrance examinations (regardless of the character of entrance examinations), and familiarizes students with the school's atmosphere.

The purpose of preparatory courses is to systematize students' knowledge received in general school. Students are prepared in subjects required for being accepted into the academy: Math, physics, chemistry, computer science, Russian language and literature. Classes are offered in small-group settings (15 persons) and are taught by the faculty of the academy according to the scope of entrance examinations. Students are given homework and tests.

Depending on desires or financial abilities of students, they can choose to take one, two, or thee subjects. One of the key factors here is each student's level of general school knowledge. This way educational content of the courses is student-oriented in the subject, psychological and social aspects, which is consistent with practice in the beginning of vocational education.

Question 5: Is there a program in Russia that is somewhat similar to our Technology Education courses for ages 11-18 intended to teach <u>all students</u> about technology? If so, describe it including: Who pays for it? What courses are available and at what grades or levels? Is it required (mandatory) of all students or is it elective in form?

Vocational and technical education in Russia has deep roots and old traditions. The first attempt at creating vocational schools (including the ones for teenagers) can be attributed to the reign of Peter the Great. By the mid-19 century the system of vocational education for youth were established in Russia, and it included technical colleges, producing engineers; junior technical colleges, preparing lower level technical service workers, masters and mechanics; and craft schools, training skilled workers and craftsmen. At the end of 19^{th} – beginning of 20^{th} century development of vocational education was largely contributed by civic organizations. For example, the Russian Technical Society (TRO) opened numerous professional (craft) factory schools for workers, children, and women. After the 1917 revolution many members of this society were persecuted and the society itself ceased to exist in 1929.

At the beginning of the soviet era there were numerous attempts at creating initial and secondary professional education on the basis of first level (for children from 8 to 13 years old) of the so-called united vocational school. At the second level for children from 14 to 17 years old vocational education was not offered. From 1926 until 1934 the main types of schools were 7 year factory schools and agricultural schools for the peasant youth. In 1927 "Manual Work" became a special subject, the purpose of which was to give general skills for various work processes. However, in 1937 this subject was canceled. Revival of vocational education in schools began in the 1950s, during the period of postwar reconstruction, when the country needed highly skilled workers, so Manual

Work was reintroduced in 1954 as an initial school subject. At the same time, in middle schools, students had practice classes in school workshops and laboratories; seniors in urban schools had a subject "Basics of Manufacturing Technology" (machine studies, industrial production basics, automobile and electrical engineering); and rural schools offered a senior grade subject "Basics of Agriculture" (animal husbandry, horticulture, basics of farm machinery studies and electrical engineering). Schools have introduced occupational training, which resulted in graduates not only receiving general education, but also professional training. Particular attention was paid to the technical base of vocational education, created with participation of industrial factories. However, by the mid-60s, the impracticality of giving professional education in schools became evident, and by 1966 it was canceled. Study hours for vocational education were reduced, and its prestige diminished.

Scientific progress triggered the development of a new concept of vocational education of the late 1970s - early 80s , which was based on an individual-oriented education model. This period is characterized by stronger professional education structure, based on a system of educational/training centers created in 1975 and stronger connections between schools and factories. By the 1980/1981 school year the transition to the new differentiated vocational programs was complete. In 5-8th grades of urban schools boys had "Technical Work" classes, and girls had "Service Work" classes, while in rural schools boys studied "Agricultural and Technical Work", and girls studied "Service and Agricultural Work", after which senior grade students were prepared to receive working professions. Realization of this new concept of vocational education resulted in creating industrial-pedagogical faculties preparing manual work teachers, and later - engineering-pedagogical faculties in technical colleges preparing teachers-engineers. By the mid-1980s such practically-oriented approach, as well as the subject "Manual Work" exhausted themselves, and the system of vocational education started reforming again. The idea of students receiving general education along with profession training became popular once more, and it became the foundation for the educational reform of 1984. Professional training was introduced starting in 8^{th} grade, study hours for it were significantly increased, and the system of educational/ training centers was enlarged. However, despite increased quantitative evidence of technology and professional education quality, as a whole the reform did not yield the expected results.

With the development of new economical and social relations in Russia in the 1990s came the necessity to shift from the study of manual labor to an emphasis on technology education. The problems of technology education, as well as the structure and contents of the subject "Technology" and some aspects of teaching technology in schools and universities are being researched by P.R Agutov, V.D.Simonenko, V.A Poliakov, J.L.Hotumtsev, and N.V.Kotriahov (see list of Russian Language Sources).

The school subject "Technology" replaced "Manual Work" in 1993. Being a necessary component of general education, it allows students to put into practice their scientific knowledge. Technology classes allow students to become familiar with different professions and to prepare for their future professional activities. It ensures continuous transition from general school to professional education and employment. The importance of pre-college technology training is recognized in the federal target program "National Technology Base for 2002-2006".

As was mentioned above (see answer to question 2), presently the general school curricula are defined by two sets of documents: Compulsory Minimum Contents of Initial, Basic and General (Complete) Education and basic curriculum of 1998, and Federal Component of State Educational Standards of General Education and, accordingly, the federal basic curriculum of 2004.

According to 1998 documents, Technology is a compulsory subject in initial school, where it is called " Manual Work", as well as in basic and general (complete) schools. On all these levels Technology is given 2-3 hours a week (a school year lasts 35 weeks). In initial school the subject "Technology" is built on a module principle with regard to school's resources and regional needs. Technology classes are designed to teach children basic vocational techniques, develop their fine motor skills, spatial imagination, visual perception skills, teach them about the world of professions, about respecting people and products of their labor. Besides learning about the role of working in a man's life, children also receive practical training, which takes up about 50% of the class time. They master specific technological operations, create items out of different materials (paper, construction paper, natural, plastic and textile materials, foil, wire and parts of construction sets (including electronic ones)), gain skills in clothing care, book repair and interior decoration, learn about functions of home appliances and how to safely operate them. Basic general school (5-9th grades) curricula include basic modules, defined by five main professional areas of a person's social and vocational activities: Man/technology, man/nature, man/man, man/sign system, and man/art. The structure of curricula and their focus are defined by types of work practiced by schools: Technical work (by types of technological activities and used materials), service work (household management, home-family, head of household, agriculture (horticulture and animal husbandry)). The module "man/technology" offers courses in sawing, planning, turning, milling, engraving, welding, gluing, soldering, grinding and polishing, wood burning, painting and lacquering. During technology lessons classes are usually divided into two groups for boys and girls. Boys learn the abovementioned activities, as well as repair and adjustment of technical, electro-technical and electronic devises, construction and remodeling techniques. Girls are taught weaving, knitting, needle pointing, cutting out and sewing, clothing repair, as well as making preserves and storing produce. The module “man/nature” is designed for rural schools and offers basic knowledge of agriculture, animal husbandry and poultry farming. The module “man/sign system” teaches working with information, graphic design and drafting using hand and computer-aided methods. In the module “man/man” students are introduced to service professions and develop skills in home design, hairdressing, photographing, library and retail services, and they learn how to administer first aid and care for children and sick persons. The module “man/art” offers courses in applied art (students can choose from clothing, shoes and accessories design, decorative weaving, wicker weaving, decorative painting, wood, birch bark and bone carving, decorative turning, engraving, mosaics, inlaying, wood burning, leather stamping, embossing, working with leather, stone, clay and other natural materials.

The Compulsory Educational Content of the subject “Technology” in the basic (complete) general school includes general and specialized technological components. The general technological component is mandatory. It includes main technological conceptions and activities, basics of designing and redesigning processes, technological and consumer culture, and occupational orientation. The contents of the special technological component depend on the school’s choice of specialization and types of professional activities. This choice is made based on school’s learning and material resources, availability of teaching staff, interests and needs of students. Schools may specialize in hand and machine-aided processing of construction materials, working with fabrics and foodstuffs, agricultural technologies, certain occupational areas- industry, economy, education, healthcare, construction, transport, clerical work, computers and information technologies, applied arts, folk arts, horticulture, animal husbandry, service work. Such approach allows instruction in the basics of technological culture as part of general culture in classes specializing in humanities/social sciences, humanities/philology, natural sciences, physics/mathematics, and others. This approach contributes a polytechnical nature to profile education and makes education more practice-oriented.

As was mentioned above (see question 2), beginning in 2004/2005 school year Russian schools started implementing the Federal Component of State Standard of General Education and federal basic curriculum. According to these documents, the subject "Technology" is studied in primary, basic and high schools. However, study hours for it are significantly cut to 1 hour in 1st- 2nd, 8th, and 10th-11th grades of non-profile education and completely left out in the 9th grade.

In primary school the subject "Technology" is designed on modular principle with regard to school resources and needs of a region. In 1st and 2nd grades Technology is assigned 1 study hour per week, and in 3rd and 4th grades - 2 hours per week. In 3rd and 4th grades the subject includes basics of working with computers (it is given no less than 20% of study time).

On the level of basic general education the structure of programs and their specializations (technical, service, and agriculture work) remain the same. However, the study hours were reduced to 2 hours per week in 5-7th grades and 1 hour per week in 8th grade. One hour in 8th grade was passed over to the national/regional component for organizing education with focus on local studies. Study hours initially allocated for Technology in 9th grade were passed over to the school component for arranging occupational orientation of students. If schools offer non-profile education in senior grades, it is recommended to give these study hours back to the Technology subject in order to ensure continuity of technological education. It is also advised to continue offering this subject when preparing students for industrial/technical, military/sports and physics/technical profiles. The compulsory minimum for basic educational programs includes creating items out of construction materials. In the earlier compulsory educational contents for the subject “Technology” this section was divided into several components: “Construction Materials Processing Technology”, “Technical Equipment” (elements of machine studies), “Decorative Processing of Materials”, creating items out of textiles (previously called “Textile Processing Technology”), cookery (previously “Foodstuffs Processing Technology”), electrotechnical works (“Electrotechnics and Electronics”), Household Management Technology (“Family Economy and Business Basics”), “Construction/ Remodeling and Sanitary/ Technical Works” and “Household Culture”, Graphic Design and Drafting (the same section existed before), Modern Manufacturing and Professional Education (previously “Career Selection”). All courses are expected to include working on projects. The compulsory minimum does not include automatics, digital electronics and robotics, but mentions assembling models of simple electronic devices and designing practical items using radio parts, electrotechnical and electronic details and devices. The compulsory minimum does not include conceptions of design and culture of human relations. Urban schools offer two lines of technology education: technical work and service work.

The biggest transformations in teaching Technology according to the new standard occurred on the level of basic (complete) education, where it is planned to introduce profile education. For some profiles in senior grades of basic (complete) education, Technology is not a compulsory subject on the basic level of the federal component, but it is added to the list of elective courses and is allotted 70 hours (1 hour a week in 10^{th} and 11^{th} grades). In senior grades of classes with a technological profile, the Basic Federal Curriculum allocates to Technology 280 hours (4 hours a week in 10^{th} and 11^{th} grades). The Technological profile of general education allows senior grade students to gain and improve their skills, and to learn science essentials while doing practical work within their chosen profile of education. For the first time in the history of Russian education, 10^{th} and 11^{th} grade students were provided with a minimum content of curricula and achievement requirements for the technological profile and basic level of education. The standard of basic education is designed for schools with a comprehensive educational profile and schools with non-technical profiles. On the basic level of senior school students' abilities to independently define their life and professional goals are further developed and the process of teaching them about design technologies and creating various items is created with regard to their learning interests. The technological profile assumes profound technical training of senior grade students in technology areas of their choice. At the end of it students receive certificates of completion of specialized technological training. When professional technology education is profound and is allotted extra study hours from the regional and school components, students may receive official certificates of professional education.

