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Edited by
Kari Kumpulainen

EDUCATIONAL TECHNOLOGY: OPPORTUNITIES AND CHALLENGES

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Abstract

Numerous educational technology programs and strategies have been developed on all continents to ensure that technology is used effectively for the benefit of student learning and achievement. The impact of technology on learning and instruction is still not clear. This book addresses several concerns of educators who rub elbows with a new technology. The book offers global research-based data on educational technology. The book consists of nine independent blind peer-reviewed scientific articles written by thirteen authors, four from Europe and nine from the USA.

The authors present diverse views on social technologies and integration of ICT (information and communication technology) in education, online teaching, and instructional design models. Creative computing, staff and student training, and effective use of technology are also examined. Several theoretical frameworks are used including the activity theory, social constructivist theory, reflective practice, and the teacher's embodied theory. The articles represent a variety of quantitative and qualitative methods, including case studies and surveys. Practical web-based links including videos and examples of good practice are offered for primary, secondary and tertiary education.

Keywords: computing skills, educational technology, instruction, instructional design, online learning, teacher education

Kumpulainen, Kari (toim.), Näkökulmia tieto- ja viestintätekniikan opetuskäyttöön
Kasvatustieteiden tiedekunta, Kasvatustieteiden ja opettajankoulutuksen yksikkö, Oulun yliopisto, PL 2000, 90014 Oulun yliopisto
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Tiivistelmä

Kansakunnat kaikilla mantereilla ovat suorastaan kilvoitelleet erilaisten tieto- ja viestintätekniikan opetuskäyttöä ja oppimista edistävien strategioiden ja toimeenpano-ohjelmien julkaisemisessa. Kuitenkaan teknologian vaikutuksista oppimiseen ja opettamiseen ei tiedetä vielä tarpeeksi. Tämä kirja pyrkii osaltaan selventämään vallitsevaa problematiikkaa tarjoamalla globaalin, tutkimuksellisen näkökulman aiheeseen. Kirja koostuu yhdeksästä artikkelista. Kaikki artikkelit on sokkona vertaisarvioitu vähintään kahden lukijan toimesta. Kirjoittajia on yhteensä kolmetoista – yhdeksän professoria ja neljä tutkijaa.

Kirjoittajat tuovat esiin monipuolisia näkemyksiä teknologian sosiaalisista vaikutuksista opetus- / oppimistapahtumaan, verkkoperustaisesta oppimisesta sekä teknologiaan liittyvästä koulutussuunnittelusta. Käsiteltäviä aiheita ovat myös tietokoneet ja luovuus, opettajankouluttajien ja opettajaksi opiskelevien tietotekniset valmiudet, sekä kouluoppimisen tehostaminen teknologian keinoin. Kirjoittajien käyttämiä teoreettisia viitekehyksiä ovat mm. aktivaatioteoria, sosiaalikonstruktivismi, reflektiivinen oppiminen, sekä teoria opettajasta opetuksensa ilmentäjänä. Tutkimusmenetelminä käytetään sekä kvantitatiivisia että kvalitatiivisia. metodeja, mukana on niin tapaustutkimuksia kuin survey-tyyppisiä kyselyjä. Artikkelit nostavat esiin useita hyödyllisiä opetuskäytänteitä, sekä ajankohtaisia ja kiinnostavia verkkolinkkejä perus-, keski- ja korkea-asteen opetukseen.

Asiasanat: koulutusteknologia, opettajankoulutus, tieto- ja viestintätekniikan opetuskäyttö, tietokoneen käyttötaito, verkko-oppiminen

Preface

People adapt very quickly to good news. Since the wheel was invented probably around 8 000 B.C. in Asia, technology has offered good news for most people. Sail, compass and rudder, printing press, steam engine, penicillin, telephone, satellite, and digital computer are just a few examples of great innovations that are advantageous to us all. Actually these are truly fantastic times in which we live. Every year, and even every day, we have witnessed unprecedented innovations.

During the rise of the Internet, governments on all continents have discovered the amazing potential technology opens up for education. Numerous educational technology programs and strategies have been developed to ensure that technology will be used effectively to benefit student learning and achievement. While doing so the need to understand technology´s impact on learning and teaching has proven vital. Not only the public funds that are invested, but also enormous technology based social and cultural changes, deserve to be examined.

Educational Technology: Opportunities and Challenges is a book for educators concerned with the improvement of teaching and learning through technology. All authors are experts in the field which encompasses a broad range of topics including information and communication technology, instructional design, global issues in educational technology, online teaching, curricular integration, and professional development. This book consists of nine blind double peer-reviewed scientific articles written by thirteen invited authors, four Europeans and nine from the USA. All authors are introduced at the end of this book.

In Chapter 1**, Cultural Globalization and Integration of ICT in Education,** *Jyrki Pulkkinen* eyes social technologies and their implications on education. According to the author, education is a constitutive element of the knowledge society and the global knowledge economy. The opportunities of information and communication technology in education are considered in a global context.

Chapter 2**, Online Teaching: the Development of a Hybrid Course in Higher Education**, written by *Thanh T. Nguyen* and *John-Michael Bodi*, examines learning outcomes of graduate students in a teacher education program using a 30:70 hybrid model in comparison to a traditional face-to-face classroom. Their conclusions will be interesting to every educator who plans to move to online courses.

Nathan Balasubramanian and *Brent G. Wilson* address several concerns of teacher-practitioners as schools strive toward ~~s~~ increasing student achievement in Chapter 3, **Learning by Design: Teachers and Students as Co-Creators of Knowledge**. They use activity theory as a framework for their study. This chapter also invites you to a net-based collaboration through Nathan's World website!

Supporting Novice Teachers in Diverse Contexts: A Practical Instructional Design Model, Chapter 4, by *Laurie Brantley-Dias* and *Brendan Calandra*, focuses on how to design a good curriculum. Authors suggest a design model that can be used by instructional designers and teacher educators to foster reflective, systematic instructional planning in novice teachers.

Chapter 5, **'Celebrating Success' - a Continuing Professional Development Project in Information and Communication Technology within a Teacher Training Institution**, by *Ray Bland*, is designed to encourage and support continuing professional development in information and communication technology. The author reports how experienced staff members support their colleagues who have not yet fully embraced educational technology.

In Chapter 6, **ICT and Creative Computing - Austrian Perspective in Teacher Education,** *Margarete Grimus* gives an overview of the current Austrian school system in a context of information and communication technology. She clarifies the demand of standards, and shows examples of a good practice at the State College of Education in Vienna.

The Editor's voice is talking in Chapter 7, **Computing Competition: Staff vs Students!,** where *Kari Kumpulainen* compares university-level teacher trainers and preservice teachers, their perceived skills, interest, and attitudes toward using information and communication technologies. In the computing competition—staff vs students—the clear victory goes to....

Robert Maninger and *Susan Anderson* in Chapter 8, **Beyond Skills: Evaluating the Impact of Educational Technology Instruction,** describe two studies that utilized self-report surveys to evaluate the impact of educational technology instruction in teacher preparation programs. The chapter concludes with a discussion of ways that educational technology instruction can go beyond teaching technology skills in order to influence preservice teachers' beliefs, and help them cope with obstacles to their future use of technology in classrooms.

Chapter 9, **The Intrepid Explorer: A Model of Effective Technology Use for All Educators,** by *Rachel Vannatta*, utilizes the model of the Intrepid Explorer as a guide for developing effective technology users among K-12 students, teachers, teacher candidates, and teacher educators. Recommendations for developing characteristics of Intrepid Explorers among these constituencies are identified.

This book was developed as part of a research activity at the University of Oulu, Faculty of Education, Department of Educational Sciences and Teacher Education, Finland.

As an editor I am grateful to all authors of this book. Your contributions have been tremendous! I highly appreciate your support, and I am looking forward to continue our fruitful cooperation. Warmest compliments also to professor Jay Thompson from Ball State University, USA, due to his valuable help.

This book is dedicated to Sailor.

Oulu, March 1, 2007

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Contents

Cultural Globalization and Integration of ICT in Education

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Abstract

Information and Communication Technology (ICT) is changing the ways and forms we are communicating and using information in education. Together with ICT, information, knowledge and innovations are also seen as a foundation of a new global knowledge economy. Education is a constitutive element of the knowledge society and global knowledge economy insofar as everything is framed and structured by ICT. The impact of ICT on education has not always been as favorable as the economic impact. It has been noted that ICT integration may help us to make education more accessible and affordable, but at the same time it may change the cultural context of education as well as the language of learning. If our language changes, our thinking, identity and culture will also change. This affects the most to vulnerable developing countries but also to small language groups and communities in industrialized countries. So-called social technologies can help us to localize and contextualize the use of ICT in education.

1 Introduction

Integration of Information and Communication Technology (ICT) in education has been one of the leading aspects in educational development in Europe and other developed countries over the last two decades. Most of the countries belonging to the Organisation for Economic Co-operation and Development (OECD) have underlined in their strategic plans that the information technology will be the driving force for development of their societies in the future. Also most of the developing countries including the Least Developed Countries (LDC's) have already acknowledged the benefits of ICT in their national education plans and poverty reduction strategies. There seems to be a broad consensus that education, science and innovations as well as information and communication technologies are at the heart of socio-economic development.

According to European Information Society for Growth and Employment, (COM 2005), ICT has been seen to help to create "Single European Information Space." The idea has been successfully adopted in many sectors of society (e-government, e-commerce, etc), but not so successfully in education. The commercial model of ICT integration includes the idea of mass production of goods and economies of scale and has been based on the logic of industrial production economy rather than educational goals emphasizing quality of learning, personal interaction and social nature of learning. This means educational services have to be more competitive, accessible and affordable through digitalized high quality learning content and services that can be distributed via broad band communication networks throughout European countries. There still seems to be confusion on aims, modes and implications of ICT integration in education that has been related to the culture of education as well as the development of global educational ICT markets (Heyneman & Haynes, 2006).

It is necessary to note in the beginning of this article, that although many negative aspects of ICT integration are argued here, the world is still divided between those, who have access to education and ICT and those who don't. Therefore, providing equal access to education and information, with the help of ICT where appropriate, should be considered as the global challenge for the education community. UNESCO (2000) has named this challenge “Education for All” and is associating this challenge strongly with bridging the global digital divide in its current strategy. However, UNESCO also suggests in "The Quality imperative" (2005), that there is no idea to provide access to low quality education. World Summit on Information Society in Geneva (2003) and Tunis (2006) emphasized the same: ICT is a key enabler for social and economic development, and access to information and knowledge is a human right for all. However, ICT, being a key enabler for global economy and cultural globalization as well, may have some undesired implications that could affect the quality of education.

The challenging question is: How we integrate ICT in education in order to realize educational challenges such as inclusive accessibility to education and better quality of education but avoid the problems caused by ICT for education and culture? In order to answer this question we should first know, what these undesirable side effects of ICT for education and culture are and how the global processes of knowledge economy related to ICT are affecting education. Unfortunately, because of the complexity and heterogeneity of education systems globally, and limitations in current research orientations on educational technology, we have not been able to answer these questions yet. Understandable holistic view of ICT integration in education is still missing. Especially the impact of ICT enabled global economy and cultural globalization in education has been under explored. (Pulkkinen, 2003.)

The aim of this article is first to analyze the concept of ICT and second to shed light on some implications of ICT integration in education that are not usually mentioned in educational strategies and ICT plans. The implications discussed here are mainly cultural by nature, have not usually been the focus of educational research on ICT either. This is not to say that the impact of ICT on education is negative but that we should broaden the scope of argumentation from technical and economic to cultural and educational.

2 ICT – More Than a New Gadget

One problem related to a concept of ICT in education as well as digital divide is that ICT has often been understood as a bunch of merged technologies, as a tool or as an infrastructure. Of course technical access is a precondition for the utilization of ICT in any context but the concept itself has emphasized the technical divide instead of the imbalance in possibilities of acquiring information, communication and knowledge. In education, of course, the question is about availability of information and communication rather than technology it self. Emphasis of technical side of ICT has led us to see only technical solutions and the provision of information, communication and knowledge as kind of "self evidential" outcome of these solutions. As we know now especially from the experiences of developing countries, building ICT infrastructure for schools has not always led to better access to information, communication and knowledge (Infodev, 2006).

To understand the impact and nature of ICT in education we should extend our understanding of ICT from a technical level to information and social system levels. For example, Miles (1996) claims that ICT is not only a new technical product, or even a radical transformation of a particular economic sector (information economy), but it is a revolutionary innovation across all sectors of society. The commercialization of the Internet through the convergence of technologies on World Wide Web (Web, WWW) service has had the advantages of bringing ICT also to the common people and to education in the industrialized countries. Affordability and availability of ICT has triggered the new generation of techno-economic and social innovations also in education just as it has done in other sectors of our society (Castells, 1996).

The convergence and integration of different technologies into all aspects of our life can lead us to think more holistically about ICT. Individual technologies and tools can now be seen as parts of an information and communication system of an institution or an organization rather than separate ICT applications or gadgets. However, the term ‘information system’ itself is still interpreted quite differently by different groups of people. It seems to be interpreted in at least three different ways (Verrijn-Stuart, 2001): 1. It has been understood as a technical system, implemented with computer and telecommunications technology (like ICT infrastructure). 2. It has been understood as a social system, such as an organization or an institution in connection with its information needs (like education institution or research network). 3. It has been understood as a conceptual system (i.e. an abstraction of either of the above).

In complex systems - like educational institutions - all three interpretations can come together. If we take the so called "social shaping" perspective to technology as a starting point for understanding ICT and information systems in education, we have to extend the information system of education by considering it as a social communication system which is a historically emerging system, and neither a tool or an infrastructure in education, nor a new form of digital content only. It is a system which carries and communicates our concepts and understanding of the physical world we are living in, and the applications of technology itself as it appears to us in our every day activities in education. From this point of view, when referring ICT integration in education, we should talk about information and communication systems in education rather than ICT as a separate technical system, a tool or an infrastructure. With this broader understanding of ICT we can see how deep impact ICT integration can make in re-shaping educational institutions by changing the structure of its constitutive element: internal and external systems of communication and information.

Another aspect is that although the same standard technical systems or application can be used globally, information and communication systems need to be situated in local and institutional contexts of use. For the information systems in education, it is the most necessary to strike a balance between sensitiveness to local contexts and a need to standardize globally. (Rolland & Monteiro, 2002.) In education, this is even more important because context of learning is also a major component of quality of learning (UNESCO, 2005)

3 ICT and Global Economy

ICT has commonly been seen as a driving force for economic globalization, which is changing the possibilities of citizens to influence their lives and organizations they operate in. According to Smith and Smythe (2002) this development is disempowering and empowering people and organizations at the same time, and is by no means homogenous in its effects. If information is the foundation of the information society (Nash, 2001), knowledge and innovations based on information can be seen as constitutive elements of the knowledge economy in the information society insofar as everything is framed and structured by information and communication technology.

In economic development ICT is generally presumed to represent two important global dynamics: the shift from the use of materials as the key economic input to the use of information as the raw material of economy (Castells, 1996); and the change from the use of passive information to the use of active knowledge or symbolic/analytical information and skills in economic processes (May, 2000). This means that knowing and learning has become key factors in the process of economic globalization. Information and knowledge are not only goals for people but also subjects of trade (Aittola & Pirttilä, 1989). This transformation is usually linked to the deindustrialization of the major developed economies (OECD) and to discussions on the possibilities of this new mode of economic and social activity, knowledge economy of information society. (May, 2000.)

According to Williams (1997), technology itself can also be seen merely as a social product rather than a technology which is separate from society. Each step on the way to developing new technologies is also connected to social, economic and political factors. Therefore, development of new forms of ICT is a key factor in globalization (new products) but also creates new educational policies, plans, activities and social structures. Consequently it is critical to consider, how and what kind of ICT's are developed and integrated in education. If ICT is a key element in increasing globalization and creating problems in education, it must be a part of solutions as well.

According to Kubicek & Dutton (1997) technical development is usually supported with massive research and development programs initiated by ministries and research funding agencies, which aim at creating new ICT based services and business in our society. Some ten years ago in the USA, former President Clinton’s government initiated the Information Highway policy in the National Information Infrastructure (NII) initiative in 1993. That initiative challenged the European Union to compete with this initiative and started the massive research programmes related to ICT's and ICT use in education. More recently, for example the e-Europe program initiated by the European Commission promised the following: “e-Europe is providing opportunities for people to participate in society and helping the workforce to acquire the skills needed in a knowledge-driven economy. It is bringing computers and the Internet into schools across the Union, bringing governments on-line and focusing attention on the need to ensure a safer online world.” (COM 2002, p.3.) The problem with these enormous scientific support actions on ICT integration in education has been mainly that they see ICT as a solution itself and their interest in increasing efficiency of education in producing labor force for more competitive economy - and maybe reducing the costs of education system. In this way, the integration of ICT in education may have been part of the process of economic globalization rather than creating better learning opportunities for individuals in local cultural context and with local content.

4 ICT, Education and Cultural Globalization

The economic approach to globalization described in the previous chapter is quite deterministic and gives no role for plans and policies in controlling of the global development of economy. It would be too much to say that ICT and knowledge economy alone is changing the world. According to Alasuutari and Ruuska (1999) the processes of globalization can be understood only from the co-existence of the uncontrollable economic development based on ICT, its cultural consequences and the policy-based development related to different sectors of society. These processes are influencing the education system at the same time, but not necessarily in the same direction. Therefore it is important to analyze these different perspectives together in order to gain a more comprehensive understanding of what kind of changes ICT is bringing along to the education system globally and at institutional and individual levels particularly.

Among educators and policy makers, educational development is commonly understood as a result of policies and plans at different levels of the education system. This approach is concerned with issues like equity of access (educational policy), curriculum relevance in technology (technology and technology education as subject), methodological development in technology (ICT and learning) and cultural diversity (versus cultural globalization) (Farrel, 1999). In the practice of education, one could easily think that globalization is only a matter of industry and business, and that education as a moral and intellectual process is no part of this development. However, if we understand information, knowledge and education as part of the global knowledge economy as described earlier, education systems and educational planning can be seen as the core of the globalization process. This is realized by most of the governments that are trying to compete on the global markets by placing the onus of policy on education to produce the “human capital” most appealing to global competition (Webster, 2001). Also Rinne (2000) emphasizes that educational policy has become an even more important part of economic, trade, labor and social policy in western countries. The anecdote "education is too valuable to be left for educators" tells us of the changing role of education in our society.

The EU’s new initiative on higher education aims to create a common European Higher Education Area (Prague, 2001). The initiative is supporting life long education, integration of work and education, student mobility and study programmes that are developed and organized jointly by several universities from different European countries. These initiatives can be seen as a part of the global development of education as business and materialization of a "training society” thinking (Panzar, 2001), where the emphasis is on producing competitive skills and labor for the markets. In the political discussion this development is called economic and cultural integration but we can see it also as part of cultural globalization to differentiate it from the purely economic aspects of globalization.

One tangible example of global educational development is the development of mega-universities, university networks and virtual universities that are based on ICT and information networks. These new forms of educational institutions can offer competitive on-line training programs for students recruited from all over the world. To be more competitive in broader world education markets, they operate in major languages only. They also unify the structure of educational programmes as well as content of programmes.

Another example of global development related closely to the education sector is the current development in the mass media, electronic publishing, and more specifically, electronic publishing of educational content. In the year 2000, the majority (80%) of all websites in the world was in English and the majority (80-85%) of scientific publications on the Internet was in English (Peraton & Creed, 2000). Recently the figures have changed because of an increased number of Chinese websites, but the dominance of English remains in education and science. This means that internationally distributed digital information is changing the language we use for acquiring information in the learning process, first in higher education and then in other levels of education, at home and at work.

Of course, most of this development is positive internalization and integration but small cultures and languages are suffering due to the competition in the international information distribution (and education) markets. Due to increased global competition in publishing markets, only the biggest international publishing and entertainment companies are able to produce high quality electronic learning materials. Global standards on e-learning make it sure that the markets are global and materials are usable in all over the world. This is how globalization and ICT are gradually changing the language of our education, our culture and our thinking.

UNESCO (2005) defines the quality of education by emphasizing the local context of education. In ICT there seems to be a trend that disconnects education from the local context. It seems to be that cultural globalization is connected with ICT use in education through standardization (= making similarities) and business models of global economy. The global trend in e-learning business is favoring standardization of learning platforms, content distribution and English as a tuition language for achieving global markets. This trend, being financially very efficient, can be very tempting for some developing countries struggling with accessibility and availability of educational services, materials and even curriculum development. In other words, one can say that by giving their own cultural context and language a country seems to better afford education for all. This is an unfortunate decision to be made in many institutions and even some countries.

As the key to quality education is the local cultural context of learning, we need to be aware of the trends and processes related to ICT that are diminishing this context. Moreover, we need to develop ICT applications that are enforcing the local context of education.

Beck (1999) describes the dialectic between globalization and localization processes as “global localization”, emphasizing that these two dimensions of cultural development are dependent on each other. Beck uses an example of global fast food chains that introduce local taste to their products. That seems to be more competitive way to make global business than with fully standardized products. Beck calls this phenomenon as "glocalization". The current development of collaborative applications of ICT and so called "social technologies" are promising in the creation of local context in e-learning although they are based on standard technologies. They usually grow and develop together with the institution, so they look like the institution and function like the institution - and can be shaped according to the strategy of the institution. This can be called "strategic use of technology" or progressive technology due its ability to change and facilitate institutional change (Roessler, 2004).

Strategic use of technology defines the use of ICT in two ways: 1. technology that is integral to a plan for achieving a strategic goal; and/or, 2. technology that fundamentally increases the scope and scale of an organization’s work. Technology used strategically moves beyond performing a support function to being organizationally transformative. (Roessler, 2004.)

Although standardized technology always defines the "space of possibilities" for interaction and collaboration within the educational institution, it makes it possible to localize the most important part of information in education - collaborative knowledge construction. These social applications of progressive technologies can consist of different collaborative technologies like wiki's, blog's, discussion forums, community platforms, e-mail, etc. that can be used and combined for local educational purposes.

5 Global Skills Revolution

It is a fact that, because of the development of ICT, there is more information available around us than ever, local or global. The overflow of information is not only changing our thinking but also our relationship with information. According to Rosenau (1999), in the global information society the relevance of information seems to become less obvious. It is getting more and more difficult for people to check the relevance of information. What is true and what is false? Therefore, one aspect of cultural globalization related to education is the fact that we need new skills related to ICT in order to survive in a global world. According to Cleveland (1999), education for the "Global Century", as he describes globalization must also help people to think critically and holistically. ICT and the widening spread of internationally distributed information is creating a "skill revolution". The skills needed at the workplace today are critical thinking, consultation, negotiation and collaboration (Cleveland, 1999). According to Reich and Goleman (1999), when the work gets more complex and collaborative, the emotional and social skills become more important success factors for individuals. In addition, in the global world, these skills should be understood in an inter-cultural context where communication skills are closely connected to language skills of individuals.

In education, ICT can offer many possibilities to practice these skills in everyday situations in schools. This changing landscape of information and skills revolution has a huge impact on education processes, content and on educational management and institutions. We should constantly develop new ways of using ICT in a more human and more critical way in education that could help us to expose the learners in schools to inter-cultural communication. This does not mean more internationally distributed standardized content but cross-border and cross-cultural collaborative elements in education, that can be organized by utilizing social technologies, for example.

However, some researchers think that there is also a danger in trying to use technology to teach people these skills. With a CD-ROM or an Internet-based training program, we do not have the face-to-face contact that is so invaluable in learning and practicing skills, especially the emotional skills. This is to emphasize that it is important to keep the balance between local and global activities when integrating ICT in to education. None of these new skills are dependent on the level of information one may possess. Therefore the focus in ICT integration in education should be on methods and applications advancing collaboration, not so much on content delivery.

6 Conclusions

If we look at the recent developments in integrating ICT in the education sector globally, we can summarize the implications and demands of global information society in the education system as follows:

1. Demand for widening the access to education for all is still a challenge in our world. It has been acknowledged that ICT can help us to achieve the goal of Education for All. It can help us to organize continuous life long learning, advance educational equality, and fade the boundaries between preset and inset as well as formal education and working life. However, the processes related to global economy and the role of ICT in that process can affect to the quality of education by diminishing local context of education.

According to Warschauer (2003) the ability to access, adapt, and create knowledge using **ICT is critical to social inclusion.** This focus on social inclusion shifts the discussion of the "digital divide" from gaps to be overcome by providing equipment to social development challenges to be addressed through the effective integration of technology into communities and institutions. What is most important is not so much the physical availability of ICT but rather people's ability to make use of those technologies to engage in meaningful local social practices.

2. Balancing between global processes and local context in educational use of ICT is important for quality of education. Creating of global virtual universities, virtual schools, multi-national educational consortiums together with international information publishing affects to the cultural foundation of education, if local context and language of delivery are not considered important. It demands the changing of educational management from hierarchical (global) institutions and delivery channels to equal distribution of network organizations and use of **social and progressive technologies** that are sensitive to local cultures and languages. It also demands more flexible and critical skills (e.g. meta-skills such as problem solving, searching information, learning skills, communication skills).

Consideration of the process of cultural globalization should be an integral aspect in the research on ICT integration in education. One fundamental research need is emerging from the interference between society's education and economic systems. Information and communication systems in education, being applications of ICT, are also outcomes of global industrial production systems of technology and information. This results in standardization of technology and technical systems that are applied in education but also standardized learning content. As we know, technology is not a neutral tool in education but a fundamental element of the social system of education enabling new emerging forms of communication and organizing of institutions. Therefore we should be aware of what the consequences of standardization of e-learning required by the global markets of education really are. As far as standards are concerned only the physical layers of technology (hardware, software), the implications may be not so enormous, but once the standards are related to the semantic, pragmatic and social layers of information and communication systems of education (content and structure of information and means of learning and collaboration), there can be fundamental consequences that should be studied.

Basically the current development of international networked institutions and virtual institutions, joint university programmes and the process of re-organizing the role of the universities in the "Europe of Knowledge" (COM, 2003) are usually seen as a part of increasing global, cultural and social awareness of education. The development can also be seen from a globalization point of view, when this development is seen as part of the global information business. These different views can be brought together by the notion that education is one system among others in our society and it can be used for solving social, economic, political, etc. problems of societies. How much research and development on ICT integration in education can take this in to account depends very much on paradigms it is following: techno-economic or social shaping of technology.

It is notable that the research on ICT in education currently lacks a global educational and societal perspective (Pulkkinen, 2003). This problem could be addressed by creating research groups together with the educational technology, economics and social sciences that are interested in information society research and the research on technology and people. This is also emphasized by Warschauer (2003) in his book: Technology and Social Inclusion. The new structure of the research groups would most probably influence the research positively in such a way that the social theories could be included into the research frameworks in their own right, not only from the contextual perspective as learning research currently does. Also research following the technical trends of e-learning or e-education focusing on the problems created by e-education itself may remain obsolete even though the application of "e-concepts" is expanding currently very rapidly in the practical development of education. These "e-problems" of "e-education" will perpetually change together with technical fads and the development of new technical devices. This is not to say that the research of ICT in education is becoming obsolete; although, it can be out of focus to some extent. On the contrary, critical research is needed urgently.

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Online Teaching: the Development of a Hybrid Course in Higher Education

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Abstract

The focus of this study was to examine learning outcomes of graduate students in a teacher education program using a 30:70 hybrid model in comparison to a traditional face-to-face classroom. In designing the 30:70 hybrid model, lectures and class discussions were continued in the face-to-face meetings, while small group discussions were moved online. The results showed no association of the learning outcomes with the classroom settings. Since this study was conservatively designed on a small scale and limited to comparison for the 30 percent of the learning outcomes between the two settings, the result of no significant difference between two classroom discussion settings should be an encouragement to investigate moving other classroom curriculum online.

1 The Hybrid Online Model

The hybrid classroom, combining both traditional face-to-face and online interaction, is a valid higher-education solution (Spanier, 2001). The hybrid classroom is often adopted in place of 100% online or 100% face-to-face teaching environments (Young, 2002). Hybrid courses offer students the convenience of online access to both lecture and course materials, and asynchronous classroom discussions while keeping the traditional face-to-face sessions. In a traditional face-to-face classroom, communication and human connection are great assets for knowledge acquisition and learning community construction. Exchanges between teachers and students and among students happen spontaneously. Good teachers know and are able to motivate each student on an individual basis. Traditionally, these connections are necessary for students and teachers to share values, ideals, and goals. When a course moves online, communication dynamics are altered and learning can be affected. Non-verbal communication cues disappear and, since students (in some hybrid models) converse asynchronously, spontaneous interaction is impossible. However, taking into consideration that online education allows students opportunities to learn independently and to construct and acquire learning at their own pace, online education provides many advantages for students beyond the classroom walls (Coates & Humphreys, 2001).

The concept of the online hybrid was introduced to higher education in the early 1990s by Rensselaer's Anderson Center for Innovation in Undergraduate Education. The 80:20 Model was developed in response to the lack of interaction of distance learning for corporate training courses. The 80:20 formats allowed students to spend 80 percent of their self-paced time to engage with online materials and 20 percent to interact synchronously with the instructor and other students (Lister, et. al, 1999). From the very beginning, the 80:20 designs attempted to integrate the social constructivist theory where students could interact socially with and learn from each other online. Capturing all the benefits of interactive online tools, the 80:20 models allowed students and their instructors to have synchronous discourses that would mimic hands-on activities similar to a face-to-face classroom (Wilson and Mosher, 1994).

2 Moving a 100% Face-To-Face Course to a 30:70 Format

In an attempt to move a 100% face-to-face course to a hybrid online format for the educational research course (one of the master education core courses) at Bridgewater State College, two different questions were discussed: Would teaching a course in educational research work for a hybrid online model? And, would the same learning activities be appropriate for both the traditional face-to-face classroom and the hybrid online?

After thoroughly discussing the pros and cons, the course EDMC530 *Teacher as Researcher* was selected for this study.

Based on the college catalogue, EDMC 530 is described as:

> This course is designed to provide graduate students in education with an introduction to the research process. Emphasis will be placed upon acquiring pragmatic skills that can be used throughout one's career. Students will not be expected to run statistical programs. The course will stress the development of skills required for the critical evaluation of current research studies. Students are expected to become informed (and critical) consumers of research literature, and become familiar with the methods and technology surrounding scientific inquiry. (Bridgewater State College course catalog)

The goals of the course were designed to enable graduate students to initiate, participate, and apply research based on readings, discussions and class activities. Students were introduced to the research process by evaluating current research studies, searching literature and designing research using a range of methodologies that apply to their chosen content area and graduate course of study. Texts selected for the course were:

- Jalongo, M. R., Gerlach, G. J., Yan, W., & Jalongo, M. (Eds.) (2000). *Annual Editions: Research Methods*. 1st Ed. Guilford, CT: McGraw-Hill/Dushkin.
- Tuckman, B.W. (1999). *Conducting Educational Research, 5th*. New York, NY: Harcourt Brace.

