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Teachers and technology : encouraging teachers to integrate technology into the curriculum

Diane Roethler

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TEACHERS AND TECHNOLOGY:

ENCOURAGING TEACHERS TO INTEGRATE TECHNOLOGY INTO THE CURRICULUM

A Graduate Review

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Abstract

Technology is one path in preparing students to enter the working world. In response to this important role, the International Society for Technology in Education has created technology standards for students and teachers to promote change in teaching and learning practices. A study done by Apple Computer identifies how far teachers are in the integration of technology to meet these standards. When teachers' levels and concerns are identified, programs help teachers overcome their computer concerns, such as not having enough time, right equipment, or knowledge. Teachers also need to frequently practice what they have learned. In this time period, follow-up support has to be readily available in case something does go wrong. This follow-up support might include a mentor or multiple trained staff members.

Introduction

Today's schools spend millions of dollars to bring the latest technology into classrooms to prepare students to live and work in an information-rich world. According to the International Society for Technology in Education (2002), the educational use of technology can create students who are:

- Capable information technology users
- Information seekers, analyzers, and evaluators
- Problem solvers and decision makers
- Creative and effective users of productivity tools
- Communicators, collaborators, publishers, and producers
- Informed, responsible, and contributing citizens (p. 4)

With rapid changes in hardware and software, keeping up with the newest developments is virtually impossible. It is difficult and expensive to have the latest technology, but learning how to use and integrate technology into the school curriculum is even more of a challenge. Many colleges and universities require courses in technology before they will grant teaching degrees. Even with this training, many new teachers find it difficult to stay current. Many experienced teachers also discover that keeping up with the latest technology consumes much of their limited time. School districts attempt to train teachers to use and integrate the technology that has been purchased, but many times the training is ineffective because the follow-up support is often neglected. Consequently, there is little

benefit to student learning and millions of dollars of equipment remains virtually unused.

This paper will examine what is currently expected of teachers regarding technology, how to identify teachers' current levels of technology integration, factors that inhibit technology integration, and staff development models that aid teachers in technology integration. This paper will also discuss mentoring as an effective method for training teachers to integrate technology into their professional lives.

Methodology

The author obtained sources from the Grant Wood Area Education Association in Cedar Rapids, Iowa. Searches were also performed on ProQuest and InfoTrac to locate additional sources. These sources were selected based on a focus on successful teacher mentoring programs or other models of staff development in technology, such as study groups, curriculum development teams, or other support systems. The sources were also examined for common technology concerns and frustrations that teachers often experience, specifically lack of time, resources, or knowledge.

Other sources were obtained at the Technology Integration Mentorship Program workshops that were sponsored by Apple Computers during the spring and summer of 2003. These sources focused on the Apple Classrooms of Tomorrow project research and the identification of teachers' levels of technology

integration. The research from this project also guided the development and implementation of technology mentoring programs into other school districts across the country.

After all of the sources were located, they were examined to find instances of successful technology integration. Characteristics of successful teacher mentoring programs were also examined to determine how those programs can be adapted for use in technology mentoring programs.

Analysis and Discussion

National Educational Technology Standards for Teachers

The International Society for Technology in Education (2002) states that teachers are essential in the preparation of tomorrow's workforce. Technology concepts and skills will be needed in students' future jobs, so it is important they be exposed to technology-rich classrooms throughout their education. Technology also allows teachers to establish new learning environments that incorporate new strategies. These environments can provide "student-centered learning, multisensory stimulation, multipath progression, multimedia, collaborative work, information exchange, active/exploratory/inquiry-based learning, critical thinking and informed decision-making, proactive/planned action, and authentic, real-world context" (p. 5).

In 2002, the International Society for Technology in Education (ISTE) published profiles for technology-literate students (see Appendix A). These

profiles are based on the six ISTE National Technology Standards (NETS) for Students, including basic operations and concepts; social, ethical, and human issues; technology productivity tools; technology communication tools; technology research tools; and technology problem-solving and decision-making tools. Teachers are responsible for creating meaningful learning environments in which students can achieve these profiles (ISTE, 2002).

To build on the NETS for Students, ISTE published the National Educational Technology Standards for Teachers (NETS·T) to assist school improvement through the appropriate educational use of technology (see Appendix B). These standards provide a framework for technology integration into the school curriculum. NETS·T indicates six areas of technology performance indicators that teacher candidates should meet after completing their teacher preparation programs. Current teachers should view the standards and performance indicators as guidelines.

