Making Education Accessible:

Universal Design for Learning

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As a relatively new concept in education, UDL is both based in research and a driving force for additional research. Making curricula more accessible to more learners is a daunting task. However, as society has evolved, so too must education. Technology is perhaps making all this possible, but it is the move towards the acceptance of human diversity and the right to participate in ones' community that is perhaps the driving force behind UDL. An overview of the current issues and debates unfolding in the literature on universal design for learning is presented. The implication of UDL and its correlation to education in the Province of Ontario is considered.

The research is spread across many fields and across many fields within education. The well known debates within the field of special education are readily apparent. Debates about inclusion and the use of technology, as well as professional development of teachers are abundant. All this is to say that issues in education are being brought together, under the umbrella of UDL. The underlying theoretical and research bases of UDL must be accepted if UDL is to be adopted as nothing short of a new model of education – a 21st century model of education that is more democratic, more inclusive, more focused on curricula, more relevant to learners, and more focused on high standards of education. To suggest that education is prepared to undertake all this is open to discussion, but to UDL suggests something far worse.

This paper begins with a brief description of the context of universal design for learning (UDL), a discussion of the definition of UDL, and the research on which UDL is based. The research presented on designs that are considered to be universal and the impact of student variance, professional development, issues related to planning and differentiation, are considered in the three models presented. Technologies (assistive and

informational), texts, instructional materials, media, and other resources are all discussed at some length. Methods of instruction and the implications for literacy are also presented here.

As the focus of this paper was UDL in the classroom, distance learning, e-Learning and on-line learning were not directly addressed here. The research in these areas is beginning to develop and the contribution of these areas would certainly enhance the understanding of the potential of technology for learning for those students who can not attend school, for whatever reason.

Context of Universal Design

The field of architecture has led the way, and the term Universal Design (UD) was coined and developed by Ronald Mace in the decade between1970 and 1980. Laws requiring access to buildings and other structures led to the design of buildings that were accessible, rather than retrofitting buildings after being built. It appears that accessibility has benefited many people, including those who were not previously seen as having issues with regards to access (e.g. people with strollers, with a broken leg, etc.).

A “life-span” needs approach to design recognizes that differences are not static or dichotomous concepts that places individuals forever in specific categories, for example abled or disabled (Bowe, 1999). An evolving understanding of human rights, as well as new developments in many areas of research (e.g. robotics, education) and technologies, has the potential to transform the lives all individuals in the community differently at different stages of their lives. Diversity of users of buildings and other structures is not dissimilar to the population accessing education in local neighbourhood

schools. “Categorizing students into two groups—regular and special—oversimplifies learner differences and fails to accurately represent the diversity of today’s … student population” (Meo, 2008, p. 21). The physical, social, and academic aspects of the learning environment all need to be accessible to the continuum of learners (Rose, 2000).

> Decades after computers found their way into schools, their much anticipated role in expanding learning opportunities for all students, including those with disabilities, remains elusive. The reason is simple: they continue to be used to support old, one-size-fits-all methods of instruction and assessment that do not support what we know about learning, namely that it is as individual as DNA or fingerprints. … The concept of designing a curriculum to support every student’s needs rather than the “average” student’s needs is a new one. … Indeed, at a time of increasing emphasis on the need for all students, regardless of ability, to meet high academic standards, universally designed learning goals, methods, materials, and assessments are essential to helping diverse learners reach a common destination. (Rose &Strangman, 2007, pp. 388-9)

As such, UDL is concerned with promoting accessibility by identifying and eliminating barriers to education, rather than focusing on narrowing the *gap* between the abled and disabled. Intervention is no longer focused on the individual. Learning environments are designed to have fewer barriers (Rose, 2001).