In examining the objectives and outcomes of the course, the course, Teacher as Researcher (EDMC 530) provided evidence that it could be moved partially online because at least 30 percent of the course emphasized group discussions. If 30 percent of the course could be moved online, then the 30:70 hybrid online model could be designed and implemented. Understanding that once the discussion component was moved online, the verbal communication cues would disappear the instructor focused on whether these online discussions would still allow students to acquire new knowledge. In examining existing studies on the brain that look at how complex and interconnected the brain is, and how the mind constructs meaning through different patterns (Gibson & McKay, 1999), it was hypothesized that the discussion components should be designed with the process of reflective inquiry that would allow students to connect problems directly to their lives. Since learning is influenced not only by new information but also by emotion and personal biases, “the need for social interaction… is ongoing and the emotional impact of any lesson or life experience may continue to reverberate long after the specific event" (Caine and Canine, 1991, p. 82). Accordingly, when moving group discussions to an online environment, the question of how non-verbal communication cues might still allow students to reassess their knowledge in response to new developments of predicted or unpredictably new knowledge created through online discussions, had to be taken into consideration when assigning the students into groups for online discussions.

Convinced that the requirements of the course were adequate for moving 30 percent of the course online, the research questions for this project were: Would the 30:70 hybrid format be sufficient to enhance students’ learning as much as a 100% face-to-face course? What would result when a course is moved to a 30:70 hybrid online format in relation to the students’ perceptions of their learning?

3 The 30:70 Hybrid Model for EDMC 530: Teacher as Researcher

In designing the 30:70 hybrid model for EDMC 530, lectures and class discussions were continued in the face-to-face meetings, while small group discussions were moved online. Using a weekly assignment format, students were required to read articles from different journals, they then posted their comments about the assigned readings and also related their personal and professional beliefs about teaching and learning. Each week, students also had to share new insights into their Research Proposal[1] (RP) to their assigned groups for discussions and feedback. At the end of the semester each student posted their RP to the whole class, and they were discussed further in the online discussion board. There, each student was assigned to critique three of their peers' RPs online, whereas the 100% face-to-face students would provide their critique in class.

4 Research Design

The main focus of this research project was to examine learning outcomes of students in the 30:70 hybrid model in comparison to the 100% face-to-face classroom for *Teacher as Researcher*, an educational research course at Bridgewater State College. Since students were self-enrolled into these courses with the cap at 20 students per class, generalization was not used for any other group of individuals. However, the samples should provide enough validity for observed differences between the two treatments. The survey tested student's knowledge about the research design process at the beginning as well at at the end of the courses. Learning outcomes were graded by the instructor using a Likert scale from 1 to 5, ranging from not understanding to clearly understanding. Since the instructor used the same syllabus, textbooks, reading assignments as well as questions for group discussions in either online or face to face classroom, a Pearson r correlation yielded a large magnitude of relationship between two variables. Demographic data for gender, teaching license status, and number of years teaching was also collected for analysis.

5 Findings

Based on student learning outcomes, no significance was found between the two groups in either pre-test (2.118 for 30:70 and 2.163 for 100% face-to-face) or post-test (4.231 for 30:70 and 4.286 for 100% face-to-face). However, when compared difference between pre-test and post-test of both class, a significant difference was found between an average of 2.141 for pre-test and 4.259 for post-test. The results indicated that the self-selected population of the two samples was homogeneous enough to reassure its validity. When demographic data for gender, teaching license status, number of years teaching was

[1] The Research Proposal was the major project for the course.

correlated to learning outcomes, the results showed no significant difference between two classrooms.

When examining treatment variations, a pre/post test design was used to explore the relationship between the two samples (see Figure 1). The results showed no association of the learning outcomes with the classroom settings, but significant difference between pre-test and post-test.

	30:70 format	100% face-to-face	Average
Pre-Test	2.118	2.163	2.141
Post-Test	4.231	4.286	4.259
Average	3.175	3.225	

Fig. 1. Pre/post test Design

6 Discussion

The focus of this study was to examine learning outcomes of graduate students in teacher education programs toward a 30:70 hybrid model in compare to a traditional face-to-face classroom. Since this study was conservatively designed on a small scale and limited to comparison for the 30 percent of the difference between the two settings, the result of no difference was not surprising. Would the result be different if the comparison was for a 50:50 or 100 percent online versus 100 percent traditional face-to-face setting? Other variables such as attitude or more time allowed for thoughtful online discussions versus spontaneous interactions, and/or understanding by means of visual communication cues versus written texts, or sharing space online versus dominating talkers in the classroom should also be investigated.

Demographic data such as age, learning styles, family living status, or living distance from campus should also be collected for comparison. The “digital divide” is another issue that one should consider when deciding to move a percentage or a course online. Are students technologically ready to get access to the online setting? If not, can the instructor or the college technology-support staff support these students? These are issues that should be evaluated and included for the next study when moving traditional face-to-face courses to a hybrid model.

Many colleges and universities are now implementing online education in a variety of formats, and the questions of reserving the quality of education have been ongoing discussions for many faculty members and administrators. It is not a question of which is better: online, hybrid or face-to-face model? It’s a question of how to design a curriculum that will deliver the most effective method for a quality education, and yet respond to the needs of the population.

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Teachers and Students as Co-Creators of Knowledge

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Abstract

This chapter addresses several concerns of teacher-practitioners as schools strive towards increasing student achievement. It shows how one classroom teacher analyzed students' academic performance, as measured through pre- and post-test scores, online think-writes, product designs, explanations and reflections in a guided-inquiry module, to find that his students made significant gains in specific learning outcomes in science and technology. Using activity theory as a framework, the authors present a conceptual model of teaching and learning as an evolving activity system that adapts and improves over time through increased student and teacher participation. The case study and narrative in this chapter illustrate how learning is enhanced when students are recognized as co-creators of knowledge in the classroom and are able to build on their existing knowledge.

1 Introduction

The problem of improving performance of students with diverse needs and abilities has concerned teachers throughout the history of modern education. More than fifty years ago the behavioral psychologist B. F. Skinner designed his first “teaching machine” after observing these challenges in his daughter’s math class (Skinner, n. d.). Today’s classrooms have similar challenges and are more demanding as teachers are expected to reach all subgroups of learners–by ethnicity, socio-economic status, pupil services, and English language proficiency. With limited contact time (Balasubramanian, 2005a; Bransford, 2000; Davis & Farbman, 2004; Popham, 2003), teachers and schools alone seem to be held accountable for helping all students meet established educational standards and perform well on high-stakes assessments.

American classrooms have not fully succeeded in this effort. Results from the 2003 Program for International Student Assessment (PISA) tests showed that 15-year-old students from 27 countries outperformed the United States in mathematics literacy; students from 28 countries outperformed the United States in problem solving (NL, 2005). These results have reopened the debate about what and how students are taught in secondary schools in the United States (Balasubramanian, 2004).

Here is a report of how one secondary school (Grade 6–Grade 12) classroom teacher has coped with these challenges by co-opting technology as an aid since December 2000, and consequently improved student performance in his classes. In sections three and four, we assume Nathan’s voice as he provides a practitioner’s perspective on efforts to help a diverse range of learners reach high educational standards in his science and pre-engineering classes. Overall, the research is a collaborative effort between Nathan and Brent, with Brent in an advisory role providing scholarly leadership, and Nathan in the classroom trenches solving problems and building successful designs for instruction.

2 Conceptual Model

In this section we provide a conceptual frame for viewing the activities of Nathan and his students. In the next section, Nathan traces the development of his ideas about teaching and their translation into a workable method for guided-inquiry lessons, which he terms the teacher's embodied theory – that is, theory embodied by a template of specific practices in the classroom. The simple model below illustrates how a teacher’s embodied theory can be combined with a core set of tools – in this case a course management system and related Web 2.0 tools – to create a meaningful learning environment for students (see Figure 1).

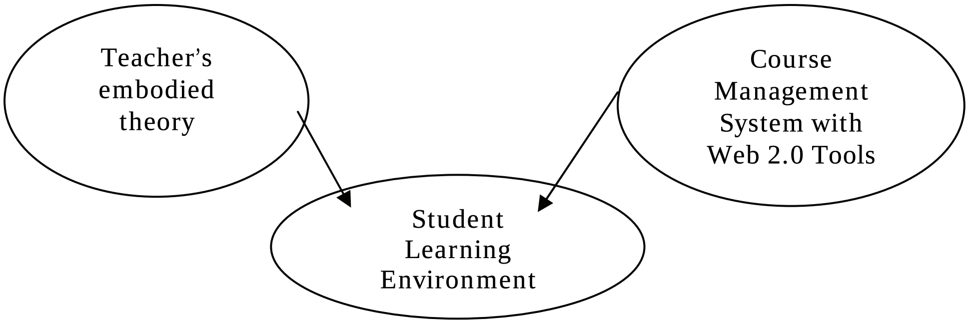

Fig. 1. Creating meaningful technology-mediated learning environments

Psychology-based learning theory can clarify how individuals process information, form and revise schemas, and develop skills and knowledge (e.g., Driscoll, 2005). *Activity theory* moves beyond individual cognition to see classroom interactions in a more objective way – as a set of nested activities within an overall system meant to pursue educational outcomes (Kuutti, 1996). Activity theory, growing out of the work of Soviet psychologist Lev Vygotsky, views learning as the inevitable result of intentional activity over time. Activity *systems* are composed of individual agents or "subjects" (teacher and students), each pursuing objects (learning goals, or more often, performance goals related to an activity). Teachers and students make use of tools (technologies but also a whole host of other tools and resources). They collaborate within a specific set of rules or conventions that dictate meaningful interactions – including some division of labor, particularly between teacher and students, but also between students, especially in working teams.

Michael Cole and Yrjo Engeström pioneered the basic analysis of an activity in activity theory (cited by Bellamy, 1996). Their ideas are widely used for understanding human-computer interactions, workgroup processes, and learning communities. Fig. 2 represents an activity analysis applied to developing "higher literacy skills" (see section 3.2) in K-12 students (adapted from Bellamy, 1996, p. 126).

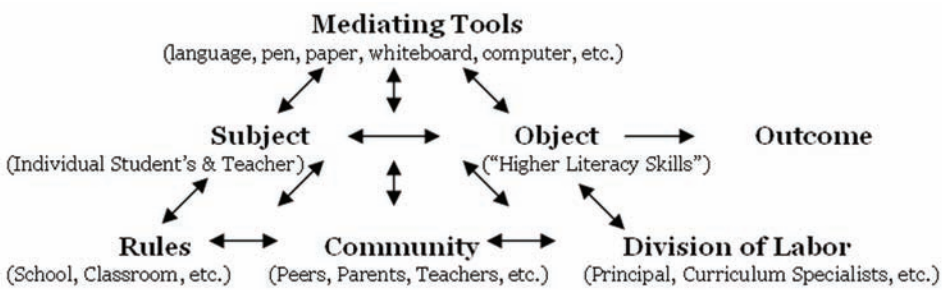

Fig. 2. Cole and Engeström's activity theory framework (adapted from Bellamy, 1996, p. 126).

The basic activity system may be defined as the entire class or a working team within the classroom, using tools and adhering to established rules and community norms to pursue objects of value. The activity leads to learning outcomes, whether intended by the curriculum or sometimes independent of a curriculum (Lompscher, 1999).

An alternate model of Fig. 1 using activity theory (Fig. 2) as a framework, illustrated in Fig. 3, reflects classroom reality. In this model, teaching and learning are part of a complex evolving activity system that adapts and improves over time through increased student and teacher participation.

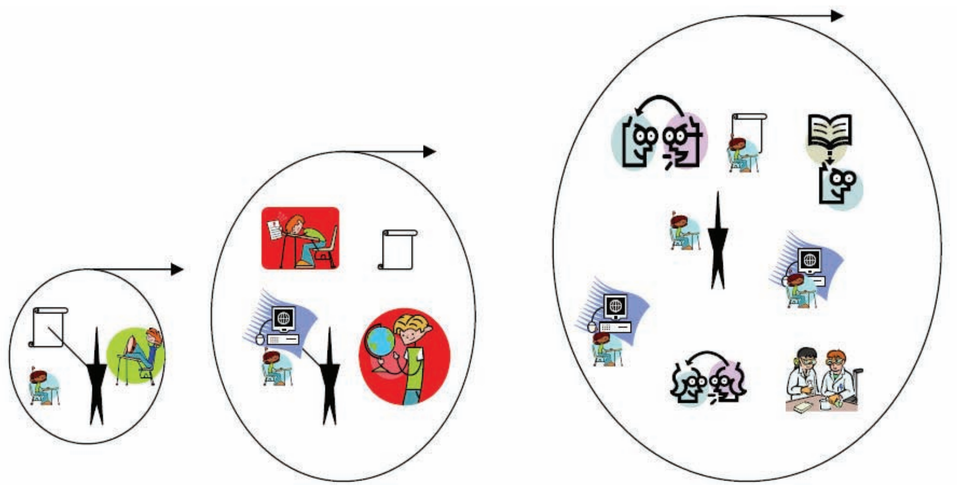

Fig. 3. Student learning environment as an evolving activity system

This figure highlights the bounded activity system typical of classrooms and how that system takes shape over time. The classroom and its corresponding online environment contain the basic elements of an activity system, including a guiding set of learning goals and objects for activity, tools and resources, division of labor, and a sense of community. The technology-based course management system and websites house the artifacts of activity, namely, the learning resources developed by the instructor, students, and the outside world.

Through an activity-theory lens, we see the central tenet of activity and people's use of tools in pursuit of goals. The learning that happens in Nathan's classes (described in sections three and four) is the result of complex, group-based, intentional activity, using available tools and resources and following established rules and roles for interaction.

3 Nathan's Journey – A Case Study

3.1 Opportunity

For 17 years, I have taught physics, applied technology and pre-engineering in middle and high schools across three continents. Since emigrating to the United States four years ago, I have immersed myself in two full-time professional responsibilities. First, I had started a doctoral program in educational leadership and innovation in fall 2002 at the University of Colorado at Denver and Health Sciences Center. Second, I had taught applied technology and pre-engineering at a middle school for three years, and now teach physics and physics engineering technology at a high school in Colorado. Both schools are considered "high-needs" because they have a large population of students from low-income migrant families and the schools' overall academic performances were "average" in 2004-2005 according to the federal School Accountability Reports (CDE, 2006). I have viewed these school environments as exciting professional opportunities – their "average" performance providing a correspondingly greater potential for improving performance.

3.2 "Higher Literacy Skills"

While interviewing students for my master's thesis (Balasubramanian, 2002) and preparing a presentation for the first Teachers-Teach-Teachers workshop at Emirates International School in Dubai, United Arab Emirates, in fall 2000, I recognized the need for making classroom resources available online for students and parents. In December 2000, I designed my first website (http://www.innathansworld.com/). This website includes extensive resources on various topics that I am passionate about, including physics, career development, and study skills. While this website afforded an opportunity to present students and their parents with up-to-the-minute curriculum information and help on physics, I recognized for the first time how few resources were available to document my effective classroom practices over the previous eleven years.

In fall 2000, I also wondered about the real purpose of teaching physics to secondary school students. Clearly, it had to be beyond helping these students be successful in their International Baccalaureate (IB) and International General Certificate of Secondary Education (IGCSE) physics examinations. I was really interested in developing students' critical thinking, mathematical reasoning, inference-making and creative problem-solving skills, what I consider "higher literacy skills" that would sustain students' lifelong learning, regardless of the career they choose. In discussions on ITForum (2003), I explored some ideas for developing enduring "higher literacy skills" by promoting deliberate reflective, critical and breakthrough thinking in our classrooms. I proposed integrating conceptual physics with career development to make learning meaningful to the students. I now know that focusing on applied science, technology and pre-engineering education in K-12 can do much to help develop students' "higher literacy skills" and enhance their career options.

Acknowledging the importance of developing students' "higher literacy skills" through technology, the International Baccalaureate Organization (IBO, 2000) concluded:

> Schools' technology courses should integrate theory and practice, including much that is scientific, ethical, mathematical, graphical, cultural, aesthetic and historical. They should encourage students to explore the synthesis of ideas and practices, and the effects of technology on societies and environments . . . (p. 9)

These conclusions have been validated by the 90% of K-12 teachers surveyed by the American Society for Engineering Education (Douglas et al., 2004) who agreed with the statements: "Understanding more about engineering can help me become a better teacher; a basic understanding of engineering is important for understanding the world around us; engineering can be a way to help teach students about business; and engineering can be a way to help teach students history" (pp. 8-10). Clearly, pre-engineering education in K-12 is supportive and not conflicting with a renewed emphasis on core academic subjects in schools.

3.3 Course Management Systems

In spite of my heavy Web use, it was not until fall 2005, when I first had access to a free course management system (CMS), that I started consistently monitoring and using students' diagnostic, formative, and summative assessments (see Fig. 5) in my classes to create a learning repository and critical mass of authentic classroom learning materials. Some of these resources have been recently featured in an educational technology magazine (Scrogan, 2006).

Course management systems (CMS) are resource-sharing environments meant to support delivery of courses from a distance. Examples are BlackBoard®, Moodle®, and FirstClass®. Services typically supported include document sharing, discussion forums, multimedia presentations, games and simulations, assessments, and grade management. In spite of some criticism concerning their embedded ideologies (e.g., Rose, 2004), CMS have proven useful supports for classroom-based, blended, and online instruction (Wilson et al., 2006).

This has proven true in my case. Throughout the 2005-06 school year, I used Schoolfusion® – a commercial course management systems effectively in my classroom to

- Monitor and manage middle-school students' work and provide them immediate feedback
- Collect real-time data on students' understanding of science and engineering concepts
- Use the information gathered to guide subsequent instruction

My students accessed these online resources while engaged in inquiry-learning activities. An analysis of students' academic performance, as measured through pre- and post-test scores, online think-writes, product designs, explanations and reflections, showed that these students made significant gains on target learning outcomes in science and technology (see Balasubramanian, 2006a).

Popham (2003) noted that the target learning outcomes handed down by the states and districts are "often less clear than teachers need them to be for the purpose of day-to-day instructional planning" (p. 6). In the following section, I illustrate how I used 41 target learning outcomes from the state science standards (Balasubramanian, 2005b) to design and develop a guided-inquiry module (Balasubramanian, 2006b). The module:

a) presents water filtration and the associated concepts in an engaging way to middle school students
b) reviews the water (hydrologic) cycle and related vocabulary with students
c) provides students an opportunity to design and build a water filter using only activated carbon, sand, gravel, cotton, plastic cup, wood structural supports, and hot glue
d) empowers students to test their filtered water for

- conductivity (remove conducting particles so electricity cannot pass),
- pH (neutralize pH to make it ~ 7 for a basic solution of salt and baking soda in water),
- turbidity (clean dirty water with tea, vinegar and coffee grounds), and
- flow rate (captured filter water should have a flow rate greater than 2 ml/s).

Even as students learn extensive content from the science standards through the water filter project, the embodied theory (section 3.4.3) provides a roadmap for designing guided-inquiry lessons that engage secondary school students. More importantly, these lessons focus on developing students' "higher literacy skills" and prepare them for their standardized tests in reading, writing, math, and science. Finally, the module empowers students by providing them valuable skills for lifelong learning. Implementation of this guided-inquiry module led to significant increases in student achievement for all subgroups of learners in spring 2006.

3.4 Embodied Theory behind Student Achievement

To foster a nurturing learning environment and student-centered instruction in my science and technology classrooms, I have students work in teams on authentic and challenging, yet fun problems. By facilitating these activities in the classroom and reflecting on my own learning, I recognize the importance of both motivational and cognitive elements in this adaptive process (Balasubramanian, Wilson & Cios, 2005; Balasubramanian & Wilson, 2006). Motivation in particular is a key for many students – one that is sometimes neglected in the compulsory educational systems now in place. The educational theories I encountered in my doctoral program are both embedded and *embodied* within guided-inquiry modules. The modules are a product of these learning theories, combined with my best creative thinking about how to embody and apply these ideas in real-life classrooms. Finally, a significant element of serendipity enters as students encounter challenges and learning materials – and respond to them thoughtfully. To some extent the modules are a product of negotiation and conversation with constituents – similar to the idea of design-based research that is increasingly popular in the literature (The Design-based Research Collective, 2003). Indeed I consider students to be my collaborators in designing effective learning experiences for them. The sections below give more detail about the water-filtration module and its conceptual basis.

3.4.1 Motivating Students through a Token "Microeconomy"

Helping secondary school students understand and be excited about science and engineering can be challenging, partly due to negative experiences many have already had in science classrooms. After presenting students with some initial challenging activities as a springboard to capture their attention, like moving a ping-pong ball from one beaker to another without touching either beaker (Movie #5, Balasubramanian, 2006c), I explain that science is a systematic inquiry directed toward an understanding of natural systems, which in turn creates new knowledge. The essence of "science" is not so much what the subject of the inquiry is, but in how the inquiry is carried out. A complete science education includes learning the processes, themes, principles, and tools of science. Technology and science are closely related. You can unlock the power of technology when you understand the science behind it. You can find out about new technology when you explore the frontiers of science. Engineering, on the other hand, requires the careful use of limited resources for solving problems in creative ways using science and technology. Besides, access to resources is always a challenge at high needs secondary schools. Although the thinking of scientists, engineers and technologists are not so stereotypical, I use Gilbert's (1978) synthesis of science and engineering to highlight two distinct approaches to problem-solving (Fig. 4).

Thinking like a Scientist	**Thinking like an Engineer**
Approaches nature with humility, for there is so much we do not know – we are surrounded by a vast sea of ignorance	Approaches nature with certainty, because there is so much we know that we have not applied – we are surrounded by a vast sea of intelligence
Is content to find out what the world is like as it is	Is intent on remaking the world
Has a well-developed methodology, and will do wherever it leads	Knows precisely where to go, and will use any methodology to get there
Makes no value judgment of nature – it is what it is	Begins with value judgment of nature – and seeks to create changes that people will value
Seeks knowledge as an end, valuable for its own sake; and worth great expenditures to gain it	Seeks knowledge as a costly means that should be applied efficiently if the costs are not to detract from the valuable ends

Fig. 4. Indicators of how scientist's and engineer's think

To *motivate* secondary school students and sustain their full interest and engagement throughout the learning process, I have used fake money for students to spend on supplies since fall 2004 in all my classes, after accidentally discovering its effectiveness in also motivating students. These token "microeconomy" dollars are not only an incentive mirroring choices and constraints in the real world, but the money also provides students both individually and collectively constant, immediate, and objective feedback on their performance in each class. The use of dollars challenges them to become creative problem solvers who are trying to maximize their limited resources. Before fall 2004, I talked to students about using resources wisely at the beginning of each school year and before each project. However, it was not very effective. In fact, when students were building air racers with railroad board paper in fall 2004, they used both paper and glue sticks recklessly. In just one class, students would consume one packet of 24 hot glue sticks. However, from the second week, when I decided that students had to pay five "dollars" to buy a glue stick, they suddenly became very responsible and used each stick almost to the last bit before they bought another. This serendipitous discovery was an eye-opener for me, as I no longer have to walk around monitoring resource use in my classes.

Here is how the system is presently implemented. Students start each year/semester/quarter with seed money of $50. Subsequently, they earn money in their classes through their active participation (Balasubramanian, 2005c) and then in turn buy all the materials or lease tools used in the classroom (like hot glue sticks, foam boards, cardboard, railroad board, string, marbles, straws, glue, x-acto knives, glue guns, laptops, probe-ware and so on). These resources cost varying amounts, from $ 1 - $200, and students use them to build and test their creations in their classes.

The monetary system of earning and trading with money has grown beyond the physical resources. The "microeconomy" is now tied in with students acting as consultants, earning royalties from patenting their prototypes, etc. Enjoying the opportunities afforded with money – or borrowing money – in a few cases, from Good Bank Inc., (if they had good credit history) or the alternate Shark Loans Inc. – coupled with the social capital they earn (green "I helped" card – or red "I asked for pointers" card) has been fascinating in its dynamic and its power (Balasubramanian, 2005c). In particular, observing a handful of students borrowing money from my loan shark company because of their poor credit history (of classroom behavior), when they ran out of money, was interesting. These students are desperate to earn and return the money at the earliest to avoid hefty interest payment (20% per week). It makes me wonder if the statistic of more individuals declaring bankruptcy in the United States than the numbers graduating from college (Godfrey et al., 2006) could not easily be reversed if more teachers instituted a "microeconomy" model of classroom management in their secondary school classrooms. Besides, the social capital component helps more students move beyond a mercenary approach to a more give-and-take collaborative approach afforded through meaningful interactions in the classroom. These goals of collaboration and empowerment stand in contrast to some uses of token economies, which place more emphasis on behavioral control.

The way in which students, colleagues and parents have resonated with this token economy amazes me. Moreover, the instantaneous feedback students receive, its highly contextual nature, and ability to support over a dozen interactions a minute during teacher-led instruction – all of these things make it a highly motivating classroom management strategy. With a concrete number for processing their learning gains, students easily recognize where they started (in $) every class and how far they have reached (in $) at the end of each class.

In fall 2005 I started the school year with the idea of studying the impact of monetary monitoring on resource utilization and student performance in two of my applied technology block classes (90 minutes each). One class served as a control group where students did not use monetary monitoring and got whatever they wanted. The other class was the experimental group – they had to buy their classroom resources. I presented both groups with the same problem – build a tallest free standing structure that is wind resistant and resembles a real building using only paper clips and straws (Movie #14, Balasubramanian, 2006c).

I abandoned the study after just the first week because students in the experimental group were careful with the use of resources and came up with elegant designs. They had to pay $2 for each straw and $10 for each paper clip. Conversely, the control-group students, however, nonchalantly depleted these resources. Specifically, while students in the experimental group barely used one box of paper clips (100 count/box) and one box of straws (100 count/box) in two classes, students in the control group used over seven boxes of paper clips (over 700) and four-and-a-half boxes of straws (over 450) in the same time.

Beginning fall 2006, I moved to teach physics and physics engineering technology at a high-needs high school in Colorado. In this school, again, the juniors and seniors, and their parents, have resonated with the “microeconomy” model, just like the earlier middle-school students and their parents. These students also use their resources carefully while creating elegant and well thought out designs and experiments because they have to buy and lease their classroom resources.

3.4.2 Bloom’s Revised Taxonomy and Levels of Thinking

When I asked middle-school students why and what they liked about hands-on activities, I heard several fascinating perceptions. One group said they liked “doing it, figuring out how it works.” Others said: “Putting stuff together was easy; don’t have to think as much; don’t have to write as much; and just have to pay attention instead of having to read a lot of stuff.” These same students however thought hands-on activities were sometimes difficult. They added:

> Building it might sometimes be hard because you have it the wrong way; write-ups and explanations after the hands-on are sometimes hard; not knowing how to solve a problem, thinking about it, measuring it right; making choices, reading a blueprint, putting it together; sometimes it is frustrating because you can’t figure it out; sometimes your team disagrees about doing things and it’s majority; not knowing how to put things together; and remembering all the stuff sometimes like in a digital multimeter.

As teachers, we know that organizing hands-on activities can be challenging because these activities require extensive planning, time commitment, organization, and modified teaching strategies. These challenges are compounded by other constraints in the classroom, like resolving group dynamics when working in teams, participating effectively during individual teams' discussions and building activities (with 7 – 10 teams, typically in each class), promoting greater social collaboration within and between teams, and coping with students' "been there, done that" attitude that hinders their learning (Balasubramanian, Wilson, & Cios, 2005). In spite of these obstacles, I use hands-on activities extensively in my classes as culminating activities because even as students build and test their creations or improve their product's performance, they spontaneously generate interesting questions. As the subject-matter expert in the classroom, it becomes much easier for me to seize these teachable moments and help my students think through their designs, carry out their investigations, and answer their own questions.

Hands-on activities, as valuable as they are, must be connected to formal terms and the established content of the science curriculum. Recognizing this, I embraced a revised two-dimensional Bloom's Taxonomy (Anderson & Krathwohl, 2001) to plan and organize the cognitive elements of my instruction. I framed the learning outcomes in such a way that students could easily see the transition from simple to complex levels of thinking for the different projects. For the filter project, even as students design, build and test their water filters, they discovered the answers to over 37 leading questions in a revised two-dimensional Bloom's Taxonomy (Balasubramanian, 2005b).

The two-dimensional framework also gave me an opportunity to present the learning outcomes using a medals-podium analogy. Although the fundamental intent was to have all students assume greater responsibility for what they learn and win, I believed that even when students demonstrated simple forms of thinking, like remembering factual knowledge, their thinking must be recognized with a bronze medal. The farther and deeper students were willing to think, the more creative and metacognitive they became, and consequently their thinking and actions must be recognized with a gold medal. While the intent was to have more students be reflective and creative "gold medal" winners, the structure provided a hierarchy for those learners who were predisposed towards linear and sequential thinking. This kind of epistemological development, helping students understand the value of creative and higher-order thinking, is a valuable learning outcome in its own right.

3.4.3 Embodied Theory Revisited

The active "doing" aspect of inquiry activities motivated several middle-school students who talked about "putting stuff together" being "easy." Others suggested that "you don't have to think as much" when doing hands-on activities. The same students were quick to point out, though, that building was "sometimes hard" and "frustrating" because, when they had a problem and "couldn't figure it out," they had to think about it. Clearly, hands-on activities were highly motivating for these middle-school students but were sometimes cognitively challenging too – even for students preconditioned to avoid thinking whenever possible. Now could I balance the two – motivation and cognition – to make learning engaging for these students and consequently increase their conceptual understanding? This question and the updated Gilbert's Behavior Engineering Model (Chevalier, 2003) continue to drive the embodied theory for increasing student achievement (see Figure 5).

The see-saw analogy is intended to show the need for both cognitive and motivational elements – and that motivational elements seem to have a significantly greater leverage than the cognitive elements. Further, the embedded four-step reasoning process becomes a cycle as students' actions turn back into reflections.

Middle-school students have a natural tendency for just completing activities without reflection. To extend Schön’s (1983) idea of “reflection-in-action,” I added the “stop” before "reflect" in the conceptual framework to add an element of cognitive dissonance, anticipation and intentionality to students’ learning. I wanted to break their rhythm and force reflection at the outset. In an effort to uncover mistaken preconceptions, I begin by asking students to respond to a hypothetical scenario and question (Balasubramanian, 2006e) – similar to a story problem about the content.

Students’ responses to these think-writes offer insights about their background knowledge. The built-in feedback in the pretest then gives them an opportunity to find out what they know and do not know. Having activated their background knowledge with my diagnostic assessments, students then access an online crossword (Balasubramanian, 2006d) to learn the essential vocabulary in a game-like environment.