A very important role in profile training and education should be given to interschool educational/training centers. [Editor's Note: these appear to be uniquely different than USA educational opportunities and may be related in a way to what NSF terms "informal education".] Possessing engineer/pedagogical staff skilled in various aspects of technology and professional orientation, as well as the necessary material base, these centers can provide technology training to students of 5^{th} -8^{th} grades, offer a wide variety of elective courses for 10^{th} -11^{th} grades of comprehensive (non-profile) education classes, and later to train students of industrial/technology profile classes and offer professional training to students according to obtained licenses.

As one can see, the idea of giving basic vocational education along with general education has once more returned to the Russian school education (however, it is not, like it was before—this was the purpose of the reform). For how long? Time will tell. Nevertheless, the recently adopted Federal Component of State General Education is a first generation of the new federal components. It is transitional and temporary, and soon will follow the second generation of educational standards. The task of creating these is outlined in the Federal Target Program of Education Development for 2006-2010.

As far as financing of vocational education is concerned, being a component of compulsory education, it is sponsored by the government, but with the present state of Russia's economy it is impossible to maintain the necessary level of its material and technological base. As was mentioned above, in the past industrial factories used to contribute to organization of material and technological base. Today, despite the development of the private sector economy in Russia, using private capital in education in general and in vocational education in particular is more an exception than the rule. Hopefully, the Russian government will create conditions under which businesses will be encouraged to become involved in financing education, including vocational education, which is always in need of replenishing.

Question 6: In the USA, there is a very visible effort to integrate learning across the curriculum and Technology Education has begun to make serious efforts to become one of the centralizing features of the curriculum such that science, math, language, and social concepts may be taught centered around technology topics and students can develop interesting projects or do technology activities as they study those other subjects. Is anything like that occurring in Russia? If so, describe it. If not, what barriers do you think would prevent development of such a program in your county?

At the end of the twentieth century, when the new technological society ("knowledge society") began to form, technological skills and knowledge became the main resource of a single individual, an enterprise and economy as a whole, and technology became an element of literacy. The recognition of this fact compelled most developed countries to include a new subject "Technology" into their school curricula at the end of the last century. The presence of this subject in the curricula of education institutions is actively supported by the industrial and business world of these countries, because "Technology" gives children a chance to acquire necessary skills in solving challenges offered by everyday life while working on projects, thus preparing them for future productive careers. Today technology education is becoming as significant a field of education as humanities and science in schools all over the world .

In 1993, as a result of the decision of Russian Ministry of Education to participate in an international project for scientific and technological literacy for all "2000+", sponsored by UNESCO, the subject "Technology" was added to the Russian school curricula . Within the past 11 years the concept, curriculum, text books and other methodological materials for Technology have been developed. The concept of this subject is based on the definition of technology as "science about transformation of materials, energy and information, according to the plans and interests of an individual", and states its purpose as "acquainting students with some technologies in transformation of materials (wood, metal, textile, foodstuffs), energy (electrical engineering and electronics) and information, as well as developing students' creativity and sense of aesthetics while they work on projects and practice decorative processing of materials". "Technology" is taught in the majority of Russian schools. There are regional and country-wide olympiads in technology; in 1997 and 2001 technology teachers received "Russian Federation teacher of the year" awards. Since 1994 Russia hosts international conferences on technology education with participation of specialists from Russia, Great Britain, France, Germany and other countries.

However, despite many successes, there are still some unsolved problems in technological education, namely: Insufficient financing of material and technological supplies for Technology classes; underdeveloped program and methodological documentation; decrease in study hours allotted for technology classes in basic school; low wages of teachers and understaffing as a result of it; weak connections between schools and factories; diminished importance of technical/technological training in the system of additional education; closing down of many interschool educational/training centers, where students could acquire an array of technological skills; and other pressures. Memorandums of previous conferences on technology education show that this situation is the result of underestimating the importance of Technology subject by former leaders of Russian Ministry of Education, which is evident from the decreased number of study hours allotted for Technology in the Federal Basic Curriculum for 2004. The teaching community also expressed its concern over the possibility of elimination of technology education for school students, shown in the Federal Basic Curriculum for 2004.

There are also some subjective problems. The main idea of the subject "Technology" is to integrate basics of sciences taught on school level, but the majority of teachers did not succeed in doing it on their own, and some instances of teaching integrative humanities and science courses within technology classes, such as "Natural-Science Picture of the World", or integrative classes with intersubject connections, are more an exception than the rule. For Russian education "technology" is still a new subject, and many educators still have not mastered the methods of teaching it, particularly the project based method, which is the key element of this subject. Some schools and lyceums give study hours allotted for Technology to other subjects (computer science, physics, etc.).

Question 7: In the USA there are specific laws requiring the free public education system to be responsive to the needs of children with disabilities and handicaps. There are two main aspects of this effort: Special Education programs designed to help such students in separated classes, and Mainstreaming which means that they are helped to succeed while attending classes with other students in the general population who do not share their disabilities. How are the "Special Needs Learners" educated in Russia? Is mainstreaming used or separate educational settings? Is their education free? How are the Vocational Education needs of these students met?

The problem of rehabilitation of children with disabilities is still one of the most complicated ones. It requires not only understanding from the society, but also involvement of special institutions and structures.

The official term accepted in Russia is "disabled children". Determination of status of disabled child is based on "biological model of interpretation of disability", according to which limited abilities result from various psychosomatic abnormalities (physical, sensory of intellectual). Status of disabled person is given in order to provide free rehabilitation services and disability benefits.

There is no special law on education of disabled children in Russia. However, there exist several laws addressing the problem of education of such children.

According to section 18 of the law "On Social Protection of Persons With Disabilities in Russian Federation", educational institutions, departments of social services, institutions of communications, information, physical education and sports ensure continuous upbringing, education, and social adaptation of disabled children. Moreover, if there is no possibility of studying in common and specialized preschool and general educational institutions, the state guarantees providing children with disabilities with home-based full general or individualized education.

The amounts of compensations for parents of disabled children receiving education at home or in non-state educational institutions are set by the Government of Russian Federation within the framework of state and local standards of financing educational expenses in various state and municipal educational institutions for different categories of children (with or without disabilities). A standard of similar content is also included in the Law of Russian Federation "On Education", which gives the right to draw up "family" education and analogous compensation for all children of school age not attending a state educational institution regardless of where and how their parents provide their education.

By creating the abovementioned laws the state has declared its responsibility to provide disabled children with necessary education and rehabilitation - either in "natural" ways, by providing rehabilitative and educational services in state institutions, or in monetary form, by paying compensations when the state does not provide necessary services in the region or when parents find better services outside of the state system of rehabilitation and pay for them out of pocket. In other words, the law takes into account lack of necessary services within the state system for some categories of children and allows families to choose their own ways of receiving such services. Such legislation is designed to support the development of rehabilitative and educational infrastructure, and in the meantime to allow parents to find required services while this infrastructure is not yet fully developed.

In this way the current Russian educational legislature guarantees education to everyone, does not interfere with development of inclusive education, but does not specifically reinforce it either. Current laws give everyone the right to receive education regardless of their health condition, let parents choose educational institutions and forms of education for their children, and allow organizing of special classes in general schools, but do not clearly establish the mechanism of creating special conditions for children with disabilities in general educational institutions. At the same time the world academic community agrees that education of such children is the most effective when received among normal children.

Such equally accessible education, which adapts to various needs of children, and gives children with disabilities access to education among other, normal children, is usually called inclusive. It is based on ideology which excludes discrimination of children and guarantees equal treatment to everyone, but creates special conditions for children with special educational needs.

According to reports of the Ministry of Health and Social Development of the Russian Federation, about 1.6 million children (at the ages of 1 to 18), have some developmental abnormalities, and among them more than 650 thousand have the status of disabled persons. For education of those children there exists an extensive differential system of special (correctional) education, which includes: Preschool educational institutions (DOU) of compensatory type, or special (correctional) groups in general preschool educational institutions; special (correctional) educational institutions for children with developmental disabilities; special (correctional) classes for students with developmental disabilities in general educational institutions; educational institutions for children requiring psychology/psychiatric, medical and social assistance. The system of special (correctional) educational institutions for children with disabilities includes 8 types of general schools (boarding schools) for disabled children and general schools of individual home-based education for disabled children. According to the State Committee of Statistics, altogether in the 2003/2004 school year there were 1956 such schools with 264,472 students (among them were 22 schools of individual education). Education and correction of development in these schools are provided by 15 educational programs. The emphasis of these programs is put upon technology education and giving children certain [vocational] skills that would allow them to obtain working professions. The "Standard Regulations for Special (Correctional) Educational Institution for Students with Developmental Disabilities" for the first time gives opportunity to children with visible mental retardation and children with numeral developmental abnormalities to study within general educational institutions [mainstreaming]. Before these provisions such children could study only in institutions within the system of social development. Considering the worldwide approach to education of children with disabilities among normal children of the same age, the process of their integration into the general educational environment is growing in Russia. Last year special (correctional) classes in general educational institutions (schools and boarding schools) were attended by 213,290 students, among which 2,580 classes for mentally retarded children were attended by 25,864 students, 16,900 classes for children with delayed psychical development were attended by 183,053 students, and 420 classes for children with physical disabilities were attended by 4,373 students. Special (correctional) classes for students with developmental disabilities are created in close proximity to their places of residence, which results in reducing the number of special boarding schools for this category of children. Almost 1.5 thousand children with hearing loss study among children with normal hearing. This is made possible by applying the methods of E. I. Leongard and the technologies developed by 18 verbotonal [Russian word for hearing/speech disorders that does not clearly translate] centers. In addition, more than 100 thousand children with slight speaking or writing disabilities attend almost 5 thousand speech therapy centers in general educational institutions.

However, promoting education of children with disabilities in general schools requires certain efforts. School buildings in Russia are still not handicap accessible. Moreover, children with disabilities are looked upon negatively by other people, and prejudices in regard to what they can or cannot do still exist.

Most students, along with their parents, and sometimes even teachers, often don't know that their schools provide home-based education for disabled children. Lack of information and prejudices against people with disabilities prevent such children from receiving inclusive education or from interacting with children of the same age, which alienates them and lowers their self-esteem. Therefore it is very important that teachers overcome their prejudices towards students with disabilities.

In addition, teachers must be familiar with specifics of dealing with such children. Society must get rid of the notion that all people with disabilities are "simply sick people" and start regarding them as individuals.

These are the problems that face the federal target program "Children of Russia", the largest part of which is a subprogram called "Disabled Children". The overall budget of this program is 8433.37 million rubles, of which 1977.8 million is funded by the federal budget, 6411.57 million provided by subjects of Russian Federation, and 44 million are given by independent sources. [One US Dollar is roughly equal to 27.6 Rubles] This program will help improve the Russian education system in regards to creating necessary conditions for proper education of children with disabilities and giving them vocational skills.