> Because the aim of universal design is to make educational environments seamlessly and inherently functional for the widest number of learners, the need for individualization is minimized. The universal design framework guides the selection of flexible, usable, and accessible tools and surroundings, the construction of collaborative and interactive learning opportunities, and the development of learner centered and constructivist curriculum. (Curry, Cohen & Lightbody, 2006, p. 33)

Individual progress is central to UDL. The rate of learning of individuals is expected to be impacted by learner differences and the impact of the learning environment. It is the learning environment that needs to be changed by increasing the use of technology. “In a single generation, the ability to learn with technology has been transformed from a helpful talent to a basic requirement for successful participation in higher education,” and

perhaps in education in general (Parker & Banerjee, 2007, p. 6). As such, UDL promotes the use of technology as a tool to access to the curriculum (Howard, 2004). Learning technologies are … "any application of technology, particularly computer and information technology, which contributes to the learning process" (Parker & Banerjee, 2007, p. 6). Meo (2008) argues that barriers to learning are not inherent to learners, but rather are the result of the interaction between the learner and curriculum. As such, curricula —goals, methods, materials, and assessment—need to be made more accessible. Technology is often argued to be the tool that has the greatest potential to revolutionize the learning environment of students.

"Current conceptions of teaching, born of the needs of the Industrial Age, are arguably ill suited to prepare individuals for full and productive participation in the Information Age" (Pisha & Coyne, 2001). Kavale (2002) argues that while inclusion and access to the general education curriculum has continued to be pushed, "the necessary attitudes, accommodations, and adaptations are not yet in place in general education to provide students with disabilities an appropriate education" (p. 201). McGuire at al. (2006) conclude that UDL moves the concept of inclusion beyond the notion of "place." Identified as an *elusive element of inclusion*, "human diversity as the norm," is the fundamental difference between inclusion and designing for inclusion (McGuire et al., 2006). UDL shifts the concept of inclusion from an issue that is primarily based on *location* to one based on *participation*, of the right of access to the classroom to the right of access to ideas and the right to contribute to the development of those ideas in a way that is meaningful to the learner. "Technological competency [is] … the ability to use digital technology, communication tools, and/or networks appropriately to solve

information problems to function in an information society" (Parker & Banerjee, 2007, p. 6). As such, UDL has emerged as a political and social movement (Curry, 2003). But in a practical sense, who is responsible for making education accessible? (Bowe, 1999).

Underpinnings of UDL: Characteristics of Learners and Cognitive Neuroscience

As educators plan for the instruction, active engagement, and assessment of students' learning, observable characteristics of students provide a wealth of knowledge of, as well as evidence of strengths, needs, and challenges faced by individual students. Teachers often plan in accord with curriculum expectations, current methods of instruction, effective past practices, availability of resources, and so on. Models of learning, such as Gardner's multiple intelligences, Bloom's taxonomy, learning styles or preferred learning styles (e.g. kinesthetic) have furthered the understanding of learning and have begun to influence teachers' planning and practice in the classroom.

As learning is not itself observable, teachers are required to make decisions based on observations of behaviours, student productivity or performance, or knowledge of the student through experience, as well as reports from their colleagues or professionals. Poor student productivity or performance and behaviour is often attributed to the characteristics of the students, rather than teaching practices, resources used, assessment methods, and so on. While UDL requires that teachers carefully contemplate the impact of teaching practices and the selection or use of resources on student learning (e.g. productivity and behaviour), Rose argues that these decisions be based on the knowledge that is emerging from the fields of cognitive science, neurology, and neuro-psychology. UDL based decisions are based in research.