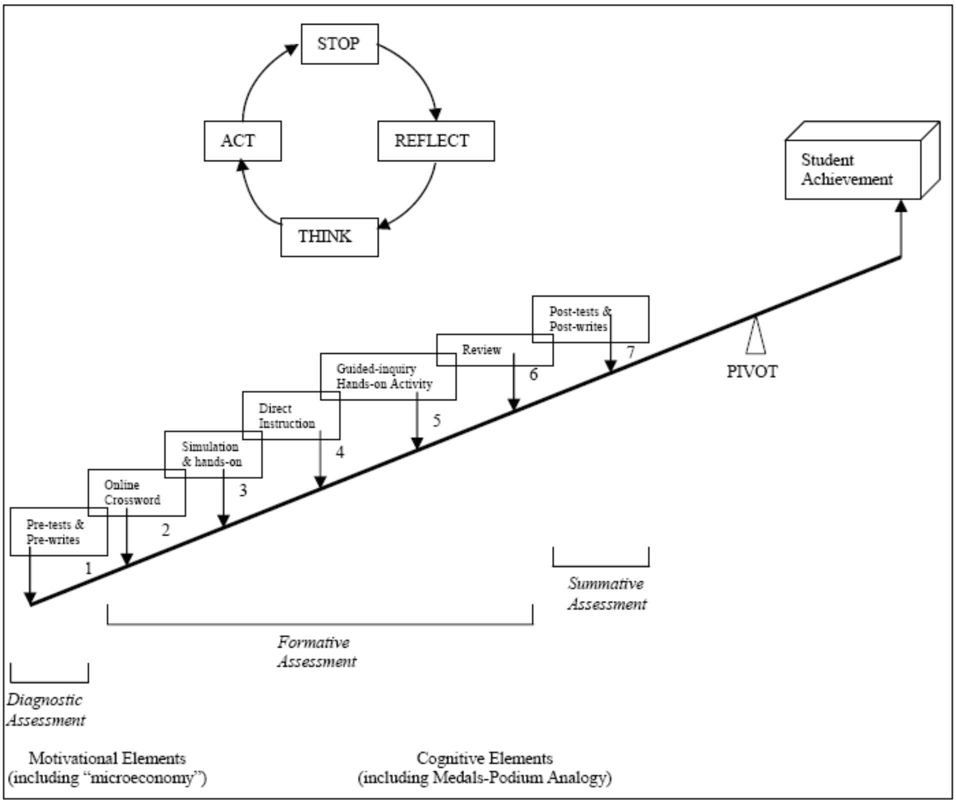

Fig. 5. Embodied theory for increasing student achievement

In my initial design, I did not provide a paper handout. However, at the high school, one student suggested that she would benefit from a paper version of the essential vocabulary in her kinematics module. Consequently, I started using a paper handout to supplement the online crosswords. While using a paper handout that contains all the clues for the crossword, students quickly learn the essential vocabulary while trying to achieve their highest percentage scores. I have had no restrictions on the number of times they may attempt the online crossword, either at school or at home. The more they practice and demonstrate their mastery, the greater their monetary gains. The "microeconomy" stimulates them to try to do their best and earn plenty of dollars before they are presented their next challenge. Students have to solve, using a simulation and/or a small hands-on activity, a simple problem. For the filter-project, students have to arrange six containers, each containing anthracite, fine sand, garnet gravel, garnet sand, gravel, and rocks, in the correct order in which they are arranged in a real filter at the water treatment plant. Then they write down their reasons for their arrangement using both photographs and the actual samples. Through this activity, students are introduced to two concepts: weight and density. And again, their writing offers "a good deal of insight into their understanding, revealing if they are on the mark or conceptualizing something very differently" (Popham, 2003, p. 88).

By this time, most students have found a clear purpose: to look, listen, and learn the concepts I then present through direct instruction. By *direct instruction*, I mean teaching students explicitly how and why things work by telling them. To give them adequate opportunities to review the resources presented during direct instruction, I use an online PowerPoint® slide show and movies of students explaining the tests for the filter-project (Balasubramanian, 2006f). In some classes where I have a prescribed textbook, students review the material with their textbook, my concept map designed with Inspiration®, follow-up homework, and mini classroom quizzes.

Once students have this rudimentary understanding, I present their final challenge as a guided-inquiry, hands-on lab activity. By *guided-inquiry hands-on activity*, I mean helping students learn by doing, including asking them questions, identifying questions to investigate (different from simply answering questions), thinking about them, designing investigations, conducting investigations, and finally formulating and communicating their conclusions in a structured, challenging and goal-oriented environment. For the filter project, students have to design a water filter using only activated carbon, sand, gravel, cotton, plastic cups, wood structural supports, and hot glue to neutralize pH, reduce turbidity, remove conducting particles, and capture the filtered water. After drawing their designs and planning how much material they would buy, students have to purchase the material for building their teacher-approved designs.

The guided-inquiry hands-on activity, followed by tests of students' designs and evaluation by their peers, leads to deeper understanding of the underlying concepts. According to Perkins (1998), students' flexibility in thinking and performing hands-on activities, beyond the rote and the routine, is one metric for measuring their deep understanding. The results of students' tests of their water filters showed several students asking more questions (Balasubramanian, 2006f), making modifications to their designs and undertaking more investigations. Finally, when they have all had a chance to build, test, modify, and test their designs, as a class we review the concepts that we set out to learn in the two-dimensional Bloom's taxonomy (Balasubramanian, 2005b). Students then take their post-tests to complete the module. The individualized feedback received via the "microeconomy" also keeps them motivated along the way. This 7-step process (illustrated in Fig. 5), I have found, results in significant learning gains for all subgroups of students in my classes. In the following section we see how inquiry activities, including some unforeseen by the instructor, led to substantial learning gains for students.

4 Results From a Pilot Study in Nathan's Class

4.1 Facilitation, Teachable Moments & Media

Several researchers (Balasubramanian, Wilson, & Cios, 2005; Yeo, Loss, Zadnik, Harrison, & Treagust, 2004) have observed that hands-on inquiry learning without domain knowledge merely entertains students and results in their inadequate conceptual understanding. Many resource-deprived students reach schools with limited cognitive skills and are consequently less motivated. Wilson (1997) observed that direct instruction to impart domain knowledge in sterile learning environments left students unenlightened and unable to see its real-world relevance. The intentional, technology-mediated "stops" thrust on students as diagnostic assessment (pretests, pre-writes, online crossword) and direct instruction (movies, PowerPoint® instruction, and concept maps designed with Inspiration®) have served as checkpoints for reflection. The periodic stops afford students more time and opportunity to access, process, review, and utilize these resources both in and outside the classroom.

However, the real fun begins, for both the students and teacher, when students actually design and engage in hands-on learning activities. For the materials module, students designed and built their water filters by using only activated carbon, sand, gravel, cotton, plastic cup, wood structural supports, and hot glue. When they tested their filters, they spontaneously started asking questions: "How do you design a filter to get a better flow rate? Does the amount of sand affect the flow rate? Does the order of the layers make a difference for filtration and flow rate? Did compressing the cotton make a difference? How many tests do you have to pass to drink the water?" and on and on (Balasubramanian, 2006e). These spontaneously generated questions are major indicators of schemas in revision. As some sixth graders reflected, "most people passed three of the four tests and none of the people passed the turbidity test with the laser." Students' passion for designing filters that could pass all four tests (conductivity, pH, turbidity, and flow rate) was fascinating and led to a remarkable investigation involving measurement, unit conversions, hypotheses testing, and density. The teachable moment serendipitously surfaced when students wanted to know how they could "pass" the turbidity test. This gave me an opportunity to highlight sand's adsorbing and absorbing abilities.

The supplementary activity started one day when I asked a sixth grade student to bring a piece of sponge (used to remove flux and excess solder in a soldering iron) from the tool room at the back of my class to illustrate absorption. She brought one along and I then asked the class, "What would happen to this sponge if we soak it in water?" They said it would become bigger and heavier because the sponge absorbs the water. They visually and physically verified their hypothesis by soaking it in running water. However, one student was skeptical and asked "How do you know the sponge become bigger when its wet then its dry? [sic]" This was a legitimate question and we had not been diligent enough to record the dimensions or masses of the dry and wet sponge. Thinking nonchalantly that I could resolve it by bringing another piece of dry sponge from the back of the class, I asked the student to bring another piece of sponge. However, when she could not find one, I had to bring a "compressed" sponge from a new soldering iron. Just then, another student had a new question: "Which would be denser, the dry or the wet sponge?" Acknowledging that it was a great question, I went on to explain how density depends on both mass and volume and then guided them through the design of an experiment for investigating the density of dry and wet sponge. We made our educated guesses about the densities of the wet and dry sponge before experimenting and students demonstrated their measuring skills with a ruler and a triple beam balance. When we started recording and calculating the density with our measurements, the problem became interesting.

Initially, almost the entire class and I guessed that the wet sponge would be denser. Our reasoning was that the change in mass was more likely to outweigh the change in volume. However, the two girls who asked these questions to start with, guessed that the dry sponge would be denser and seemed bent on proving their hypothesis. Students took turns carefully measuring the dimensions and masses, and then had their measurements verified by their peers. Since the first student started measuring the length using the standard English units, the others continued using the same units. I recorded the results on a data table (Balasubramanian, 2006g) and showed them how I use Google® to change units from the English to the metric system. For example, I typed in the search box, 2 3/8 inches = ? cm and clicked on search, and bingo, Google® immediately returned (2 3/8) inches = 6.0325 centimeters. Students were thrilled to see this and one student immediately asked "Can Google® convert decimals into percents? [sic]" This one student was disappointed that it could not. At any rate, after recording their measurements, we converted them to metric units and calculated the density in metric units. Instead of confirming the hypothesis of the majority of our class, the hypothesis of the two girls seemed to be validated from our initial results. We were now close to the end of our class and I asked them what they had learned from this activity.

Students said this experiment showed them:

> that the wet sponge has less density than dry sponge; we learned numbers like g, cm, length, of wet and dry sponge, that the absorption goes in the middle and the adsorption goes around it. I also learned that Google® cannot convert decimals into percents, and also if you squeeze cotton it traps dirt easier; I learned that the skinny little sponge can grow up to the size of the big one and can weigh the same; I learned that the wet sponge has less density; I learned that the wet sponge has less density by measuring the mass, the weight, and the length and the height of the wet and dry sponge. I also learned that there is absorption and adsorption. Absorption is when the particles go to the inside and adsorption when the particles stay on the outside; I learned that when you get a sponge wet, it gets bigger; I learned that the wet sponge is less dense than dry sponge; I learned that Google® will give you answers to equations; I learned that absorption goes to the middle of the sponge and adsorption is on the outside [sic].

Although school ended and I had to rush to a class at the University, I could not stop thinking about the results of our experiment. I was thinking about these results all night and decided to investigate our findings further the next day with my eighth graders. I told them about what had happened the previous day and repeated the student's question "Which would be denser, the dry or the wet sponge?" I asked them to design an experiment to investigate this and they repeated the activity. This time though, we used the same sponge, first for the dry sponge activity and then for the wet sponge activity, during our investigation. The results this time, in contrast, confirmed our initial hypothesis that the wet sponge was indeed denser. This was a fascinating learning experience for all of us and I thought my students had done almost a semester's worth of science in just one class. When I shared this thought with the eighth graders and asked them to give me an honest rating from 1-10 on my gut statement, based on their three years of middle-school experience, the average class rating was an eight. I repeated this claim after sharing the new findings with my second sixth grade class as well and commended the two girls from the first sixth grade class for leading us into this interesting investigation. The girl, who asked the question "How do you know the sponge become bigger when its wet then its dry? [sic]," spontaneously took ownership for preparing a PowerPoint® slide show and came up with this interesting presentation (Balasubramanian, 2006g). She was one of my English language learners and a student with pupil services, and her outstanding slide show is further testimony to what might be accomplished when technology becomes an aide to motivated students and competent teachers.

4.2 Pretest and Post-test Comparisons

The results from the pilot study using a pretest-post-test design with 56 students (one Grade 8 and two Grade 6 classes), taught at a high-needs middle-school north of Denver during the school's "waning days" (Lyman, 2006) in spring 2006, are summarized below. I developed the 60 multiple-choice questions from the two-dimensional Bloom's taxonomy (Balasubramanian, 2005b) to assess students' science, technology and pre-engineering knowledge and skills. I used the same 60 questions for both the pretest and post-test.

Interestingly, despite the small sample sizes and minimal teacher intervention, the mean test scores increased significantly (except for direct instruction for Caucasian male students) from pretest to post-test for the entire class, even with disaggregated data by gender, ethnic minorities (African-Americans and Latinos) and pupil services (SPED, ILP, IEP & Math Lab). These gains are statistically significant (at the established 0.05 level and $p < .001$) suggesting less than .1% probability that the observed differences happened by chance. The number after ± in the pretest and post-test mean scores is the error, the standard error of the mean – the standard deviation of the distribution of the mean of samples.

Group	N	Pretest Mean (%)	Pre-test SD (%)	Post-test Mean (%)	Post-test SD (%)	t-value	p- value	Pre-Post Δ (%)
Entire Class	56	37.9±2.3	17.1	52.4±2.4	18.1	6.230	<.001	14.5±4.7
Caucasian Male	13	50.8±5.0	18.1	57.7±4.0	14.4	1.326	.209	6.9±9.0
Girls	29	34.3±2.6	14.2	50.6±3.8	20.3	5.011	<.001	16.3±6.4
Ethnic Minorities	26	33.8±2.7	14.0	49.6±3.0	15.3	5.448	<.001	15.8±5.7
Pupil Services	21	29.4±2.8	12.7	44.4±3.6	16.6	4.238	<.001	15.0±6.4

Fig. 6. Summary of two-tailed, paired sample t-tests on hydrologic cycle test (before and after direct instruction)

Group	N	Pretest Mean (%)	Pre-test SD (%)	Post-test Mean (%)	Post-test SD (%)	t-value	p-value	Pre-Post Δ (%)
Entire Class	56	39.4±1.4	10.6	58.5±2.2	16.6	10.282	<.001	19.1±3.6
Caucasian Male	13	40.7±2.2	8.1	65.4±5.0	17.9	5.556	<.001	24.7±7.2
Girls	29	40.5±2.1	11.2	57.2±2.9	15.6	7.593	<.001	16.7±5.0
Ethnic Minorities	26	38.5±2.0	10.1	53.4±3.0	15.3	5.336	<.001	14.9±5.0
Pupil Services	21	35.1±2.0	9.4	50.3±3.1	14.1	4.975	<.001	15.2±5.1

Fig. 7. Summary of two-tailed, paired sample t-tests on water test (before and after guided-inquiry hands-on activity)

I further examined the pretest and post-test scores of these 56 students and found that the questions were highly correlated. This suggests that the observed changes in students' scores may not be attributed to the regression effect, a regression towards the mean. Instead, all subgroups had actually made significant gains in their post-test scores as Figures 8 and 9 illustrate.

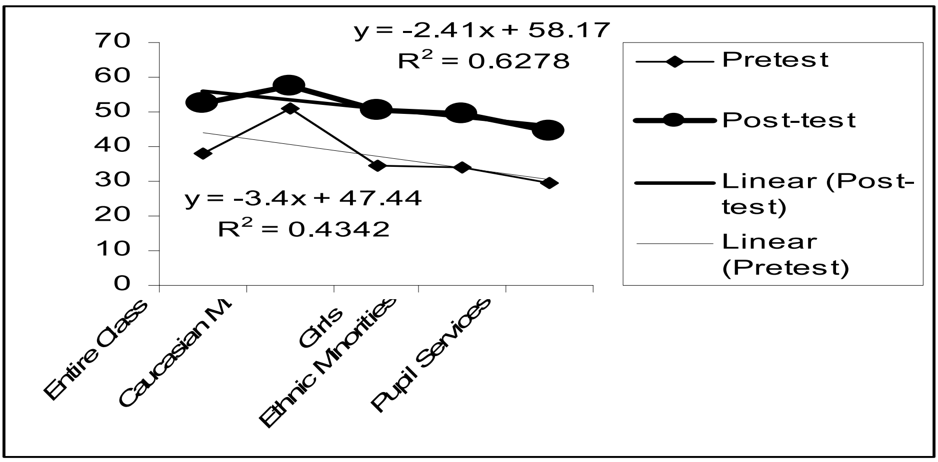

Fig. 8. Pretest and Post-test scores of four subgroups in the 18-item hydrologic cycle test in the filter project, before and after direct instruction

The y-intercept of the trend lines in Figures 8 and 9 for the pretest and post-test data provides interesting information. For the direct instruction, student achievement increased from 47.4% to 58.2%, showing a 10.8% performance gain. However, for the guided-inquiry hands-on activity, the increase in student achievement almost doubled, increasing from 42.1% to 65.5%, showing a 23.4% performance gain.

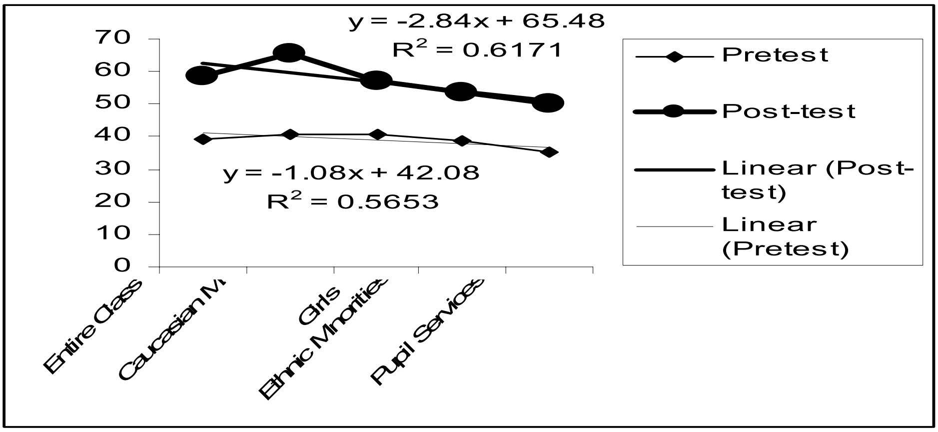

Fig. 9. Pretest and Post-test scores of four subgroups in the 42-item water test in the filter project, before and after guided-inquiry hands-on activity

These numbers are promising when we consider the stark inequities in engineering education in American society. With decreasing trends in engineering in recent years (Douglas et al., 2004), "Female students make up 20% of engineering undergraduates, but 55% of all undergraduates; African-Americans, 5.3% in engineering, 10.8% overall; and Latinos, 5.4%, compared to 6.4% overall" (p. 5). Experts nationally have noticed these trends and consciously try to recruit more minorities in science and engineering through outreach programs. However, the Caucasian male students and their parents, who are not aware of these trends often feel left out when institutions or teachers talk about these equity issues. The findings from this study might comfort them, because they show that with well designed guided-inquiry hands-on science and technology instruction, Caucasian male students also make significant learning gains in the post-test scores, 24.7%, more than the 23.4% gain in the trend line. Evidently, guided-inquiry hands-on learning not only addresses equity issues and increases student achievement for all subgroups of learners but it also results in significant learning gains for the Caucasian male students.

5 Conclusion

We started this chapter by introducing the challenges and questions that teacher practitioners have to deal with in today's classrooms. While students might come from different backgrounds and differing abilities, learning is enhanced when students are recognized as co-creators of knowledge in the classroom and are able to build on their existing knowledge. In addition to providing content expertise, a teacher's role is more of a facilitator who is responsive to learner needs and actions. We described how the curriculum standards were operationalized by a teacher through design of a guided-inquiry module that resulted in significant learning gains for all subgroups of learners. While substantially hands-on and inquiry-based, the module included elements of direct instruction and game-like activities. Moreover, the narrative in section 4.1 illustrated how inquiry activities lend themselves to unforeseen teachable moments based on students' questions, adding a spontaneous level of true inquiry for teacher and students alike.

Our secondary school students arrive in our classrooms ready to collaborate in both face-to-face and online environments. Teaching and learning are enhanced when teachers use tools like online discussion forums and interactive games and simulations, which can be embedded in course management systems to aid reflection, data collection, and student engagement (Balasubramanian, 2006a; Balasubramanian & Wilson, 2006; Wilson et al., 2006).

In this chapter we presented a conceptual model of teaching and learning as an evolving activity system in which the "higher literacy skills" of critical thinking, mathematical reasoning, inference making, and creative problem solving are nurtured through guided-inquiry hands-on activities. Everyone is a winner when students and teachers accept and exploit the evolving nature of such learning environments. Evidently, using these techniques require innovative teacher-leaders who are willing to contribute their time for planning, reflecting, sharing and collaborating with their peers and students to create engaging technology-mediated learning activities in their classrooms.

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Supporting Novice Teachers in Diverse Contexts: A Practical Instructional Design Model

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Abstract

Novice teachers encounter a variety of challenges and uncertainties not only regarding classroom management and cultural diversity, but also subject matter expertise, integrating technology, and instructional design. Understanding how to design a good curriculum is a way to reduce these uncertainties. The purpose of this chapter is to suggest a design model that can be used by instructional designers and teacher educators to foster reflective, systematic instructional planning in novice teachers.

1 Introduction

Novice teachers encounter a variety of challenges and uncertainties not only regarding classroom management and cultural diversity, but also subject matter expertise, integrating technology, and instructional design. Preparing novice teachers to teach in a high need and low socio-economic status (SES) school in both rural and urban environments can significantly increase the burden placed upon teacher educators. Learning how to plan, both physically and mentally, is a way to deal with unpredictable situations in school environments. The aim of this chapter is to help novice teachers become intentional instructional designers and reflective practitioners – professionals who can work with the complexities of teaching in classroom contexts in an age of rapidly advancing digital technology and cultural diversity. To prepare novice teachers to work with these complexities, they must be not only guided through basic stages of lesson design; but also prompted to engage in reflective activities. In this chapter, the authors present a working model for facilitating this process called *Introducing Design to Novice Teachers* (ID_{NT}).

2 Rationale: Another Instructional Design (ID) model for teachers?

There are a variety of instructional design models that have been developed specifically for use by teachers (e.g. Gustafson & Branch, 1997). In addition, preservice teachers have been documented using different instructional design models for lesson planning (Klein, 1991). Instructional design models can be used as tools in helping novice teachers to think like experts. For example, Clark and Peterson (1986), in a review of teacher planning, found that systematic planning provides novice teachers with a framework for developing a personal lesson-planning style. In addition, the systematic approach is something inherent in the field of Instructional Design and is represented through the number of design models that inform our practice. Some selected examples of ID models for teachers are the following: the Technology Integration Planning (TIP) Model (Roblyer, 2004), the iNtegrating Technology for inQuiry (NTeQ) Model (Morrison & Lowther, 2005), the ASSURE Model (Smaldino, Rusell, Heinich & Molenda, 2005), and the Design-Plan-Act (D-P-A) System (Lever-Duffy, McDonald, & Mizell, 2003). In most cases, existing ID models for teachers appear to either: a) have been developed for more experienced teachers who have prior knowledge of teaching and learning, b) promote a single instructional strategy, or c) seem too complex for novice teachers to internalize and use. In addition, they usually do not explicitly promote reflective practice. Although Baylor and her colleagues have created two “self-reflective” tools for preservice teachers, the Instructional Planning Self-Reflective Tool (IPSRT) (Baylor, Kitsantas & Chung, 2001) and the Constructivist Planning Self-Reflective Tool (CPSRT) (Kitsantas, Baylor & Hu, 2001). However, these two tools do not move novice teachers towards a deeper level of practical and critical reflection.

As Ertmer (2001) suggested, novice teachers need a more responsive instructional design model - one that addresses both the principles of systematic design as well as teachers' beliefs about teaching and learning. The ID_{NT} model addresses the needs of preservice teachers who lack knowledge of design principles and reflective dispositions. ID_{NT} is not a prescriptive model, rather one that teacher educators can use as a schema-building strategy to guide novice teachers in their investigation of successful instructional design and teaching practice.

3 Theoretical Framework: What is the basis for the model?

3.1 Novice Teacher Performance

In their review, Hogan, Rabinowitz and Craven (2003) describe several important differences between expert and novice teachers in the area of pedagogy. For example, unlike expert teachers, novice teachers fail to visualize planning as a scaffold of events. Instead, they perceive lesson planning as an individual, daily episode unconnected to the curriculum as a whole. Experienced teachers require more details when planning a lesson (such as availability of equipment, student ability, and prior knowledge). In contrast, novices generally disregard these details and proceed to develop the lesson. While experts tend to use multiple assessment strategies throughout a lesson in order to understand students' schema before introducing new materials, novices tend to teach in ways that disregard the importance of the connection between prior and new knowledge. In fact, experts regard the classroom as a make-up of individuals with personal prior knowledge and individual differences. Effective teachers meet the needs of diverse learners, are skilled in culturally responsive pedagogy (Gay, 2002; Ladson-Billings, 1995), and implement particular multicultural instructional strategies such as active learning, critical pedagogy, and student choice (McNeal, 2005). On the other hand, novices attach a homogeneous identity to the class and base their instructional strategies on a general level of ability, knowledge, and interest.

Designing reform-based, technology integrated lesson plans is particularly challenging for preservice teachers who lack the level of content knowledge, pedagogical content knowledge and pedagogical expertise possessed by their more experienced colleagues**.** Novices tend to implement their lessons in a more scripted manner and lack the ability and confidence to change directions during implementation. According to Tubin and Edri (2004) experienced teachers who use a "flexible" planning approach, one that is open to change during the implementation phase, are more effective in integrating technology than those who used fixed planning.

Although teacher education programs can not graduate experts, they can assist preservice teachers in their development of pedagogical expertise. Instructional design models are useful tools in helping novice instructional designers think more like experts. They provide explicit directions, steps and scaffolding for the beginning designer. The ID_{NT} model addresses the pedagogical gaps of typical novice teachers. It also encompasses a reflective component to promote schema development and a level of awareness that could assist novice teachers with lesson design in complex and diverse environments.

3.2 Reflective Practice

A core element of teacher development, and thus IDNT, is reflective practice (Dewey, 1933; Zeichner & Liston, 1987, 1996;). Schön, (1983) suggested that there are two types of reflection: reflection-on-action (looking back on an incident) and reflection-in-action (considering the incident as it unfolds). According to Schön (1983), reflection-in-action depends on the intuitive performances that lead to surprises that can be pleasant, desired, confusing, or unwanted. Reflection-in-action is bounded by the "action-present," the amount of time in which an action can impact the situation. Killion and Todnem (1991) extended the ideas of Schön to include reflection-for-action, the desired outcome to guide future action. Thus the reflection process simultaneously includes past, present and future timeframes.

Researchers have developed frameworks to measure different levels of reflection. For example, Van Manen (1977) created a three-level-taxonomy of critical reflection: technical (application of knowledge and skills), contextual (analysis and clarification of practices, consequences, meanings and assumptions) and critical (questioning worthiness, socio-political issues, and inequality). Another framework, Reflective Pedagogical Thinking, was created by Sparks-Langer, Simmons, Pasch, Colton and Starko (1990). This framework distinguishes seven types of language and thinking employed by the teacher. These range from "no descriptive language" to "explanations with consideration of ethical, moral, political issues" (p. 27).

Increasingly, teachers encounter schools with students that are diverse in culture, ethnicity, race, religion, and language. Prospective teachers bring prior educational experiences and beliefs about teaching, learning, children, and culture into their preservice teacher preparation programs. These powerful influences create deeply ingrained schemas that can be difficult to alter (Feiman-Nemser, 2001). In order for teachers to create meaningful, culturally relevant instruction, they first need to develop deeper self-knowledge about how their own backgrounds and beliefs might shape their teaching and their students' self- perceptions (Howard, 2003).

For teacher educators, the key to promoting reflective practice lies in helping preservice teachers look beyond just the technical (application of knowledge and skills) and contextual (analysis and clarification of practices, consequences, meanings and assumptions) aspects of teaching to questioning their knowledge and assumptions at the critical level (Van Manen, 1977; Gay & Kirkland, 2003). Ideally the level of reflection parallels the growth of the practitioner from novice to expert (Van Manen, 1977). However, research by Ferry and Ross-Gordon (1998) indicates that experience alone may not promote more sophisticated levels of reflection. Rather, the way that the educator uses the experience to reflect upon specifics of a problematic situation appears to foster development as an expert.

Novice teachers need opportunities to construct their own teaching narratives that are not only informed by research, theoretical frameworks, and outside experts (Sparks-

Langer & Colton, 1991) but also connected in numerous ways to their experiences in schools. This narrative construction promotes the practice to theory approach embraced by teacher educators (e.g. Korthagen & Kessels, 1999). Responsive instructional design (Ertmer, 2001) suggests that in order to build efficacy and influence teachers' pedagogical approaches, their beliefs need to be made overt. Therefore, developing reflectivity in novice teachers during their instructional design process is an important first step toward exposing teachers' beliefs and design decisions as well as promoting professional growth (Dewey, 1933; Schön, 1983; 1987).

4 The Introducing Design to Novice Teachers (IDNT) Model: How does the model work?

The IDNT model blends a learner-centered philosophy with the proper amount of guidance needed to help novice teachers become more comfortable planning activities for their classrooms. IDNT also helps novices draw attention to cultural and socioeconomic awareness, awareness of self, and awareness of context necessary for working in diversely populated environments (an element not considered in many currently published ID models). IDNT is a two-part model. One component is a guide for lesson/activity design. The other represents a metacognitive process to promote reflection and identify beliefs. See Figure 1.

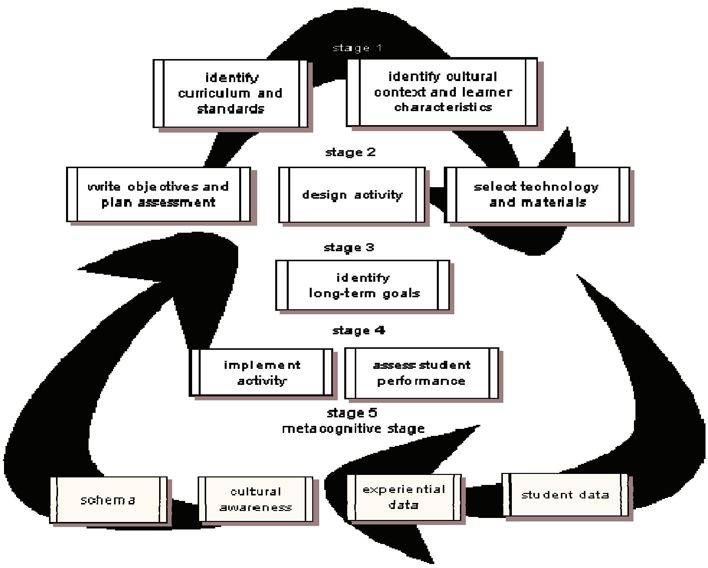

Fig. 1. IDNT model

IDNT is a model meant to link practice and theory. Part 1 for lesson design includes four stages through which novice teachers develop lesson plans.

Part 1: Lesson Design

Stage 1. Novice teachers identify the curriculum and its corresponding standards as well as cultural context and learner characteristics. The first step is to identify students' knowledge, skills, and attitudes related to the curriculum as well as preferred learning styles. Novice teachers are encouraged to use surveys, pre-tests, or class discussions in order answer questions such as: In what ways are students diverse (including exceptionalities)? What are their learning styles? What experiences or background knowledge do they have in relation to this topic?

Often teachers do not design their own curriculum, but rather modify or tailor the subject matter to better reflect their students' knowledge and experiences. Thus, as part of stage 1, the IDNT model recommends novice teachers to examine the prescribed curriculum and standards in relation to their local context. For example, a science lesson on iron ore may be presented differently to students of a rural mining community than to students of an urban business community. What the students know about the topic and how they relate to the curriculum could be quite different. This information may be obtained from local and state curriculum guides, national educational organizations, textbooks, school faculty, and other resources. Novice teachers would be asked to consider questions such as: What is the curriculum for your students? Does it include diverse and multiple perspectives? What are the standards aligned with your curriculum and your specific lesson? A review of the materials may reveal gender or cultural bias or absence of a particular group's representation. Supplemental materials could then be added.

Pedagogical content knowledge (PCK) is the teachers' ability to identify learning difficulties and students' misconception combined with the fluidity necessary to transform subject matter using "the most powerful analogies, illustrations, examples, explanations, and demonstrations—in a word, the ways of representing and formulating the subject that makes it comprehensible for others" (Shulman, 1986, p. 9). Because novice teachers often have gaps in their content knowledge as well as PCK, the novice teacher is asked "What do *you* know about the subject matter in the curriculum?" Later, in stage 3, they will be asked how they will teach it.