ISTE has produced these standards to aid districts in determining which teachers are proficient in professional technology use and the integration of technology into the curriculum. However, all teachers do not meet all of these standards. Teachers will need to change or modify their current practices in order for these technology standards to be achieved. In promoting change, it is necessary to understand how educational changes occur.

Teachers and Change

Cuban (1993) studied patterns of change in education between the years of 1890 to 1990. He gathered data and descriptions of classrooms from across the nation from this period of time. From his research, Cuban was able to put together explanations for constancy and change in educational practices. Some of the explanations are as follows:

1. "Cultural beliefs about the nature of knowledge, how teaching should occur, and how children should learn are so widespread and deeply rooted that they steer the thinking of policymakers, practitioners, parents, and citizens toward certain forms of instruction" (p. 14).
2. "The organizational structure of the district, school, and classroom shaped teachers' dominant instructional practices" (p. 17).
3. "Teachers' knowledge of subject matter and their professional and personal beliefs about the role of the school in society, about classroom authority, and about children's ethnic and socioeconomic status shape classroom practices" (p. 19).

Other researchers have also identified key issues to the educational change process. Lieberman and Miller (1999) identify five building blocks that underlie efforts in changing schools and teaching. These building blocks are "rethinking curriculum and instruction to improve quality and promote equality, rethinking the structure of the school, adopting a two-pronged focus: students and teacher,

making connections outside the school, and encouraging increased participation by parents and the community" (p. 7).

In order for teachers to embrace technology, they need to view technology as having a vital role in improving curriculum and instruction. In addition, the structure of the school needs to be supportive of teachers' efforts to integrate technology. The following section will examine one project that allowed teachers to be in an environment where they were able to improve curriculum and instruction while receiving the necessary support.

The Evolution of Thought and Practice

Dwyer, Ringstaff, & Sandholtz (1990) report that the Apple Classrooms of Tomorrow (ACOT) project provided constant access to technology for teachers and students in selected schools and districts. The purpose of the technology was to be used as a tool to support learning, not as a tool to replace existing instructional technologies. Classrooms were already multimedia environments through the use of textbooks, workbooks, manipulatives, white boards, crayons, overhead projectors, televisions, and VCRs. Computers just added to the resources that were already present. Teachers were to use the media that best supports the learning objectives.

Dwyer et al (1990) indicates that data analysis revealed how teaching and learning changed in these environments, and it also showed the factors that prevented change from occurring. ACOT researchers discovered five

developmental stages that teachers advance through while making choices regarding technology in their teaching and learning. While advancing through these five stages, the text-based curriculum that teachers typically deliver in a lecture-recitation-seatwork fashion is strengthened through technology. Eventually, this instructional method is replaced by learning experiences that are more engaging for students. The ACOT researchers refer to the continuum as the Evolution of Thought and Practice, and the stages include entry, adoption, adaptation, appropriation, and innovation.

Entry stage. Teachers in the Entry stage are characterized by their lack of experience and comfort with computer technology in most areas of their personal and professional lives. Teachers in this stage typically do not use technology unless it is absolutely required of them. Entry-level teachers doubt their abilities when using technology and rely on others in the building to fix any problems that may arise. In the ACOT program, teachers in Entry-level found themselves facing first-year-teacher issues such as discipline, resource management, and personal frustration (Dwyer et al, 1990).

Direct instruction is common in an Entry-level classroom. Teachers often instruct in a traditional manner, and they do not integrate technology into the curriculum. Entry-level teachers often lack vision of the usefulness of computers, and they view technology as one more thing that they need to squeeze into a tight curriculum. So they occupy as little space as possible, computers in an Entry-level

classroom are typically located in a remote corner. Students in an Entry-level classroom are exposed to classroom technology only for independent purposes, such as math drill software (Dwyer et al, 1990).

Teacher interaction in the Entry stage is typically limited to informal exchanges focusing on emotional support. Teachers share frustrations and successes, and they also provide encouragement to one another. In the ACOT study, few teachers in the Entry stage took advantage of professional release time, training workshops, and telecommunications between participating sites (Sandholtz, Ringstaff, & Dwyer, 1991).

Adoption stage. Teachers in the Adoption stage have more confidence in their personal and professional use of technology. Sandholtz et al (1991) state that teachers' concerns shift from hooking up computers to using them. They have one or two favorite programs that allow them to create worksheets, banners, newsletters, and other items for classroom instruction. The teacher may even use the Internet for lesson planning.