Question 8: What do you believe the future will be for Technology Education and Vocational Education in Russia?

As was mentioned in the answer to question 6, in today's Russia the "Technology" subject is going through difficult times. Unfortunately, one can say that even before being included into school curricula, Technology became a pariah of Russian education. This may be the only explanation for the decision of Russian Ministry of Education and Science officials to move Technology from federal to national-regional component, even though Technology today is one of the main factors of globalization and undoubtedly should already be included into the "international" component of curricula. How else could the absence of Technology in 9th-10th grades, where in non-profile classes it can be studied only as a selective course, be explained? While the rest of the world considers this subject one of the core ones in education, Russian school students are depraved of such an important instrument of professional orientation just at the time of choosing a profession.

Among the problems faced by "Technology" the most serious one is that of reduction of study hours allotted for this subject. The solution or at least a partial remedy for this problem would be an introduction of pre-profile education of 8th and 9th-graders in Technology classes. It would allow giving back to Technology the study hours allocated to regional and school component for pre-profile education. Many technology teachers speculate that not doing this would significantly degrade technology education and professional orientation of school students.

This crisis situation with Technology is indicative of an overall crisis in the Russian education system, which for a long time was justly considered one of the best in the world, but presently shows some negative tendencies. Among them are: Russian school students falling behind in gaining practical scientific skills and knowledge; large educational gap between children from different social strata; inadequate compliance of vocational education system to the needs of the job market; insufficient development of continuous education system; weak integration between higher education and scientific community; low popularity of Russian system of education among investors along with inefficient utilization of available funds, and many others.

It is high time now to institutionally change (update) the Russian system of education in order to ensure better quality of schooling and its accessibility to everyone. The main directions of these changes are outlined in the state document "The Concept of Modernization of Russian Education for the Period Until 2010" and defined in the recently adopted "Federal Target Program of Educational Development for 2006-2010".

The core strategic aim of the program is to provide conditions for meeting the demand of citizens, society and job market for quality education. This can be done by creating new institutional mechanisms of regulating the educational sphere, updating the structure and contents of education, building solid foundations for educational programs and developing their practical approaches, as well as establishing the system of continuous education. To achieve this strategic aim the following areas of Russian education must be improved:

- The contents and technologies of education;
- The system of educational services' quality assurance;
- Managing educational institutions;
- Economic mechanisms in the educational sphere.

Achievement of the strategic aim and strategic problems are ensured by implementation of program measures.

The program measures improving contents and technologies in education will be: creating an educational system for children of preschool age to ensure equal preparedness for consequent primary school education; creating more possibilities for extracurricular education; introducing profile education in high schools; allowing students to choose their individual curricula; implementing new state standards of basic education; launching new models of continuous professional education; establishing a new list of professions and specialist training areas in the spheres of professional education as well as corresponding state educational standards; introducing new educational technologies and standards of organizing the educational process with the help of modern information and communication technologies.

To develop the system of educational programs' quality assurance it is necessary to: improve the state system of evaluating quality of services offered by educational institutions; develop new forms and mechanisms of evaluating and controlling quality of educational institutions' operations, including the mechanisms that employ opinions of community and professional associations; improve the mechanisms of diploma evaluation in order to increase academic mobility and boost export of educational services, as well as to support integration of Russia into the world educational community; conclude the experiment in introducing a unified state examination, the results of which will allow to ensure equal accessibility to professional education, objectivity of entrance examinations, continuity of basic and professional education, and will let the state control and manage quality of education; to create a county-wide system of educational quality assurance; and improve the system of state certification of scientists and teachers.

To improve effectiveness of managing educational institutions it is planned to introduce new models of integrated schools that offer curricula for different educational levels; to establish the mechanisms of cooperation between educational institutions and employers; to determine which higher professional education institutions have country- and system-wide significance in order to concentrate material/technical and financial resources in the key areas of Russian education development; to introduce new models of state/public operated educational institutions in order to make the educational sphere more transparent and popular among investors; to increase responsibility of educational institutions for their final products; improving the education managing system through effective utilization of informational and communicational technologies.

In order to improve economical mechanisms in the educational sphere, it is important to develop new models of financing educational institutions at all levels, and to introduce new mechanisms reinforcing schools' economic independence.

The program measures are closely connected with implementation of measures to ensure participation in the Bologna Process, which was joined by Russia in 2003.

The program is expected to be realized in three stages. In the first stage (2006-2007) it is planned to establish and test models of educational development in different directions and to start large-scale reorganizations and experiments. In the second stage (2008-2009) priority is given to modernization of the material infrastructure of education as well as providing methodological and information materials and workers to various projects within the program. In the third stage (2010) the results of the previous stages are expected to be disseminated and put into practice.

Russian education is expected to go through significant transformations. In fact, it has already started changing. Just recently during the meeting of the working group of State Council on Education of Russian Federation in Petrozavodsk, an idea of joining PTUs and Technikums was suggested. In the words of Russian minister of education and science Andrey Fursenko, today's system of primary and basic vocational education is ineffective, and the Ministry of Education and Science is going to follow an example of the Western World and to create two separate lines of education: that of institutions of higher education and that of schools offering what in Europe and the United States is called "vocational training" for practical specialists ("blue collars"). As Fursenko said, "…the state is back in the education. The national project is the proof of it." (Agranovich, 2006, p.3)

Conclusions and Questions for Further Research

It appears that the status and potential of technology education and other aspects of education in the new Russia involve many paradoxes of various sorts. There is widespread recognition of ways to improve Russian education at all levels, but the problems of financing and supporting many of the proposed changes are difficult ones to overcome. Government documents frequently espouse policies and programs that are loftier than the actual existent examples. Though some great strides were made for technology education in the 1990's, a "back to basics" movement of sorts is curtailing it in some grades, regions, and in certain types of schools. In today's Russian schools technology education is having a very difficult time. Hopefully, most of the abovementioned problems are just "growing pains", and modernization of Russian education will bring teaching of technology to a new level.

Additional information and perspectives may be found in an article in The Technology Teacher-E, December-January, 2003. The upcoming CTTE Yearbook on international technology education will also be helpful.

In our global society of today, it would be wise for technology educators in the USA to closely monitor and learn from the efforts in other countries. Since we share a close-knit world, it would be in our common interest to also share means of educating its entire population to be technologically literate—the cost will be great if we do not. It is proposed that the findings of this study, especially those concerning technology education in Russia, be updated in five years.

References

English Language Works Used:

Bennett, C. A. (1926). *History of manual and industrial education up to 1870*. Peoria, Illinois: Bennett, 1926.

Russian Language Works Used: [Cited using Russian standards rather than APA]

Agranovich M. "Zachem Filfak Ofitsiantu?" ("Why Would a Waited Need a Fililigical Degree?"). Rossiiskaya Gazeta, 01.03.2006.

Atunov P.R. Didactika Tehnologicheskigo Obrazovaniia v Dvuh Chiastiah (Technological Education Didactic in Two Volumes). Moscow: IOSO, 1997.

"Federal'naia Tselevaia Programma "Deti Rossii". Rasporiazhenie Pravitel'stva Rossiiskoi Federatsii ot 13 marta 2002 g. # 292-r" (" Federal Target Program "Children of Russia". Instructions of the Government of Russian Federation as of March 13, 2002 # 292-r"). Ministry of Education and Science of Russian Federation. Federal Education Agency. Feb. 02, 2006. <http://www.ed.gov.ru/ntp/fr/chil>.

“Federal’naia Tselevaia Programma “Natsional’naia Tehnologicheskaia Baza” na 2002-2006 gg. (“Federal Target Program “National Technological Base” for 2002-2006"). Federal Target Programs Informational Server. Feb. 10, 2006. <http://www.programs-gov.ru/cgi-bin/indeg.cgi?prg=123>.

“Federal’naia Tselevaia Programma Razvitiia Obrazovaniia na 2002-2006 gg. Utverzhdena Postanovleniem Pravitel’stva Rossiiskoi Federatsii ot 23 Dekabria 2005 g. #803" (“Federal Target Program for Educational Development for 2002-2006. Passed by the Decree of the Government of Russian Federation as of December 23, 2006 # 83").Federal Target Programs Informational Server. Feb. 10, 2006. <http://www.programs-gov.ru/cgi-bin/indeg.cgi?prg=2005>.

Federal’nyi Komponent Gosudarstvennogo Standarta Obshego Obrazovaniia. Chast’ I. Nachal’noe Obshee Obrazovanie. Osnovnoe Obshee Obrazovanie (Federal Component of State Standard of General Education. Part I. Primary General Education. Basic General Education). Moscow: Ministerstvo Obrazovaniia Rossiiskoi Federatsii, 2004.

Federal’nyi Komponent Gosudarstvennogo Standarta Obshego Obrazovaniia. Chast’ II. Srednee (Polnoe) Obshee Obrazovanie (Fedral Component of State Standard of General Education. Part II. General (Complete) Education). Moscow: Ministerstvo Obrazovaniia Rossiiskoi Federatsii, 2004.

“Federal’nyi Zakon “O Social’noi Zashite Invalidov v Rossiiskoi Federatsii” ot 24 Noiabria 1995 goda # 181-FZ” (“Federal Law “On Social Protection of Persons with Disabilities” as of November 24, 1995 # 181-FZ”). *Sobranie Zakonodatel’stva Rossiiskoi Federatsii*, sec. 4563. 1995 (48)

Glozman E.S. “Pedagogicheskaia Sistema Technologicheskogo Obrazovaniia Tsentra Obrazovaniia #293 G. Moskvy” (“Pedagogical System of Technology Education in Educational Center # 293 of Moscow”). Federation of Internet Education. Feb. 23, 2006.
< http://som.fio.ru/RESOURCES/GLOZMANAE/2004/STO1.HTM>.

”Gosudarstvennyi Obrazovatel’nyi Standart Srednego Professional’nogo Obrazovaniia - Klassifikator Spetsial’nostei Srednego Professional’nogo Obrazovaniia” (“State Educational Standard of Secondary Vocational Education - Secondary Vocational Education Occupation Classification List”). Prikaz Ministerstva Obrazovaniia Rossii ot 02.07.2001, N 2572. Moscow 2001.

Hotuntsev I.L., Kozhina O.A. Razvitie Tvorcheskih Sposobnostei Uchiashihsia v Obrazovatel’noi Oblasti “Technologiia” (Student’s Creative Skills Development in the Subject “Technology”). Moskow: IOSO RAO, 1999.

Kontseptsiia Modernizatsii Rossiiskogo Obrazovaniia na Period do 2010 goda. Utverzhdena Rasporiazheniem Pravitel’stva Rossiiskoi Federatsii # 1756-r ot 29 Dekabria 2001 g. (The Concept of Modernization of Russian Education for the period until 2010. Approved by the Decree of the Government of Russian Federation # 1756-r as of December, 29, 2001). Moscow: TSGL RON, 2004.