Characteritics

Planning for all students requires that classroom teachers are familiar with research on all learners, including those with exceptionalities. Wehmeyer, Smith, Palmer, & Davies (2004) describe the characteristics of learners with intellectual disabilities. These include: language and communication ability, auditory reception, reasoning, cognitive speed, visual perception abilities, memory skills, learning skills, prior knowledge and general school achievement (Wehmeyer et al., 2004). Research in the areas of learning disabilities, deaf education, visual impairment, emotional-behavioural disorders (EBD) and other exceptionalities similarly describe characteristics of learners. Relatively recent advances in neuro-science and imaging fields have allowed researchers to begin to describe these observable *characteristics* as they relate to brain functioning. Recognizing and understanding the implications of the characteristics of all learners on the classroom, pedagogy, and cognition is useful for teachers in planning for all students, as well as developing an appreciation for the needs, strengths, and challenges faced by students with exceptionalities. Developing student and class profiles speaks directly to the development of this understanding at the level of the individual. The development of resources used to generate a profile should be based on the research on characteristics of various learners. With profiles informing and driving planning, the learning environment needs to be developed to allow for the greatest access possible for all learners.

Neurology

The understanding of the impact of the learning environment on learning is continuing to be developed. In reviewing the literature on the foundations of neurological anatomy and physiology associated with brain function and brain disorders, Hoppestad

(2006) described the brain as monitoring and controlling a person's internal and external environments. "A concept in contemporary neuroscience that models the functioning of the brain is expressed as *distributed* or *parallel processing*, in which multiple neural networks operate in concert with one another to complete a task" (Hoppestad, 2006, p. 6). As such, Hoppestad (2006) argues that understanding the effect of disabilities of and on the central nervous system (CNS) and the peripheral nervous system (PNS) is required to assess the needs of persons with exceptionalities. The nervous system is continuously adjusting to respond to changes in the environment, and the brain continues to change itself (e.g. pruning process, disease). However, a single pathological process or neurological condition can produce multiple impairments in behaviour, cognition, communication, or sensory-motor functioning resulting in the diagnosis of a neuropsychological condition (i.e. mood disorders, behaviour disorders, or cognitive disorders). Multiple neurological conditions further complicate situations for individuals and those serving them. As education continues to benefit from the continuing research on brain function, the ramifications of neurological and neuropsychological conditions for individual learners and teachers remain a central concern for many fields (e.g. legal, medical, technology), including education. It would appear that the impact of the learning environment on the brain and central nervous system is an area that is not often considered by teachers. It is just this type of research that UDL requires that teachers become familiar with and incorporate into their planning.

Neurology, Working Memory, and Learning Disabilities

Working in the area of LD, Elkin (2007) identifies the research that currently exists that supports that learning difficulties may be the result of differences in brain

structures or genetics. However, he cautions that “current functioning may reflect a permanent state, a malleable state, or an adaptation to tasks that are not easily performed in the way that most people do them” (Elkin, 2007, p. 394). The work of Baddeley and others in the area of working memory and its component parts (i.e. visuo-spatial sketch-pad, phonological loop, central executive, and episodic buffer) continue to contribute to the work of researchers in the area of LD. Effective interventions based on the evidence provided by neuropsychological research may not yet exist (Elkin, 2007). However, research in the areas of learning difficulties in reading and math certainly demonstrate that progress in developing effective interventions or teaching strategies continues to emerge. There is growing evidence that some teaching practices are more effective than others, such as providing additional time for students with LD (not for students without LD) and that reading the questions improves the performance of all students. Research on the impact of technologies on the performance of students with LD is extremely limited, with the various findings difficult to compare.

UDL and the Cognitive Sciences

Education research is vast and fraught with differences. The correlations between the physical aspects (e.g. brain), cognitive aspects (including facts and methods of accomplishing tasks), and affective aspects of learning are often teased apart for research, but need to be considered as aspects that impact each individual student in the classroom. Rose & Strangman (2007) and earlier, Rose & Meyer (2002), put forward a model of education that is based on research that implicates the joint action of three cognitive neural networks in learning.