Adoption-level teachers still rely on direct instruction as the primary mode of instruction. Whole-group lectures, recitation, and seatwork are still common in these classrooms. The technology supports drill-and-practice instruction. The computer is located where it is convenient for the teacher. Students in this classroom may use the computer occasionally to type a final draft of a report or paper after all corrections have been made. The technology resources are typically

used to replicate traditional activities that the teacher has done in the past (Dwyer et al, 1990).

Collegial interactions of teachers in the Adoption stage center around obtaining technical assistance, as well as emotional support. Topics discussed include managing and using equipment, locating and using software, and dealing with technical problems. In the ACOT study, teachers in this stage participated more in formal meetings to share experiences and ideas across sites. Teachers seek out more experienced colleagues for assistance and to learn something new from them (Sandholtz et al, 1991).

Adaptation stage. Teachers in this stage begin the integration of technology into their curriculum. They are typically comfortable with their personal computer use, and they begin to use technology with their students and the curriculum (Dwyer et al, 1990).

Direct instruction is still the main teaching mode. The teachers clearly lay out the computer assignments that the students will be completing. The assignment is usually creating a word-processed document. Students rarely construct their own knowledge through the use of technology in this level. Teachers' concerns regarding the use of technology typically center on classroom management, assessment, time, and impact on student learning (Dwyer et al, 1990).

In the ACOT research, productivity was a major outcome in this phase. Students progressed through the curriculum more quickly, which allowed extra time for higher-order learning activities and problem solving. Accuracy, greater understanding, and high levels of enthusiasm were also reported as major outcomes in the Adaptation stage (Dwyer et al, 1990).

Teacher interaction shifts from seeking emotional support and technical assistance to sharing instructional strategies. They are motivated to share their experiences and experimentations they have done beyond text-based drill-and-practice activities. Teachers observe instructional strategies of other teachers when visiting classrooms instead of simply learning about the technology. During the ACOT study, interactions occurred over the network, and some teachers provided opportunities for their students to communicate over the network to other classes and countries (Sandholtz et al, 1991).

Appropriation stage. Movement into the Appropriation stage is determined by each teacher's personal technology mastery. The ACOT research has reported few observations of classrooms outside of their project in this stage because of the lack of technology access. Teachers in this stage start to recognize the curricular possibilities and advantages that are only available through the use of technology. They realize the profound impact that technology can have on the learning experience. When examining teaching objectives and approaches, teachers may consider how technology tools might be used to attain goals such as

higher order thinking skills, collaboration, deeper comprehension, and problem solving (Dwyer et al, 1990).

Classroom management regarding technology is not as rigid as it was before this stage, and students are engaged in more open-ended activities involving more subject areas. Because of this classroom structure and the higher frequency of students teaching each other, the role of the teacher changes. In this stage, teachers are facilitators rather than givers of information. Many times, teachers learn from the students (Dwyer et al, 1990).

Team teaching, cross-curriculum project-based instruction, and individual instruction are more common in the Appropriation stage (Dwyer et al, 1990). Sandholtz et al (1991) reported that ACOT study teachers viewed team teaching as too much work for little gain. Differences in technology skills, personalities, teaching styles, grading guidelines, and classroom management affected how teams worked together. Teams that continued working together found ways to overcome these obstacles. Classrooms and offices were moved closer together to create greater contact. Schedules were created that allowed teachers to have time during the day for meetings. Compromises were reached, and teachers found that some areas that were first obstacles ended up complementing each other. Some advantages that teachers gained from team teaching included:

- Shared responsibilities
- Increased friendship, enthusiasm, and support

- Creation of activities based on teacher strengths
- Creation of new ideas and methods
- Employment of strategies that further student understanding
- Increased one-on-one support for students
- Increased flexible grouping of students
- Increased production during class periods
- Greater ease in determining student misunderstanding
- Continuation of instruction when one teacher is absent
- Creation of a cross-subject curriculum
- Greater student ability to address more difficult material

Innovation stage. The last stage in the ACOT hierarchy is the Innovation, or Invention, stage. This stage is characterized by the presence of student-directed activities. Students construct their own meaning and knowledge through learning units that provide options such as projects. Technology is constantly available as a tool for student use when students deem it necessary for their projects (Dwyer et al, 1990).