Kotriahov N.V. Teoriia I Praktika Trudovoi Shkoly v Rossii (1917-1932) (Theory and Practice of Vocational School in Russia (1917-1932). Kirov, 1993.

Nogina G. “Dyshite Glubzhe, Refleksiruite! Metody Lecheniia “Kul’turnogo Shoka” (“Have a Deep Breath, Self-Reflect! Methods of Treatment for “Culture Shock”). Uchitel’skaia Gazeta. 2006 (3).

"O Remeslennicheskoi Deiatel'nosti v Gorode Moskve. Zakon g. Moskvy ot 16 Iiunia 1999 g., N 25" ("On Craftsmanship in the City of Moscow. The law of the City of Moscow as of June 16, 1999, N 25").Departament Podderzhki I Razvitiia Malogo Predprinimatel'stva Goroda Moskvy. 7 Jan.2006.<http://dmpmos.ru/law.asp?id=90>.

"Ob Obiazatel'nom Minimume Soderzhaniia Obrazovatel'nyh Programm Osnovnoi Obcheobrazovatel'noi Shkoly (Pis'mo Ministerstva Obshego I Professional'nogo Obrazovaniia RF # 74/14-12 ot 18 Iiulia 1997 g.)" ("On Compulsory Minimum Content of Basic General School (Letter of the Ministry of General and Professional Education of Russian Federation #74/14-12 as of July 18, 1997)"). *Vestnik Obrazovaniia*. 1997 (17).

"Obiazatel'nyi Minimum Soderzhaniia Nachal'nogo Obshego Obrazovaniia (Prikaz Ministerstva Obrazovaniia Rossii # 1235 ot 19.05.1998)" ("Compulsory Minimum Content of Primary General Education (Decree of the Ministry of Education of Russia # 1235 as of 05.19.1998)"). State Institute of Information Technologies and Telecommunications. Jan.26, 2006. <http://www.informika.ru/text/goscom/dokum/doc98/1235-1.html>.

"Obiazatel'nyi Minimum Soderzhaniia Srednego (Polnogo) Obrazovaniia (Prikaz MInisterstva Obrazovaniia Rossii # 56 ot 30.06.1999 g.)" ("Compulsory Minimum Content of General (Complete) Education (Decree of the Ministry of Education of Russian Federation #56 as of 06.30.1999)"). State Institute of Information Technologies and Telecommunications. Jan.27, 2006. <http://www.informika.ru/text/school/p_min/pr56-1.html>.

"Perechen' Professii (Spetsial'nostei) Nachal'nogo Professional'nogo Obrazovaniia.(Utverzhden Postanovleniem Pravitel'stva Rossiiskoi Federacii ot 8 Dekabria 1999g., N 1362)"("List of Professions (Specialities) of Initial Vocational Educaion (Approved by the Decree of the Government of Russian Federation from December 8, 1999, # 1362)"). Rossiiskoe Obrazovanie. Federal'nyi Portal. 7 Jan.2006 <http://www.edu.ru/legal/public/default.asp?no=81389>.

Poliakov V.A., Kazakevich V.M. "Trudovaia Podgotovka Shkol'nikov v Zerkale Pedagogicheskoi Nauki (k 50-Letiiu Rossiiskoi Akademii Obrazovaniia)" ("Vocational Education of School Students in Pedagogical Science (In Commemoration of the 50-th Anniversary of Russian Academy of Education)"). *Shkola in Proizvodstvo*. 1994 (2).

"Rossiiskaia Federatsiia. Federal'nyi Zakon "O Vysshem i Poslevuzovskom Professional'nom Obrazovanii". Priniat Gosudarstvennoi Dumoi 19 Iiulia 1996 goda. Odobren Sovetom Federatsii 7 Avgusta 1996 g."("Russian Federation. Federal Law "On Higher and Post Tertiary Level Professional Education ". Passed by State Duma as of July 19, 1996. Approved by the Council of Federation as of August 7, 1996"). Vuzovskie Vesti 11/33 (1996).

Sherbakov S., Agafontsev V., Markov V. "Summa "Tehnologii". Ot Taburetki k Mikroelectronike" ("The Sum of "Technologies". From a Stool to Microelectronics". Uchitel'skaia Gazeta. 2004 (42).

Simonenko V.D., Matiash N.V. Osnovy Tehnologicheskoi Kul'tury: Uchebnik dlia Uchiashihsia 11 Klassov Obsheobrazovatel'nyh Shkol, Gimnazii, Litseev (Basics of Technological Culture: Textbook for Students of Genereal Schools, Gymnasiums, Lyceums). Moscow: Ventana Graf, 2000.

Simonenko V.D., Riativyh M.V., Matiash N.V. Tehnologicheskoe Obrazovanie Shkol'nikov: Teoretiko-Metodologicheskie Aspekty Red. V.D.Simonenko (Technological Education of School Students: Theoretical and Methodological Aspects. Ed. V.D. Simonenko. Briansk: BGPU, NMTS "Tehnologiia", 1999.

Timoshenko A., Kosiukov M. "Mezhpredmetnye Mosty. Integrativnye Uroki po Tehnologii" ("Intersubject Bridges. Integrative Technology Lessons"). Uchitel'skaia Gazeta. 2006 (3).

"Tipovoe Polozhenie o Spetsial'nom (Korrektsionnom) Obrazovatel'nom Uchrezhdenii dlia Obuchaiushihsia, Vospitannikov s Otkloneniiami v Razvitii. Postanovlenie Pravitel'stva RF # 288 ot 12.03.97" ("Standard Regulations for Special (Correctional) Educational Institution for Students with Developmental Disabilities. Decree of the Government of Russian Federation # 288 as of 03.12.97"). *Vestnik Obrazovaniia*. 1997 (6).

"Tipovoe Polozhenie ob Obrazovatel'nom Uchrezhdenii Srednego Professional'nogo Obrazovaniia (Srednem

Spetsial’nom Uchebnom Zavedenii). Utverzhdeno Postanovleniem Pravitel’stva Rossiiskoi Federatsii ot 3 Marta 2001 g., #160)”(“Standard Regulations on Secondary Vocational Educational Institution (Approved by the Decree of the Government of Russian Federation from March 3, 2001, N160"). Vestnik Obrazovaniia. Sbornik Prikazov I Instruktsii. Ministerstvo Obrazovaniia Rossii. Moscow 9 (2001): 48-66.

“Tipovoe Polozhenie ob Obrazovatel’nom Uchrezhdenii Vysshego Professional’nogo Obrazovaniia (Vyshem Uchebnom Zavedenii). Utverzhdeno Postanovleniiem Pravitel’stva Rossiiskoi Federatsii ot 5 Aprelia 2001 g., N264" (“Standard Regulations on Higher Professional Education (Higher Education Institution). Passed by the Decree of the Government of Russian Federation as of April 5, 2001, N264"). (Statia 1595). Sbornik Zakonodatel’stva Rossiiskoi Federatsii 16 (2001).

“Tipovoe Polozhenie ob Uchrezhdenii Nachal’nogo Professional’nogo Obrazovaniia s Izmeneniiami ot 3 Dekabria, 23 Dekabria 2002 g. (Utverzhdeno Postanovleniem Pravitel’stva RF ot 5 iiunia 1994 g., N 650" (“Standard Regulations on Primary Vocational Schools with Additions and Amendments from October 3, December 23, 2002 (Approved by the Decree of the Government of Russian Federation from June 5, 1994, N650"). Sobranie Zakonodatel’stva Rossiiskoi Federatsii 27 (1994): 864.

Zakon RF “Ob Obrazovanii” # 3266-1 ot 10 Iiulia 1992 g. (s Izmeneniiami ot 24 Dekabria 1993 g., 13 Ianvaria 1996 g., 16 Noiabria 1997 g., 20 Iiulia, 7 Avgusta, 27 Dekabria 2000 g., 30 Dekabria 2001 g., 13 Fevralia, 21 Marta, 25 Iiunia, 25 Iiulia, 24 Dekabria 2002 g., 9 Maia, 18, 21 Iiulia 2005 g.) (Russian Federation. Federal Law “On Education” # 3266-1 as of July 10, 1992 (with amendments as of December 24, 1993, January 13, 1996, November 16, 1997, July 20, August 7, December 27, 2000, December 30, 2001, February 13, March 21, June 25, July 25, December 24, 2002, May 9, July 18, 21, 2005). Moscow: Omega-L, 2006.

Integrating Mathematic, Scientific, and Technological Concepts Through Visual-Based Materials

Dr. Jeremy V. Ernst
Dr. Aaron C. Clark

National emphasis is being placed on schools to produce technologically literate students while promoting and teaching scientific and mathematical concepts. A technologically literate person understands and effectively communicates basic technological concepts and processes. The Visualization in Technology Education (VisTE) project focuses on helping students achieve technological literacy by: (1) developing computer-based technical activities that increase student interest and competencies in technology, (2) fostering interdisciplinary instruction helping teacher's link technology education to concepts in mathematics and science, (3) supporting authentic learning experiences that appeal to diverse learners and learning styles, (4) teaching communication skills that cut across all content areas of technology education standards, and (5) challenging students to evaluate the societal impacts of certain technologies.

VisTE is a National Science Foundation Instructional Materials Development grant (ESI-0137811) that promotes technological literacy by attempting to link math, science, and technology concepts through the study and creation of visualizations. Over a three-year period, the VisTE project team has developed, piloted, and is now field-testing 12 units for technology education in grades 6 to 12. The research is based upon six basic areas of investigation during the piloting phase of the integrated VisTE materials: students' test scores on knowledge of technology, teachers' ratings of effectiveness of VisTE regarding enhancing students' understanding of intended learning goals, teachers' ratings of effectiveness of VisTE regarding enhancing students' understanding of real-world applications of technology, students' self-concept of ability in technology, math, and science, students' attitudes toward general technology, and frequency of teachers' contact with VisTE staff. The purpose of this research was to provide a process and outcome evaluation for the 12 VisTE instructional units. The data used in this discussion of research was drawn from several sources. Students' content knowledge and conceptual understanding were measured. Beliefs about their own abilities in learning technology, math, and science, and their attitudes toward technology in general and toward the specific type of technology taught in each unit were measured. Also, data was gathered from teachers through teacher logs. While teaching the VisTE units, teachers were asked to fill in a unit completion log for each unit they taught. Through the logs, teachers reported on several different topics, including their reaction to the unit, their students' reactions to the unit, aspects of the unit they liked, and aspects they did not like.

The study of math, science, and technology-based content and the application of conceptual modeling, data-driven visualizations, physical modeling, and presentations promote visual literacy. Visual and technical literacy maintain a significant role in successful knowledge and skill development in technology career paths. Data and information collected from this project is beneficial to K-12 outreach through the expansion of research and extension of knowledge. Research-based findings, from projects such as VisTE, provide for the continued successes in math, science, and technology education.

Introduction

Technological literacy is vital to national interest. Instructional materials that address the Standards for Technological Literacy ensure the development of technologically literate students. Developing topical units based around identified benchmarks equip educators to prepare students for a technological society. Advancement throughout the world can be attributed to technological discovery. Societal needs and demands further necessitate the drive for technological expansion. Standards-based units of instruction support the development of students who can appreciate, understand, and utilize technology in their daily lives.