Stage 2. Novice teachers need to identify long-term goals that reflect upon the data analysis of both learners and curriculum. Novice instructional planners are asked to consider the following: At the end of this unit of curriculum, what is it that you want your students to recognize, know, and be able to do?" Towards the end of the lesson design a follow up question could be, "Did the lesson design build the knowledge, skills, dispositions that your students will need to reach the objectives and long term goal?" Repeating the goals for the unit of curriculum each time the daily lesson plans are written is designed to help novice teachers avoid the pitfall of dividing lessons into discrete pieces of instruction (Hogan, Rabinowitz & Craven, 2003).

Stage 3. Novice teachers write the objectives, plan the assessments, design the activities, and select the technology and materials needed for the lesson. These elements are recursive. The teachers may modify each at any point as they work through this stage of the design process. Novice teachers often list performance standards as their objectives; thus, IDNT encourages novice teachers to rewrite these standards into measurable outcomes that reflect their learners' characteristics and align with the broad curriculum goals. At the same time, novice teachers also determine what evidences they will use to determine if their students have achieved the desired understanding. Novice teachers might be asked: "Considering your learners' characteristics and curriculum standards, what should your objectives be?" Or, "What types of evidence do you need to measure students' understanding?" Because some teachers tend to think of assessment as a "single-moment-in-time test at the end of instruction" (Wiggins & McTighe, 2001, p.13), the IDNT model is designed to encourage novice teachers to plan for collecting multiple and varied pieces of evidence over time in order to document students' ongoing inquiry, rethinking, and growth. This information is crucial for use by the teacher at a later time to analyze student work, thus determining the strengths and weaknesses of the lessons.

As novice teachers design their activities, they are encouraged to consider a holistic integration of technology, culture, and critical thinking suitable for the content area. The following are examples of guiding questions: "Using what you know about your students, how will you gain the students' attention and motivate them?" "What specific types of activities will the students and teacher engage in that support higher order thinking skills?" "What grouping arrangements, if any, will you use?" "Can you use technology to support this lesson? If so, how?" During this recursive step, novice teachers might realize that their learners need additional skills in order to complete an activity; thus, additional objectives and modification of lesson activities might occur. Questions such as, "Looking back at your lesson design, what, if any, changes do you need to make before implementing with your students?" are intended to promote the design flexibility found in expert teachers (Koeppen, 2005; Tubin & Edri, 2004).

Stage 4. Novice teachers are asked to implement their activities and assess their students' performance. They may be asked: How long is each activity? What materials and supplies are needed? How will you transition from one part of the lesson to the next? Implementation and assessment generally occur simultaneously as the teacher checks students' understanding and abilities to meet lesson objectives.

Next, the novice teachers evaluate how well they implemented the lesson. This is the reflection piece of our model or *the metacognitive component*.

Part 2: Reflective Evaluation

Part 2 of the IDNT model is designed to help novice teachers develop pedagogical problem solving ability and PCK. Based on Schön's (1983) idea of reflection-in-action, pedagogical problem solving is the ability of the teacher to analyze a learning situation in progress, select appropriate strategies or interventions and make corrections while teaching. Sweller (2005) contends that working memory can process only a limited amount of information. However, information in long-term memory can vastly expand the working memory. Furthermore, “all skilled performance in complex domains requires the acquisition of countless numbers of schemas held in long-term memory” (Sweller, 2005, p.21). The IDNT model is to facilitate the continuous development of beginning teachers’ schemas regarding effective teaching and learning within the complexities of classroom contexts.

Stage 5. Instructional designers and teacher educators can use the model to scaffold preservice teachers through a reflective process in which they consider four elements: student data, experiential data, cultural awareness and their mental models of teaching. First the preservice teachers make meaning of the students’ performance derived from both informal and formal assessments given during this lesson and build upon it from previous lessons. They consider questions such as, “What understandings or misconceptions did the students have about the content?”

Next, the novice teachers are asked to reflect on their own teaching and learning experiences in relation to their students’ learning. This experiential data is derived from critical incidents (Tripp, 1993) that occurred during the lesson. Tripp (1993) suggests that teachers identify or “create” critical incidents based upon value judgments: “Incidents happen, but critical incidents are produced by the way we look at a situation” (p.8). Critical incident analysis provides novice teachers a venue for deeper and more profound levels of reflection as well as a means to challenge their teaching and learning schemas (Griffin, 2003; Hamlin, 2004). It also provides the opportunity for a novice teacher to begin to understand teaching events from their students’ perspectives – something that has been identified as an effective way to plan and improve lessons (Ornstein, 1997). Using Griffin’s (2003) framework for reflecting on the critical incident, a novice teacher might be asked to document what occurred during their teaching episode, how they felt about it, and why certain events happened - telling it from the perspective of each participant (themselves and their students). Next they classify aspects of teaching, learning and schooling surrounding this episode, and connect it to educational theories and professional standards.

The novice teachers are then asked to consider their own cultural background, beliefs, prejudices and notions of culture and how these might have influenced the lesson design, lesson implementation, and their students’ understandings and perceptions. Finally, they are asked to describe their mental model of effective teaching and compare their own practice to this model. Mental model here means, “an internal mental representation of some domain or situation that supports understanding, problem solving, reasoning and prediction in complex, knowledge-rich domains,” such as a teaching (Azevedo & Cromley, 2004, p.525). With the insights gained from this metacognitive activity, the novice teachers are encouraged to make modifications to the current activity and future lessons, thus moving from reflection to action (Killion & Todnem, 1991).

5 Evaluation: Does the IDNT model work?

The IDNT model is in various stages of validation. First, development research was employed as a design framework to ensure not only the soundness of practical and theoretical goals, but to also guarantee the use and sustainability of the model. Development research is appropriate when both practical and theoretical research goals are involved (Reeves, Herrington, & Oliver, 2004; Richey, Klein, & Nelson, 2003); and when the research aims to solve imminent, authentic problems while at the same time generating design guidance for practitioners in the field (Ma & Harmon, 2006; Reeves, 2000). For internal validation, input from middle and secondary education teacher educators during the construction of the model was collected. These teacher educators have implemented the model on a limited basis with their students in order to make suggestions for revision. Internal validity is being established via a rapid prototyping process that involves presenting the model in various forms to stakeholders and potential users for review and for further revisions (Calandra, Lai, & Sun, 2007). For example, early field tests on the reflective component of the model showed that ID_{NT} used in conjunction with digital video editing assisted novice teachers in reaching higher levels of reflection (Calandra, Brantley-Dias & Dias, 2006; Fox, Brantley-Dias & Calandra, 2006). External validity will be established by observing the model being used by novice teachers in elementary, middle and secondary education programs at various stages in their programs.

6 Conclusion

Professionals have attempted to use ID models to improve K-12 education (Moallem, 1998; Young, Reiser & Dick, 1998). Moallem and Earle (1998) identify two primary approaches that have been taken in the past to disseminating ID models in the public schools: 1) Providing school systems with systematically designed curricula and materials to be implemented by the teachers; and 2) empowering teachers as designers of their own curricula through the use of the fundamentals of instructional design models to "plan, evaluate, and modify instruction as a regular ongoing process in their classroom instruction" (p. 6). IDNT is designed to promote the latter approach.

Learning to teach is a process. Novice teachers cannot be expected to have access to schemas regarding teaching and learning that are as robust or as easy to access as experts whose teaching practice has become more internalized and automatized through time and experience. Teacher educators therefore need to model planning and reflection for preservice teachers. Expressively deconstructing lessons following IDNT can expose these novice teachers to the complexity and uncertainty of lesson design and delivery (Koeppen, 1998). Discussing with them how their own professors go about designing, evaluating, and modifying a lesson demonstrates the recursive nature of design and exhibits the "flexible" pattern that Tubin and Edri (2004) describe as characteristic of expert teachers. IDNT can scaffold such a process. It is the authors' desire that instructional designers and teacher educators use IDNT to aid novice teachers in developing an internal set of schemas that would simultaneously shape and be shaped by their learning and "real-world experience" of effective teaching and learning. These schemas should in turn support their teaching efforts in the socially, culturally, and linguistically diverse classrooms of the twenty-first century.

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‘Celebrating Success’ – a Continuing Professional Development Project in Information and Communication Technology within a Teacher Training Institution

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Abstract

Within any Initial Teacher Training (ITT) institution, there will be both those members of staff who are forging ahead at the cutting edge of the technology and applying Information and Communication Technology (ICT) in every possible way to assist them with their daily work, and there are others who remain committed to the ‘old’ ways of working. This developmental project has been designed to encourage and support Continuing Professional Development (CPD) in ICT, where those members of staff with experience share and support their colleagues who have not yet fully embraced the technology. The outcomes were interesting in that not only were ICT skills generally enhanced and applied more ‘effectively’ and ‘efficiently’, but also that a much richer research culture developed.

1 Introduction

The current situation with regard to the application of *Information and Communication Technology* (ICT) by members of staff within *Initial Teacher Training* (ITT) institutions, is highly variable. At one extreme there are the staff who are advanced practitioners ('early adopters') using ICT extensively, whilst at the other end of the spectrum there are those who are struggling to come to terms with the 'new' technology within their daily work, and rarely apply it, if at all. This raises an important question as to how the difference in the level of competence can be reduced by helping those with less ability? What are the problems which generate this gap and how can they be overcome?

The School of Education and Training at the University of Greenwich, trialed a methodology of *Continuing Professional Development* (CPD), which was designed to not only improve ICT knowledge and skills level of staff, but also to ensure that they were able to apply the technology appropriately to enhance their daily work. The Greenwich CPD Project utilized 'early adopters' as mentors to guide and support a colleague's ('buddy') ICT development. The project lasted one year, from January to December 2006 and involved two departments within the School of Education and Training, the Department of Primary Education and the Department of Education and Community Studies. Four mentors and four buddies were chosen from each of the two departments, to be involved in the project. The low numbers involved was governed by the fact that there were only a few members of staff who had the necessary skills and competence to be selected as mentors.

2 Research

According to the University's 'Strategy for Development' document, there is:

> '… an increasing expectation of ICT competence of all its staff as appropriate to their role, experience and responsibilities (administration, technical, general Higher Education Teaching and Learning, Initial Teacher Training teaching and assessment). In this context the University intends also to build an ethos of staff entitlement to CPD to support their attainment/ extension of relevant skills where they are missing / weak / have potential to be extended.'

The key word in the above statement is 'entitlement', and it was the work of the Greenwich CPD Project to examine how this could be achieved at a local level. The School of Education and Training ICT Strategy provided greater detail relating to ICT CPD. It states:

- All staff to be entitled to ICT induction and on-going development appropriate to their levels of responsibility and roles.
- All departments to exploit technology effectively in all aspects of their work including, learning, teaching, research and administration.
- To model best practice in the use of ICT with students at all levels and in all departments.

– To seek to strategically develop (through appropriate resourcing and CPD) and periodically review our use of ICT over an agreed number of years (e.g. 3 years).

These points formed the specific core objectives of the Greenwich CPD Project and were constantly revisited.

Two major research projects were analysed and provided extremely useful guidance for the Greenwich CPD Project. One project was the National (UK) 'New Opportunities Fund', or NOF Training Programme (1999-2003), and the other was entitled 'Teacher Institute for Curriculum Knowledge about Integration of Technology' (TICKIT) Project, which was based at the Indiana University over a similar time period. The NOF programme was a bold step to use innovative teaching methods, such as applying e-learning, and to emphasise pedagogy rather than just ICT skills. The aim was to provide training opportunities to all teachers in the country and was certainly ambitious. Few training programmes in any sector have ever been undertaken on a similar scale. The NOF programme found that there was a need for 'flexibility' and the 'ability to modify/adapt to local conditions'. Although the University of Greenwich has a central e-learning support team to assist staff with ICT developments, it was considered important that the School of Education & Training should be represented by its own co-ordinator ('champion') who not only would have a much greater understanding of the staff involved, but also have a close affinity for the School's idiosyncrasies.

One paragraph of the NOF programme findings was particularly enlightening: (the author has used bold lettering to highlight key issues)

> 'From the quality assurance perspective, the most successful schools seemed to enjoy **good strategic leadership** and **collegiate work patterns**. In these schools **ring-fenced time**, **technical support** and **general encouragement**, contributed to staff enthusiasm. The schools used strategies like **regular workshops, informal problem solving pairs and groups that helped to balance staff strengths and weaknesses**'. (Mirandernet 1994)

The most important point is the need for 'good strategic leadership'. This can be taken at two levels, not only that of the Senior School Management (Head of School plus Heads of Departments), but also at Project Co-ordinator level. It was important that these two bodies worked closely together and kept the other informed of any developments. Technical support is a key issue for all the 'cogs' had to be in the correct place at the right time and suitably 'oiled' / maintained regularly. What ever was required of the system, it had to work well. The NOF report highlighted that the majority of teachers preferred to seek help from colleagues rather than be taught by trainers and only a few were interested in participating in accreditation. The research findings of the NOF project went on to explain that a successful training programme advocated a 'blended learning' approach to teaching and learning. Staff involved in the Greenwich CPD Project would need to be initiated into ways in which such an approach can enhance more 'traditional' methods.

The allocation of time for staff development was given several mentions within the NOF Project report. It states:

> **Time** was a major issue. Requests included more time to explore new ideas, more meeting and sharing with colleagues from the school and beyond.

In the UK teachers generally feel that they have been living in a time of constant change and that if they adopt these further changes, then they need to be given the necessary time and therefore 'space' to come to terms with that which is expected of them. Too often, teachers have been asked to make changes to their teaching (sometimes against their better judgement) and yet they have had to do it in their 'own' time. The NOF report goes on to elaborate exactly how this time should be best spent:

> Teachers must have **time** for practice based research learning cycle: learning skills and understanding concepts, consolidation of skills, implementation, reflection, sharing with colleagues, re-construction of concepts and embedding in curriculum.

What is being advocated, is the need for greater action research and a coming together of staff to share their findings. It is the author's view that this does not happen as often as it should. Some staff can be very insular or simply reluctant to make public their good work. Certainly there is still room for possible development in this area. To foster a caring, sharing community became a guiding principle of the Greenwich CPD Project. In some cases this would mean a 'cultural shift' from staff working in isolation, to a more positive, collaborating culture.

Another statement from the NOF report provided beneficial guidance: (the author has again used bold lettering to highlight key issues)

> **Positive attitudes,** good leadership and **strong community building**, as well as a tendency toward **enthusiasm and good humour**, seemed to be paramount in overcoming the ICTprogramme's challenges. **Risk taking** appeared to be encouraged where relationships were good.

In order for the Greenwich CPD Project to have any degree of success, it was important that all staff participants needed to be interested in developing their ICT capability. Positive attitudes were therefore an essential prerequisite before being chosen to take part in the project. Good leadership, enthusiasm and a good sense of humour', were considered to be the important qualities of both the School co-ordinator and the mentors. All staff were taking some kind of risk and therefore the conditions had to be right so that people felt comfortable about undertaking this venture. It was important to build in a strong sense of 'community' of support staff and failure was to be avoided at all cost.

The other major research project studied in some depth was that undertaken at the Indiana University America (1999-2003). This research, entitled 'Teacher Institute for Curriculum Knowledge about Integration of Technology' (TICKIT) Project, established the University as the hub of several schools, in which a small group of teachers were developing their ICT capability within the classroom. In the report of the project (Ehman 2005) it is interesting that a strong correlation was found between the findings of the TICKIT and the NOF projects. Common issues within these two projects included promoting collegial collaborations, using a 'blended' instruction approach, participants engaging in action research and sharing their findings. The TICKIT project highlighted that teacher beliefs were considered particularly important in professional development programs, because teacher change is more successful when both teacher beliefs and new teaching practices are aligned (Richardson, 1994). The TICKIT project provided a degree of teacher choice within their professional development activities, which has been found to be an important part of successful professional development programs (McKenzie , 2001; Richardson & Hamilton, 1994).

The approach of the Greenwich CPD project was to encourage staff to take the 'best' of their previous practices and apply ICT to do what they do, even 'better'. This would mean that staff were being encouraged to take risks and try something new, but this begs the question, how can this be achieved? According to Clark (EPIC 2004) and November (2002), the greatest obstacle to success is 'cultural resistance', which is in its most extreme in education where 63% of workforce place greater focus on the 'Technology' (skills) and not enough on the 'Process of Learning' (applying those skills)'. Clarke, in the first instance raises issues related to bringing about change:

- It is not just about keeping people happy
- Reactive behaviour is normal
- It is about managing expectations
- Participants will feel uncomfortable
- It is important to help them succeed despite their discomfort

Clarke then goes on to provide guidance to help ICT change-makers:

- Sell a vision
- Encourage participants not to get left behind
- Appeal to their personal goals
- Saves participants time
- Highlight benefits of 24/7 access
- Reposition, not as training but part of the job
- Embed change in performance reviews

Selling what the future could be like but without making false claims would be critical in order to enlist staff's support for change. They have to want to be a part of the future so changes need to be both realistic and in keeping with their own personal goals. This is not simply change for the sake of change, but rather in order to move forward. Change has to be accepted as inevitable in order to keep pace with modern developments and as such needs to be included in our CPD training and work performance reviews.

Kotter and Cohen (2002) provided a little more guidance with regard to managing a project in his eight steps of change management:

- Urgency
- Guiding coalition
- Vision
- Communicate to get buy-in
- Empower to succeed
- Celebrate quick wins
- Momentum must be built
- Reinvigorate continuously

Like Clarke (2004), Kotter and Cohen see the need for vision as an essential key to success. A sense of urgency is also seen as important in terms of keeping up a momentum of a project. However, Kotter and Cohen place great importance on empowering staff to succeed and this became a central focus of the Greenwich CPD Project. The theme of ‘**celebrating success**’ was adopted for all project meetings and became the title of the website used to communicate ideas, developments, and progress reviews.

3 Potential Barriers

The research highlighted barriers to overcome and possibly hinder progress. Two main types of barriers presented themselves immediately, that of *INSTITUTIONAL* and those pertaining to the individual member of *STAFF*. A summary of the findings is presented in Fig.1 and 2.

Fig. 1. Institutional Barriers

Fig. 2. Staff Barriers

On studying the two figures, there is a high correlation between the institutional and staff barriers. Resources are a key issue and feature, both from the point of view of the provider and the user. Unfortunately the budget for the Greenwich CPD project was limited, and therefore there was not going to be a significant change in the area of resources. Staff time figures highly in both mind-maps and needs to be considered sufficiently important by management to allocate and budget for it in order to allow changes to take place. The bulk of the Greenwich CPD Project funding was to be allocated to buy staff time in order that they may accommodate the changes more readily (NOF).

Several researches show a strong importance of staff attitudes and beliefs as a key influence on success, e.g., Veen (1993), Simpson (1999), Ertmer (1999), Mumtaz (2000), Snoeyink and Ertmer (2001). The extent to which the staff value those skills and see them as relevant and useful, could make or break the project. It is interesting that Yuen (2002) in his article explores the variables affecting teachers' acceptance of computers, with a focus on gender differences in computer acceptance. A questionnaire was administered to 178 pre-service teachers, comprising of two independent variables (perceived usefulness and perceived ease of use), together with a dependent variable (intention to use). The results indicate that perceived usefulness and perceived ease of use directly affect the intention to use computers. Significant gender differences were also found: perceived usefulness will influence intention to use computers more strongly for females than males; perceived ease of use will influence intention to use computers more strongly for females than males; perceived ease of use will influence perceived usefulness more strongly for males than females. As it is the appropriate application of computers to teaching which is at the heart of this project and not simply skills for skills sake, this should influence a more positive outcome.

In his investigation into the study of US elementary teachers' personal experience with computers in classroom instruction, Guha (2000) identified key causes of comfort or discomfort with computer use in the classroom. Ten teachers taking part in a larger related study were selected for interview and classified as either more comfortable with computers or less comfortable. The interviews revealed that both groups believed computers could enhance student learning and all wanted to be competent in their use. It is interesting that the less comfortable teachers tended to prefer networked computers, while the more comfortable teachers preferred stand-alone machines. The less comfortable group mentioned workload and time management as barriers to implementing computers in classroom instruction. Whilst the Greenwich CPD Project can assist in staff workload by buying them out temporarily, time management presents a greater challenge. However, through the intimate contact of the ‘mentor-buddy’ system, it was foreseen that the ICT could play a large part in overcoming this problem and make life easier and not more difficult as a result of its adoption and application.

Mumtaz (2000) agrees that teachers' beliefs about teaching and learning with ICT are central to the integration of ICT. He goes on to reveal a number of factors that influence teachers' decisions to use ICT in the classroom: access to resources, quality of software and hardware, ease of use, incentives to change, support and collegiality in their schools, school and national policies, commitment to professional learning and background in formal computer training. All of these issues were endorsed by the Greenwich CPD Project’s coordinator and considered important for its success.

An investigation by Russell & Bradley (1997) of teachers' computer anxiety through a questionnaire survey of 350 Australian primary and secondary school teachers, found that although teachers were generally positive about the use of computers in education, they reported moderately low levels of computer competence and one-third of the sample found computers to be a source of anxiety. The reasons for this anxiety are categorised in the following order of importance: relating to tasks involved in using computers; fear of causing damage to the computers; embarrassment associated with the inept use of computers. Snoeyink and Ertmer (2001) found that ‘first-order’ (extrinsic) barriers to computer use, such as problems with equipment, were often found to mask ‘second order’ (intrinsic) barriers, such as lack of computer skills. The high level of support within the Greenwich CPD Project was chosen deliberately to overcome such problems. It was envisaged that the close-at-hand support would reduce the negativity of any problems generated by the learner because it would be immediate, as and when needed, always on call. Strategically, the developmental approach is very expensive in terms of labour, but it is often forgotten that staff are an institutions greatest resource and as McKenzie (2001) puts it:

> The better the job we do of identifying, grooming and rewarding local talent, the greater the professional growth and development we will see. It is a simple [but usually ignored] truth. We are too often penny wise and people foolish.’

4 Implementation

It was Hannan and Silver (2000) who raised the issue:

> those initiatives to improve teaching and learning that were located in departments or drew respected representatives from departments into schemes run at the centre, were more likely to succeed.

It was therefore important that the Greenwich CPD Project Co-ordinator (ICT 'champion') was a member of staff within the School of Education and Training, so that they would be closely affiliated with the needs of the departments involved (Department of Primary education and Department of Education and Community Studies).

The NOF Project found that staff preferred to learn from their colleagues and it was Kotter and Cohen who said that if staff can be empowered to change their teaching methodology by supporting them on a one–to–one basis, then there was every chance of success. Such research work led to the Greenwich CPD Project to adopting a mentor – buddy approach to staff training. Four members of staff were chosen from each of the two departments, via discussions with the Heads of Department, to become 'mentors'. The numbers were low because relatively few staff were suitably skilled to be allocated this role. They were selected on the basis that they not only already had a good level of ICT skills ('early adopters') but also would be keen to help colleagues to come to terms with the appropriate application of skills to meet their individual needs. These mentors were to be the key players in the process of bringing about change and it was they who had a major say in the choice of their 'buddies', i.e. a person with whom they could work closely in order to develop their ICT skills. It was considered very important that all taking part had a positive attitude to be involved (Ertmer (1999), Mumtaz (2000), Snoeyink and Ertmer (2001). Giving responsibility to the mentors would mean a close bonding and support for their buddies. See the structure diagram in Fig.3.

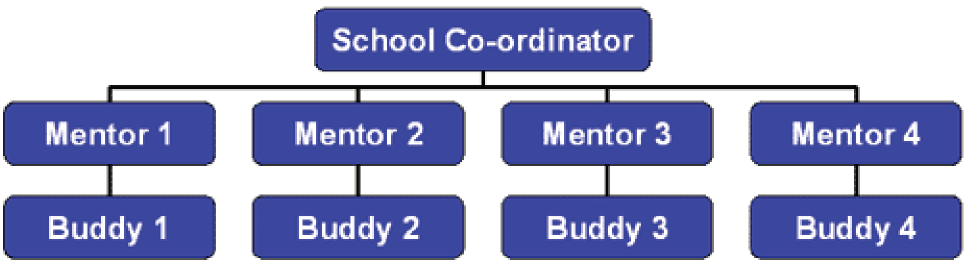

Fig. 3. Project Structure for each Department

The quality of the buddies experiences were considered to be critical to the overall success of the Greenwich CPD Project, for if others could begin to see exactly what can be achieved, this could stimulate some staff to try a similar experience. It would be like throwing a few stones into a pond and the ripple effect moving others to become part of the overall movement. Trying new ventures would mean staff having to take risks and therefore a safety net was required to help provide them with confidence to take the ‘leap of faith’. As the NOF findings highlighted, risk taking was encouraged where relationships were good, which was an inherent quality of this mentor-buddy approach. This methodology already had this feature in-built because they could work so closely.

The Greenwich CPD Project was ‘sold’ to the participants by highlighting the benefits to be gained by taking part. These can be seen below (Figures 4 - 6). In the words of Clark (2004) and Kotter and Cohen (2002), the Greenwich CPD Project was ‘selling a vision’, though this had to ‘appeal to their personal goals’ (Ertmer (1999), Mumtaz (2000), Snoeyink and Ertmer (2001)), by enhancing their teaching. All the advantages of participation would have to be clarified, together with an explanation of how the mentoring works, particularly when things become a little uncomfortable. Participants would have to fully understand that the way ahead would be a little difficult at times, but be reassured that the methodology was able to provide support exactly as and when required.

All staff had to agree to the taking some risk (NOF and TICKIT projects) to try something new, as well as share their findings with the project community. The strength of the bond between the participating staff supporting one another in times of need was seen as crucial for success. The community was seen as the ‘heart’ and the individuals the ‘organs’ of the ‘body’. The success achieved was the ’lifeblood’. Without any of these parts, the body would not function healthily, i.e. the project would not succeed.

Clark’s (2004) statements about including ICT as part of personal annual performance management discussions, together with analysis of its application and future use in course reviews were issues not being addressed at the outset of the Greenwich CPD Project, but were by the end of the project. It has to be said that this was not a direct result of the CPD Project, but it was a useful inclusion to further develop ICT developments in parallel with the project. It meant that periodic reviews would have to be undertaken to check members of staff’s progress applying ICT in their daily work and thereby make suitable adjustments and prioritise new directions, as found to be necessary.

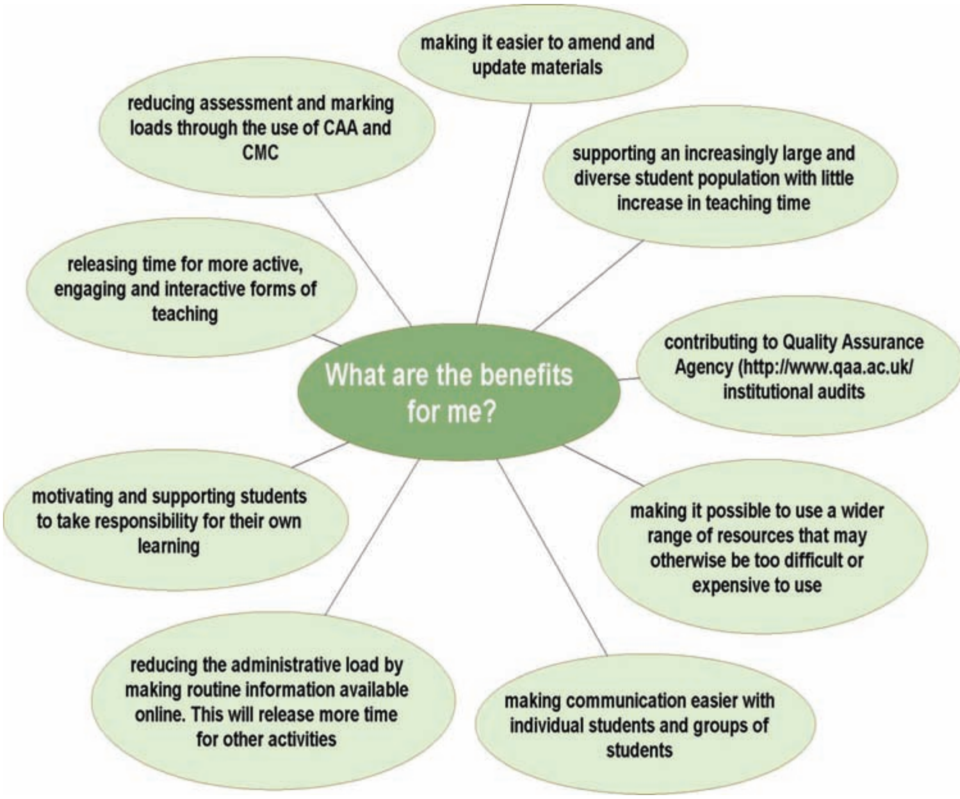

Fig. 4. Mind map 1

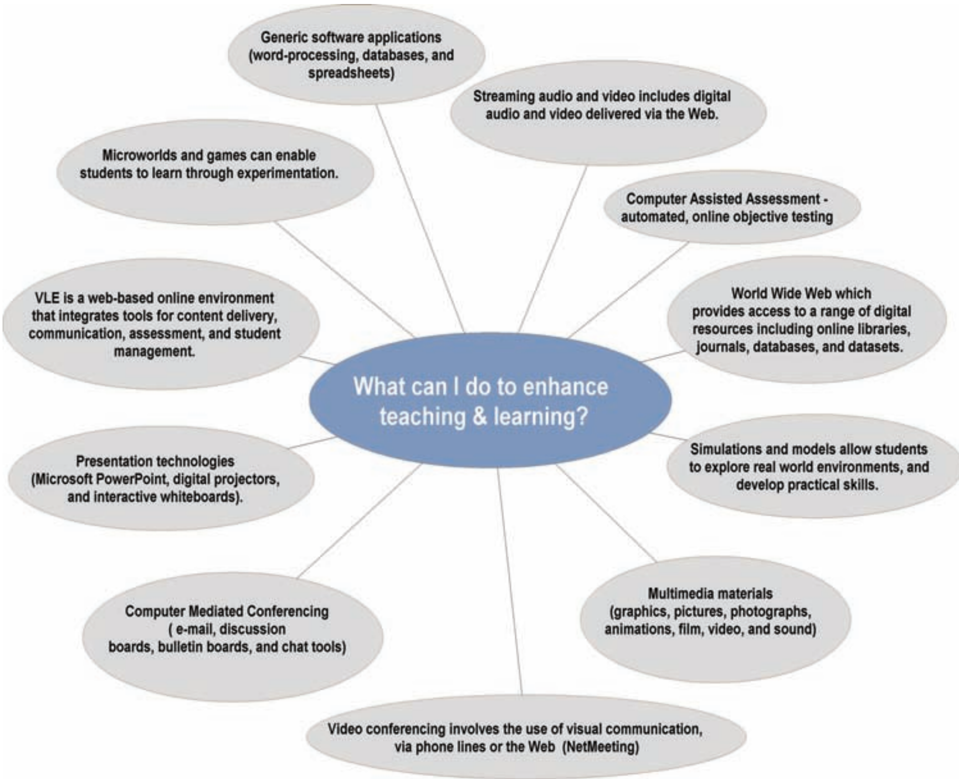

Fig. 5. Mind map 2

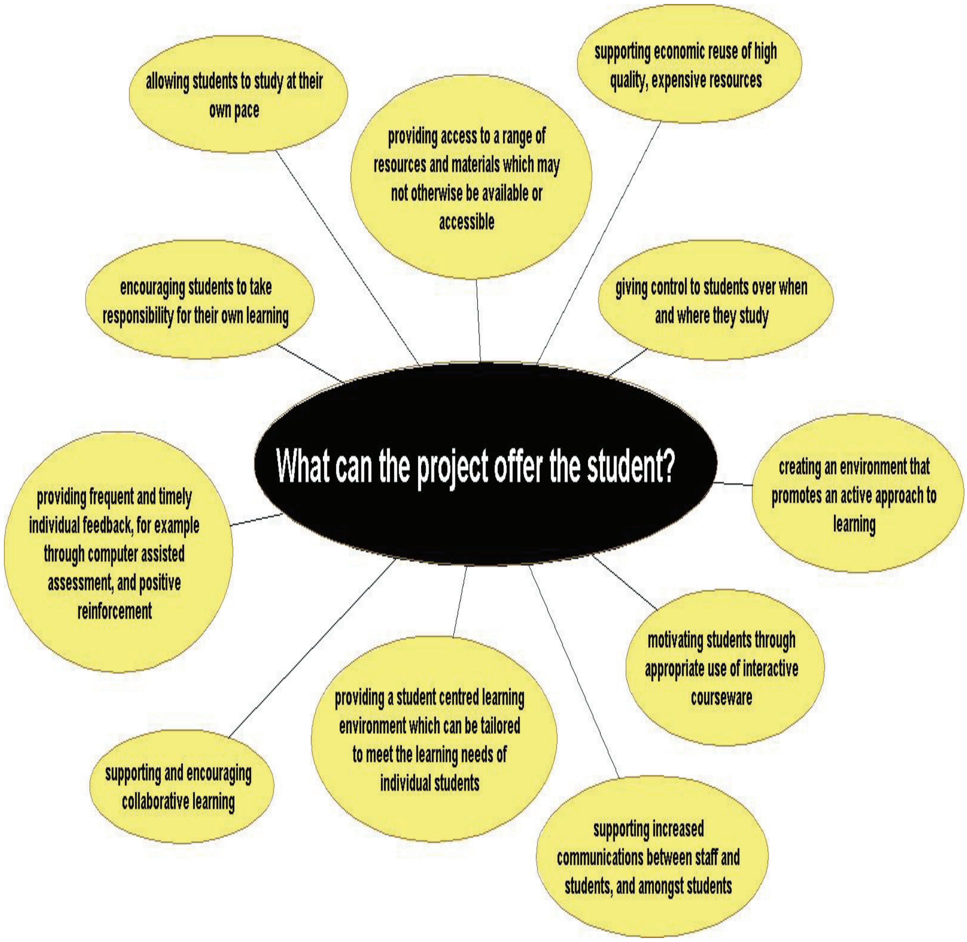

Fig. 6. Mind map 3

The Project Coordinator held interviews with individual members of staff, who when approached, expressed an interest to be part of the Greenwich CPD Project. Interviews were chosen to establish staff ICT capability in preference to a paper audit, which was recommended in the findings of the NOF training programme. It was felt that an interview would be much more flexible, adaptive and solicit this information much more readily than a questionnaire. In the interviews, possible ways of applying ICT were presented to the members of staff and then discussed to establish which of these 'new' teaching methods they felt could possibly enhance their teaching. (This range of applications included topics as can be seen in Fig.5). From this choice, a particular skills audit was established in order for the member of staff to be able to achieve the desired outcomes. As Wild (1996) points out, 'there is a need to demonstrate the relevance of ICT in teaching and to design CPD courses around successful pedagogical strategies rather than the now-discredited model of predominantly teaching ICT skills'. It was important within this project that the 'new' methodology which the member of staff wanted to adopt decided the skills to be acquired ('top-down model) and not vice versa ('bottom-up' approach), i.e. skills training and then the member of staff analyzing how those skills could be applied in their own teaching (see Fig.7). By adopting a 'top-down' approach this does not negate the member of staff being creative with their newly learnt skills after their training, in fact this was to be encouraged, though prioritizing skills over application of those skills was seen to be a weaker base on which to build for the 'beginner'.