There are a few key characteristics of the teachers at the Appropriation and Innovation stages that distinguish them from the other levels of teachers. One factor is that students are working on different tasks instead of all students working on the same assignment. Another factor is that students take on different roles, such as an expert after researching a specific topic. Students also

collaborate on a project by assigning themselves different parts of the project and bringing the findings together to produce a new result. Another characteristic is that classrooms in these stages tend to have constructivist approaches. The use of technology in these classrooms allows teachers and students to do things that could not be done without technology, such as contacting experts, multi-class collaboration, and sharing information through the Internet. Teachers in these classrooms have a variety of assessment methods, such as performance, peer-review, self-assessment, tests, and quizzes (Dwyer et al, 1990).

Although it would be ideal for all teachers to be in the Appropriation and Innovation stages, the reality of the situation indicates that a more feasible goal might be for teachers to move from one level to the next. In order to encourage movement along this evolution of teacher thought and practice, it is necessary to understand why teachers are stalled in a level.

Reasons Teachers Do Not Integrate Technology

Teachers give several reasons why they are not able to integrate technology into the curriculum. The most common reasons fall into three areas – lack of time, lack of equipment, and lack of confidence and knowledge.

"I don't have time." Technology does take time to implement. Teachers need to expect to devote some time to learning and incorporating technology. Brooks (2000) recommends that 15-60 hours of staff development should be

provided annually. Like anything else, the time needed will improve with practice and use (Davison et al, 2000).

The purpose of technology is serving as a tool for learning. It should not be viewed as another subject to teach. Technology integration "is not substituting 30 minutes of reading for 30 minutes of computer skill development. It is, however, using computers to teach 30 minutes of reading" (Dockstader, 1999, p. 73). Technology should supplement lessons to deepen student learning instead of acting as a replacement for proven strategies. Instead of overhauling lesson plans, teachers can use technology to enhance and deepen what they are already teaching (Hopkins, 1999).

Sparks and Hirsh (2000) recommend that states and districts allow twenty-five percent of the school day for teachers to plan lessons together. By making the school day more efficient, time can be allotted for collaboration. Changes in scheduling, such as block scheduling, and reduction or elimination of non-teaching duties, such as recess, detention, and lunchroom duties, can aid in making the school day more efficient and allowing time for teachers to focus on learning.

Another purpose of technology is to make the teacher's routine work easier. Using the computer to write lesson plans, write quizzes, make word puzzles, design newsletters, and keep track of student grades can save time for teachers once they learn how to use it (Wang, 2000).

"I don't have the computer access I need." The ACOT project produced an environment that had immediate access to current technology. Most schools do not have the resources necessary to replicate the technology environments that Apple Computer created for their project.

Outside of the ACOT project, hardware problems are all too common in today's schools. New software cannot be run efficiently on computers that have slow modems, old printers, slow chip speeds, insufficient memories, or low storage capacities (Fuller, 2000). Some teachers have difficulty finding quality software to use on these older and outdated computers. If they do find software to share with the class, the hardware may not run it efficiently. Some teachers are afraid of having downtime during lessons while waiting for the programs to run and load. Teachers are also afraid of how to manage the class when everyone is huddled around one computer.

In schools with updated computer labs, many teachers experience frustration when the lab is not available during the desired class periods. Some teachers are only able to take classes to the lab once a week. This access is not adequate if the teacher wants the students to create a large computer project. The project would last for weeks until the students have had the computer access necessary to complete the project.

"I'm afraid of breaking the computer." Fuller (2000) and Davison et al (2000) also note that reliability is an issue that concerns some teachers. Even

though the reliability of technology is constantly improving, some teachers are afraid that computers will fail at key moments in the lesson, and they will not know how to fix them. Machines do and will break, so backups are needed so that the lesson can go on without the technology. Glitches do happen, and it is necessary to know how to fix the most common ones.

Hopkins (1999) states that the Education World's Tech Team members encourage new technology users to explore computer software so that they can learn how to fix common mistakes. The team members claim that little damage can be done to computer systems through keyboard functions.

In her in-service technology training sessions, Wang (2000) first focuses on extending the comfort zones of teachers. Teachers need to feel comfortable with the technology in order to use it. Once their fears are overcome, it should be easier to introduce the new equipment without fear of breaking it. Many of the teachers in her session feared technology to the point where they were afraid that they would break it if they pressed a wrong key. To help overcome their apprehension, Wang brought in pieces of computer hardware for the teachers to handle. She also states that moral support, step-by-step demonstrations, and detailed handouts helped teachers to feel more comfortable. Dr. Linda Roberts, the U.S. Department of Education special advisor on technology, says that if teachers will use technology effectively in their own lives, ninety percent of the battle has been won (Rosenthal & Poftak, 1999).