Communication technology is an integral component of technological literacy as articulated in the Standards for Technological Literacy (*Standards for Technological Literacy: Content for the Study of Technology*, 2000). Modeling, visualizations, and presentations enforce communication technology concepts. Communication technology strengthens individual technological and scientific knowledge and abilities while providing students with an opportunity to gain a firm grasp of principles behind the technologies (Newhagen, 1996). The study of technology-based content and the application of conceptual modeling, data-driven visualizations, physical modeling, and presentations promote visual literacy.

Scientific visualization is an emerging academic field where elements of science, computing, semiotics, and the visual arts merge (Gordin and Pea, 1995). It synchronizes a set of advanced technologies to collect, store, process, and image large sets of data. Visual and technical literacy maintain a significant role in successful knowledge and skill development in engineering and technology career paths (Wiebe, Clark, Ferzli, and McBroom, 2003).

VisTE (Visualization in Technology Education)

The department of Mathematics, Science, and Technology Education at North Carolina State University received a three-year Instructional Materials Development grant (ESI-0137811) in May 2002 from the National Science Foundation. This project's purpose was to develop instructional units that utilize scientific and technical visualization. VisTE (Visualization in Technology Education) promotes technological literacy by attempting to link engineering, mathematics, science, and technology concepts through the study and creation of visualizations (Wiebe, Clark, Petlick, and Ferzli, 2004). Over a three-year period, the VisTE project team has developed, piloted, and is now field-testing 12 units for technology education in grades 6 to 12. The VisTE units are based on benchmarks identified in the Standards for Technological Literacy. The 12 instructional units cover topics on agricultural and related biotechnologies, medical technologies, transportation technologies, information and communication technologies, and principles of visualization skills. Each of the three VisTE Instructor CDs contains an overview of the unit materials, unit projects, teacher resources, and unit PowerPoint presentations. The twelve VisTE units are:

- Unit 1. Communications Technology: Introduction to Visualization
- Unit 2. Medical Technology: Imaging
- Unit 3. Biotechnology: The PCR
- Unit 4. Transportation Technology: Visualizing Rocketry
- Unit 5. Communications Technology: Introduction to 3D Modeling and Animation
- Unit 6. Energy and Power Technology
- Unit 7. Bioprocessing
- Unit 8. Prosthetics
- Unit 9. Weather
- Unit 10. Nanotechnology
- Unit 11. Biometrics
- Unit 12. Careers and Technology

Unit 1: Communications Technology: Introduction to Visualization unit is centered on Information and Communication Technologies of the Designed World as indicated in the Standards for Technological Literacy. Students learn about the design process for graphic communication of technical and scientific information. The inadvertent and purposeful misrepresentation of information with graphics is also examined. Unit 2: Medical Technology: Imaging unit is focused on Medical Technologies of the Designed World and Information and Communication Technologies of the Designed World. Students learn about the history and societal ramifications of medical technology. Unit 3: Biotechnology: The PCR unit is alert to Agricultural and related biotechnologies of the Designed World. Students learn about the history of biotechnology with relation to PCR and why and how this technology is used. Students also learn about the societal and ethical implications of using biotechnologies such as the PCR. Unit 4: Transportation Technology: Visualizing Rocketry unit is centered on Information and Communication Technologies and Transportation Technologies of the Designed World. Students learn basic aeronautical principles, the use of chemical reactions for rocket transport, and about the use of Newtonian physics and mathematical tools in rocket design.

Unit 5: Communications Technology: Introduction to 3D Modeling and Animation unit concentrates on Information and Communication Technologies of the Designed World. Students explore 3D computer animation tools and have the opportunity to use object oriented graphics software to represent different types of pump technologies. The material helps students develop an understanding of the mathematical and geometric basis for 3D modeling and animation. Unit 6: Energy and Power Technology unit is focused on Energy and Power Technologies of the Designed World. Projects focus on forms of energy, law of conservation of energy, and the role that technological tools play in the transformation of energy from a non-useful form to a useful form. Students also explore renewable and nonrenewable resources of energy.

Unit 7: Bioprocessing caters to Agricultural and Related Biotechnologies of the Designed World. Students learn about bioprocessing technology and how it is used to produce and manufacture many different products for the industrial, pharmaceutical, food, and environmental sectors. Unit 8: Prosthetics is focused on Medical Technologies of the Designed World. Students learn about the history of prosthetics and explore and solve some of the design problems associated with prosthetics construction. Students also explore the societal implications of providing support for persons with disabilities as well as the engineering and design involved in creating that support.

Unit 9: Weather focuses on remote imaging technologies and data collection involved with global and local weather systems. Students learn about image enhancement through the LUT (Luminosity), image measurements, and image sequencing and comparison. This unit contains recent weather information and data from Hurricane Katrina and Rita and their consequences on the southeast region. Students study the technologies involved in hurricane tracking as well as the impacts on environments of a hurricane's landfall. Unit 10: Nanotechnology encompasses nanotechnology, a term often used in a very general manner to refer to all aspects of nano. Nano, however, is truly a multidisciplinary field with individuals from fields such as chemistry, physics, biology, materials science, and engineering, all working to better understand and apply knowledge of objects that are nanoscale in size.

Unit 11: Biometrics focuses on tools that encompass a wide range of biosecurity technologies, which provide precise confirmation of an individual's identity through the use of that individual's own physical or behavioral characteristics. Physical characteristics include fingerprints, retinal scans, hand geometry, and facial features; and they are most often stable. Behavioral characteristics include voiceprints, signatures, and keystrokes; and they are influenced by a person's personality. Unit 12: Careers presents information about careers through activities, some of which focus more globally on careers, while others have a more molecular or in-depth focus. The goal is for students to develop the skills necessary to research out various careers to determine the training or education that is required, as well as to locate geographical areas for which those careers are in demand. Students learn about ways in which technology and technological advancements have impacted society, the workforce, and career availability. Students also learn about different ways individuals can prepare for a career. For the careers that require a four-year college degree or higher, there is a project that focuses on researching colleges and college majors. In addition to learning about careers at a global level, students also learn about how the design of a city acts to shape local workforce.

VisTE Research Areas

VisTE's research was based upon six basic areas of investigation during the piloting phase: students' test scores on knowledge of technology, teachers' ratings of effectiveness of VisTE regarding enhancing students' understanding of intended learning goals, teachers' ratings of effectiveness of VisTE regarding enhancing students' understanding of real-world applications of technology, students' self-concept of ability in technology, math, and science, students' attitudes toward general technology, and frequency of teachers' contact with VisTE staff (Frome and Bell, 2005). The purpose of this research was to provide a process and outcome evaluation for the 12 VisTE instructional units.

Information was collected from 271 students. After excluding students who did not have pre and post-unit data for at least one unit, 199 students remained in the data set (see Table 1 for demographic information). The number of students with data for each unit ranges from 28 to 87 students.

Table 1: Project Demographics

Grade	Gender	Race/Ethnicity	Geography
6th graders – 18% 7th graders – 1% 8th graders – 19% 9th graders – 12% 10th graders – 15% 11th graders – 18% 12th graders – 18%	Male – 84% Female – 16%	Asian – 6% Black – 16% Latino – 9% Multiple Ethnicities – 5% Native American – 5% White – 60%	Rural – 11% Suburban – 62% Urban – 27%

Multiple-choice tests were taken before and after each unit to measure student knowledge of the subject area. The multiple-choice test was developed by the writers of the VisTE materials to correspond with the units of instruction. The purpose of the assessment is to highlight standards-based competencies for the Standards for Technological Literac*y*. Research Triangle Institute (RTI), an outside agency that conducts contract research, identified question types for the data collection. The content questions were then written by the unit authors based on RTI's question outline and then approved by RTI's Institutional Review Board. All questions were then reviewed by VisTE's advisory council for readability and alignment with the Standards for Technological Literacy. The data from the 12 units is displayed in Table 2.

Table 2: Students' Test Scores on Knowledge of Technology

Unit	**Pre-Unit Avg. Score**	**Post-Unit Avg. Score**	**Paired t-test**	**n**	**Avg. Score Change (Range)**
Unit 1. Communications Technology: Introduction to Visualization	8.0	9.8	3.6***	68	1.8 (–8 to 11)
Unit 2. Medical Technology: Imaging	7.4	12.3	6.5***	40	4.9 (–5 to 14)
Unit 3. Biotechnology: The PCR	6.9	7.9	2.3*	50	1.0 (–9 to 6)
Unit 4. Transportation Technology: Visualizing Rocketry	11.5	12.3	1.1	27	0.7 (–7 to 5)
Unit 5. Communications Technology: Introduction to 3D Modeling and Animation	6.6	7.7	2.1*	28	1.1 (–4 to 7)
Unit 6. Energy and Power Technology	9.0	10.1	3.7***	86	1.1 (–7 to 11)
Unit 7. Bioprocessing	6.3	8.6	5.6***	62	2.2 (–3 to 8)
Unit 8. Prosthetics	6.2	8.1	3.4***	54	1.9 (–5 to 13)
Unit 9. Weather	3.1	3.3	0.6	28	0.21 (–4 to 4)
Unit 10. Nanotechnology	7.6	10.7	6.3***	69	3.1 (–7 to 12)
Unit 11. Biometrics	8.6	11.8	5.3***	42	3.2 (–3 to 17)
Unit 12. Careers and Technology	6.8	8.9	5.0***	57	2.1 (–5 to 9)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The instructional units were examined through a student survey used to indicate any influence of VisTE on students' self-concept of ability in technology, mathematics, or science. The student survey was given before each unit and once again after the completion of each unit. Student participants responded to three questions with Likert Scale response options. The three questions were: 1. How hard or easy is it for you to learn technology?, 2. How hard or easy is it for you to learn math?, and 3. How hard or easy is it for you to learn science?. Students answered these questions on a scale where 1 = very hard, 2 = hard, 3 = neither hard nor easy, 4 = easy, and 5 = very easy. Table 3 shows a breakdown of student self-concept of ability in technology, mathematics, and science for each question asked.

Table 3: Students' Self-Concept of Ability in Technology, Mathematics, and Science

Attitude Toward Unit	**Pre-Unit Avg. Score**	**Post-Unit Avg. Score**	**Paired t-test**	**n**	**Avg. Score Change (Range)**
How hard or easy is it for you to learn technology?	3.6	3.6	0.1	523	0.0 (–3 to 3)
How hard or easy is it for you to learn math?	3.5	3.5	0.1	520	0.0 (–4 to 3)
How hard or easy is it for you to learn science?	3.5	3.5	0.4	519	0.0 (–3 to 3)

The data indicates that participation in VisTE was related to a slight increase in students' self-concepts of mathematical ability, but was not related to change students' self-concepts of abilities in technology and science. One possible explanation for lack of a bigger effect is that students' academic self-concepts of ability are formed starting at a young age, and participating in one or more VisTE units is not enough time to allow for a change in one's self-concept. The majority of students (53 percent for technology, 56 percent for mathematics, and 55 percent for science) reported no change in self-concept of ability.