> Although neuroscience suggests that every act of cognition is considerably complex, psychological and neuropsychological research recognize three broad

> but anatomically and psychologically distinct functions that are involved in every act of cognition. Broadly speaking, one component recognizes patterns, a second one plans and generates patterns, and a third one determines which patterns are important. Each of these components is involved not only in the general act of cognition, but also in the specific functions, including memory, language, problem solving, and possibly thinking. (Rose & Strangman, 2007, p. 382)

This model is implicit in UDL. Recognition networks relate current experiences with past experiences and include the ability to recall and recognize facts, methods of accomplishing tasks or solving problems, skills, language, and information in abstract forms (e.g. pictures). Deficits in the recognition networks (e.g. back of the cortex, working memory) may be implicated in LD. Strategic networks manage the executive functions – attend, set goals, plan, organize, co-ordinate, monitor progress, reason, and so on. Deficits or differences in strategic networks (e.g. front of the cortex, frontal lobe) appear to be implicated in attention deficit/hyperactivity disorder (ADHD), movement disorders, LD, and giftedness. Affective networks interpret the world in terms of emotional meaning to an individual, as well as regulating hormones, and influencing biological drives and motivational levels. The limbic system and the amygdala are considered to be the core of the affective networks. Deficits in the affective networks affect social judgment, emotion perception, and biological responses, and may be involved in cases of Asperger's syndrome, shyness, and EBD.

The continued development of the UDL model of education is dependent on the recognition of the combined and ever changing impact of the physical and neuro-psychological aspects of individuals on cognition. Further, the application of the growing and emerging bodies of research from various fields to models of learning or education, pedagogy, epistemology, and human rights will serve to define UDL as a flexible concept

rather than a static methodology. Simply put, UDL is based in research and should continue to develop and change as a result of research.

UDL Defined

Much of the work in the growing field of UDL is based in the United States and based on the legal educational requirements in that country. The Individuals with Disabilities Education Improvement Act (IDEAIA; 2004) defines Universal Design (UD) as "a concept or philosophy for designing and delivering products and services that are useable by people with the widest possible range of functional capabilities, which include products and services that are directly useable (without requiring assistive technologies) and products and services that are made useable with assistive technologies" (Spooner et al., 2007, p. 109). Similarly, North Carolina State University defines UD as "the design of products and environments to be usable by all people, to the greatest extent possible, without the need for adaptation or specialized design" (Burgstahler, 2006, p. 81). The concept of UD appears to be evolving from that of focusing on increasing accessibility for persons with disabilities to providing a universal method of accessibility for all persons.

"Universal Design for Learning [is] … a research-based set of principles that forms a practical framework for using technology to maximize learning opportunities for every student" (Rose & Meyer, 2002, p. 5). The dual requirement of standards based achievement (high standards for all) and the diversity of students in classrooms has driven UDL to the forefront of education (Rose & Meyer, 2002). Various inclusive educational approaches have provided the foundation for UDL (Wehmeyer, 2006). In

particular, differentiation appears to have provided teachers with a model on which to build UDL practices, as well as providing support for UDL as it developed as an educational approach (Abell, 2005; Meo, 2008, National Center for Assessing the Curriculum [NCAC], 2000). On going changes in education, technology, and legal or human rights continue to alter the classroom.

The changing classroom requires that curriculum needs to be broadened to be more inclusive (Hitchcock, Meyer, Rose, & Jackson, 2002). Goals and milestones for instruction need to be evaluated in light of the "big ideas" inherent in curriculum expectations and teachers need to provide students with conspicuous strategies to get there (Kameenui & Carnine, 1998). Media and materials to be used by students need to reflect the learning styles of students, zones of proximal development of students, as well as provide scaffolded choices and alternatives that allow students access to information by working with the teacher or peers (Kameenui & Carnine, 1998). Instructional methods prescribed in teacher manuals and teacher training need to include multiple means of presenting material, provide students with multiple means of expressing their knowledge, and have built in support or scaffolding for learning. Suggestions for accommodations and modifications need to be included as choices in students' versions of texts and other materials. Strategy intervention needs to be integrated into instruction to promote higher order thinking (Kameenui & Carnine, 1998). Assessment needs to consider the progress made by students, rather than simply the end state. Education, not educated, is the goal. Further, assessment methods need to allow students in a class the opportunity to demonstrate that learning has occurred, rather than learning has occurred in a given way.