Teaching Teachers to Use Technology

Now that teacher concerns have been addressed, the question remains of how to train teachers to integrate technology into the curriculum. Given the limited amount of time and resources, what is the most effective way to build teacher knowledge and confidence so time is not wasted?

McKenzie (2000) and Brooks (2000) claim that the learners are rushed through many skills, with not enough guided practice to achieve a comfortable familiarity. After training activities, it is important that teachers are able to go back to the classroom and immediately implement what they have learned. They need to be able to apply this knowledge repeatedly and have follow-up support available (Brooks, 2000).

McKenzie (2000) and Brooks (2000) suggest many strategies to use when creating staff development programs to train teachers in technology use and integration. Some of the models that they recommend include study groups, curriculum development teams, "just-in-time" support, and technology mentors.

Study groups. Joyce, Wolf, and Calhoun (1993) define study groups as a group of four to six people that work together on selecting topics for study and initiation. The group members examine professional publications, participate training sessions together, and support each other in the integration of skills. McKenzie (2000) has also researched study groups and suggests that teachers assemble in self-chosen groups on a weekly basis to work toward group goals in

technology. This option contributes to learning by encouraging the learner to pursue what is important to them. Activities that might be included are technology classes, tutorial sessions, exploration of online sites, and discussion of professional readings. When the learner can identify personal topics of interest and study partners, the learner's goals are more likely to be achieved.

Curriculum development teams. Curriculum development teams are composed of teachers who vary in levels of teaching experience and technological skills. The job of curriculum development teams is to identify and develop units that would benefit student learning through technology integration. The team can be divided into groups to pursue particular aspects of the unit, such as online materials or incorporating the use of software. In this way, teachers can work together to create units that will be ready to use. Every teacher will not have to spend time putting the unit together alone. This strategy is also a way to introduce late-adopting teachers to new technology and show them how to use it in their classrooms. Teachers can use what they are already doing in their classroom, but a curriculum development team can prepare a package of additional resources to add depth to the material (McKenzie, 2000).

Dockstader (1999) gives seven steps in planning for technology integration that can be used by a curriculum development team. The first step is to choose a core area, such as science, math, or reading. After the subject area is selected, the members of the group should identify standards and benchmarks that

may be better achieved through the use of technology. From the standards and benchmarks, the planners should choose one lesson or unit that is fairly easy and uses information that is comfortable. The next step is to develop that one lesson or unit using software that is familiar. The final steps are to use the lesson or unit, evaluate what was successful and what failed, and make the necessary changes. The important point is to start small with tools that are familiar to build confidence.

Just-in-time support. McKenzie (2000) defines just-in-time support as a person who has specialized technology skills that is available to the teacher in need within minutes. The idea is that instead of having a few technology experts in the district that have limited availability, a school ensures that one-third of the staff has been trained in specific technology skills. This support system is quicker than a district or building technology representative and lessens the reliance on these few people. It also allows the problem or question to be dealt with in a timely manner to reduce frustration of less experienced technology users.

Mentoring. Hurst and Reding (2002) report that many states require mentor programs for new teachers. The experienced mentor is a resource to the novice teacher when he has questions concerning policies, curriculum, or classroom management. Over time, the reliance on the mentor lessens until the new teacher feels comfortable with his role as an educator. The same can be said when it comes to technology. In a technology-mentoring program, a teacher who

is experienced in technology is paired with a teacher who is a technological novice. The technology mentor serves as a temporary support for the teacher who is integrating technology into lesson plans. The mentor is available to answer questions regarding technology or can provide suggestions and general support. As the technology novice becomes more comfortable with the software and equipment, the involvement with the mentor decreases (McKenzie, 2000).

One form of mentoring is peer coaching. Joyce and Showers (1995) define peer coaching as one teacher observing another teacher implementing a new behavior in order to learn from the attempt. This coaching is a continued assistance that occurs right in the classroom as a follow-up to initial training. Joyce and Showers found that teachers who were coached on a regular basis applied these new techniques more frequently and developed greater skill with this technique than teachers who were not coached, but who received the same initial training. They also found that when whole-school participation is organized into peer-coaching teams for follow-up, classroom implementation of new strategies could reach 90 percent or better.