In addition to examining self-concept of ability, the relationship between participation in VisTE and students' attitudes toward general technology was explored. The student participants responded to five statements about technology: 1. I have a good understanding of the ways that technology can be used in the real world., 2. I will probably choose a job in technology., 3. You have to be smart to study technology., 4. I would like to know more about technology., and 5. Consequences of technology. Students answered these questions on a scale where 1 = disagree, 2 = tend to disagree, 3 = neutral, 4 = tend to agree, and 5 = agree. Table 4 shows the statistical results for VisTE students' attitudes toward general technology.

Table 4: Students' Attitudes Toward General Technology

Attitude Toward Unit	**Pre-Unit Avg. Score**	**Post-Unit Avg. Score**	**Paired t-test**	**n**	**Avg. Score Change (Range)**
I have a good understanding of the ways that technology can be used in the real world.	4.0	3.8	–2.4**	340	–0.1 (–4 to 4)
I will probably choose a job in technology.	3.2	3.3	0.7	338	0.0 (–3 to 3)
You have to be smart to study technology.	2.9	2.9	0.6	333	0.0 (–4 to 3)
I would like to know more about technology.	4.1	3.7	–5.6***	334	–0.3 (–4 to 3)
Consequences of technology	3.8	3.6	–5.0***	319	–0.2 (–2 to 1.6)

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

The analysis of data shows either no change in students' attitudes toward general technology or slightly more negative attitudes toward technology after participation in VisTE. For example, after participating in VisTE, students were less likely to want to know more about technology and were less positive about the consequences of technology. One interpretation is that any change in student attitudes, positive or negative, represents an effective result. Attitude change in either direction might show that students were engaged in the material and were considering both the positive and negative effects of technology. However, these differences were very small (–0.2 and –0.3), and while statistically significant may not be meaningful.

While teaching the VisTE units, teachers were asked to fill in a unit completion log for each unit they taught. Through the logs, teachers reported on several different topics, including their reaction to the unit, their students' reactions to the unit, aspects of the unit they liked, and aspects they did not like. Teachers rated their students' interest in the material taught in each unit. Their response options were "not at all interested," "somewhat interested," and "very interested." In addition, teachers rated change in their students' attitudes towards the material covered. Their response options were "students' attitudes became more negative," "no attitude change," and "students' attitudes became more positive." Teachers were also asked whether they thought that participation in VisTE was helpful for increasing their students' understanding of the role of technology, science, and/or mathematics in real-world contexts. The response options were "not at all helpful," "somewhat helpful," and "very helpful". Aside from the response options, teachers were provided space to comment specifically on this survey item.

Table 5: Teachers' Ratings of Effectiveness of VisTE Regarding Enhancing Students' Understanding of Intended Learning Goals/Real-World Applications of Technology

Unit	# of Teachers	# of Teachers Returning Logs	Ratings (# of teachers) Learning Goals	Ratings (# of teachers) Real-World Applications
Unit 1. Communications Technology: Introduction to Visualization	4	2	Somewhat effective (2)	Somewhat helpful (1) Very helpful (1)
Unit 2. Medical Technology: Imaging	3	2	Somewhat effective (2)	Very helpful (2)
Unit 3. Biotechnology: The PCR	2	1	Very effective (1)	Somewhat helpful (1)
Unit 4. Transportation Technology: Visualizing Rocketry	2	2	Somewhat effective (2)	Very helpful (2)
Unit 5. Communications Technology: Introduction to 3D Modeling and Animation	2	2	Very effective (2)	Somewhat helpful (1) Very helpful (1)
Unit 6. Energy and Power Technology	7	5	Somewhat effective (3) Very effective (2)	Not at all helpful (1) Somewhat helpful (4)
Unit 7. Bioprocessing	3	2	Somewhat effective (2) Very effective (1)	Somewhat helpful (1) Very helpful (1)
Unit 8. Prosthetics	3	1	Very effective (1)	Very helpful (1)
Unit 9. Weather	2	2	Somewhat effective (1) Very effective (1)	Very helpful (2)
Unit 10. Nanotechnology	5	4	Somewhat effective (1) Very effective (3)	Somewhat helpful (1) Very helpful (3)
Unit 11. Biometrics	4	3	Somewhat effective (1)	Very helpful (3)

			Very effective (2)	
Unit 12. Careers and Technology	4	4	Very effective (1) (3 teachers had missing data)	Somewhat helpful (1) (3 teachers had missing data)

Most teachers rated the units as "somewhat" or "very effective." The teachers' reported that the units were effective in enhancing students' understanding of the intended goals and objectives, which confirms the results of the student multiple-choice knowledge tests. Teachers responded that the units were "somewhat" or "very helpful" regarding enhancing students' understanding of real-world applications of technology, and they gave a variety of examples of how the units were helpful in this way.

Table 6: Frequency of Teachers' Contact with VisTE Staff

Phone Contact	**E-Mail Contact**	**ListServ Contact**	**In-person Contact**	**Contact Through Materials VisTE Staff Posted on VisTE Website**
Less than once a month = 4 About once a month = 4 A few times a month = 1	Less than once a month = 3 About once a month = 5 A few times a month = 4	Less than once a month = 2 About once a month = 4 A few times a month = 2	Less than once a month = 2 About once a month = 3 A few times a month = 0	Less than once a month = 2 About once a month = 4 A few times a month = 1

The frequency of teachers' contact with the VisTE Staff (Table 6) identifies e-mail contact as the primary form of communication, while in-person contact ranked last due to faster and more efficient options. Contact frequency was considerably low given the amount of workshop preparation provided for pilot test teachers, indicating high usability.

<u>Discussion and Conclusions</u>

From the analyses of the VisTE pilot test data, it was found that students who participated in the VisTE units significantly increased their knowledge in the areas of technology covered by the units. In addition, teachers rated all of the units as effective in enhancing students' understanding of the intended learning goals and objectives of the unit. This rating confirms the results of the student test scores. There was little change in students' self-concepts of ability in technology, mathematics, and science. This lack of change might be due to the fact that self-concepts of ability have been formed throughout students' lives, and perhaps there was not enough time for them to change while participating in the VisTE units. In analyses of all 12 units, students' attitudes toward technology in general and toward specific areas of technology addressed in the units generally stayed the same. It is not quite clear why students' attitudes typically remained unchanged during the VisTE units. It could be that the length of time that each unit lasted was insufficient to create changes in attitudes.

With regard to students improving their understanding of the role of technology in the workplace and other real-world contexts, there was not much change in student data. Teachers thought that Unit 9. Weather, Unit 10. Nanotechnology, Unit 11. Biometrics, and Unit 12. Careers and Technology were somewhat or very helpful in increasing students' understanding of the role of technology, science, and/or mathematics in real-world contexts. The majority of the teachers responded that it was "not at all difficult" to integrate the VisTE units into their curriculum. Additionally, the low frequency of pilot teacher VisTE staff contact indicates high usability of the materials.

After fulfillment of the initial VisTE project, an extension to aid in dissemination, conduct field-testing, develop assessment rubrics, and develop tutorials was proposed. To further disseminate the VisTE materials an additional workshop was conducted in July 2005, randomly selecting 14 volunteers from across the United States to test the materials in their published form. In the fall and early spring of the 2005-2006 school year each of the 14 unit field test sites will conduct the VisTE pre-assessment and post-assessment, the Purdue Spatial Visualization Test: Visualization of Rotations, and the VARK Questionnaire. This data will enable the analysis of impacts and influences of the VisTE materials. The VisTE pre-assessments and post assessments for each of the 12 units will be used to establish competency development based on the Standards for Technological Literacy through the study of visualization, science, and technology. The Purdue Spatial Visualization Test assesses the abilities of students to visualize rotated three-dimensional objects (Bodner and Guay, 1997). The test consists of thirty questions that require students to employ their spatial abilities. VisTE utilizes the Purdue Visualization Test to assess visual aptitudes prior to implementing the VisTE materials and then again after the completion of the VisTE units. The VARK questionnaire assesses learning preferences of students (Fleming, 2001). The questionnaire will determine if the student is a visual, aural, read/write, or kinesthetic learner. There are 13 questions to be answered directly on the VARK questionnaire. Unlike the VisTE pre and posttest evaluations and the Purdue Spiral Visualization Test, the VARK questionnaire is only to be taken once during the field-testing.

Feedback from both pilot site teachers and workshop participants has uncovered a need for VisTE material assessment rubrics. A team of pilot site teachers has developed four rubrics. The four rubrics develop are categorized by the region of scientific visualization they assess: conceptual modeling, data-driven visualizations, physical modeling, and presentations. The assessment of these visualization areas is essential for the activities associated with the VisTE units in technology education classrooms. The rubrics will be used for assessment of the units during 2005-2006 field-testing. Feedback, edits, and changes will be made for the four rubrics and implemented in the next revision of the VisTE materials for publication.

A need for tutorials that will assist with the integration of software into existing VisTE activities has also been noted. Four unit specific tutorials on the use of animation and conceptual software have been developed, critiqued by VisTE pilot site teachers, and modified based on suggestions. The four tutorials developed pertain to biotechnology and medical technology in the VisTE Bioprocessing, Biometics, and Biomanufacturing units. The tutorials were composed of descriptions and user directions for 2D development software, web development software, 3D animation software, and 2D animation software.

A qualitative research component has been added to VisTE. Student and teacher interviews will be conducted using direct questions and response prompts based on the capacity and implementation of the materials by a qualified qualitative researcher. Two middle school and two high school pilot sites will be identified. Site visits will be made where qualitative data will be collected for analysis.

The integration of mathematics, science, and technology promote visual literacy when utilizing conceptual modeling, data-driven visualizations, physical modeling, and presentations. Visual and technical literacy promote successful knowledge and skill development in technology career paths. Research-based findings from projects such as VisTE provide for continued successes in math, science, and technology education. Further investigation of science, technology, and mathematical areas is needed to further identify efficient methods of curriculum integration through support materials.

References

Bodner, G. M. and Guay, R. B. (1997). The Purdue visualization of rotations test. *The Chemical Educator*. 2 (*4)*, 38.

Fleming, N. (2001). VARK: A guide to learning styles. Retrieved January 10, 2006 from http://www.vark-learn.com/english/page.asp?p=faq#What%20is%20VARK

Frome, P. and Bell, K. (2005). VisTE final evaluation report. (RTI Project Number 08423.000). Raleigh, NC: RTI International: Center for Research in Education.

Gordin, D.N., and Pea, R.D. (1995). Prospects for scientific visualization as an educational technology. *The Journal of the Learning Sciences.* 4 (*3*), 249-279.

Newhagen, J.E. (1996). Why communication researchers should study the Internet: A dialogue. *Journal of Communication*, 46 (1), 4-13.

Standards for Technological Literacy: Content for the Study of Technology. (2000). Reston, VA: International Technology Education Association.

Wiebe, E. N., Clark, A. C., Ferzli, M., and McBroom, R. (2003). The VisTE Project: Visualization for improved technological and scientific literacy. *Published Proceedings of the American Society for Engineering Education Annual Conference and Exposition*, Nashville, TN, Session 2438.

Wiebe, E. N., Clark, A. C., Petlick, J., and Ferzli, M. (2004). VisTE: Visualization for Technology Education; An outreach program for engineering graphics education. *Published Proceedings of the American Society for Engineering Education Annual Conference and Exposition,* Salt Lake City, UT, Session 313.