The central goal of UDL is the progress that students demonstrate with regards to *learning to learn* (Hitchcock, 2002).

"UDL is a strategy to eliminate barriers to learning that students may encounter, and it includes universally designed instruction (UDI), universally designed curriculum (UDC), and universally designed assessment (UDA)" (Lieberman et al., 2008, p.33). UDL anticipates differences in the three learning networks (see UDL and Cognitive Sciences in this paper) by building flexibility into support provided to all students in the learning environment, and as such minimizes barriers to student learning. The learning environment has been extended from the classroom to include the resources, and the use of technology by teachers for instruction and students for engagement. Within the general curriculum, content is presented in multiple ways using multiple methods. Assuming diversity, students' abilities fall along a continuum. Teacher and student use of flexible digital curriculum materials and tools, for instruction and learning, suggest that accessibility to curricula will be enhanced (Abell, 2005). Acceptance of student diversity is reflected through students' choice of assignments and their individual demonstration of their understanding of content through those choices.

Parette, Wojcik, Peterson-Karlan, & Hourcade(2005) argue that students' capacity to learn is furthered by the creation of learning environments where students have access to educational experiences. Not only is knowledge (e.g. facts) increased, but the skills used to build that knowledge are developed. Wehmeyer (2006) posits that consideration of the wide differences in students' abilities to see, hear, move, read, write, understand English, attend, organize, engage, and remember in the design of materials and activities promotes increased participation through increased access to curricula. By providing

students with flexible means of representation of information, flexible strategic support, and flexible means of engagement, UDL recognizes the three learning networks, uses research based practices and resources (e.g. technology), values student diversity, and is expected to increase the level of inclusion and performance of all students.

Universal Designs

As early as 1996, Upcraft was calling for a shift in education and noted that "in classes with great diversity … there must be great diversity of instruction" (p. 34). According to the Centre for Universal Design (1997), designs which are said to promote access and participation feature:

- ✓ Equitable use
- ✓ Flexibility
- ✓ Simple, intuitive designs
- ✓ Perceptible information
- ✓ Tolerance for error
- ✓ Minimal physical effort
- ✓ Size and space for approach and use

According to Abell (2005), the establishment of UDL in a school system incorporates accessible digital curriculum materials, technology supports (e.g. text reader), accessible on-line assessment, and a broad array of technical support and implementation training. Teachers have to be given the training and time to develop these skills and knowledge. By making UDL an add-on to teachers' planning, UDL may fail. In addition, Abell argues that UDL requires on going support, as well as IT upgrades and

instructional integration strategies. However, in 2000, NCAC reported that there was no universally designed curriculum or perfectly accessible instructional products.

Current Limitations of UDL: A Lesson

Howard (2004) reported her considerations when designing a Grade 1 cross curricular (science and literacy) guided reading lesson based on the principles of universal design and only one computer in her classroom. She used simple guiding questions that included: What is the basic idea that students need to learn? What different ways can the idea be learned? Do students need to read independently? How can students be assessed to demonstrate their understanding? Providing choice of texts at different reading levels, she recorded a copy of a book on tape for one group and used an eReader program with another group. Howard observed that the students were all engaged and that all appeared to have the level of support that they required to be engaged, as well as demonstrate their understanding of the material covered. She reflected afterwards that while the time to design the lesson was significant, it was worth the time. Howard (2004) reported now she has a UDL resource that can be used in the future by herself and other teachers.