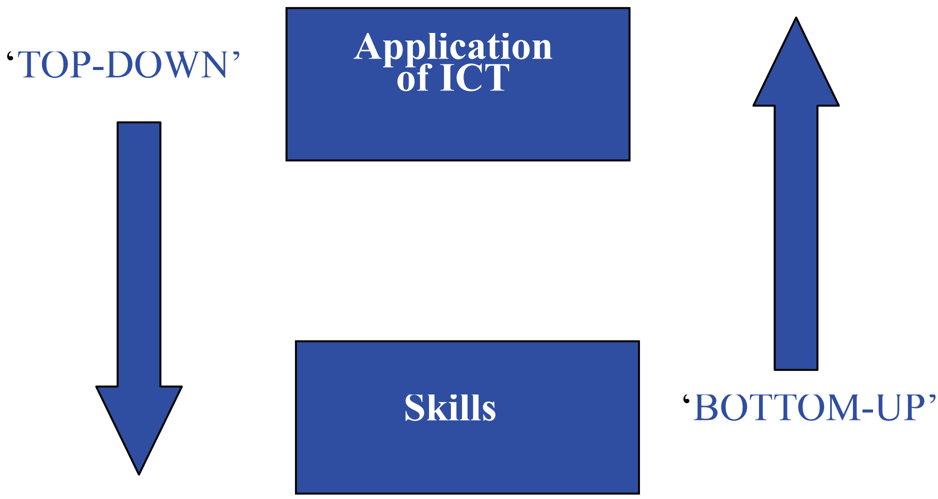

Fig. 7. Establishing learner needs – 'top-down' v 'bottom-up' approach

An objective of the Greenwich CPD Project was to concentrate effort with highly focused activities. Each buddy had to take small steps and be successful. Well 'nurtured', well 'fed' participants, with just the right amount of 'nutrition' as and when needed to meet their individual needs, was planned. After all, 'from little acorns, do oak trees grow', which in time can become whole forests. What was not clear in the beginning though was **which** nutrients to apply, together with **when** and **how** they would be applied. It was important in other words, to initially determine what the needs of the individuals taking part were, and then begin to formulate individual programmes to meet those requirements, as recommended in the TICKIT Project findings. This approach was taken for mentors as well as buddies because it was considered that all participants should develop their ICT skills in some way, no matter how skilled they may be. For the mentors this meant that it was not just about giving, but also receiving.

Once an individual action plan had been generated, the project adopted an approach as shown in the Fig.8 below. A period of time was allowed to focus and possibly remodel thinking if necessary. This would involve further discussions between mentor and buddy, in the preparation for the initial trialing of the 'new' (to the buddy) approach. Unavoidably there had to be some risk taking, as this was necessary if gains were to be made. However, with careful prior preparation and setting the level of risk within the 'comfort zone' of the buddy (TICKIT Project), the chances of failure could be minimized. If possible failure had to be avoided, or certainly minimized, at all cost. This was the main function of the mentors, who because of their proximity to the buddies, were able to provide the necessary support as and when needed. It was crucial to evaluate all stages of development at every opportunity in order to guide further work. This was to be done both by the mentors and the buddies. What was established to be worthwhile would be carried forward to further enhance both the teaching and learning experience of our students.

Fig. 8. Project Development

It was Hargreaves (2003), who from a study of shadowing his colleagues, pointed out that learning is most likely to happen if it involves:

– demonstration
– explanation
– replication (in a new context)
– repetition; and
– creative adaptation.

We can all learn something from each other by working more closely together. Mentors shadowing their buddy will have a much greater understanding of their needs and therefore work from a position of strength in terms of 'demonstration' and 'explanation'. New (to the staff) approaches can be 'replicated', discussed and personalized for the buddy to try. Subsequent discussion can critically evaluate what was achieved within the lesson, draw out the essential ingredients, and plan stages of development, with a view to future alterations to improve performance. A buddy can then plan a similar session but with a different context ('creative adaptation'). Again, after the event, these results can in turn be examined and improvements considered for re-trialing. By this process of 'repetition' ways of working can be internalized.

What the Greenwich CPD Project has done from the outset was to run with the motto, ‘people matter’. People need to feel wanted, cared for, after all it is a basic instinct. A project website (see Fig.9) was created to begin to develop this sense of belonging to a ‘community’. This website used another project motto for its title, ‘Celebrating Success’. We work from day to day with little praise or thanks and this website was trying to redress this situation (McKenzie 2001). All staff involved in the Greenwich CPD Project had their achievements made public. This is based upon the principle that all children like to see their work on display. Members of staff are no different to the children. What was interesting was the fact that the participants began to feel special. Instead of working within their own little environment they were coming together. Collectively they felt a much stronger force in the movement of taking teaching and learning to a higher plane, one in which ICT figured, not as an add-on, but rather as an essential component.

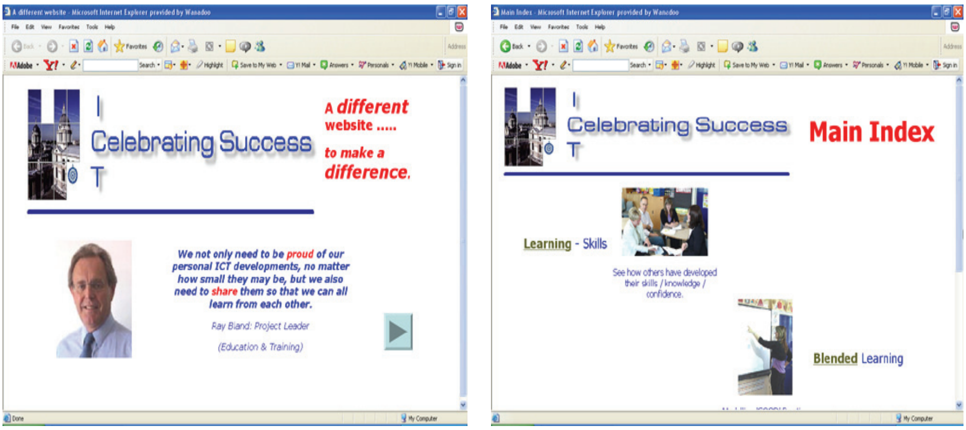

Fig. 9. Project Website

The website was created, not only as a source of ‘information’, but also a source of ‘inspiration’. Everyone’s successes were made public to the community (this was only to the departments involved in the project and not the whole School). The emphasis of the project was always based upon sharing and caring, no matter how trivial the result may be to some, all developments mattered. Staff could see and relate to other staff’s problems because they were having similar problems and therefore they felt that they were not alone. A mutual support community was being established.

5 What was achieved?

Adopting a ‘top-down’ approach in the initial interviews worked successfully in the sense that the focus was not simply on skills, but rather on their appropriate application to enhance teaching and learning. This necessitated the buddies being exposed to several different possible ways of employing ICT in order to make an informed judgement as to which would be most appropriate for them. As the mentors were early adopters, their experience was able to provide these examples. By adopting such an approach the skills were put into context (Veen 1993) and it was found that this generated a good level of incentive on the part of the buddy, to want to learn the necessary skills. The one-to-one interviews were appreciated by the staff as it made the process much more personal. Embarrassment of inadequacy in ICT was minimised at an early stage in the project (Snoeyink and Ertmer, 2001)

Prior to the commencement of the Greenwich CPD Project most staff, although part of a departmental team, tended to work in isolation. Collectively, staff may have discussed the content of sessions, but rarely had they talked about the delivery of the content. The Greenwich CPD Project sought to correct this situation by encouraging staff to discuss possible ways in which ICT could be applied appropriately to meet their own needs. The introduction of using ICT through 'blended learning' (NOF, TICKIT) was the main focus for all staff, though accepting the concept, has been for many, a revolution in itself. What staff had to appreciate is that 'blended learning' is not new as all would probably have been practicing a mix-and-match of 'chalk and talk' with some question / answering, together with discussion about the topic. What the project needed to achieve was to incorporate ICT to complement and enhance the student learning experience through some of these existing blends. Some staff had already begun to use powerpoint for presentations, although this invariably was simply 'death-by-bullet-point'. (In defence of powerpoint this need not be the case and indeed the national examination boards are now beginning to use it for portfolio work and there are many other exciting possibilities). However, for staff to begin the internalisation of these 'new' ICT approaches, they first needed to be exposed to them and then encouraged / supported to use them (Hargreaves 2003). This is where the mentor/buddy system excelled, by being always in the proximity and providing the necessary drip feed of 'nutrients' at exactly the right time.

The methodologies to put the individual action plans into practice, utilised a range of techniques, including blended learning, 1:1 face to face and/or e- mentoring and 'tutoring–at–the–desk'. All participants gained something from the experience, although some much more than others, depending upon the initial targets set and level of previous experience. Some partnerships flourished in abundance, though not necessarily because of the correct 'nutrients' being applied at the correct time, but more a situation waiting to happen. Such cases occurred simply by bringing people together who really did want to get together, and which because of lack of previous communication, had not occurred to the extent in which it did during the Greenwich CPD Project.

Strategically, such a developmental approach does have a serious flaw in that it is so labour intensive and therefore expensive. On this basis alone, such an across institution adoption of this approach to ICT CPD may not happen. However, this current situation need only be seen as a temporary measure, for as more and more staff become proficient in using and applying the technology, and as new staff have this as a pre-requirement of their taking up post at the University, the problem will diminish. In time, the current hype surrounding 'e-learning' will change from defining what it is, to exploring its possibilities, through to an established way of working. For as Professor Mark Stiles said at a conference at the University of Greenwich (June 2006), 'When we stop labelling it ('e-learning'), we will have it'.

As well as the website praising successes, it provided a very important means of communication for staff. Unfortunately there is currently no means of centrally communicating exactly what research is being undertaken across the University. Several people could well be working on the same research topic and there is no means of knowing. This website provided a means of communication to keep all participants informed of what was currently taking place, as well as reporting experiences from prior activities. For the duration of the Greenwich CPD Project, the website was only made available to those participating, though in view of its success, it will subsequently be made available to all in the School of Education and Training. Small steps in ICT development were encouraged in order to maximise the chances of success and this worked very well. It also meant that activities were much more manageable and easier to record on the website. Colleagues presented techniques and tricks to aid personal learning, and as a consequence staff were more likely to try what was being proposed (NOF training programme). Through the website, staff were provided with a point of contact should they wish to discuss issues further or indeed try a similar experience.

One of the most difficult barriers to break down in both the NOF programme and the TICKIT projects was getting staff to overcome their personal anxiety and in some cases, fear of working with the computer. All staff taking part in the Greenwich CPD Project had used a computer to some extent, mainly Microsoft Word, but getting them beyond their ‘comfort zone’ was one of the greatest challenges to the project. As the two large projects (NOF, TICKIT), also Russell and Bradley(1997) pointed out, a major staff concern was of personal embarrassment or ridicule from making mistakes, or another, getting into trouble and not being able to correct the situation. This is where this project’s design pre-empted such issues and the intimacy of the mentor-buddy partnership was highly effective in allaying fears and overcoming these difficulties. All problems, no matter how great or small, were treated with respect. Working closely together helped the project grow from strength to strength, but also by highlighting achievements and experiences on the website increased the chances of success, for in the words of the old adage, ‘nothing succeeds like success’.

As the project gained momentum, the training for the buddies was sometimes opened to all staff within the school. In the first instance, all training was focussed on the needs of the buddy’s, but it was felt that others outside of the project may benefit from joining the presentation / workshop. This was always undertaken with the buddy’s consent and indeed the buddy’s sometimes preferred this approach for the camaraderie of working within a group. One such example was developing skills using the interactive whiteboard. Several members of staff came along who were not actually taking part in the project, but it was useful as they supported each other when practicing the skills. It was also a convenient way of advertising what was happening within the project and so stimulate interest in developing ICT skills of other members of staff and thereby widen the net.

The staff for whom the Greenwich CPD Project was largely intended, i.e. those who had not yet fully adopted an ICT approach to their career development, there has been some success. More resources still need to be set aside for this particular work, though the buddies have definitely benefited from the close support system. It was so important to have someone who is readily available to help them overcome their difficulties and therefore cut down on the level of frustration usually experienced when learning something new. For those at the forefront of developments, the mentors, it has added another dimension to their daily work. They are now not working in isolation, but within a group who want to talk to one another about sharing possibilities of incorporating more

ICT into their work. Once the project's website has been made accessible to non-participating staff, others will be able to benefit from the increase in communication. They will be able to easily isolate people to link up with, in order to work together towards a common ICT developmental goal.

6 To sum up

The essential themes or mottos running through the Greenwich CPD Project have been:

- 'People matter'
- Develop a caring / sharing 'community'
- There is strength in 'collaboration'
- Learning should be a 'quality experience'
- 'Celebrate success' at every opportunity

Through a learner–centred approach, contextualised by the individual departmental needs, the Greenwich CPD Project sought to raise the level of staff skills and application of ICT. Clearly, ICT was not going to make a teacher necessarily improve performance just because they use it. What was needed was to develop a much greater understanding of how ICT can 'enhance' teaching and learning.

The aim of the Greenwich CPD Project was to assist teachers, through the application of ICT, to do what they do, 'better'. The initial interviews established that a 'culture change' was necessary in order to begin to tackle the problems. Like all culture changes, there are no quick fixes. Certainly the mentor-buddy approach was very successful because the greatest need for any learner, is the appropriate support at the exact moment in time it is needed (i.e. the call out time in any emergency is critical and therefore needs to be reduced to a minimum). It was because of the intimate relationship between the mentor and the buddy, that the needs of the latter were usually met in full. Focusing on a small group of staff, whilst including others wherever possible, had impact and made the project manageable. By the end of the project an academic 'community' was beginning to emerge, which was not only based on action research, but also on sharing and collaboration. There is still work to be done to lure those members of staff who are reluctant to incorporate ICT into their teaching. However, it is envisaged by the author that there will shortly be a mounting pressure from students who are coming through the educational system, and who use ICT as their preferred style of learning, who could help speed up the cultural change. Time will tell.

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ICT and Creative Computing, Austrian Perspective in Teacher Education

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Abstract

To initiate creative use of ICT in the learning process means to motivate student teachers to establish ICT as a tool in their daily teaching practice. Some issues are discussed to focus on the different positions which are related to teacher education: An overview is given about the current situation in Austria in primary and lower secondary schools and teacher education. Based on empirical data, the demand of standards of ICT competences in primary and lower secondary education is discussed. Some examples for good practice at the State College of Education in Vienna are presented.

"I never teach my pupils; I only attempt to provide the conditions in which they can learn." -Albert Einstein.

1 Introduction

ICT (Information and Communication Technology) is increasingly important in every aspect of life (learning, work, health and leisure). It is necessary to become competent in ICT for everybody, which means acquiring the necessary skills during education. ICT plays a major role in dealing with information and its transformation into knowledge, which is a basic requirement for citizens to become effective participants in the information society. But even in countries like Austria, there is an issue of diversity relating to the need of an underserved population, which is being left behind in a digital divide. Some Academic Lower Secondary Schools in Carinthia report up to 99% of students with computer and internet-access at home (Micheuz, 2005). In Vienna there are General Secondary Schools with up to 92% immigrant pupils and less than 20 % of these have home computers. Education in ICT is requested to balance the gap. Schools should also take advantage of digital tools to improve life-long learning skills and habits of their students.

2 General Education in Austria

Compulsory education in Austria lasts for nine years and includes primary education (age 6 to 10, "Grundschule, Volksschule"), and secondary education (age 10 to 14) which has two parallel strands (BM:BWK, 2006): General Secondary School ("Hauptschule") and Secondary Academic School ("Allgemeinbildende Höhere Schule", AHS). In year 9 (age 14) there are pre-vocational schools ("PTS"). See Fig.1 below.

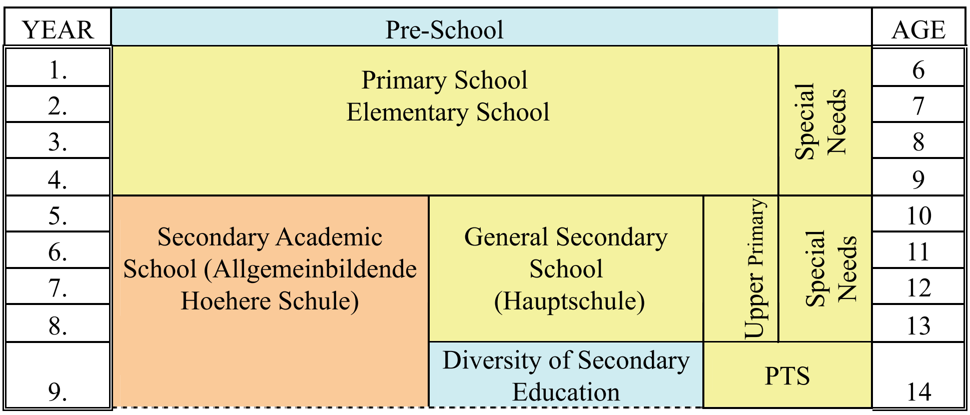

Fig. 1. Compulsory School System in Austria

3 Teacher Education

Teachers of primary and general secondary school are trained at the State College of Education ("Paedagogische Akademie" which is to be renamed "Paedagogische Hochschule" from 1st October 2007) – after qualification for University entrance. They graduate with a bachelor's degree. Teachers for secondary academic schools go to University to graduate with a Masters degree. This diversity affects some aspects of the focus of ICT education within secondary schools. One important difference is that no ICT related teacher-education is established for general secondary schools. In contrast in secondary academic schools teachers for the subject IT are educated at the University.

4 ICT in the Curriculum

Media education has been established as a principle of education in the compulsory Austrian school system. ICT, where applied, is taught in an integrative manner within other subjects. This integrative approach has been propagated and demanded by ministry enactment. Various practical applications of ICT are integrated in subject teaching as well in primary and lower secondary education. There is no subject "informatics" (a common expression in German speaking countries instead of computer science) integrated within compulsory education (age 6 to 14). Informatics as a subject is only established in those lower secondary and academic secondary schools with a special focus on informatics, because of autonomous decisions made by the individual schools. Some schools have specialized in informatics by establishing this subject at the expense of other subjects. It was designated to achieve a certain kind of computer literacy, though without specifying a particular framework for doing so. "But in retrospective, one can state that this did not work in a satisfactory manner" (Micheuz, 2005, p.169). Reasons for this were pointed out at a variety of different levels: lack of appropriate standardized software, insufficient hardware at that time and rather poor acceptance of the teachers involved.

4.1 Primary School

With an alteration to the curriculum in 1999 the integration of ICT was added to the syllabus in primary education (BM:BWK, 2006, part. 9). In the chapter "general education goals" it is stated:

> Starting from the individual prerequisites of the individual pupils and trainees the primary school has to accomplish the following: development and transfer of basic knowledge, skills, abilities, insights and attitudes, supporting the acquisition of so called "cultural techniques" (including child-oriented interaction with modern communication and information technologies).

In the second part it continues, under the topic "General Regulations - Study and Teaching in Primary Schools":

> The possibilities of the computer shall be used for independent, directed and individualised study, and for creative work. The computer can support immediate and individual self-directed learning. For practical use of computers in lessons the possibility of uncomplicated and simple access for the pupils should be provided.

The expression later in the paragraph "…according to the equipment and conditions available throughout the school " leaves many possibilities for autonomy and realisation. Comments of the diversity – how primary schools are equipped with computers and how this influences classroom routine- can be found in reports of student teachers. (See the chapter "Empirical Research" later).

In primary education the integration of open learning environments in the daily school routine, including computers and internet, is realised by establishing computer corners. There are at least two computers with internet access and a printer in every classroom. The teacher can organise phases of work according to their needs. The class-teacher knows how competent the pupils are in the use of ICT. If necessary, there is some flexibility in daily school routine. Some schools could autonomously organise equipment and establish a separate additional computer lab.

4.2 Lower Secondary School

Lower secondary school is divided into two parallel branches: General Secondary School and Academic Secondary Schools Providing General Education (AHS).

A new curriculum for lower secondary education in 2000 replaced the former one, where in 1990 teaching of ICT basics became a matter of course in Austria in grade 7 and 8. The central ideas of the new curriculum were based on the fact that innovative information and communication technologies as well as the mass media penetrate all areas of life. In lessons, these developments have to be taken into account to utilize the didactic potential of the information technologies in accordance with critical rational discussion of the effects in economy and society. ICT is perceived as a necessary tool for information access and validation, as well as for individual production (presentation, diagrams, statistics, texts and layout). Of importance is the expression in the curriculum "…with a consideration to the equipment available…." (BM:BWK, 2000). Details of how to achieve this goal in class are left to the didactic and methodological ability of the teacher. Unlike traditional subjects, the role of ICT is not clearly defined within single subjects, nor is there a clear framework defined to what extent knowledge of ICT (skills, terminology) should be taught.

In secondary education there are usually no computers in the classroom. One or two (seldom more) computer laboratories are established in each school and internet is standard. But planning to use ICT in subject teaching means having to deal with the restrictions of the schedule of the computer laboratory and a high number of students with limited number of PCs (about 15 PCs in a lab).

Due to the educational diversity during years 5 to 8, a number of questions and different developments regarding ICT teaching arise. One of these aspects can be identified in different teacher education.

5 Initial Teacher Education

5.1 Teachers of Primary and General Secondary School

At about the same time as the new curriculum for General Secondary School was implemented (in 2000), the possibility for graduation to "teacher of informatics" at the State College of Education (where teachers are trained for primary and general lower secondary education) as an additional qualification was terminated. Due to various autonomous study plans at different Colleges there are now different compulsory approaches, ranging from "media education" to "basic introduction to ICT applications", with a variation of lessons in the curricula (32 to 64 hours in total). The aim is to establish ICT as a teaching principle among prospective primary and secondary teachers, and to organize interdisciplinary projects using ICT. Today's teacher trainees are quite competent using ICT, but lack in didactical matters for increasing learning outcomes by practical ICT use in class teaching. The level of individual ICT competence influences the learning process by fostering social interaction and communication. Recently Vienna State College implemented a successful model that motivated teacher trainees to extend the productive use of ICT in the learning process. The aim of the task is to encourage them to introduce similar activities in schools where they are trained, because research has shown that productive use of computers in classroom is rarely integrated in the entire learning process. Therefore tasks for trainees are designed to integrate practical studies in class and by examining contributions to ICT competitions for primary schools and secondary schools (pupils age 6 to 14). (See chapter *Examples of Good Practice* later). There are several Austrian education web servers where the newly created exercises can be published, which is also highly motivating.

5.2 Teachers of Secondary Academic School

Teacher education for secondary academic school in general is linked to the University. For prospective teachers of the secondary academic schools in the academic year 2000/01 *informatics* and *informatics management* was established at University level. This was 15 years after the introduction of the subject informatics in the 5th form of secondary academic school (which is compulsory since 1985)! Academic secondary school is designed to offer an eight year education and therefore there are some specific efforts being made regarding ICT and informatics. In year nine a compulsory subject informatics has been established, followed by different options for informatics in subsequent years. This perspective influences decisions and teaching ICT in years five to eight.

6 In-service Training

After the implementation of ICT as a principle in the curriculum various courses were offered. For each teacher there was an opportunity to participate in a course suitable to his/her level of ICT knowledge. In recent years the number of courses offerings has declined. Currently there are two courses for in-service training established at State College of Education in Vienna. Each course lasts two semesters involving six hours per week and 10 ECTS (European Credit Transfer System) which can be obtained in each course. One course is entitled "*How to do with computers*?" ("Computer – gewusst wie!") and is designed for teachers who want to train skills to be able to start with computers in class teaching. Another course, *"Virtual Worlds",* has two strands: "Creative Computing" and "Multimedia and Web Design" (PA Wien, 2001). This course incorporates digital media in addition to the traditional scientific based and practice-oriented approach. One focus is laid on organizational matters (continued education of teachers in the relevant school by establishing models of good-practice in ICT) and the integration of e-learning within education. Evaluation and development of learning programs with regard to user-friendly interfaces is another important part of the course.

The fact that ICT is not compulsory in teacher education is often brought up in discussions about basic knowledge of ICT (or the lack of it) among teachers. As a consequence of the different forms of teacher education, a vital flow of information regarding developments and projects between these two groups does not occur. Unfortunately, some nation-wide research and projects are restricted to one specific school type, despite the similarities in curriculum.

7 Empirical research

Within the Austrian educational system there are no comprehensive studies available regarding the situation of the ICT initiative in schools (age 6 to 15). Recent reports on different types of secondary education are not comparable. There is therefore a lack of general information and statistics about the real situation of ICT in schools and in the learning process. This influences the development of the curriculum in teacher training. Three studies are chosen to highlight the situation in Austria.

7.1 ICT in General Lower Secondary Schools: Perceived and Actual State (Fleck and Hauser, 2006)

The study aims to document the actual state of ICT integration in the daily school routine in *General Lower Secondary Schools*. There are different conditions and population in schools in capital cities and rural areas. Data was gathered through questionnaires and interviews in 28 general secondary schools throughout different parts of Austria. See Fig. 2.

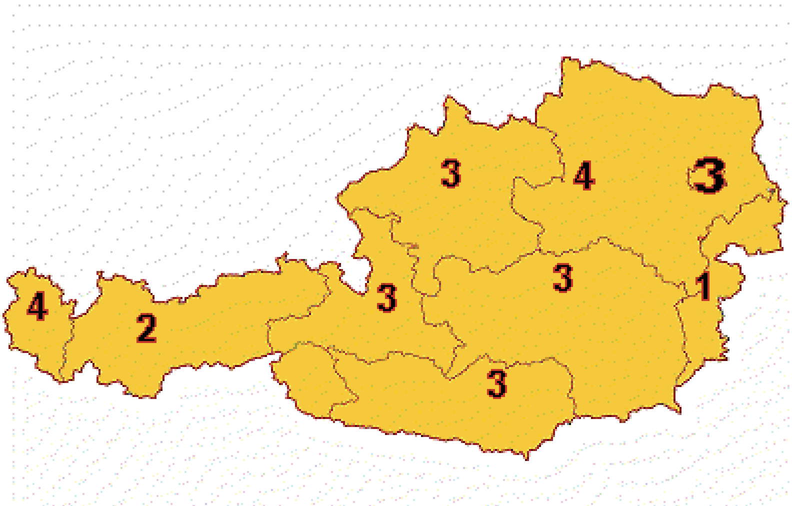

Fig. 2. Numbers of Schools in the different parts of Austria

Conditions, autonomy within the teaching curriculum, and central ideas and aims of ICT instruction, according to the general syllabus, were investigated. The outcome should lead to recommendations for good practice and develop a proposal for learning outcomes in ICT skills. The sample consisted of smaller schools as well as bigger schools: 42% of the schools enroll 100-200 students, 50% house 200-400 students, and 8% take more than 400 students. Of these schools 23% are equipped with one computer laboratory, in 62% there are 2 computer laboratories and in 15% there are 3 laboratories. The authors compared the former curriculum (1989) with the new curriculum (2000) in order to identify the development of ICT practice in schools. It was recognized that innovations of the 1989 amendment were not continued in the curriculum 2000. Integration of ICT in *all* subjects was a new addition, but the general teaching of ICT skills was reduced (The "Warm-up phase" in year 7 and the "project-phase" in year 8 were removed). The teaching curriculum of 2000 was scrutinized regarding its ICT content. The authors reported that 34 indications relating to the use of ICT were extracted. The report analyses various possibilities for interpretation of the teaching curriculum using ICT as a tool. One should note that these findings have to take into consideration that two thirds of the 28 schools already have informatics established as an additional subject following autonomous regulations. Therefore the report does not reflect the overall situation in secondary schools in Austria. How ICT is integrated within secondary schools varies a great deal. In some schools different models are integrated in parallel. See Fig. 3 below.