Robots On the Palouse:

Increasing Technology Awareness in At-Risk Fourth Grade Students

by Terri E. Varnado

Introduction to the Study

As we move into the 21st century, our needs as a society are rapidly changing. However, change is not a new concept. Throughout history, humankind has strived to find ways to make life more comfortable, more efficient, and more productive. From hunting and gathering to farming and ranching; from writing in stone with a chisel to using a pencil; from slavery to automation; from the horse and wagon to rockets and space stations; these things and many more indicate progress. Progress – made possible through technology. The International Technology Education Association, ITEA, (2000) defines technology as “human innovation in action that involves the generation of knowledge and processes to develop systems that solve problems and extend human capabilities” (p. 242).

We live in a technological world. Increasingly, society demands more modern conveniences to better our way of life. Without technology, these demands could not be met. Accordingly, the need for a more technologically literate society must be satisfied; therefore, this same postulating population must become educated about the technology being requisitioned. Different societies have different needs, but all should be able to make well-informed decisions about the world in which they live. It is important to formally educate all students in grades K-12 about our technological world so they might obtain the skills needed to make those kinds of decisions (ITEA, 2000). In order to do this, the focus should be on the integration of technology into the academic arena (ITEA, 2000). One way to integrate technology is by using robots.

Statement of the Problem

The problem of the study was to identify the change in students’ perceptions about technology using robot construction as an instructional methodology in an at-risk fourth grade classroom. By incorporating robotics technology into a hands-on, problem solving approach to instruction, issues with attention deficit (Smith & Irvine, 1999), poor motor abilities (Cardon & Scott, 2000), cognitive strategies (Herschbach, 1998, Korwin& Jones, 1990), language difficulties (Cardon, 2000), and inappropriate social behaviors (Cardon, 2000), might be addressed in a more motivational learning environment.

Purpose of the Study

The purpose of this exploratory study was to determine whether experiences with robot construction would change at-risk fourth grade students’ reported perceptions of technology and robots. To be aware of technology is to be informed about technology (ITEA, 2000; Pearson & Young, 2002). Correspondingly, to be aware of robot technology is to be informed about robot technology. Study conclusions will provide information necessary to develop training opportunities for teacher educators, in-service teachers, and pre-service teachers for integrating technological literacy into curricula development using robots as the motivating tool.

Need for the Study

The transition from the Industrial Age to the Robotics Revolution has not been as revolutionary as it may seem. When one considers “robots” as mechanical systems the connection is clear; machines have driven the industrial enterprise, and more recently, computer technology has accelerated the efficiency of those systems. Whereas the machines of factories and assembly plants changed slowly over time, tremendous advances in memory processors, electronic components, and software development has increased the speed and functionality of machinery. Presently, robotics and automated systems are widely used throughout business and industry to perform many functions previously done by humans.

Today, the use of robotics is not limited to the factory alone. Robotics is found in toys and games, medical technology, space technology, interactive displays in museums and zoos, as assistive service for the disabled, in the entertainment industry, and even as pets. Consumers can now purchase personal robots for vacuuming, lawn mowing, and surveillance. The medical field uses robotics in surgery, in pharmaceutical production, and in constructing artificial muscles. It seems only a short time ago the computer was a *new technology* in the homes of United States citizens. Now, driven by economics and inventiveness, our children are using computers to create new technology, advancing robotics with their own scientific discovery. Perhaps ten years from now our first steps to introduce robotics technology into school curricula will itself seem an antiquated event.

We live in a technological world; therefore, the need for a more technologically literate society must be satisfied. In order for students to become more technologically literate, we must teach them how technology works, where it came from, where it is going, and how it impacts our daily lives. One way to do this is by using robots. Robots are motivating teaching tools that readily accommodate technology integration across curricula. The need for elementary, middle, and secondary robotics curricula can be easily satisfied if teachers enhance teaching and learning by using robots and documenting and sharing successful activities.

What We Already Know About Robotics Curricula

Traditionally, the majority of formal robot programs have been offered through community colleges and technical colleges, because these programs prepare students for the workforce in positions such as the robotics technician. Community colleges and post-secondary institutions have been developing robotics programs since the early 1980s, but "the changes brought about by robots, and their impact on production systems, are being felt in a need for more engineers plus the need in many academic departments for changes and modernization of their curricula" (Kimbler, 1984, p. 122). Having industry partners, these higher-level programs have the knowledge support to move forward (Electronics Education, 1984, p. 13).

Robotics can be taught as a stand-alone course, but some post-secondary educators do not recommend that it be done. There is "need for [robotics] education in the broad requirements of manufacturing automation, but not training that just stops with robot maintenance and repair" (Rehg, 1985, p. 18). These broad requirements may be appropriate for those post-secondary institutions, but if secondary educators are to best prepare students to move forward after graduation, robotics implementation would make a significant impact. Pierno (1985) believes that high school robotics curricula should focus on the manufacturing processes in which robots are used. Hutwagner (1986) suggests that "Industrial technology educators can help prepare students for the future by including the construction and application of robotics in the curriculum. Guiding students toward an understanding of how, why, and what makes robots work provides one avenue for realistic instruction relevant to an advanced technological work environment" (p. 16).

These components are sufficient to teach a stand-alone applied course in robotics. However, insomuch as ideal robotics curricula will include these components, it will also incorporate core subjects, encompassing all other content areas, supporting the ease of integration across curricula. To meet the needs of everyone involved, secondary robotics curricula should include industrial and mobile systems, design and construction, and programming.

In the 1980s, the problem with implementing robotics into the classroom was due to the lack of curricula materials available. All the excitement caused a surge in the literature during that time. In the early 1990s, Dunlap suggested three technical categories that need to be addressed in robotics curricula: "design, application, and maintenance" (p. 67). Most curricula available in the 1980s dealt with industrial robots: nomenclature, applications, and programming (Cassetto, 1989). This approach was necessary (and still is) to answer the questions, "What are robots?" and "What do they do?" Dunlap (1991) recommends that industrial robots be taught "during the latter part of the core curriculum" so that students might "draw upon past subjects" such as applied mathematics. In studying industrial robots, geometry, trigonometry, and calculus can be applied to "coordinate transformation, off-line programming, tool-path movement and work cell configuration, including quality assurance and control" (p. 67). These mathematics courses are excellent components for industrial robotics curricula, but a K-12 robotics curricula needs to be more encompassing.

Dunlap is not alone in pointing out the importance of mathematics in technology. In 1986, Hsiung researched designing robotics curricula. After reviewing the literature, he formulated a twenty-five-statement survey and sent it out to eighty companies that use robotics in manufacturing and asked them to rank the statements from one (least important) to five (most important). Upon receiving this input, Hsiung developed ten lab experiments, number one being an introduction to the coordinate system. This study shows the important correlation between math and technology. Oaks and Richards (1988), and Deal, Hadley, and Jacobs (1990) reported that robotics should be coordinated and interfaced with mathematics, science, and technology education. "Robotics is a perfect course for palatably applying large doses of computer science, trigonometry, physics, electronics, and industrial sociology" (Heckard, 1986, p. 15).

The need for secondary robotics programs is to provide students with the necessary skills and basic understanding of automation systems so that they become more productive and efficient in the highly technological world of work and/or become better prepared to study at a four-year institution. Robotics could be used in the elementary, middle, and high school curricula to get students excited about learning and to give them the confidence needed to move on to more meaningful career choices.

Studying robotics technology may motivate students' learning, increasing technological literacy to become better able to function in an advancing technological world, and providing opportunities to experience real world, workforce situations, problems, and solutions. Contrarily, Goldberg (1984) believes, "Schools should develop in youngsters concepts about technology as a core of general education, and less about robots, as such. We've got enough students now in training in community colleges and vocational centers to satisfy the need for robot technicians for the next decade" (p. 35). While this may or may not be true of community colleges and vocational centers, as a K-12 educator, one should look at robots not only as technology, but also as a motivating teaching tool to integrate across all aspects of elementary, middle, and secondary curricula.

> It is not only important that two-year post-secondary institutions turn out robot technicians and that robot designers and automation engineers become products of four-year higher education programs, but it is also important that primary and secondary students become familiar with current and future robotics trends and applications. The goal is not to produce a world full of robotics engineers, but to teach primary and secondary students problem-solving skills, commitment and responsibility to self and others, good work ethics, good attitudes, professionalism, and a "design and implementation capability" (Miglano, Lund, and Cardaci, 1999) through construction to solve a task" (Varnado, 2000, p. 22).

Lovedahl (1983) predicted, "Jobs in the future will depend less on manual skills and more on perceptual aptitude, formal knowledge, and precision. Industrial arts [technology education] classes must include robotics in their curriculum if they intend to reflect accurately American industry" (p. 15). Surely we want robot engineers to help make our lives easier and more productive, but studying robotics leads to other professions as well – electrical, mechanical, and industrial engineering, space technology, medicine, computer science, and even education, to name a few. If done carefully, robotics curricula will teach not only of design, operation, and maintenance of robots but will also help students become excited and develop an understanding of why we teach English, Math, Science, Social Studies, and other content area courses.

Method

Subjects in this study were convenience sampled. A traditional fourth grade class was chosen on the basis of its teacher's desire to participate in the project and for the diversity of the group. There were eight females and twelve males in the class, hence, the sample size of twenty. The target population was intended to be at-risk fourth grade students in a northwest region of the United States known as the *Palouse* (Eastern Washington and part of North Idaho). Students were 8 to 10 years of age. Participation was voluntary and anonymous. Human subjects approval was received, and then parental permission was obtained. There was no cost for the student to participate. A monetary gift from Schweitzer Engineering Laboratories allowed students to keep their robots at the end of the unit.

Each student exhibited some type of at-risk challenge. Five students were from foreign countries (India, Kenya, Latvia, and Mexico); some students were diagnosed with ADD and/or ADHD; most students performed below grade on reading level; some students performed below grade level in math. No student had previous robot construction experience.

The robot construction unit consisted of twenty contact hours with the students – one hour of lecture/discussion, covering the basic types and principles of robotic systems, and nineteen hours of hands-on robot construction. Over a ten-day period, two-hour sessions were conducted during the regular school day. Students were introduced to electronic components involved in building a robot from a kit employing basic soldering techniques.

Students set a goal “to build a fully functional mini-mobile robot.” Other goals set forth by the students were “to use good organization skills” and “to follow directions carefully.”

Students were given a twenty-question survey before instruction began, then again at the end of the twenty-hour unit (Appendix A). The survey was intended to acquire students’ perceptions regarding technology, tools, robots, and school. Seventeen questions required “yes” or “no” answers. The remaining three questions were open-ended and required students to think about their perceptions of what technology is and how it is used.

Results

At-risk fourth grade students’ reported perceptions of technology and robots did change after experiences with robot construction. Frequencies and percentages were calculated on this nominal data. Tables reporting technology awareness data and robot awareness data were formed. Inferential statistics data analysis was not performed on these data, because the sample was one of convenience. Therefore, no attempt was made to indicate whether increases or decreases in percentages were statistically significant.