It is clear that this teacher felt that the UDL based lesson was effective for all students. However, it is one lesson. If she was to attempt to extend this level of planning to all literacy lessons, or all curricula, it might prove to be impossible. It is clear that there may be several options available, including working with a professional learning community of Grade 1 teachers to develop resources, posting and searching the Internet for resources, and so on. Students in her class have experienced success and UDL, as she has developed the concept in her classroom. As a practitioner, she too has experienced

success in her classroom. UDL requires a different approach to planning and practice, and it appears that we do not yet have the resources, tools, or experience to implement UDL in an efficient manner. As UDL is able to be implemented in a more efficient manner, the concept of UDL itself is expected to change and become increasingly effective.

Limitation of Special Education

McGuire et al. (2006) caution the "history of failed practices" of special education not be repeated with UDL. The use of "specialist" teachers with limited time or lack of competence, coupled with *dyspedagogia* in general education have failed to effectively meet the academic needs of high incidence, low needs students (e.g. students with learning disabilities) (Elkins, 2007). Accordingly, McGuire et al. (2006) have called for a critical approach to the implementation of UDL and advised that special education develop a research agenda to guide the practice of UDL in classrooms. While these suggestions are intended to guide researchers, teachers at the school level may further their own professional development by asking the same guiding questions:

- Are the components and principles of the proposed model [of UDL] valid?
- In what ways can the model [of UDL] be implemented in educational environments?
- What are the outcomes of interventions based on the model for students with and without disabilities?
- Are these differential effects of interventions based on variables such as learner and environmental attributes?
- Does UD reduce the need for specially designed instruction or the identification and placement of students with disabilities?
- What are efficient and effective approaches to prepare faculty, teachers, and pre-service teachers to implement UD in their instruction?
- What do stakeholders [parents, administrators, IT personnel, etc.] perceive to be the benefits of instruction based on UD?
- What, if any, revisions to the model are warranted based on results from empirical studies? (McGuire et al., 2006, p. 172).

Limitations of Technology

Today's model of UDL requires that teachers use technology. Simply put, teachers need to use technology for instruction, student activities, and assessment. Teachers must be ever mindful however of the fact that technology has limitations. Technology (hardware and software) was not necessarily designed or informed by pedagogy or cognitive sciences, but has the potential to revolutionize both (Deubel, 2003). The use of IT only in instruction may be a barrier for students with AT. That is to say, embedding AT into instruction may enhance learning for students with AT. Additionally, there are students who might benefit greatly from access to AT, but without identification are denied that right. And again, without the right to AT, students are subject to copy right laws that deny them access to texts in formats that make those texts more accessible. As technological advances are made, the differences between IT and AT may disappear. For example, text to speech technology allows readers to multi-task. Teachers need to model the use of the tools of technology to all their students during instruction so that all students learn to use the tools effectively to communicate with one another and demonstrate their understanding (Parette & Peterson-Karlan, 2007).

Accessibility to Curriculum

Using the idea that learning involves both a process and a place, Gerber and Scott (2007) suggest that the use of technology in education alters both the process and the place. That is, the learning environment moves from the four walls of the classroom to the World Wide Web. The tension between a teaching curriculum and a learning curriculum is obvious in debates surrounding the increased use of technology in the

classroom, especially by students. The former, teaching curriculum, focuses on the skills and knowledge to be achieved by students for successful learning having been deemed to have occurred. Whereas, learning curriculum focuses on student progress, building upon students' current understanding. Features of both curricula have implications for both learning content and using IT to access content (Gerber &Scott, 2007). IT as an authentic tool (i.e. technology use in real world settings to solve real problems) to access curriculum alters both the process of education and the place of education (Gerber & Scott, 2007). The curriculum or learning environment impacts both the process of learning and the resulting understanding of content.

Curriculum Expectations

The primary or established learning goals for all students are those laid out in the general curricula of the *province* (Rose, 2000). UDL is concerned primarily with access to these curricula (Lieberman et al., 2008). As such, curricula requires built-in access that incorporates accommodations and recognizes the range of users' abilities, as well as allowing for learner variance vis-a-vis diverse backgrounds, interests, and rates of learning (Rose, 2000). As such, "[c]urriculum should be made flexible to accommodate learner differences" (Patterson, 2005, p. 62). From the outset, curricula should be designed to include all learners such that retrofitting curricular expectations is not required, or at the very least minimized (Meo, 2008).