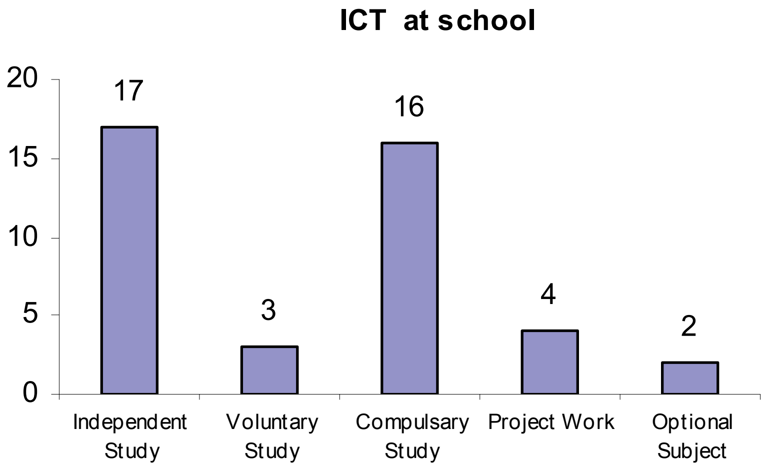

Fig. 3. How ICT is Integrated within Schools

Findings included that:

– In most of the examined schools informatics was taught as a subject or could be taken voluntarily.
– In general teachers were satisfied with the hardware equipment.
– Less than 50 % of teachers had taken courses in computer science (during initial teacher training or in-service training).

Fleck and Hauser also investigated how frequently computers were used in different subjects.

Subject	Abbr.	Religious Education	RE
English Language	EL	Chemistry	Ch
German Language	G	Physics	Phy
Technical Drawing	TD	Music	Mu
Geography and Social Studies	GS	Art and Design	A&D
Mathematics	M	Home Economics	HE
History	H	Design and Technology	D&T
Biology	Bio	Sports	Sp

See Fig.4.

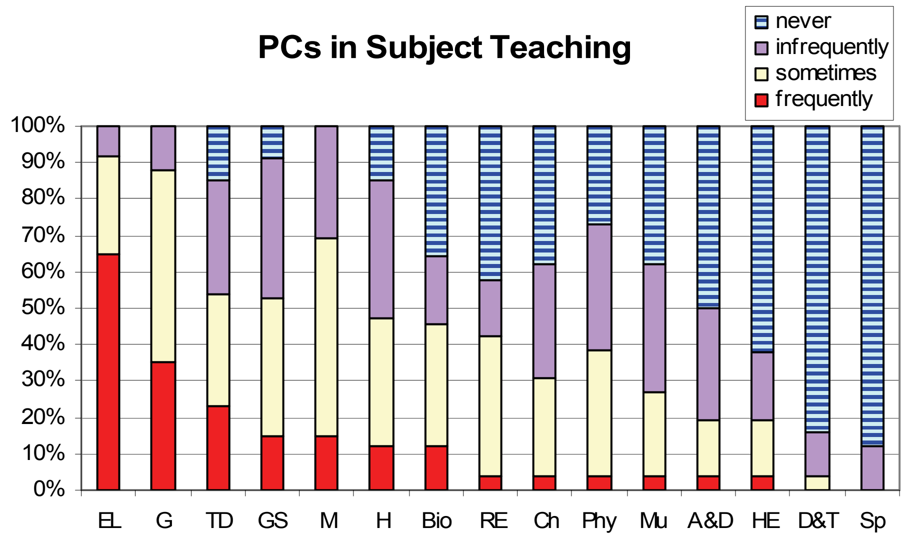

Fig. 4. Frequency of Computer Use in Lesson - Subjects

The leading subject, where 65% of the teachers reported frequent use of computers was English Language, followed by German Language with 35%. In both subjects tutorial programs and word processing followed by internet research are reported to be the main areas of ICT use. In English Language teaching 90% of the teachers report use of tutorial software. A possible reason for this could be that there is user-friendly software closely coordinated with available textbooks. The highest use of tutorial software was found in mathematics. One reason for this could be that it generates a higher level of motivation, and specific software is easy to access for practice and revision exercises. Subjects who were thought to be well disposed to using PCs such as Art, Design and Music did not show the expected representation. About 75% of the schools report the possibility of reading English text on the internet as important. This suggests that the web is increasingly used as a considerable resource of information. Types of software used was also examined in this study and Microsoft Office is the common software with word processing being the most frequently used. To work on topics using word processing is reported by two thirds of the schools. Online dictionaries are only used in 50% of the schools. A reason for this low percentage could be lack of knowledge by teachers as to the availability of this tool. Presentation software (MS PowerPoint) is rarely used in teaching in the various subjects, but more frequently used by students for reports (more than two thirds of the students use presentations). Use of standard software is recommended because it is almost always available at home and pupils are experienced in its use. Other software mentioned to be used (other than MS Office) included graphics software and software to generate websites.

As in most of the schools ICT was also taught in individual subjects, research was undertaken as to what kind of software was taught additionally in the subject informatics. See Fig.5.

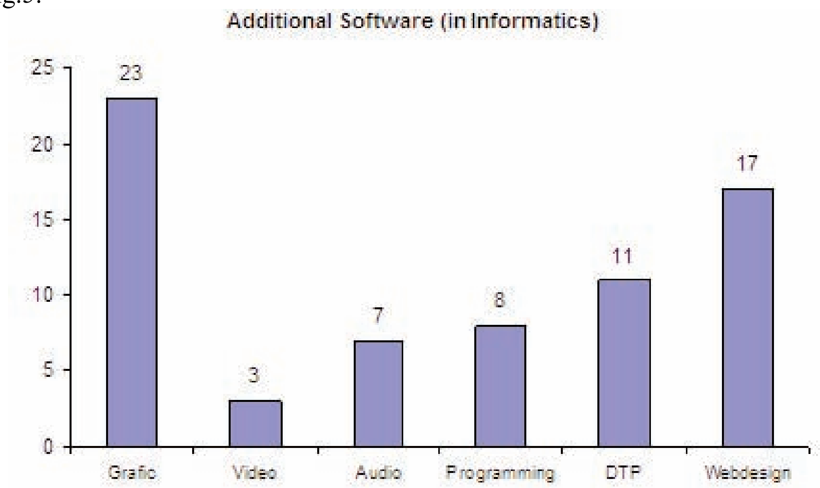

Fig. 5. Software taught other than MS Office

In 23 out of 28 schools, graphic software use was taught in informatics, and in 17 schools (60%) web design was part of the teaching.

The survey also asked teachers who did not use computers in their subject teaching why this was the case. Three main reasons could be selected. See Fig.6 below**.** Why Teachers Do Not Use PCs

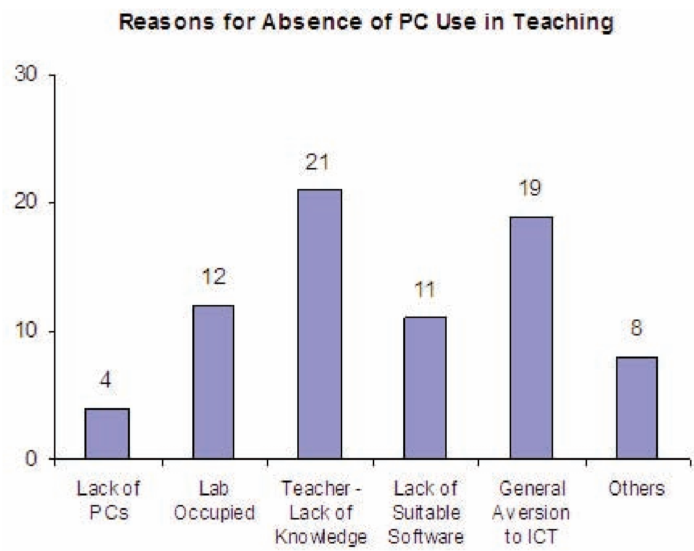

Fig. 6. Why Teachers Do Not Use PCs

If teachers do not use computers in the lesson it is interesting to note that this is not due to hardware or computer laboratory availability but rather the lack of ICT competence of the teachers. Teachers sometimes show general ignorance in respect of ICT, or just to avoid additional lesson preparation. Other reasons mentioned in single schools were addressed as PC restricts scope of lessons, obsolete equipment, lack of time, too many pupils, not effective enough.

Finally, the ICT competence of the teachers was questioned through self-assessment. See Fig.7 below.

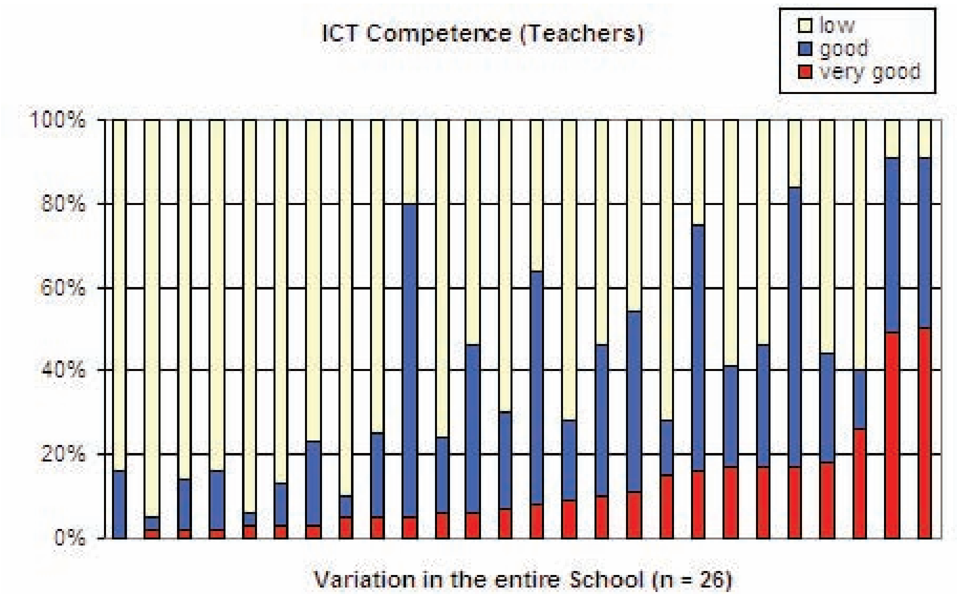

Fig. 7. How Many Teachers are Educated in ICT

Finally, the report illustrates that there is an imbalance between the awareness of the importance of ICT for everybody in the information society and the representation of this matter in the curriculum of compulsory schools and teacher education.

The comparison between the curriculum and daily school practice has been taken as a basis for further research and initiatives for improvement in educating students to use ICT for life long learning. As a follow up project in September 2006 “STAND – Network ICT at Secondary Schools (Hauptschulen)” was initiated. The main objective of this project is to examine a definition of basic knowledge and abilities of ICT that should be demonstrated by each pupil by the age of 14 years. The project is published at the internet under http://epmp.bmbwk.gv.at/. This research is in an initial stage, the outcome is expected to have influence on teacher education and the curricula.

7.2 Integration of ICT in primary education

At the State College of Education in Vienna in initial teacher education the extent of ICT practice in primary schools was investigated by an analysis of reports of teacher trainees during their practical studies (teaching) in selected Vienna primary schools (Grimus, 2007). Sixty four teacher trainees in their second year reported the extent of ICT use in schools of which 59 trainee teachers observed computer use during lessons. See Fig.8 below.

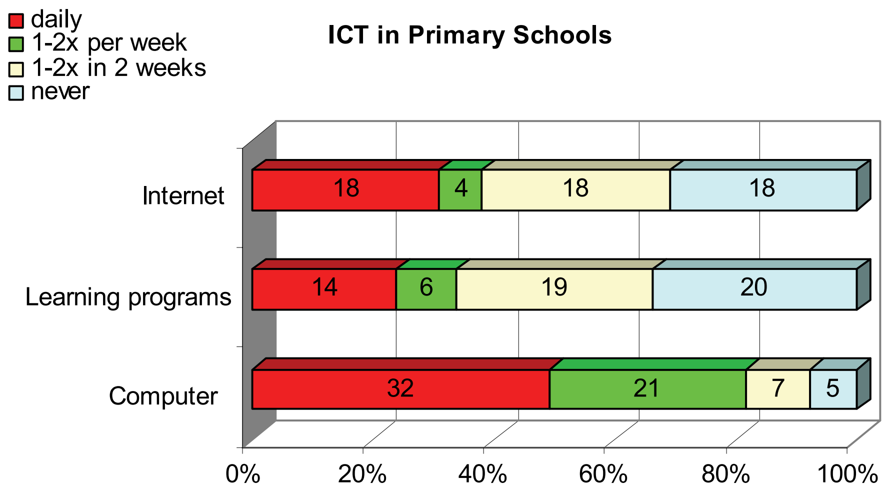

Fig. 8. Frequency of use of ICT in daily school routine

Some results are outlined: A distinction between internet use and the use of learning software was made. The use of learning programs and encyclopedia was reported by 45 trainee teachers (71%). The frequency of use varied between daily and once to twice per week. Internet research is the most common use reported; in approximately 30% of classes observed, and it was a daily practice. Most of the pupil's research results were printed out (text and graphics). Finally, the report illustrates that there is an overload of *passive* use, learning software and encyclopedia are "consumed", but follow up exercises, e.g. extracting texts, followed by re-shaping and illustrating the information gathered in the individual learning process is rarely to been seen. Some of the results were taken to discuss with the prospective teachers aspects of creative use of standard software for individual knowledge construction process.

7.3 Informatics and Standards at an Early Stage

Another research from Carinthia (one of nine states of Austria) investigated ICT teaching in *Academic Secondary Schools*, including a look back to ICT relevant issues in primary education (Micheuz, 2005a, p.10). Almost *all* academic secondary schools in Carinthia have taken advantage of autonomous regulation and established the subject informatics in years 5 and 6 for one hour per week since the school year 2002/2003. An online survey measured various organizational formats and teachers' attitudes towards informatics in the first two school years. The project involved about 15 schools, 85 teachers and approximately 2000 pupils (age 10 to 12). Some results are outlined below:

- An internal ICT curriculum is predominant at schools (> 90%). Only one school made use of a text book, all others developed their own material, but additional E-Learning material was exchanged between colleagues, and computer magazines were widely used.
- Prior knowledge of pupils was another interesting question. As the number of computers in primary schools varied greatly (a shortage of PCs was found in most of the schools), it was assumed that a systematic introduction to ICT is not viable. Regarding the frequency of computer use in primary school (regularly/sometimes/never), it was discovered that very few pupils had regularly worked with computers (about 10%), and about 40% of pupils did not have any experience with computers at primary schools. Outside school 80% of pupils gained experience with computers by playing games (30%), word processing (20%), using internet (20%) and e-mailing (10%). The fact that pupils gain their experience with computers outside school and taking in account that there are no compulsory goals figured out in regard of ICT competence in the curriculum of primary education there is a need of standards for ICT in education. This was one aim of the study, to show that, especially at the transition between primary and secondary schools, an attempt at standardization is beneficial to avoid a further digital divide among the pupils at a young age.

In summary primary schools from both studies (Vienna and Carinthia) report a deficit in ICT use in daily routine.

8 Standards

Educational standards describe the competences of students necessary to meet the objectives. This is to ensure that the objectives of specific subject areas at different levels can be fulfilled. “Standards foster the learning process, provide for a solid basis, and help prevent an early digital divide among the pupils.”(Micheuz, 2005). School efficiency and acquisition of skills, as a basis for life-long learning, are of increasing importance in the European member states (European Union, EU) and are currently integrated in a number of international studies (PIRLS, TIMMS, PISA). In Austria a nationwide trial for definition of educational standards for schools has been restricted until now within the subjects of German Language, Mathematics and English Language, the evaluation process is in progress. The matter of standards in ICT is subject to ongoing research and initiatives. Regarding life-long learning skills, ICT standards (knowledge, skills, and competence) should provide a solid foundation for the use of ICT in other subjects as well as in forthcoming E-Learning environments. Discussions based on experience in some general lower secondary schools where informatics is taught as a subject were presented during the IMST Conference in Vienna (IMST, 2006). A proposal for standards in schools with a main emphasis on ICT and informatics is published under http://www.gym1.at/schulinformatik/unterstufe/standard/ in German Language. There are 37 categories listed, the topics are: basics (e.g. hardware, operation systems, data management, software), text processing, presentations, spread sheets, graphics and communication.

Because of the lack of standards and objectives in the curriculum a number of certificates adjoined to ICT have been developed and are widely appreciated as compensation. In many schools some of the certificates are offered on a voluntary base.

9 Certificates

Because there are no standards of ICT in schools students and teachers are very eager to gain a certification for their endeavours. The most common within compulsory education are discussed below.

9.1 E Junior

The eJunior program was developed by the Austrian Computer Society (OCG, 2005) to give younger children a chance to demonstrate their ICT skills and acquire an ICT certificate. The eJunior course provides valuable preparation for the international ECDL program (European Computer Driving License). To formulate an age-appropriate certificate, eJunior was split into two levels:

- eJunior basic: recommended for 8 to 10 year olds
- eJunior professional: recommended for 10 to 12 year olds

Both levels encompass five modules: computer competence, word processing, graphics, presentations, internet and e-mail usage. Module syllabi guide the instruction of ICT content and identify the competencies that young pupils should acquire. Certification tests are completed online when students feel competent to pass.

9.2 European Computer Driving License, ECDL

A number of secondary schools with a main emphasis on ICT offer courses to encourage students and teachers to get a certificate in ICT. ECDL, known as ICDL outside Europe (I for International), is the global standard in computer skills, offering participants an internationally recognized certification that is supported by governments, computer societies, international organizations and commercial corporations globally. ECDL is recommended for students of age 12 and upwards. The so called CORE ECDL consists of seven modules: Module 1 - Concepts of Information Technology (IT), Module 2 - Using the Computer and Managing Files, Module 3 - Word Processing, Module 4 – Spreadsheets, Module 5 – Database, Module 6 – Presentation, Module 7 - Information and Communication. This certificate is well appreciated by students and the syllabus is taught in the subject informatics in many secondary schools.

Already 180.000 students at secondary schools have passed individual modules since the year 2000 in Austria, while 14.000 modules were passed by teachers (ECDL, 2006).

9.3 Computer - Fit for Teaching

A new module for teachers, Computer-Fit for Teaching ("Computerfit fuer den Unterricht") has recently been developed by the Austrian Computer Society. This is an additional module of the ECDL and is designed to supplement basic skills, which are represented by the four ECDL modules: 2 - Using the Computer and Managing Files, 3 - Word Processing, 6 – Presentation and 7 - Information and Communication, with didactical emphasis on ICT in teaching of all subjects. The syllabus of this module includes the use of various digital media (digital camera, scanner, sound) and competences for troubleshooting (printers, networks) in the classroom. The use of word processing is enlarged by additional skills, to include generating a table of contents and lists of references in documents. The use of graphic software is also part of the syllabus and also didactical aspects are integrated.

ECDL is not demanded to be a prerequisite for all teachers and therefore is not integrated in the curriculum of Colleges of Education throughout Austria.

10 Creativity and ICT

One issue in teacher education is to point out that learning software (interactive CD-ROM and online-instruction) is only one specification of ICT within the learning process, addressed as the "passive use". There is insufficient emphasis laid on the further development of the pupils' information-handling skills, including analysing, evaluating and refining the information retrieved. To design tasks including ICT as a tool which supports the learning process is important for prospective teachers. Therefore an introduction of the topic of creativity in combination with ICT is given.

Creativity can be described as a human capacity to take what we have and use it in new ways. "Creativity is displayed by the application of thoughts to our personal experience and understanding in order (…) to help us to make things in our way, and produce innovative ideas and solutions to problems." (BECTA, n.d.) Recent developments in pedagogy have focused on shifting from instruction to problem solving and influence increasingly the learning culture. In educational settings – focussed on ICT related activities - we can try to encourage creativity in thinking imaginatively, generating something original to the individual. Creativity in education can be stimulated by circumstances or events, which challenge students, are thought-provoking, interesting or demanding.

ICT offers both parties, teachers and learners, opportunities for creativity in all areas of the curriculum. Improved subject knowledge could be demonstrated by presenting the outcome to the class in a creative combination of text and graphics, spreadsheets and diagrams. To be creative when using ICT depends on skills, experience and imagination and the appropriate combination of each. The characteristics of ICT can also make a distinctive contribution to those processes, providing new tools, media and environments for learning to be creative and learning through being creative. To look what others are doing or to have the chance to ask an "expert" comprises the chance for progress. Good practice means children working in an exciting environment, they share ideas informally. By using familiar tools (word processing, graphic software, and web-browser are standard on nearly all computers) the students are developing additional skills in thinking, research, developing, creating, exploring and presenting commonly very quick.

11 Examples of Good Practice

Getting the balance between pupils learning ICT as a skill and using it as a tool is an important topic in teacher education: How can ICT inspire both pupils and teachers through a range of exciting activities? Therefore it is one aim in teacher education in Austria to provide prospective teachers with examples and project-ideas to encourage them to experience new ideas about how they can use ICT to improve pupils' learning.

To involve prospective teachers in project and group work is addressed to be continued during class teaching. Individual work and cross-subject projects contribute to the wide range of didactic approaches in ICT teaching. Didactical approach is prescriptive in a sense that it should provide both teachers and learners with concrete methods for achieving ICT competence, which could be a motivation for further self-organised projects.

At the State College of Education in Vienna prospective teachers (primary and lower secondary schools) develop interactive learning sequences including multimedia applications and online-quizzes during their third semester. Tasks are designed in a manner that allows a wide range of freedom for decisions on various levels and to become familiar with different software-tools. The teacher trainees are encouraged to create a website and learning sequences that fit to their classroom practice. Teacher candidates have the freedom to:

- decide to work on their own or in pairs,
- specify which software would fit best to their proposed project,
- elaborate on a topic (subject) of individual choice,
- collect and research appropriate material (digital pictures, encyclopedia). References have to be included into the documentation in a scientific notation,
- document their planning (learning objectives, learning outcomes, structures, time line, team organization) with tools they have identified to be appropriate (combinations of diagrams, text-documents, mind maps, organigrams, etc).

Interactive tests (e.g. living books, quizzes, worksheets, etc) have to be included in the multimedia-product. Hot Potatoes is a particular application which is easy to use and offers the possibility to create interactive exercises (multiple-choice, short-answer, jumbled-sentence, crossword, matching/ordering and gap-fill exercises). The aim is to introduce this software during the teaching practice to pupils to motivate them to repeat topics by creating exercises and quizzes for other pupils.

The productions of the teacher candidates are evaluated within their group. After the evaluation the applications can be borrowed from the library. In some cases the learning sequences are extended by follow up tasks in cooperation with teachers who evaluate the products during classroom teaching. This experience should encourage prospective teachers to incorporate similar tasks in their classroom routine. Motivating novice teachers to share their ICT skills with experienced teachers and teacher trainers have shown some creative ideas for innovative classroom practice. Students were actively engaged in what are sometimes called "constructivist activities", such as searching for information, designing products, and publishing or presenting the result of their work.

Another example for acquisition of experience with ICT in daily classroom work is shown with the project "Pocket PC's, small computers for small hands". (Bailicz, Seper and Sperker, 2006). The project was developed at the observation primary school (Uebungsvolksschule) which is part of the College of Education of the Archdiocese of Vienna. Pocket PC's (PPCs, PDAs, Personal Digital Assistants) were integrated in every day teaching to take advantage of the so called "Gameboy effect". They are generally used as tools for teaching and learning, at spelling and reading exercises, and for drawing and communication in grade three and four (age 8 to 10). Prospective teachers are observing lessons and also taking part in lessons.

In the courses for in-service training at the State College of Education in Vienna a focus is put on observation of ICT competitions for pupils (primary and secondary school teachers join the same courses). The aim is to encourage teachers to participate in ICT competitions with their classes and also to discuss the abilities and ICT experience of students in the various grades. This motivates teachers to work with different software and to create ideas together with the students of their classes. Most of the contributions are created with office-tools or web-editors, few with Flash, Mediator or Robotic-Kits. (OCG & JIW, 2007).

In pre-service training there was detected a lack of knowledge concerning ICT skills of pupils in primary and secondary schools. The evaluation of different contributions of pupils to ICT competitions was figured out to be useful to show prospective teachers what pupils produce in primary schools, when they have opportunities to make informed choices of ICT tools and media available for different creative processes and stages. Exemplar project work of year two gives an impression of the tools and how they are used for research and knowledge representation in primary schools. See Fig. 9 below.

Fig. 9. Klimt for Kids, Homepage of Grade 2

"Klimt fir Kids" has been taken as an example to explain, how the learning environment can stimulate the use of innovative ICT applications. Web research for example, is daily routine in many classes. The more skilled users take a copy of the web materials and elaborate on it by use of word-processing and image integration. Text can be re-shaped, re-organized, images integrated and enhance the written word. Skills involved in data and file organization are required. Exchange of these files and digital content is part of the necessary skills. The analysis of a sample of contributions allow teacher trainees to extract what skills pupils need to achieve in ICT.

12 Conclusions and Outlook

Media education has been established as a principle in the Austrian school system, but it is left to the teacher's ability in ICT and related skills, if he (she) is able to make appropriate use of it. As a consequence of the advance of the information and communication technologies in daily school routine, the impact of ICT instruction has been watered down. A gap between the autonomous acquisition of ICT competences on an individual basis and regulations by the curricula of primary and secondary education has been identified. Since ICT is not a compulsory subject, it is up to the individual teacher to determine to what extent ICT competence can be developed in compulsory education.

Examples of 'good practice' are elaborated to motivate teachers and trainees to integrate creative ICT use into daily school routine.

The definition of a set of teaching objectives in ICT, as an orientation for teachers, should be added to the primary school curriculum as also to the curriculum of secondary education, so that changes in learning culture by ICT integration can be anchored in the Austrian School system. As a consequence specifications of abilities and skills should be integrated in teacher education curricula.

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Computing Competition: Staff vs Students!

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Abstract

Prevailing initial teacher training policies try to ensure that the entering teaching workforce has a substantial background and a basic set of information and communication technologies (ICT) skills, including how to apply technologies in pedagogical settings. Since teacher trainers and staff members in general, play key roles in implementing these policies, their own ICT skills should be adequate. This comparative study was initiated to investigate university-level teacher trainers' and preservice teachers' perceived skills, interest, and attitudes for using ICT. The survey was distributed to teacher trainers and first-year students at the University of Oulu, Finland (N=189). The findings indicate that the staff is well prepared to meet the challenge of the information society. The results have implications regarding the use of technology in education, staff training, and activities of educators in general.

"*Who dares to teach, must never cease to learn*." *(John Cotton Dana)*

1 Introduction

John Schacter (1999) reported an analysis of several large-scale studies of education technology (Harel 1990, Harel & Papert 1991, Kulik 1994, Baker, Gearhart & Herman 1994, Scardamalia & Bereiter 1996, Sivin-Kachala 1998, Wenglinsky 1998, Mann et al. 1999). These studies showed that students with access to teachers who received professional development on computers, demostrated positive gains in achievement on researcher-constructed, standardized, and national tests. General support for the use of information and communication technology (ICT) in teacher training is reflected in several studies. Henriquez & Riconscente (1999; see also Atallah & Dada, 2006) reported that teachers who participated in training programs on the use of laptop computers noted positive change in their students' abilities and work habits. Substantial changes in teachers' professional practices were also found, including teachers becoming more reflective about their teaching practices, spending more time advising their students, and spending more time working with other teachers. Also Davis (2000) urged that teachers need comfortable access to and preparation for effective deployment of information technology (IT) in education in schools, colleges, communities, and teacher education programs.

According to European Schoolnet (2005):

> Concrete definitions of terms and precise description of skills or competencies should be part of each policy that sets the goals for developing teachers' (digital) competence. It appears that the concept of digital literacy for teachers nor the skills that are required to integrate information and communication technology (ICT) in pedagogical practices are not yet sufficiently defined.

European Schoolnet does not only demand these concrete definitions, but they also try to explicitly specify required ICT skills, by surveying ICT use in sixteen European countries. Due to distinct practices in each of these countries only a few common ICT skills are listed, such as

- use of Internet and email, competencies to integrate ICT in subjects
- skills to use digital reference materials
- skills to use ICT for class preparation
- the use of ICT tools for illustration (whiteboards, multimedia)
- skills to master learning objects

European Schoolnet noted the importance of helping teachers gain both pedagogical skills and technical ICT skills.

In Finland the government has chosen the information society as the theme of one its policy programmes. The aim is to promote information society development by enhancing cooperation between various partners, by developing citizens' information society skills, ensuring access for people to fast connections, promoting the availability of educated and trained labour, and by utilisation of ICT in public services and administration (Finnish Ministry of Education, 2004).

Since 1995 multiple strategy papers for applying ICT in education have been released by the Finnish Ministry of Education. One recent paper, *Information Society Programme for Education, Training and Research 2004-2006,* sets a goal:

> Before the end of this planning period appropriate use of ICT in learning and in teaching is part of everyday school life. ICT is also used widely and appropriately in research and electronic materials are of a high quality, pedagogically justified, serve different user groups and are available openly.

In the everyday life of educators this should mean that ICT is used extensively in studies and teaching at all levels of education. Basic education should provide initial grounding for ICT skills. These skills are deepened at the secondary level, and the higher-education level. Recently the Finnish "*National Knowledge Society Strategy for 2007-2015"*, published in September 2006, calls for a well-designed infrastructure including fast network connections, lifelong learning, working copyright mechanism, and international cooperation (Information Society Programme, 2006).

In modern teacher training, good overall and pedagogical ICT skills are required to train forward-looking teachers and to renew instructional methodology. Care should be taken to provide teacher trainees with sufficient knowledge and skills for utilising ICT and electronic materials in education and in school-home interactions. The aim is that in Finland by 2007, no less than 75% of teachers will have the knowledge and skills to use ICT in teaching.

Technologies themselves can serve the broader interests of social equity and educational transformation. Production of digital materials for teaching and learning will be promoted. Open access to quality materials will ensure more equitable access to reliable information. This will be particularly important for materials produced with public funds.

Previous plans and strategies are exactly what Davis (2000) means while talking about what governments on all continents have discovered. At the practical level educators are responsible for enacting ICT strategies. That happens in kindergartens and primary schools, in high schools and universities. In many cases the same software are taught in parallel in primary, secondary and tertiary education. That particular situation raises serious challenges especially for higher education. In other cases students continue through school grades without mastering critical ICT skills. Differences in student outcomes raise serious challenges, especially for higher education. Are staff members at colleges and universities ready to meet the needs of a wide spectrum of students whose computing skills might be extremely divergent? Are professional educators prepared to help all learners move toward the information society? These challenges serve as a point of departure for this study, which examines computing skills and related factors among staff and students.

2 Background and Literature Review

According to Meisalo (2006):

> Beginning in the late 1980s, the use of ICT in education greatly expanded, spurred by the launch of the microcomputer and following the lead of top American universities and schools, as well as interesting projects in United Kingdom, France and other European countries. Finland, along with many other developed countries, followed a similar path, though sometimes with delays and sometimes finding new paths or development. Finnish experts involved in developing ICT use in education considered teacher education as a key area for the intended breakthrough of new technologies.

In spite of its acknowledged importance, computing did not gain the status of compulsory school subject in Finland. Instead, computing was integrated in all school subjects. Local schools got power to decide how to prepare a curriculum that ensures proper skills in computing for their pupils. That has led to a situation of irregular integration of ICT at schools and inconsistent outcomes in student learning. The Finnish National Board of Education (FNBE), which works under the auspices of the Ministry of Education and is in charge of development of education in Finland, has provided massive refresher courses for in-service teachers, and this process continues. A recent Annual Report (FNBE, 2005) delineates grants of EUR 2.5 million for establishing computer networks and purchasing computers for 289 general education providers. This investment led to purchases made by 1,082 comprehensive schools, 179 upper secondary schools and 15 other educational institutions. The idea is to ensure an adequate level in infrastructure and know-how among all educators and education providers.