Technology Awareness

Responses related to technology are shown in Table 1. Students’ perceptions changed positively as little as 5.3% when asked if there is technology in their school (Q3), and as much as 42.1% when reporting that their teacher teaches them about technology (Q7). Concerning the use of technology at school (Q4), students’ reported perceptions changed 6.1% and a increase of 10.8% was measured pertaining to the use of technology at home (Q5). A 21% increase was shown related to the teacher teaching students to use technology (Q6). On the post survey, 80% of the students reported that they could not live in a world without technology (Q8), a change of 6.3% from the pre survey.

Table 1 - Responses Related to Technology Awareness

Question	Pre Survey Response		Post Survey Response		Change
	% (yes)	n	% (yes)	n	%
Q 03 There is technology in my School.	94.7	19	100.0	20	5.3
Q 04 I use technology at School.	78.9	19	85.0	20	6.1
Q 05 I use technology at home.	84.2	19	95.0	20	10.8
Q 06 My teacher teaches me to use technology.	63.2	19	84.2	20	21.0
Q 07 My teacher teaches me about technology.	31.6	19	73.7	19	42.1
Q 08 I can live in a world without technology.	73.7	19	80.0	19	6.3

Robot Awareness

Responses related to robots are shown in Table 2. Many students (78.9%) perceived robots to need electricity to work (Q16). That percentage did not change on the post-survey. However, positive perceptions (“yes” answers) pertaining to whether or not robots are good for people (Q14) changed 10.5%. Learning that they must use tools in order to construct a robot (Q12), students’ positive perceptions (“yes” answers) increased 20.1%. In response to Q15, “I think robots can do better work than people,” students’ positive perceptions changed from 33.3% to 89.5%, an increase of 56.2%.

Table 2 - Responses Related to Robot Awareness

Question	Pre Survey Response		Post Survey Response		Change
	% (yes)	n	% (yes)	n	%
Q 12 I can build robots without using any tools.	62.2*	19	83.3*	18	20.1
Q 14 I think robots are good for people.	89.5	19	100.0	20	10.5
Q 15 I think robots can do work better than people.	33.3	18	89.5	19	56.2
Q 16 A robot needs electricity to work.	78.9	19	78.9	19	0.0

*Reverse scaled for consistency

Discussion

Because students were excited about building a robot, I was able to use that robot as a vehicle to teach at-risk children about general technology and robotics. Math, science, and writing skills (journaling) were also incorporated. The difference, in percentage points, between pre-survey responses and post-survey responses were quite positive.

Technology Awareness

Smaller changes (5.3, 6.1, 6.3 respectively) could be due to the fact that, as indicated by their responses, most students were already aware that there is technology in their school (94.7%); that they use technology in school (78.9%); and that they cannot live in a world without technology (73.7%). The slightly greater change (10.8%), pertaining to the use of technology at home, might mean that students became more aware that, although they may not have a computer, technology in their home is still present. The greatest changes, occurring in Q6 (21.0%) and Q7 (42.1%), are probably a realization that the teacher is teaching students how to use technology, and the teacher is teaching students about technology.

Robot Awareness

Overall, students became more informed about robots in technology and society. Performing the actual construction helped students to realize that tools are necessary to build a robot. Reported perceptions of robots needing electricity to work were already high (78.9%), and probably did not change because the class completed a unit in electricity earlier in the year. Developing robot awareness through construction is illustrated in that before the robot construction unit, most (89.5%) students reportedly perceived robots to be good for people, and after robot construction, all (100%) students reportedly perceived robots to be good for people. Likewise, students' responses pertaining to robots doing better work than people changed from 33.3 % (pre-survey) to 89.5% (post-survey).

Recommendations for Further Research

In order to acquire more specific data, the survey used should be revised. In the future, fewer general questions should be included. For example, "I think robots can do better work than people" would be changed to "I think robots can do more accurate work than people." Additionally, conducting student interviews would better inform the survey results. Also, to determine whether or not teachers realize when they teach students about technology, they are actually teaching Technology Education, further research is required.

"Technology will play an important role in the future of human development. This role provides teachers and schools administrators with both an opportunity and a responsibility to prepare students with an education that empowers them to understand and participate in their technological society" (Gilberti, 1999, p. 6). Technological literacy, "an understanding of the nature and history of technology, a basic hands-on capability related to technology, and an ability to think critically about technological development – is essential for people living in a modern nation like the United States" (Pearson & Young, 2002, p. 11-12). Based upon this study it is recommended that teachers begin to explore using robots in classroom activities and develop elementary, middle, and secondary robotics curricula. There is a need to document and share these endeavors. Search the Internet for resources and lessons pertaining to robots. Also, there are many children's books written with robot themes. Find a place to start this integration that is conducive to your comfort level. Ask students to help teachers find that place by bringing in the robotic systems they have at home for a "show and tell." An initial lesson may last twenty minutes, but will soon increase to hours and days. Robotics units will expand from days to weeks and months. Student enthusiasm is contagious and will help to ease teacher anxiety.

Robotics activities help students to become more technologically literate. Increasing technological literacy in students will enable them to become productive and successful citizens of the 21st century. Students are more motivated to learn, because the methods by which they are learning are genuinely applicable to society as a whole. They will not only be able to use technology, but will also know how it works and why they are using it. They incorporate critical thinking skills, problem-solving skills and creativity. As students choose to enter the highly technological world of work or that of higher education, they will be prepared to do so with the knowledge and skills necessary to accommodate their technological needs and desires. Progress is inevitable. As educators, we must prepare the next generation to meet the challenges that face them. We, as educators, must teach all students about the technological world in which we live.

References

Cardon, P.L. (2000). At-risk students and technology education: a qualitative study. *Journal of Technology Studies, 26*(1), 49-57.

Cardon, P.L. & Scott, M. L. (2000). Using problem solving to teach the disabled. *The Technology Teacher, 59*(8), 12-15.

Cassetto, J. M. (1989). Teaching robotics without robots: simple method introduces students to the basics. *School Shop Tech Directions, 49,* 16.

Deal, W. F. 3rd, Hadley, W. F., Jacobs, J. A. (1990). Resources in technology: robotics; an emerging technology. *The Technology Teacher, 49,* 15-22.

Dunlap, D. D. (1991). A systematic approach to robotics instruction. *T.H.E. Journal, 18,* 66-9.

Gilberti, A. F. (1999). Why technology should be integrated into the curriculum as a core subject. *National Association of Secondary School Principals Bulletin, 83*(608), 1-15.

Goldberg, A. L. (1984). The eclectic technologist; robotics: what's in it for education? *Educational Technology, 24,* 34-5.

Heckard, M. (1986). Career-minded high school students are commanding robots. *Tech Trends, 31,* 15-17.

Herschbach, D.R. (1998). Reconstructing technical instruction. *Journal of Industrial Teacher Education 36*(1), 36-61.

Hsiung, S. C. (1986). Designing a robotics curriculum. *Industrial Education, 75,* 37-8.

Hutwagner, J. (1986). Construction and application of robotics. *Industrial Education 75,* 16-17.

International Technology Education Association (2000). *Standards for Technological Literacy: Content for the Study of Technology*. Reston, VA: International Technology Education Association.

Kimbler, D. L. (1984). Robotics – the new silent majority: engineering robot applications and education. *T.H.E. Journal, 11*(8), 122-26.

Korwin, A. R., & Jones, R. E. (1990). Do hands-on, technology-based activities enhance learning by reinforcing cognitive knowledge and retention? *Journal of Technology Education 1*(2), 39-50.

Lovedahl, G. G. (1983). Robotics: a new challenge for industrial arts. *Man Society Technology, 42,* 14-15.

Oaks, M. M., Richards, H. (1988). Robotics in the technology education curriculum. *The Technology Teacher 48*, 23-6.

Pearson, G. & Young, A. T. (Eds.). (2002). *Technically speaking: why all Americans need to know more about technology.* Washington, D. C.: National Academy Press.

Pierno, M. (1985). Automation/robotics in high school. *Industrial Education, 74,* 20.

Rehg, J. A. (1985). Robotics programs: automation training in disguise. *Industrial Education*, *74,* 17-18+.

Robotics moves in at S.C.T.I. (1984, October). *Electronics Education 4*(2), 13-14.

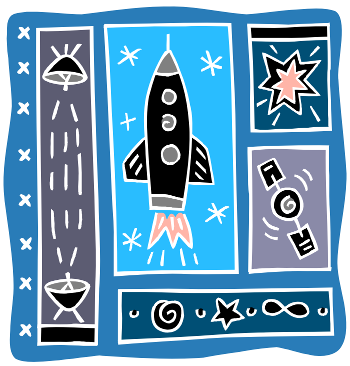
Smith, S.L. & Irvine, S.E. (1999). Technology the lab school way: a multisensory empowering experience for students with severe learning disabilities and ADHD. *Learning Disabilities: A Multidisciplinary Journal 9*(3), 99-105.

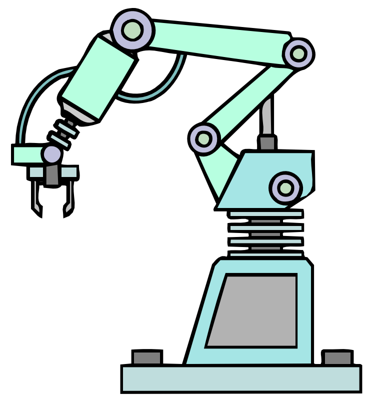
Varnado, T. (2000). Robotics across the curriculum. *Tech Directions, 60*(4), 22-5.

Appendix A

MRS. SEWELL'S FOURTH GRADE

CLASS SURVEY





Directions: Plea s survey to the best of your ability. Take your time and answer honestly. There are no right or wrong answers, so you don't have to worry about a grade. When you finish, please turn your survey over and wait for everyone to finish. Thank you for helping us with this survey.

1. I can follow step-by-step directions to build something yes no

2. I think technology is ____

____

____

____

3. There is technology in my school yes no

4. I use technology at school yes no

5. I use technology at home yes no

6. My teacher teaches me to use technology yes no

7. My teacher teaches me about technology yes no

8. I can live in a world without technology yes no

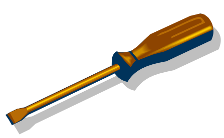
9. Sometimes using technology can be a bad thing yes no

10. I can learn about technology in math, science, social studies
and language arts yes no

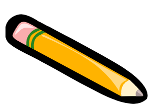
11. Circle all of the items below that you think are tools.

a. 

b. 

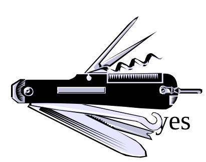
c. 

d. 

e. 

f. 

g. 

h. 

12. I can build robots without using any tools yes no

13. I think a robot is ____

____

____

____

14. I think robots are good for people yes no

15. I think robots can do work better than people yes no

16. A robot needs electricity to work yes no

17. Can you think of any things that robots can do?

    a. At my house____

    ____

    b. Where people work ____

    ____

    c. When I play ____

    ____

    d. In a hospital____

    ____

    e. At my school ____

    ____

18. I am a good student yes no

19. I like school yes no

20. School is easy for me yes no