According to Rose (2000), setting goals that focus on the big idea, allows teachers to broaden the goal so as to consider the progress made with regards to the strengths, weaknesses, and interests of all learners through instruction. "Open-ended standards do not restrict the ways in which students exhibit knowledge or skills and focus more on

expectations that students will interact with content, ask questions, manipulate materials, make observations, and then communicate their knowledge in a variety of ways" (Wehmeyer, 2008, pp. 226-7). When UDL was implemented, Dymond, Renzaglia, Rosenstein, Chun, Banks, Niswander, and Gilson (2006) found that the process of education continually shifted from creating opportunities for physical presence for students with exceptionalities, to a focus on socialization, to a focus on IEP goals, and finally, to a focus on curriculum expectations. For Meo (2008), it is the students' interaction with the curriculum that determines success. That is, accessible curriculum allows for and promotes greater success for all students.

Furthermore, accessible curriculum provides the necessary scaffolds to support the best teaching practices that promote and facilitate education. Learning may be further enhanced, or at the very least altered in a positive sense, by using flexible and accessible electronic and information technologies. Educational policies and curriculum increasingly require educators to implement technology into their teaching practices, through Individual Education Plans (IEPs) and the general education curriculum (Ferdig & Harshorne, 2002). Some educators argue that technology "transforms the educational environment to provide almost all students with the same rigorous, progressive, and thoughtful curriculum" (Curry, 2003, p. 56). While others argue that IT is another panacea for education and more research is required to justify its expansion into education (Ferdig & Harshorne, 2002). Clearly, there is a requirement for additional research into the implications of implementing technology in the classroom for all those involved, students and teachers alike. However, the use of technology in society suggests

that it is here to stay and by implementing its use in the classroom, education is made all the more relevant to the lives of students outside school.

Students and Technology

Parette et al. (2005) describe a significant generational difference between teachers and students—technology. The generational gap is, at least in part, technologically based. Technology is deeply embedded in the behaviour, culture, and daily experiences of students. Students' abandonment of dated school technologies is both a concern and a current area of research. The relevancy of school is evaluated, not only by the content presented, but by the tools used. Insofar as students participate in their community, the tools used by them are technologically based. Technology has become integral to the 21st century culture (e.g. communication, work, leisure)—we google and tweet.

Wehmeyer et al. (2004) reported the following facts with regards to the use of IT by children and adolescents:

- 90% of children, aged 5-17, use computers
- 59% of children, aged 5-17, use the Internet
- approximately 75% of 5 year olds use computers
- approximately 90% of 13-17 year olds use computers
- 25% of 5 year olds use the Internet
- 50% of 9 year olds use the Internet
- 75% of 15-17 year olds use the Internet
- 81% of students use computers at school
- 65% of students use computers at home
- 5-17 year olds without disabilities are significantly more likely to use computers
- among students with disabilities, students with intellectual disabilities are less likely to have access to or benefit from technology
- 10% to 23% of students using AT have an intellectual disability
- 34% of students with an intellectual disability use some form of AT

While these data are American based, Canadian children are assumed to have similar experiences with technology.

Interestingly, based on a rating scale of 10, persons with disabilities reported that their quality of life improved from a 3 to an 8.4 when AT was made available to them (Hoppestad, 2006). When families with a school aged child with a disability were surveyed, 68% reported that their child had access to a computer in their home, 15% had access to a computer in another environment (usually school), and that 78% of families whose child did not have access to a computer, felt that their child would benefit from a computer (Wehmeyer et al., 2004). The two main reasons for students with an intellectual exceptionality not to use technology were found to be the characteristics of the learner and the lack of universal design features that take into account issues related to cognitive accessibility (Wehmeyer et al, 2004).