Conclusions and Recommendations

Most of the technology budget in schools has been earmarked for purchasing hardware and software to ensure that students leave school with the skills necessary to be a contributing member of the workforce. In order to do this, ISTE has created technology standards for students. Since teachers are

responsible for seeing that students meet these standards, ISTE has created technology standards for teacher education programs. Few teachers currently meet all of these standards.

In order to promote change in teaching and learning practices, teachers need to understand the role that technology has in the change process. Teachers need to realize that technology can have an enormous impact on student learning.

When teachers begin to integrate technology into the curriculum, each teacher's level of integration can be identified, and steps can be taken to encourage movement to the next level of integration. Programs need to be set up to help teachers overcome their computer concerns, such as not having enough time, right equipment, or knowledge. These programs need to be time-efficient, build confidence, and have tangible goals at the end, such as a completed unit or training in a specific program. Once the program has been completed, teachers need to frequently practice what they have learned. In this time period, follow-up support has to be readily available in case something does go wrong. This follow-up support might include a mentor or multiple trained staff members. With these tools in place, teachers can use technology to prepare students to enter their community roles after graduation.

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Appendix A

Profiles for Technology-Literate Students

Grades PK-2

Prior to completion of Grade 2, students will:

1. Use input devices (e.g., mouse, keyboard, remote control) and output devices (e.g., monitor, printer) to successfully operate computers, VCRs, audiotapes, and other technologies.
2. Use a variety of media and technology resources for directed and independent learning activities.
3. Communicate about technology using developmentally appropriate and accurate terminology.
4. Use developmentally appropriate multimedia resources (e.g., interactive books, educational software, elementary multimedia encyclopedias) to support learning.
5. Work cooperatively and collaboratively with peers, family members, and others when using technology in the classroom
6. Demonstrate positive social and ethical behaviors when using technology.
7. Practice responsible use of technology systems and software.

8. Create developmentally appropriate multimedia products with support from teachers, family members, or student partners.
9. Use technology resources (e.g., puzzles, logical thinking programs, writing tools, digital cameras, drawing tools) for problem solving, communication, and illustration of thoughts, ideas, and stories.
10. Gather information and communicate with others using telecommunications, with support from teachers, family members, or student partners.

Grades 3-5

Prior to completion of Grade 5, students will:

1. Use keyboards and other common input and output devices (including adaptive devices when necessary) efficiently and effectively.
2. Discuss common used of technology in daily life and the advantages and disadvantages those uses provide.
3. Discuss basic issues related to responsible use of technology and information and describe personal consequences of inappropriate use.
4. Use general purpose productivity tools and peripherals to support personal productivity, remediate skill deficits, and facilitate learning throughout the curriculum.
5. Use technology tools (e.g., multimedia authoring, presentation, Web tools, digital cameras, scanners) for individual and collaborative writing,

communication, and publishing activities to create knowledge products for audiences inside and outside the classroom.

6. Use telecommunications efficiently and effectively to access remote information, communicate with others in support of direct and independent learning, and pursue personal interests.
7. Use telecommunications and online resources (e.g., e-mail, online discussions, Web environments) to participate in collaborative problem-solving activities for the purpose of developing solutions or products for audiences inside and outside the classroom.
8. Use technology resources (e.g., calculators, data collection probes, videos, educational software) for problem solving, self-directed learning, and extended learning activities.
9. Determine when technology is useful and select the appropriate tool(s) and technology resources to address a variety of tasks and problems.
10. Evaluate the accuracy, relevance, appropriateness, comprehensiveness, and bias of electronic information sources.

Grades 6-8

Prior to completion of Grade 8, students will:

1. Apply strategies for identifying and solving routine hardware and software problems that occur during everyday use.

2. Demonstrate knowledge of current changes in information technologies and the effect those changes have on the workplace and society.
3. Exhibit legal and ethical behaviors when using information and technology, and discuss consequences of misuse.
4. Use content-specific tools, software, and simulations (e.g., environmental probes, graphing calculators, exploratory environments, Web tools) to support learning and research.
5. Apply productivity/multimedia tools and peripherals to support personal productivity, group collaboration, and learning throughout the curriculum
6. Design, develop, publish, and present products (e.g., Web pages, videotapes) using technology resources that demonstrate and communicate curriculum concepts to audiences inside and outside the classroom.
7. Collaborate with peers, experts, and others using telecommunications and collaborative tools to investigate curriculum-related problems, issues, and information, and to develop solutions or products for audiences inside and outside the classroom
8. Select and use appropriate tools and technology resources to accomplish a variety of tasks and solve problems.
9. Demonstrate an understanding of concepts underlying hardware, software, and connectivity, and of practical applications to learning and problem solving.