While investing in educational technology, policymakers are certainly looking forward to some payback for that investment. Prior research has documented that technology can support the learning of an individual student by structuring inquiry activities, providing tools for recordkeeping, highlighting essential phases of the process, and guiding metacognitive and reflective activity (Pea, 1993). There is also evidence indicating that technological tools can also enhance students' conceptual understanding by providing tools for organising, representing, and visualising knowledge (Salovaara, 2005; see also Pea et al., 1999; Rochelle & Pea, 1999). These higher-level knowledge-construction processes are, nevertheless, invoked only if people, staff and students have skills and willingness to engage in utilizing the potential of ICT in education.

According to Williams, Coles, Richardson, Wilson & Tyson (2000), teachers' ICT development needs can be categorised into the three major areas*:*

1. Access to ICT
2. Appropriate training (in terms of skills, knowledge, relevance to educational goals and priorities; and delivery)
3. Ongoing support to encourage progression beyond initial teacher education or training

In their study 57% of primary teachers (n=1480) and 61% of secondary teachers (n=1314) expressed a need for more technical skills and knowledge. Only 5% of primary teachers and 4% of secondary teachers expressed a need for teaching ICT skills.

Sinko and Lehtinen (1999) perceived a gender difference in the self-evaluations of university teachers and students on their own information technology skills. Among both students and teachers, males tend to say they have better skills in the use of information technology than females. They also discovered that both teachers and students have a relatively good mastery of the basic skills of using information technology (word processing, email, operating systems, web browsing).

Sandholtz, Ringstaff, and Dwyer (1997) discovered that teachers need not only advanced computing skills, but also the ability to integrate tools seamlessly into the curriculum, as well as an understanding of the ways in which computers affect notions of school reform and relationships with students and society. All computer use in schools must be seen in an appropriate context, to allow teachers to predict what their outcomes will be for their particular class.

A study by the Milken Exchange on Educational Technology (1999), and conducted by the International Society for Technology in Education, found that teacher preparation programs "are not providing the kind of training and exposure teachers need if they are to be proficient and comfortable in their teaching" (Willis 2005). In the development of teacher education, within Finland, special attention should be paid to knowledge and skills needed in guidance counselling and in the teaching of different learners (e.g. pupils with special educational needs and immigrants), and to the use of information and communications technology in teaching (Finnish Ministry of Education, 2003).

3 The Study

This study was completed in Finland at the University of Oulu, Faculty of Education, Department of Educational Sciences and Teacher Education. The Department has approximately 1300 lower or higher academic degree or postgraduate degree seeking students.

Annual enrollment figures of students for 2006, categorized by different programmes, are as follows: Educational Science 30, Teacher Education 40, Master of Education / International Teacher Education 20, Technology Oriented Teacher Education 20, Early Childhood Education 20 and Music Education 18. In addition, approximately 150 students from outside the department are taken in annually to complete studies in pedagogics.

The Department has approximately 130 staff members of which 17 are professors, 9 senior assistants, 11 assistants, 31 lecturers, and 14 other teaching staff. There are also about 20 researchers. The rest of the remaining staff belongs to administration. In this study all staff members are treated as teacher trainers, regardless of someone's specific job or position – diverse and versatile know-how is needed to train modern teachers. That also means that every staff member has a disparate background: all are professionals and experts in their own subject matter, but only a few of them have studied computing science or related subjects. However most of the staff members have participated in at least some short ICT courses, and some have studied educational technology as a minor subject.

4 Research Questions

The following three research questions guided the study:

1. What is the common level of computing skills among the staff and first year students of Department of Educational Sciences and Teacher Education?
2. How do the computing skills of staff and students compare?
3. How do other factors (gender, age) interact with computing skills?

Answers to these research questions should have implications for current teacher training in a context of recruiting staff and students, and their further training. To address these questions a survey was utilized among staff members and students.

5 Data Collection and Instrument Description

In September 2006 data were collected among the Department staff and first-year students. A multiple-choice questionnaire were mailed to each staff member (N=130) to which they were to respond anonymously. Seventy-two (55.4%) of staff questionnaires were returned. The same questionnaire was delivered to students (N=148) and 117 questionnaires (79.1%) of those were returned.

The questionnaire was divided into three parts:

1. *Background Information*: Affiliated professional group, gender, age, ownership of personal computer with Internet connection, and average weekly computer use.
2. *Practical Computing Skills*: Operating system, word processing, spreadsheet, presentation software, email, Internet (information seek, webpage design, music and video downloading, Internet phone calls, videoconferencing), digital image editing, digital sound, virus protection and firewalls, and web-based learning environments.
3. *Experiences and Attitudes Towards Applying ICT at Schools*: Students versus staff in computing skills, origin of computing skills gained, and computing as a hobby.

Respondents were asked to describe the level of their computing skills by selecting one of the five choices in a Likert-style assessment as follows:

1. "I can do that easily"
2. "I can do that, even though that might be toilsome for me"
3. "Perhaps I can do that, I´m not sure"
4. "I probably need some help to do that"
5. "I can´t do that"

6 Data Analysis and Findings

Responses to the survey items were analyzed using SPSS 11.5 for Windows. The basic statistics were calculateed including frequencies, mean, percentages, and two independent-samples t-tests. A total of 189 questionnaires were received, of which 38.1% consisted of staff and 61.9% of students. The proportion of females in this study was 132 (69.8%), with 57 (30.2%) of the respondents male (see Table 1 for a demographic summary).

Table 1. Description of Participants.

Staff	Female	Male	∑	Description
Researchers	7	11	18	Full-time researchers, professors, assistants
Teaching personnel	14	13	27	Lectures and other teaching staff
Administration	16	6	22	Administrative affairs
Other	3	2	5	E.g. project-personnel
Sub-total	*40 (55.5%)*	*32 (44.5%)*	*72 (38.1%)*	
Students	Female	Male	∑	Description
Teacher Students	46	23	69	Primary (55) + subject (music, 14) teacher students
Early Childhood	16	1	17	Kindergarten teacher students
Educational Science	30	1	31	Future researchers, administrators, teachers…
Sub-total	*92 (78.6%)*	*25 (21.4%)*	*117 (61.9%)*	
Total	132 (69.8%)	57 (30.2%)	189 (100%)	Total number of respondents

Note: $N = 189$

Although staff was asked to identify the main focus of their profession (research, teaching, administration), some staff members indicated that they do both research and teaching. In those cases every other respondent was assigned to the 'Researchers' or 'Teaching personnel' groups. Eight respondents out of 72 staff members work at the Research Unit for Educational Technology. The questionnaire, intended for first-year students only, received seven (6%) replies by third- and fourth-year students.

At work or study, 186 (98.4%) of respondents had access to a personal computer. A home computer was owned by 168 (88.9%) of the respondents (91.7% of staff and 87.2% of students). The computer was connected to Internet in 97.8% of cases at work or study. At home 81.0% of the respondents had an Internet connection (84.7% of staff and 78.6% of students). One staff member was not sure about Internet access from home.

Respondents reportedly use their computers 15.3 hours in a week on average, with a median of 10.0 hours. Staff members reported substantially higher weekly usage levels at 28.2 hours, compared to 7.5 hours among students (t-test, $^{***}p<.001$).

Females reportedly significantly lower levels of computer use at 12.6 hours in a week (staff 27.8 hours, students 6.4 hours), compared to male reports of 21.2 hours (staff 28.8 hours, students 11.5 hours). This statistically significant difference (t-test, $^{***}p<.001$) confirms Kumpulainen's (2006) earlier finding: first-year male teachers student reported an average of 11.9 hours per week with the computer, compared to 6.6 hours per week for females.

The first main research question was 'What is the common level of computing skills among the staff and first year students of Department of Educational Sciences and

Teacher Education'? The Computing Competence Profile (CCP) was figured for that purpose. In this study the CCP consists of nine factors, and each factor refers to 2-9 (A-I) items (variables) in the questionnaire. The CCP factors and included items are the following:

1. *Operating System (Windows).* A. I can install and update Windows operating system. B. I can use most of the functions of Windows Explorer. C. I can search for a specific file that exists on my hard drive.
2. *Word processing*. A. I can edit, format, save, open and print text. B. I can create mass mailings (mail merge). C. I can use formatting styles. D. I can create an automated table of contents.
3. *Spreadsheet Software*. A. I can create simple formulas and use them for calculation. B. I can illustrate tables with graphs.
4. *Presentation software*. A. I can create a simple presentation by using PowerPoint (etc). B. I can add effects (sound, image, movie, animation) to my presentation. C. I can chain presentations by using links and interactive buttons.
5. *Email***.** A. I can use the basics of emailing (send, read). B. I can send and open attachments. C. I can create and update mailing lists.
6. *Internet Usage*. A. I can create bookmarks in my browser. B. I can change settings in my browser, e.g., set restrictions. C. I can search information on the web. D. I can use more advanced searching methods (exact phrase, file format, date, domain, language etc). E. I can build websites by using html. F. I can build websites by using some editor (Dreamweaver etc). G. I can download music or movies from the Internet. H. I can use the Internet for phone-calls (e.g., Skype). I. I can use computer-based videoconferencing (e.g., NetMeeting).
7. *Digital Image*. A. I can scan images and move my images to a computer. B. I can use digital camera and move my images to a computer. C. I can save my images in different file formats. D. I can do the basics in digital image editing (draw, erase, select, crop). E. I can use layers.
8. *Digital Sound*. A. I can run mp3 files via computer. B. I can edit .wav files and add effects on those (e.g., echo). C. I can convert .wav-file to .mp3-file.
9. *Data Protection*. A. I can avoid viruses in email. B. I can install and update virus protection on my computer. C. I can install and update a firewall on my computer

Sum variables (scales) were calculated for these factors by the using items listed above. Finally all factors were standardized to the original scale of 1 through 5. In this research a quasi-interval scale was assumed for those variables/factors representing computing skills, which means that mean value-based statistics were used ("meaningful interpretation of a mean value" prevails; see Valtari 2006). Table 2 describes the CCP scores of staff and students together, that is to say 'the common level of computing skills among the staff and first year students.' Figure 1 graphically illustrates the data from Table 2.

Table 2. Computing Competence Profile (CCP), Staff & Students

Item	Mean	Std. Deviation
Operating System (Windows)	2.60	1.25
Word Processing	2.51	1.01
Spreadsheet Software	3.01	1.39
Presentation Software	3.14	1.39
Email	1.80	0.80
Internet Useage	3.45	1.09
Digital Image	2.81	1.32
Digital Sound	3.54	1.37
Data Protection	2.86	1.39

Note: *N = 189*

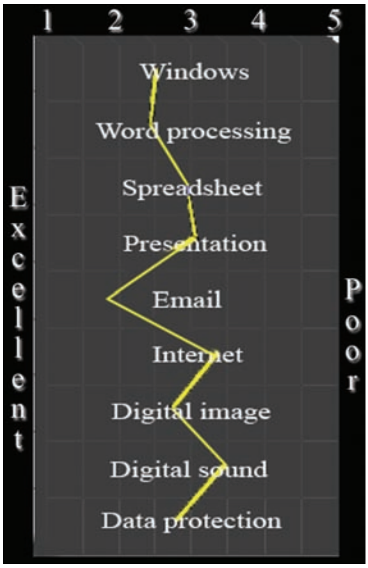

Fig. 1. CCP, Staff & Students.

As Figure 1 illustrates, the typical Computing Competence Profile among all survey respondents seems to be mainly positive weighted. Respondents scored highest in email, while digital sound caused the greatest challenge. Although these findings do offer a good institutional image of staff and first-year students, more specific comparative information can be gained by answering the next research question.

The second research question was ‘How do the computing skills of staff and students compare’? To find that out, the CCP was calculated separately for staff and students, which is shown in Table 3.

Table 3. CCP, Staff vs Students.

Item	S t a f f (N=72)		Significance of	S t u d e n t s (N=117)	
	Mean	Std. Deviation	difference (p)	Mean	Std. Deviation
Operating System (Windows)	2.34	1.28	.028 *	2.75	1.22
Word Processing	2.18	1.03	.000 ***	2.72	0.95
Spreadsheet Software	2.38	1.25	.000 ***	3.39	1.34
Presentation Software	2.53	1.28	.000 ***	3.51	1.32
Email	1.46	0.67	.000 ***	2.00	0.81
Internet Useage	3.14	1.19	.003 **	3.63	0.99
Digital Image	2.65	1.43	.179	2.91	1.24
Digital Sound	3.39	1.55	.235	3.63	1.24
Data Protection	2.81	1.44	.691	2.89	1.37

Note: * *p<.05,* ** *p<.01,* *** *p<.001*

As mentioned earlier, a value of 1 equals to *"I can do that easily"* and a value of 5 equals to *"No, I can't do that."* Table 3 shows that the staff scores higher in every single CCP factor compared to students. In four factors out of nine (word processing, spreadsheet, presentation software, and email) the observed difference is statistically highly significant (t-test, ***p<.001). The difference between the skills of staff and students are minor for digital image, digital sound, and especially for data protection. Figure 2 illustrates the data that is presented in Table 3, showing that in the computing competition – staff vs students – the clear victory 9 – 0 goes to staff!

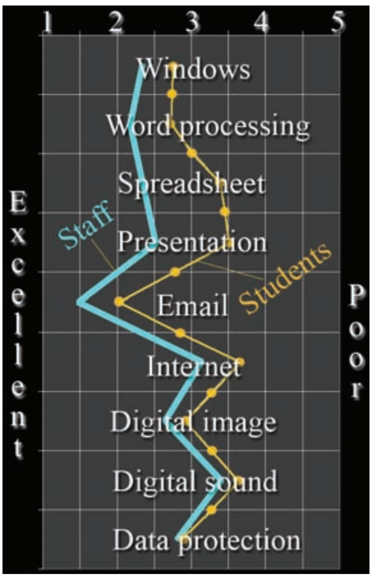

Fig. 2. CCP – Staff vs Students.

The profile of computing skills demonstrates clearly the similarities and differences between the staff and students. Among the measured skills, proficiency in emailing was common across the board. By contrast, the scores in digital sound and Internet usage were relatively low in both groups. Group differences were particularly noted in using spreadsheet and presentation software.

Comparative analysis yilded evidence of wide diversity. Thus, other factors must be examined in attempt to understand the results. That analysis will be produced by answering the next research question.

The third research question was ‘How do other factors (gender, age) interact with computing skills’? Gender was examined first by calculating the CCP scores separately for male and female respondents (see Table 4).

Table 4. CCP, Male vs Female.

Item	M a l e (N=57)		Significance of difference (p)	F e m a l e (N=132)	
	Mean	Std. Deviation		Mean	Std. Deviation
Operating System (Windows)	1.82	1.14	.000 ***	2.93	1.15
Word Processing	2.07	0.86	.000 ***	2.70	1.02
Spreadsheet Software	2.26	1.28	.000 ***	3.33	1.32
Presentation Software	2.30	1.19	.000 ***	3.50	1.31
Email	1.59	0.80	.000 ***	1.89	0.79
Internet Useage	2.72	1.00	.000 ***	3.76	0.98
Digital Image	2.16	1.22	.000 ***	3.10	1.26
Digital Sound	2.39	1.47	.000 ***	4.04	0.96
Data Protection	2.02	1.34	.000 ***	3.22	1.26

As Table 4 reveals, a detected difference in computing skills was statistically highly significant ($^{***}p<0.001$) in every CCP factor, indicating that among respondents, male scored clearly higher compared to females. That is shown graphically in Figure 3.

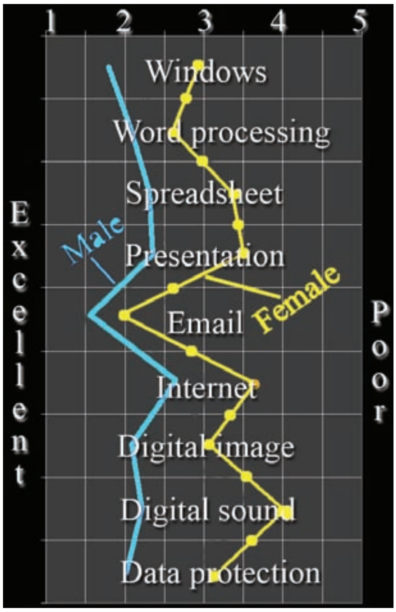

Fig. 3. CCP, male vs female.

The gender issue is also depicted in Table 5. In that table, respondents were divided into groups of staff and students by gender. It shows that male scored higher than females among staff, and also among students.

Table 5. CCP, male vs female, staff & students.

Item	Staff			Students		
	Male (n=32)	Sig (p)	Female (n=40)	Male (n=25)	Sig (p)	Female (n=92)
Operating System (Windows)	1.75	.000***	2.82	1.92	.000***	2.98
Word Processing	1.81	.006**	2.48	2.40	.060	2.80
Spreadsheet Software	1.91	.004**	2.75	2.72	.004**	3.58
Presentation Software	2.06	.005**	2.90	2.60	.000***	3.76
Email	1.29	.044*	1.60	1.96	.782	2.01
Internet Useage	2.59	.000***	3.59	2.88	.000***	3.84
Digital Image	2.16	.008**	3.05	2.16	.000***	3.12
Digital Sound	2.53	.000***	4.08	2.20	.000***	4.02
Data Protection	2.09	.000***	3.38	1.92	.000***	3.15

Note: * *p<.05,* ** *p<.01,* *** *p<.001*

All CCP factors yielded statistically (highly) significant difference between male and female staff members. Among students, the difference is almost as clear: only ‘Email’ and

'Word processing' are roughly equivalent between groups; every other CCP factor shows statistically (highly) significant difference.

The next focus in the third research question is, *How does age interact with computing skills*? The average age of respondents was 31.3 years (median = 25 years, range 18 to 63). The average age among staff was 45 years (median = 44.5 years, range 24 to 63). The standard deviation was 11.57 years. Students were 22.8 years old on average (median = 21, range 18 to 46). Standard deviation was 5.04 years. One staff member and one student did not report their ages.

In Table 6 respondents are divided into two groups, 'age below median' and 'age equal or above median', and staff and students are examined separately.

Table 6. CCP, Age Below and Equal or Above Median.

Item	Staff			Students		
	Age< Median (n=36)	Sig (p)	Age>= Median (n=35)	Age< Median (n=44)	Sig (p)	Age>= Median (n=72)
Operating System (Windows)	2.00	.024 *	2.69	3.00	.091	2.60
Word Processing	1.89	.015 *	2.47	2.75	.766	2.69
Spreadsheet Software	2.14	.109	2.61	3.52	.368	3.29
Presentation Software	2.11	.005 **	2.94	3.57	.666	3.46
Email	1.37	.250	1.56	1.96	.652	2.03
Internet Useage	2.81	.015 *	3.49	3.68	.710	3.61
Digital Image	2.17	.005 **	3.11	2.91	.975	2.92
Digital Sound	3.08	.095	3.69	3.70	.599	3.58
Data Protection	2.44	.032 *	3.17	3.00	.495	2.82

Note: *Median staff age = 44.5 years, Median student age = 21 years.*

Age seems to be a marginally helpful variable in understanding computing skills among staff. Presentation software and also digital image skills were clearly better adopted by younger staff members, compared to older staff members. But all other factors of the CCP did not manifest statistically significant differences due to age.

Among students, the CCP is even more constant: there is no observed divergence among different ages on this issue. One reason for that is clearly quite a homogenous age of students, which is seen in the low standard deviation.

In addition to technical skills, attitudes towards applying information technology were also investigated. Respondents indicated their level of agreement with the statement *Personally I am interested to apply information technology in my work (1=very much, 5=not at all)*. Among all respondents the mean response for staff members was 1.58 compared to 1.94 for students ($^{**}p<.01$). Among male respondents the mean value was 1.49 and among female 1.94. That difference is statistically highly significant ($^{***}p=.001$). Among staff members aged above 44.5 years (median) the mean value was 1.69 and below median age the mean was 1.47. That difference was not statistically significant (p=.315).

Staff members were asked to evaluate the common level of ICT skills among their students by responding to the statement, *The students' computing skills in my institution* *are (1=top, 5=very poor)*. Some (9) staff members did not answer that question. The rest of them (n=63) valued students' ICT skills as follows: 1) 0.0%, 2) 39.7%, 3) 50.8%, 4) 7.9% and 5) 1.6%. The mean value was 2.71.

Likewise, students were asked to evaluate the common level of ICT skills among staff by responding to the statement, *The staff-members' computing skills in my institution are (1=top, 5=very poor)*. Some (15) students did not answer to that question. The rest (n=102) rated staff members ICT skills as follows: 1) 16.7%, 2) 38.2%, 3) 45.1%, 4) 0.0% and 5) 0.0%, with a mean value of 2.28.

If comparing the mean values given by staff to students, and by students to staff, the difference is statistically highly significant ($^{***}p<.001$). Students rate the ICT skills of staff members at a higher level than staff members rate the skills of students.

7 Conclusions

The aim of this study was to investigate university-level teacher trainers and teacher students and their perceived skills, interest, and attitudes for using information and communication technologies. The results indicate that at least in this case, computers for staff are not "oversold and underused" as Cuban (2001) claims. Overall, the findings of the study reveal that computers were heavily used; indeed, personal computers seem to be a main tool for most of the respondents. Assuming that an average staff member works 40 hours in week, he or she spends more than 70% of the working time using the computer (an average of 28.2 hours in a week). Over a 40-year career that means some 52,000 hours of computing (freetime useage and six week yearly holidays excluded), which is equal to 2,166 days or 6 years of nonstop usage!

However, this study confirms the idea of diversity among the staff. Computing skills of male staff members were higher than those of female staff members. Males also reported using software beyond the conventional core, while females tended to stay in more routine usage patterns. One reason for that might be that more of the male staff members work in roles that involve technology-based duties. Their average weekly computing hours were also slightly higher compared to females (28.8 hours vs. 27.8 in a week). These weekly computing hours are high indeed: Kumpulainen (2004) discovered that among computer hobbyists ("nerds"), males spent about 33 hours weekly with computers, where as females spent only about 25 hours.

This study does not suggest that all staff members and preservice teachers will need to acquire all the skills included in the CCP. Some skills will be needed by all and some by only a few. The data supported the idea that at the University of Oulu, in the Department of Educational Sciences and Teacher Education, the staff were well prepared to meet the challenge of information society. Their ICT skills were on a high level compared to the first-year students.

A limitation of this study points to the survey instrument: The Computing Competence Profile factors are not necessarily commensurable. For example, 'Internet usage' included nine items and described variety of competencies. Contrast this with 'Spreadsheet software,' a factor represented by two items only. Though all items were strictly and accurately chosen, a more extensive survey might produce even more specific data.

Another limitation of the study was that only first-year students are represented, among the whole population of 'students.' That was a willful choice made by the researcher. It was important to investigate the level of ICT skills in the beginning of teacher studies, and to find out if teacher trainers were ready to meet their students' needs.

However, further research is required to find out whether students make any progress in ICT skills during their studies, compared to the staff. Do the differences in skills and attitudes between staff and students even out? What is the influence of training? Does the staff manage to keep their advantage as explicit as it was shown in this study? Further research is also needed to get more extensive national and global understanding of the subject.

In the next ten to twenty years there will be major changes in the ways that education and learning happen; teachers' skills will need to develop alongside these changes. Technology has the potential to change the way we teach and learn (McManus & Kumpulainen, 2002). Advanced skills to master that technology are certainly vital, but still the main transition in education will be cultural. Soon a new generation will rule the world, a generation that has grown up in a digital environment. These digital thinkers are used to make on/off –decisions; they are brave enough to communicate with the whole globe or universe when needed, and digital networks are just a natural extension to their own nerves and senses. Techno culture, currently prevailing in the USA and spreading rapidly, values those citizens who are mastering digital devices (Varis, 1995), and teacher training is no exception to that. This cultural change will be a real challenge for present-day teacher trainers. Enhancing students' conceptual understanding (Salovaara 2005), yielding positive change in students abilities and work habits (Henriquez & Riconscente 1999, Atallah & Dada 2006), and showing positive gains in achievement on tests (Schacter 1999) - these all will come true if teacher trainers and students as a group work together (Glenn 2000). Mihaly Csikszentmihalyi's (1990) widely referenced concept of 'flow', a mental state of operation in which the person is fully immersed in what he or she is doing, well describes the kind of activity that may eventually characterize our routine interactions mediated by technology.

This article starts with a quote from John Cotton Dana. In a spirit of that citation the research findings support the idea that so far teacher trainers have not ceased to learn – let's keep that tide of progress in flow!

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Beyond Skills: Evaluating the Impact of Educational Technology Instruction

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Abstract

This chapter describes two studies that utilized self-report surveys to evaluate the impact of educational technology instruction in teacher preparation programs. One study demonstrated changes in preservice teachers' technology-related abilities, beliefs, and intentions during a stand-alone technology course. Preservice teachers' beliefs regarding technology integration were significantly correlated with their intentions to use technology in their future classrooms. Their technological abilities were correlated with self-efficacy beliefs, but not with value beliefs or intentions. In the other study, preservice teachers who took a technology-integrated math methods course demonstrated higher levels of confidence with using software in instruction than did students who did not experience technology integration. However, the students' inclusion of technology in lesson plans during student teaching was minimal. These results highlight the importance of relationships between preservice teachers' beliefs about technology integration and their potential use of technology in their classrooms, as well as identify barriers to technology integration during student teaching. The chapter concludes with a discussion of ways that educational technology instruction can go beyond teaching technology skills, in order to influence preservice teachers' beliefs and help them cope with obstacles to their future use of technology in classrooms.

1 Introduction

One of the critical issues in teacher education is how to best prepare preservice teachers to integrate technology into their future classrooms. According to one study, novice teachers, many of whom had grown up using technology, were no more likely to use technology than were their peers who had been teaching for over 20 years (Fatemi, 1999). One possible explanation for this finding is that the teacher education programs did not adequately prepare the novice teachers to use technology in their teaching. Teacher educators must ensure that their students have sufficient technology skills, understand the advantages of using technology in the classroom, and can use it to improve the instruction provided to K-12 students (Wright & Wilson, 2005-2006). Many researchers have argued that integrating technology into the teacher preparation curriculum is very important (Collier, Weinburgh, & Rivera, 2004; Halpin, 1999; Hargrave & Hsu, 2000; Moursund & Bielefeldt, 1999; Pope, Hare, & Howard, 2002; Wright & Wilson, 2005-2006). However, schools of education in the United States often require students to take a stand-alone educational technology course (Hargrave & Hsu, 2000). This type of course is considered most valuable for building skills that support technology integration during subsequent semesters (Bielefeldt, 2000; Hargrave & Hsu, 2000). Topper (2004) raised several relevant questions related to efforts to prepare preservice teachers to integrate technology in their classrooms:

- How can we tell if our programs are adequately preparing teachers for technology integration?
- What is the relationship between knowledge, skill, and attitudes toward technology?
- How do these concepts relate to technology use or integration in classroom settings?

In this chapter, we describe two studies that address these questions and discuss the implications of this research for teacher preparation programs.

2 Review of the Literature

Since the ultimate goal of educational technology instruction is to influence preservice teachers' ability and willingness to use technology effectively in their teaching careers, it is worthwhile to first consider factors associated with teachers' instructional use of computers. Evidence suggests that teachers' intrinsic beliefs about teaching and learning interact with extrinsic factors such as access to computers, software, time, training, and support to facilitate or limit their technology use (Becker, 2000; Ertmer, 1999; Ertmer, Addison, Lane, Ross, & Woods, 1999; Honey & Moeller, 1990; Lumpe & Chambers, 2001). While teacher educators cannot directly influence external factors that may impact their students' future technology use, they can attempt to influence intrinsic factors such as preservice teachers' abilities and beliefs regarding technology integration.

Abilities. Basic computer competency has been viewed as a necessary "stepping stone" toward technology integration (Albion, 2001; Topper, 2004). Technological competence was among the variables that predicted preservice teachers' commitment to use computers (Kay, 1990), student teachers' computer use (Negishi, Elder, Hamil, &

Mzougi, 2003), and classroom teachers' computer use (Becker, 2000). Several researchers have used pre- and post-course surveys to investigate changes in education students' perceptions of their abilities to perform specific computer tasks or to integrate technology in classrooms. Improvements in students' technology skills and knowledge were reported during one-semester educational technology courses (Anderson & Boarthwick, 2002; Topper, 2004; Willis & de Montes, 2002) as well as in methods courses in which instructors integrated technology (Halpin, 1999; Pope, et al., 2002; Ropp, 1999). Not surprisingly, Anderson and Boarthwick (2002) found that students enrolled in a stand-alone technology course improved in ability more than students taking a methods course in which technology was integrated. However, Halpin (1999) reported that students who learned to use spreadsheet software in an integrated, rather than isolated, manner were more likely to use it in their first year of teaching.

Beliefs. Several authors have highlighted the important role of beliefs in determining how teachers use technology in their classrooms (Albion & Ertmer, 2002; Becker, 2000; Honey & Moeller, 1990; Niederhauser & Stoddart, 2000). Pajares (1992) asserted that the future teaching behavior of preservice teachers relies greatly upon their beliefs.

Self-efficacy beliefs. Evidence suggests a strong relationship between self-efficacy and computer usage patterns (Compeau, Higgins, & Huff, 1999; Olivier & Shapiro, 1993). Bandura (1986) defined perceived self-efficacy as a person's judgment of his or her capabilities to organize and execute courses of action required to attain certain performances. High levels of technology use during student teaching occurred when preservice teachers' confidence in using specific technologies was high and their cooperating teachers also used those technologies (Pope, Hare, & Howard, 2005). Several studies demonstrated improved self-efficacy or confidence in using computers during educational technology courses (Albion, 2001; Swain, 2006; Willis & de Montes, 2002) and technology-integrated methods courses (Pope, et al., 2002; Ropp, 1999; Schrum & Dehoney, 1998). In one study, demonstrations of specific computer integration techniques strengthened students' confidence in using technology in their future classrooms. More than 90% of those students anticipated that they would use spreadsheets and databases in their future classrooms (Schrum & Dehoney, 1998). Researchers have found relationships between technology-related self-efficacy and past success with computers, technology proficiency, perceived value of computers, and use of technology in an integrated project-based learning environment (Kellenberger, 1996; Lynch, 2001; Ropp, 1999).

Value beliefs. Teachers are motivated to use technology when they have a clear understanding of how it will improve their teaching and students' learning (Albion & Ertmer, 2002). Value beliefs involve perceptions of the importance or relevancy of a task for the accomplishment of future goals (Keller, 1983; Pintrich, 1990). Swain (2006) found that preservice teachers' perception of the utility of computers was positive, but only improved slightly from the beginning to end of an introductory educational technology course. Preservice teachers' ratings of the value of computer use were associated with their perceptions of the likelihood that they would use computers in their future classrooms (Kellenberger, 1997). Technology-related value beliefs were also correlated with preservice teachers' use of technology in an integrated project-based learning environment (Lynch, 2001). Perceived relevance of computers to teaching and technological self-competence were correlated with each other and together predicted preservice teachers' expectations regarding future computer use (Marcinkiewicz &

Whitman, 1995). Nearly all (97%) of the students expected to use computers in their teaching. However when surveyed again at the end of their first year of teaching, only 61% reported using computers in their classrooms. Their ratings of perceived relevance and self-competence remained high but did not predict actual computer use during the first year of teaching.