10. Research and evaluate the accuracy, relevance, appropriateness, comprehensiveness, and bias of electronic information sources concerning real-world problems.

Grades 9-12

Prior to completion of Grade 12, students will:

1. Identify capabilities and limitations of contemporary and emerging technology resources and assess the potential of these systems and services to address personal, lifelong learning, and workplace needs.
2. Make informed choices among technology systems, resources, and services.
3. Analyze advantages and disadvantages of widespread use and reliance on technology in the workplace and society as a whole.
4. Demonstrate and advocate for legal and ethical behaviors among peers, family, and community regarding the use of technology and information.
5. Use technology tools and resources for managing and communicating personal/professional information (e.g., finances, schedules, addresses, purchases, correspondence).
6. Evaluate technology-based options, including distance and distributed education, for lifelong learning.

7. Routinely and efficiently use online information resources to meet needs for collaboration, research, publications, communications, and productivity.
8. Select and apply technology tools for research, information analysis, problem solving, and decision making in content learning.
9. Investigate and apply expert systems, intelligent agents, and simulations in real-world situations.
10. Collaborate with peers, experts, and other to contribute to a content-related knowledge base by using technology to compile, synthesize, produce, and disseminate information, models, and other creative works.

Appendix B

ISTE National Educational Technology Standards (NETS) and Performance Indicators for Teachers

All classroom teachers should be prepared to meet the following standards and performance indicators.

I. Technology Operations and Concepts

Teachers demonstrate a sound understanding of technology operations and concepts. Teachers:

a. demonstrate introductory knowledge, skills, and understanding of concepts related to technology (as described in the ISTE *National Educational Technology Standards for Students*).

b. demonstrate continual growth in technology knowledge and skills to stay abreast of current and emerging technologies.

II. Planning and Designing Learning Environments and Experiences

Teachers plan and design effective learning environments and experiences supported by technology. Teachers:

a. design developmentally appropriate learning opportunities that apply technology-enhanced instructional strategies to support the diverse needs of learners.

b. apply current research on teaching and learning with technology when planning learning environments and experiences.

c. identify and locate technology resources and evaluate them for accuracy and suitability.

d. plan for the management of technology resources within the context of learning activities.

e. plan strategies to manage student learning in a technology-enhanced environment.

III. Teaching, Learning, and the Curriculum

Teachers implement curriculum plans that include methods and strategies for applying technology to maximize student learning.

Teachers:

a. facilitate technology-enhanced experiences that address content standards and student technology standards.

b. use technology to support learner-centered strategies that address the diverse needs of students.

c. apply technology to develop students' higher-order skills and creativity.

d. manage student learning activities in a technology-enhanced environment.

IV. Assessment and Evaluation

Teachers apply technology to facilitate a variety of effective assessment and evaluation strategies. Teachers:

a. apply technology in assessing student learning of subject matter using a variety of assessment techniques.

b. use technology resources to collect and analyze data, interpret results, and communicate findings to improve instructional practice and maximize student learning.

c. apply multiple methods of evaluation to determine students' appropriate use of technology resources for learning, communication, and productivity.

V. Productivity and Professional Practice

Teachers use technology to enhance their productivity and professional practice. Teachers:

a. use technology resources to engage in ongoing professional development and lifelong learning.

b. continually evaluate and reflect on professional practice to make informed decisions regarding the use of technology in support of student learning.

c. apply technology to increase productivity.

d. use technology to communicate and collaborate with peers, parents, and the larger community in order to nurture student learning.

VI. Social, Ethical, Legal, and Human Issues

Teachers understand the social, ethical, legal, and human issues surrounding the use of technology in PK-12 schools and apply that understanding in practice. Teachers:

a. model and teach legal and ethical practice related to technology use.

b. apply technology resources to enable and empower learners with diverse backgrounds, characteristics, and abilities.

c. identify and use technology resources that affirm diversity.

d. promote safe and healthy use of technology resources.

e. facilitate equitable access to technology resources for all students.