3 Effects of a Stand-Alone Technology Course

The authors conducted a study to determine changes in, and relationships among, students perceived technology skills levels, beliefs, and intentions to use technology in their future classrooms while they were taking a one-semester educational technology course. This study also demonstrated the utility of using a self-report questionnaire to evaluate course effectiveness.

3.1 Method

Participants. The sample included 76 preservice teachers enrolled in three undergraduate sections and two graduate sections of an introductory educational technology course held at a private university in Texas. The majority of participants were female (88%) undergraduate (90%) students. The sample included 31% sophomores, 24% juniors, 35% seniors, and 10% graduate students. Nearly half (45%) were between the ages of 18-20, 46% were between 21-25, and 9% were older than 25.

Setting. Participants were taking a one-semester course that provided an introduction to using educational technology for professional productivity and instructional purposes. The course covered the application of a wide variety of software programs, including word processing, spreadsheet, database, presentation, paint, draw, desktop publishing, graphic organizer, Internet, and instructional software. Students also learned about instructional approaches, such as cooperative learning, constructivism, and direct instruction, as well as various issues including copyright and censorship. Teaching methods included discussions, demonstrations, cooperative learning activities, and hands-on practice. In addition, students observed, interacted with, and/or tutored individuals who were learning with computers. An online course management system provided access to assignments, quizzes, threaded discussions, and links to Internet resources. The final course project was an electronic portfolio containing work samples, reflections, lesson plans, web resources, and a position statement regarding future classroom use of educational technology.

Instrument. The 54-item survey addressed the following factors: abilities, self-efficacy beliefs, value beliefs, intentions to use software, and demographics. In order to reduce the number of variables to a manageable number, items from each category were combined into scales with Coefficient Alpha scores ranging from .77 to .92.

– *Abilities.* Students' abilities to perform specific operations for word processing, spreadsheets, databases, presentation software, and the Internet were each measured by 6 items. The items asked respondents to indicate whether they could perform the skill. All 30 items were combined to form a scale.

- *Self-efficacy beliefs.* Perceived self-efficacy for integrating technology was measured by seven statements to which students indicated their level of agreement on a 5-point Likert scale. This scale reflected the participants' confidence that they could accomplish tasks such as selecting and using software, creating a lesson or unit that incorporates software, and using technology tools to perform administrative tasks.
- *Value beliefs.* Beliefs about the value of classroom technology use were measured by three statements to which students indicated their level of agreement on a 5-point Likert scale. The scale assessed students' beliefs that technology integration would positively affect their students and that using technology would help them, as well as other teachers in their school, to be more effective.
- *Intentions.* Nine items measured students' intentions to use various software applications in their future classrooms. The items asked participants to rate the likelihood that they would use each application on a 5-point Likert scale. These applications included word processing, spreadsheet, database, presentation, graphic organizer, instructional software, teacher-developed web pages, Internet search engines, and web page authoring.
- *Demographics.* Five items gathered information about the availability of an internet-connected computer, grade level teaching interest, current level in school, age, and gender.

Procedure. The survey was sent via an online course management system during the first and last weeks of each term. The response rate was 100% for the pre-test and 99% for the post-test. In order to match the surveys, while still allowing students to remain anonymous, one survey item asked them to provide a code that they could remember. More than half (58%) remembered their code and thus, their surveys could be matched.

4 Results and Discussion

Students' abilities, self-efficacy, value beliefs, and intentions increased over the course of the semester. Students' word processing and Internet skills were strong to begin with, whereas they were not as skilled with presentation, spreadsheet, and database software. By the end of the course, their skills were uniformly high. Students' self-efficacy beliefs, value beliefs, and intentions to use software in their future classrooms started out fairly positive, yet each increased during the semester. Analysis of variance tests conducted for the sub-sample of 43 surveys that could be matched revealed a statistically significant increase in students' abilities (F =184.26, $p < .001$), self-efficacy beliefs ($F = 54.27$, $p < .001$), value beliefs ($F = 6.58$, $p = .014$) and intentions ($F = 26.55$, $p < .001$) from the beginning to end of the semester. These findings were consistent with the results of other studies (Albion, 2001; Anderson & Boarthwick, 2002; Swain, 2006; Topper, 2004; Willis & de Montes, 2002).

Correlation coefficients were calculated for the full sample (N = 71 - 74) to determine relationships among students' software abilities, self-efficacy, value beliefs, and intentions at the end of the semester. There were moderate and significant correlations between self-efficacy and value beliefs (r = .35), self-efficacy and intentions (r = .44), and value beliefs and intentions (r = .37). Other studies have also demonstrated relationships among similar variables (Kellenberger, 1996; Marcinkiewicz & Whitman, 1995; Ropp, 1999). Consistent with the results of other studies (Kellenberger, 1996; Ropp, 1999), abilities were significantly correlated with self-efficacy (r = .34). However, the correlation between abilities and intentions was not significant. This finding contradicts other studies in which technological competence was related commitment to use computers (Kay, 1990) and classroom computer use (Becker, 2000; Negishi, et al., 2003). Perhaps, after students attained a certain level of proficiency, additional skills did not increase their intentions to use technology in instruction.

5 Effects of a Technology-Integrated Methods Course

One of the authors conducted another study to assess the effects of technology integration in an elementary mathematics methods course on preservice teachers' software integration confidence. In addition, the researcher analyzed selected lesson plans to determine if preservice teachers' confidence in using technology integration carried over into their planning during student teaching.

5.1 Method

Participants. The participants were 27 preservice teachers enrolled in two sections of an elementary math methods course at a public university in Texas. There were 17 participants in the experimental group and 10 participants in the control group. All participants were female college seniors scheduled to student teach the following semester. Age range, certification levels, and mean grade point averages were similar between groups.

Setting. The same instructor taught both sections and provided similar classroom experiences in several respects. Both groups experienced the same lecture presentations over the same mathematics methods content. In addition, all students participated in hands-on, manipulative training activities that modeled appropriate pedagogy for math classrooms. Lastly, the major assignments for both classes were very similar.

Treatment.. In one section of the course, the instructor regularly used technology applications such as the World Wide Web and PowerPoint presentation software. Also, guest instructors made a presentation demonstrating integration techniques for spreadsheet and database software. Students turned in assignments via e-mail, used computer software in the execution of assignments and lesson plans, and searched for technology-integrated lesson plans on the Internet. They also constructed a portfolio with 10 sections, each covering a different mathematics concept and including a minimum of one technology-integrated lesson plan. Finally, students presented in groups using PowerPoint.

Instruments. The software integration confidence scale consisted of 10 items with 5-point Likert scales. Participants rated their levels of confidence regarding the utilization of computer integration techniques in classrooms. Some items specifically addressed confidence in teaching with spreadsheet and database software. The Coefficient Alpha score for this scale was .95. A demographic questionnaire also collected information relating to personal information, prior educational experiences relating to computer use, and current computer use.

Procedure. At the beginning of the semester each participant completed the demographic survey and at the end of the semester all students completed the software integration confidence scale. During the next semester, when the participants were student teaching, the researcher collected math lesson plans from three students in the experimental group and three students in the control group. Raters used a systematic method of categorizing and scoring to describe student teachers' inclusion of technology integration practices in their lesson plans. Inter-rater reliability was greater than 90%.

6 Results and Discussion

Preservice teachers in the experimental group were much more confident with integrating spreadsheet and database software into their future teaching than were those in the control group. The between-group difference in the means of the software integration confidence scale was tested using analysis of variance. The difference was statistically significant ($F = 5.74$, $p = .02$), with an adjusted R squared equal to .15. Thus, the use/non-use of technology integration techniques in an elementary math methods course explained 15% of the variance between groups. The results of previous research studies parallel this finding (Pope, et al., 2002; Ropp, 1999; Schrum & Dehoney, 1998). While the sample lesson plans of students in the control group showed virtually no signs of technology integration, the lesson plans of students in the experimental group demonstrated slightly more (but statistically insignificant) evidence of technology integration, with one student performing well above the other students. Limiting factors included the minimal number of computers in the student teachers' classrooms and the absence of technology integration techniques displayed by cooperating teachers.

7 Conclusion

These two studies strongly support the effectiveness of a stand-alone course in technology applications during preservice teacher preparation and continued integration support in subsequent methods courses. This research suggests that an introductory educational technology course can improve not just students' abilities, but also their self-efficacy beliefs, value beliefs, and intentions with regard to technology integration. The results highlighted the relationship between preservice teachers' beliefs and their intentions to use technology in their future classrooms. Furthermore, the findings indicated that a technology-integrated methods class can also positively affect preservice teachers' confidence with regard to integrating software into instruction. However, even though students were confident about integrating technology, their actual use of technology in student teaching was minimal. Their intrinsic beliefs did not prevail over limiting extrinsic factors, such as insufficient computer access and lack of modeling of technology integration techniques by cooperating teachers. Fortunately, better conditions exist in many schools, and at least one other study has shown that student teachers who are confident in their use of technology and who are working with technology-using cooperating teachers tend to integrate technology during student teaching (Pope, et al., 2005).

Our research also demonstrated that using self-report surveys was a simple and effective means of evaluating the impact of educational technology instruction. How can teacher preparation programs know if they are succeeding in technology preparation if they do not collect data and study the results? Among the recommendations made by Moursund and Bielefeldt (1999) was the use of surveys as tools for internal needs assessment and action research. While self-assessment instruments only measure students' perceptions, not their actual abilities and behaviors, they are easy to administer and thus more likely to be used as evaluation tools.

The survey results suggest that instructors should consider how they can influence students' beliefs as they relate to intentions to use technology in the future. Preservice teachers need to have a clear understanding of how technology can improve their teaching and their students' achievement. According to Albion and Ertmer (2002), beliefs may be changed by providing prospective teachers with "alternative visions of what teaching with technology looks like and with opportunities to experience different approaches in supportive contexts." We accomplished this by having students create classroom applications with various types of software, providing fieldwork in which they could experience technology use in classrooms, modeling the integration of technology in instruction, and having students create reflective portfolios that included technology-integrated lesson plans. Another strategy that we have recently implemented is having students view multimedia case studies such as those in VisionQuest software. Research has shown that using this software, which depicts the practices and beliefs of exemplary computer-using teachers, improved students' self-efficacy with regard to technology integration (Wang, Ertmer, & Newby, 2004).

Instructors should also help preservice teachers develop strategies for overcoming potential obstacles to their future computer use. For example, students need to be prepared to integrate technology in classrooms with limited numbers of computers. In addition, they need to be aware of effective ways to use computer labs as a viable resource. Typically computer lab instructors teach a separate curriculum from that taught by classroom teachers. Preservice teachers should be encouraged to make better use of this lab time by engaging in team planning with colleagues, including other teachers at their grade level as well as the school's computer lab instructor.

Teacher educators must prepare preservice teachers to initiate, with confidence, technology activities that are real-world, innovative, and integrated into the curriculum. If the future teaching behavior of preservice teachers relies greatly upon their beliefs (Pajares 1992), then it is incumbent on teacher preparation institutions to do everything possible to influence these beliefs and to arm graduates with the skills and knowledge that will allow them to act upon their convictions.

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The Intrepid Explorer:
A Model of Effective Technology Use for All Educators

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Abstract

Most educators at every level struggle to fully understand the complexity of developing an effective technology user. In an attempt to fulfill standards and facilitate effective use, teachers and teacher educators have often focused their efforts on the acquisition of technology skills for themselves and for their students—skills that are only one component of becoming an effective technology user. This paper utilizes the model of the Intrepid Explorer (Denner & Bean, 2005; Turkle, 1984) as a guide for developing the effective technology user among K-12 students, teachers, teacher candidates, and teacher educators. Recommendations for developing characteristics of Intrepid Explorers among these constituencies are identified.

1 The Challenge

For nearly a decade, educators and policy makers have worked to develop K-12 students as effective technology users. Achieving this goal is complex and requires the fulfillment of several essential conditions (ISTE, 2002). Developing K-12 tech-users relies upon the creation of a technology-rich learning environment that not only includes equipment, electronic infrastructure, and support, but also K-12 teachers who can effectively use and model technology in the classroom. The preparation of these teachers either depends upon quality professional development and/or graduate education for inservice teachers or effective teacher preparation for preservice teachers, all of which require teacher educators who can effectively use and model technology in the learning environment. Compounding the situation is the evolution sequence of the educator in which K-12 students become teacher candidates, who then become K-12 teachers; those K-12 teachers instruct the K-12 students, and some K-12 teachers may move on to become teacher educators, who prepare the teacher candidates and often provide professional development to K-12 teachers. As such, the challenge of facilitating effective technology use among our K-12 students is a cyclical one—an interconnected process of teacher educators teaching teachers who teach students, who then become teachers and may later become teacher educators (see Figure 1). The effectiveness of each group's technology use is often dependent upon the effectiveness of the previous group.

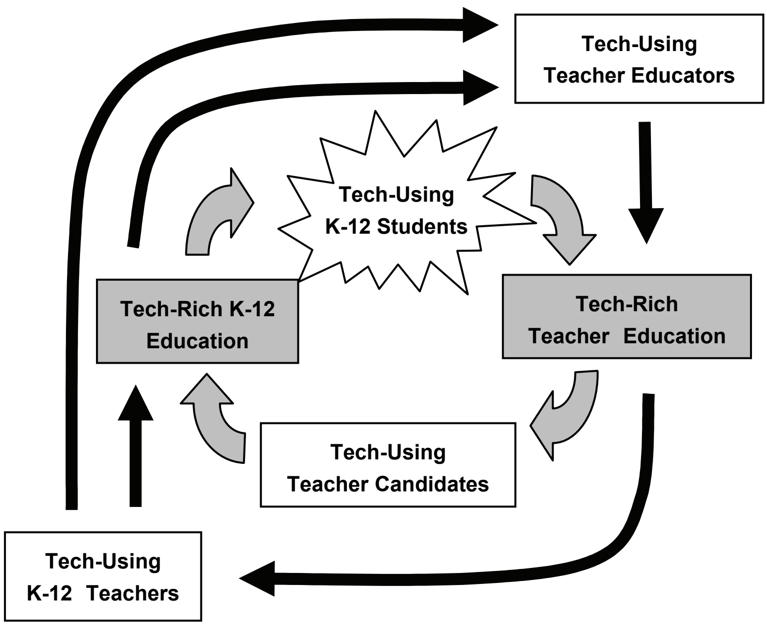

Fig. 1. The Cycle of Developing the Effective Technology User

National and state technology standards for students and teachers have guided many initiatives in advancing technology in schools and have helped educators in defining the specific skills necessary for effective technology use at a variety of levels (ISTE, 2000; ISTE, 2002). However, most educators at every level struggle to fully comprehend the complexity of developing effective technology users. In an attempt to fulfill standards and facilitate effective use, teachers and teacher educators have often focused their efforts on the acquisition of technology skills for themselves and for their students. Unfortunately, knowledge of technology skills is only one, albeit important, component of becoming an effective technology user. Recent research has revealed that personal beliefs and dispositions, such as openness to change/risk-taking (Marcinkiewicz, 1994; Vannatta & Fordham, 2004), computer self-efficacy (Milbrath & Kinzie, 2000), and attitudes (Albion, 1999; MacArthur & Malouf, 1991) regarding technology are related to technology competence and classroom integration. Consequently, the development of the effective technology user must go beyond the acquisition of skills but also include the facilitation of positive attitudes, beliefs, self-efficacy, and even emotions regarding learning and technology.

2 The Intrepid Explorer

The model of the Intrepid Explorer provides a broad yet succinct picture of the effective technology user that can serve as a guide for all educators. Originally introduced by Turkle (1984) as a means of describing the successful computer scientist, the Intrepid Explorer is one who enjoys “playing” with the computer and is excited by trying new things with the computer. Denner and Bean (2005) have since elaborated on this model through their study of 126 middle school girls participating in after-school and summer computer programs called *Girls Creating Games*. This unique program applied a project-based learning model in which learning was organized around a project of creating an interactive story-based game that required “students to plan, organize, problem solve, and make decisions” (p. 382). By studying these participants, Denner and Bean (2005) operationalized the Intrepid Explorer as encompassing five characteristics that are embedded in social and motivational factors of learning as well as higher order thinking (see Table 1). They describe the Intrepid Explorer as one who fearlessly uses technology for problem-solving, communicating, and creating products—a risk-taker with technology because he/she is able to learn from mistakes and confidently deals with setbacks (Denner & Bean, 2005).

Table 1. Characteristics of the Intrepid Explorer

Characteristic	Description
Computer Fluency	▪ Has necessary skills and abilities for the task ▪ Able to communicate needs and tasks related to technology
Self-Efficacy	▪ Has confidence in using technology ▪ Attributes achievements to ability, not luck ▪ Views self as "good with computers" ▪ Willingness to learning from mistakes
Independent problem-solving	▪ Likes to be challenged ▪ Enjoys problem solving ▪ Seeks out other's ideas ▪ Gathers information from mistakes and computer glitches
Curiosity	▪ Seeks out new things to learn ▪ Tests the ranges and limits of technology ▪ Enjoys learning and discovering new ways to do things
Creativity	▪ Uses technology in new ways ▪ Uses technology to express individuality and communicate ideas and feelings ▪ Transfers knowledge to new situations

Note**.** From "Learning as Intrepid Exploration: A New Model for Teaching Children to Work with Computers," by J. Denner and S. Bean, 2005, *Proceedings of the Eighth IASTED International Conference on Computers and Advanced Technology in Education*. Copyright 2005 by IASTED. Adapted with permission.

Although Denner and Bean identify the Intrepid Explorer as the target for technology development among their female participants and imply its application to K-12 students, if the goal of developing effective K-12 technology users is reliant upon each group of educators to also be effective users, then the model of Intrepid Exploration is relevant to teachers, teacher candidates, and teacher educators. As a result, teachers, teacher candidates, and teacher educators could strive to emulate and facilitate the Intrepid Explorer so that their students have a clearer vision of effective technology use and can become Intrepid Explorers themselves.

3 Developing the Intrepid Explorer at Every Cyclical Point

3.1 One More Challenge: Gender

The challenge of developing the Intrepid Explorer (IE) is further intensified by the predominance of female K-12 teachers, teacher educators, and teacher candidates (AAUW, 2000). Numerous researchers have identified gender differences in computer attitudes, use, and self-efficacy in that males are much more likely to view technology positively, see technology as a toy, exhibit risk-taking behaviors, and see themselves as "good with computers" (AAUW, 2000; Christensen, Knezek, & Overall, 2005; Collis, 1985). Accordingly, when approximately 70-80% of K-12 teachers in the U.S. (NEA,

2003) and 65% of teacher educators are female (Pinker & Spelke, 2005), the likelihood of these educators modeling IE characteristics and facilitating the Intrepid Explorer among their students is not high. Thus, facilitating the IE across the educational technology cycle necessitates the transformation of several innate dispositions and beliefs. As such, training and instruction that aims to develop the Intrepid Explorer must seek to cultivate positive beliefs, attitudes and dispositions regarding technology while advancing technology skills. Denner and Bean (2005) have suggested five strategies for supporting Intrepid Exploration among K-12 students. This paper elaborates on their recommendations and extends them to teachers, teacher candidates, and teacher educators.

3.2 Increase Computer/Technology Fluency

Technology skills and fluency are essential to using technology; however, learning skills in isolation is not very exciting or motivating. Thus all potential users should learn skills in the process of completing a task or project. Establishing an authentic need for technology projects is critical (AAUW, 2000). For teachers developing IE students this may mean utilizing project-based learning or creating an environment for showcasing student work. K-12 students, especially girls, would likely enjoy digital story-telling, where communication and multi-media are centerfold to the project (Cassell, 1998). Gaming or the design of computer games is another project that establishes an authentic need for advancing technology skills (Denner & Bean, 2005).

When providing technology training to teachers, teacher educators, and teacher candidates, Vannatta and O'Bannon (2001) found that providing a vision of effective classroom technology integration (e.g. concrete lessons plans and products for appropriate grade levels and contents) motivated the educators in completing the necessary training to implement the targeted lesson/product. The vision established an authentic need and thus provided meaning for the acquisition of skills. Finally, all potential users will benefit from a welcoming, relaxed learning environment (Denner & Bean, 2005).

3.3 Promote Self-Efficacy

Being willing to try something new with the risk of making a mistake is essential to the learning process (Bandura, 1993). Often one's mistake provides the most powerful learning experience. Thus learning technology, a field that is constantly advancing and changing, requires sufficient self-efficacy for all potential users. Educators should scaffold skills and tasks to enhance mastery, which in turn can build confidence. Teachers, teacher educators, and trainers also need to model risk-taking with technology, dealing with setbacks, and learning from mistakes (Denner & Bean, 2005; Vannatta & Fordham, 2004). This is especially important for female users, since such modeling will assist in deconstructing negative stereo-types of technology users that often communicate males as the dominant technology users (Margolis & Fisher, 2002). Essentially, girls and women need to observe positive female Intrepid Explorers in order to envision and adopt such a role for themselves (AAUW, 2000).

Providing an opportunity to showcase technology products also enhances technology self-efficacy among all users. For K-12 students, this may mean displaying/presenting work at parent night, uploading products to a class website, or providing parents and students with a class CD. For teachers, teacher educators, and teacher candidates, showcasing opportunities may include displaying/presenting technology-rich lesson plans, and products to peers and colleagues in a workshop, class, meeting or website.

Another technique that enhances self-efficacy among all users is collaboration, as it not only provides a safety-net in the learning process but also facilitates social interaction, a desirable experience for female learners hesitant to take risks in the technology learning process (AAUW, 2000). Denner and Bean (in press) utilized a collaborative structure called "paired programming" in which two learners work together at one computer taking turns at being the "driver" of the computer and the "navigator" who provides guidance and monitors for errors (Williams & Kessler, 2000). The partnership often encourages risk-taking as it provides the support and security for dealing with mistakes. Vannatta and O'Bannon (2001) found that partnering a K-12 teacher with a teacher candidate in the technology learning process was extremely successful in advancing classroom technology use and self-efficacy in that it often merged the curricular expertise from the teacher with technology skills of the teacher candidate. In addition, the collaboration provided the necessary support in the classroom to try new technologies with students. Vannatta, Banister, Fischer, Messenheimer, and Ross (2005) also found that teaming teacher educators in their technology endeavors created somewhat of a technology support group, in which they commiserated on the frustrations of technology integration and use, collaborated on the development of technology-rich curriculum, and celebrated the accomplishments of technology use. The regular sharing of mishaps, success stories, and ideas encouraged risk-taking and a sense of togetherness among the participants.

Finally, providing all users with affirmations for stretching oneself, mastering technology tasks, and utilizing technology in new or creative ways is extremely important (Denner & Bean, in press). Most of the preceding strategies for enhancing self-efficacy provide opportunities for complements and acknowledgements for individuals advancing technology.

3.4 Encourage Independent Problem Solving

Utilizing technology in new and innovative ways requires one to be able to solve problems (AAUW, 2000). Independent problem solving is critical in making advances in any field. Since technology is one of the fastest changing fields, the ability to tackle new technologies and solve the multiple problems embedded in such an undertaking is integral for all users. One of the most important strategies that teachers, teacher educators, and trainers can utilize with their tech learners is to resist rescuing a struggling user by "driving the mouse." Instead, educators should establish a process for problem-solving that is regularly modeled and is referred to during difficulties. Such a process might include: identify/articulate the problem, utilize printed resources, and discuss possible solutions with peers (Denner & Bean, 2005). Educators may want to use directed questioning to assist the user in identifying the problem and exploring possible solutions. Providing job aids that describe step-by-step instructions for specific tasks is a great resource for all users experiencing technology dilemmas (Denner & Bean, 2005). Finally, educators should determine the appropriate level of instruction for the user, so that the technology tasks are achievable and challenging.

3.5 Cultivate Curiosity

"Curiosity is a heightened state of interest resulting in exploration . . . and is also a critical component of creativity" (Arnone, 2003, p. 1). Being curious about how or why things work or how to make something better is the capstone of industrial and technological development. Cultivating curiosity among all potential users is the only way technology will continue to advance. Although a life-altering advancement may not take place in the classroom, planting the seeds of curiosity among all users will likely lead to new and creative ways of using technology. Berlyne (1960) was one of the first researchers to associate curiosity with the response of exploratory behavior. He defined two types of exploratory behavior: 1) *diversive*, which seeks to relieve boredom, and 2) *specific*, which seeks to relieve the uncertainty of a conceptual conflict. It is the curiosity in conjunction with specific exploration "that motivates the quest for knowledge and is relieved when knowledge is procured" (1960, p. 274).

Arnone (2003) has identified numerous strategies for fostering curiosity among K-12 students, strategies that are also applicable to all technology users including teachers, teacher educators, and teacher candidates. In order to facilitate *specific* exploration with technology, educators and trainers could introduce a conceptual conflict by utilizing contradictions, incongruities, or uncertainties around technology tasks or projects. Such conceptual conflicts may serve as a "hook" or motivator at the beginning of a lesson. Others curiosity hooks may include the use of thought-provoking questions regarding technology issues or tasks, surprising statements about technology beliefs or attitudes, or new technologies (Small & Arnone, 2000). Another strategy that may foster curiosity is creating a learning environment that is open to questioning, brainstorming, and discussion. Such an environment requires that the educator models curiosity, engages in specific exploration, and expresses the frustration and excitement that accompanies exploration. As a result, the "curious" learning environment will also encourage problem-solving as well as enhance self-efficacy as an IE. Arnone (2003) further recommends that educators provide adequate time for learner exploration and opportunities to make choices in those explorations.

3.6 Provide Opportunities for Creativity

"Creativity is the ability to produce something new—if not new to the world, at least to the person producing" (Piirto, 1992, p. 30). Because the creative possibilities in using technology as well as developing technology are limitless, ways in which technology users can be creative in the learning process are immense. Several studies have indicated that having the opportunity to be creative and express one's individuality has been identified as a motivator for females in using technology and achieving confidence in using technology (Cassell, 1998; Cone, 2001; Denner & Bean, in press). Yet, creative expression for both males and females "comes from a need to express emotion and an inner drive" (Piirto, 1992, p. 285).

Consequently, the following strategies for encouraging creativity with technology are applicable to both male and female users. One way in which K-12 teachers, teacher educators and trainers can enhance creative responses with technology is to implement projects or assignments that utilize digital media and communicate personal experiences, thoughts, and or feelings. Denner and Bean (in press) encouraged creativity among their middle school participants by having them design an original computer game that applied their technology skills and utilized individual interests. Teacher educators and trainers should encourage teacher candidates and K-12 teachers to develop technology-rich lesson plans that address the unique instructional needs they experience in their own classrooms—this not only provides an authentic need for technology use but also allows for creative problem-solving and response. Another strategy for enhancing creativity in technology use is providing users with a variety of technology product examples that serve as creative responses. While this may seem counter-intuitive, it can provide "baby-steps" for early users as they will likely be able to utilize one of the examples, expand upon it, and personalize it.

Finally, all educators should create a learning environment that values creative expression and has a sense of playfulness, adventure, and fun (Piirto, 1992). As such, educators should regularly share with students the personal creative responses that he/she has produced, even if those products were not developed specifically for the learners. Whoever the students are, they can benefit from and will likely enjoy seeing how the instructor personally and creatively interacts with technology. Personal products might include: a cool holiday card, a conference presentation, a slide show of family photos with music, and a computer game.

3.7 Finding the Intrepid Explorer

Since developing an Intrepid Explorer often relies upon altering the way the learner thinks, believes, and feels about one's ability, risk taking, curiosity, and creativity; utilizing some techniques applied in cognitive therapy may be helpful for all technology users (Bush, 2003). Cognitive therapy is based upon the principle that one's feelings/moods and often behaviors are a result of one's thoughts, beliefs, and attitudes (Burns, 1980). For example, a K-12 teacher who expresses anger over and resistance to the new computers installed in her classroom may be entrenched in an internal dialogue that includes: "I hate computers. I am always messing things up on a computer. If I use technology with my students, I will look like a fool in front of my students and peers. I am a bad teacher." Changing these negative internal messages to positive ones is imperative to facilitating the Intrepid Explorer. One method used to practice new thoughts and beliefs is through role playing (Bush, 2003), which can be extremely effective for young students trying to become Intrepid Explorers. Steps to facilitate such role playing might include the following activities for students: 1) identify traits of Intrepid Explorers as well as other well known explorers; 2) discuss negative stereotypes and connotations that are often associated with technology-users and even research role models of Intrepid Explorers; 3) create a character that represents the Intrepid Explorer that he/she strives to be and identify descriptors and behaviors that this character would exhibit when using technology (students can even name their IE characters); 4) role play, at various times during technology projects, as personal Intrepid Explorers; 5) analyze the differences in behaviors and feelings from completing a task as oneself and when they were in the IE character. When students experience a setback or problem with technology, encourage them to think about and demonstrate how their IE would respond to the challenge. Eventually through role playing and reflection, students will become more aware of the IE traits and seek to integrate these into their personality.

A strategy for encouraging the Intrepid Explorer in older K-12 students, teachers, teacher candidates and teacher educators is *reflective transference* in which the potential user reflects upon other areas in life where one is more of an explorer and then attempts to transfer those thoughts, feelings and behaviors to using technology (Vannatta, 2006). In a sense, reflective transference seeks to transfer the positive thoughts and feelings one has as an explorer of something else (e.g., cooking, woodworking, traveling) to that of being an Intrepid Explorer of technology. Facilitating this process might include the following steps for learners: 1) discuss Intrepid Explorer characteristics; 2) identify other individual situations in which those characteristics (e.g., self-efficacy, risk-taking, confidence in making mistakes, the desire to dig deeper, the willingness to be creative) are personally demonstrated; 3) reflect on and identify the thoughts, feelings, and behaviors experienced when being an "Explorer" in other venues; 4) identify the negative, internal thoughts/messages experienced when typically using technology; 5) create a positive, "replacement" message for every negative message the user experiences when using the technology. Replacement messages may originate from the dialogue one experiences in other "Explorer" scenarios, an analysis of the cognitive distortions (Burns, 1980), or just coming up with a great comeback. During technology use, the learner practices the replacement of negative messages with the positive thoughts so that the learner is then more likely to behave as an Intrepid Explorer.

4 Conclusions

The Intrepid Explorer Model provides all educators with a tangible framework of the effective technology user! While technology skills are important in becoming an Intrepid Explorer, such fluency should be facilitated in conjunction with the development of self-efficacy, problem-solving ability, curiosity, and creativity. This dynamic model allows for the continuous advancement of technologies and technology standards—so it will never become outdated. In summary, some primary strategies that educators could implement to facilitate the development of an Intrepid Explorer, whether the explorer is a K-12 student, K-12 teacher, teacher candidate or teacher educator include:

- create a learning environment that is welcoming, supportive, inquisitive and adventurous;
- model technology risk-taking, problem-solving, curiosity, and creativity by regularly expressing personal and professional experiences (feelings and products) with technology;
- incorporate projects/assignments/tasks that fulfill an authentic need; utilize multimedia, gaming, and communication technologies; and provide an environment for showcasing products and achievements;
- provide technology examples that demonstrate creativity and problem-solving and foster curiosity;
- facilitate collaboration among learners; and
- facilitate reflection upon and adoption of IE characteristics through discussion, role playing, and reflective transference.

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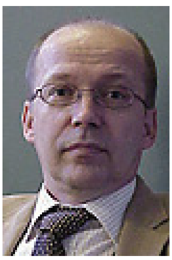

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