Planning for Technology

When planning for learner variance, teachers needed to continue to develop an understanding of the impact of their choices on the learning of their students. Research, while far from conclusive, has suggested ways ahead. When using the Internet for research, students were found to repeatedly use sites that they knew, use only one or two search terms, select only the first few items that resulted from searches, and trust web-sites developed by companies (Ginee, Eagleton, & Hall, 2003). Clearly, students need instruction in how to use technology to learn.

Using the theoretical foundations of Dual Coding, Beacham and Alty (2006) found that the use of media to present e-learning material to students with and without dyslexia made significant differences in the understanding of students with dyslexia.

However, learning style preferences did impact the performance of students with dyslexia (Beacham & Alty, 2006). And lastly, different combinations of media appeared to differently impact learning performances of students with dyslexia and students without dyslexia (Beacham & Alty, 2006).

Video appears to be a very effective tool for teaching students with mental disabilities, allowing students to maintain and generalize the skills at high levels (Norman, Collins, & Schuster, 2001). And yet more traditional teaching tools, such as graphic organizers, chunking, mnemonic strategies, goal-setting, and problem solving have also been found to be very effective teaching methods for students with intellectual and cognitive disabilities (Lee, Amos, Gragoudas, Lee, Shogren, Theoharis, &Wehmeyer, 2006). Of course these teaching practices need to be adapted to meet the specific needs of students, and usually incorporate pictures or symbols. What is of particular interest here is that these are tools that are already used in many classrooms and could make curricula more accessible to all students, allowing all students to make progress vis-à-vis curricula.

In their study of students with LD and/or ADHD, Parker and Banerjee (2007) found that undergraduates' abilities to use technology effectively in school was impacted by whether or not they had a disability. Students with either or both LD and ADHD reported a lack of comfort with using e-mail to communicate, multi-tasking on the computer, and doing on-line literature searches. Interestingly, students with ADHD reported a higher level of comfort with basic computer operations, multimedia presentations, and spreadsheet software than did students with LD and those with no disability. The authors of the study suggest that greater effort in the training of

technology use happen at the high school level (Parker & Banerjee, 2007). Parette & Peterson-Karlan (2007) argue, access to technology is insufficient in and of itself.

The effectiveness of IT or AT in education will be determined by student achievement in the academic and life skills curricula (Parette & Peterson-Karlan, 2007). The use of IT in instruction appears to be increasing and is growing area of educational research. However, the use of AT in instruction is not well understood or currently, an area of research. Furthermore, the critical shortage of AT specialists for student and teacher training suggest that much more work and research is still required to assess the effectiveness of AT. Then again, Hitchcock and Stahl (2003) argue that by making AT accessible to all students, and embedding it in instruction, all students will be trained to use technology. Simply put, a shift in the use of technology from AT to IT for all may be required to make instruction accessible to all.

Students and UDL

Many authors and researchers posit that all students, not just those with an exceptionality, benefit from UDL instruction and resources (Abell, 2005). Adjustments made for learner differences include all students, not simply those with an exceptionality (Rose, 2000). By providing students with a flexible learning environment that provides many opportunities, challenges, choices, and various levels of supports, the level of interaction of students with peers and with the teacher (and other staff) increases (Bernacchio & Mullen, 2007). It is this interaction that is key to communication and democracy in education. By developing a sense of membership within the academic culture, students participate and contribute to the whole of the class. All students are socialized to develop an understanding of difference as a variance in humanity. Respect

for all learners is demonstrated by imparting each student with goals, materials, and methods of assessment that are appropriate to them, and that relate to the big ideas of curricula. Through design, teachers provide the range of opportunities that are needed to demonstrate that all learners are respected as contributing members of a classroom.

Typically, students who come to the attention of teachers and special education teachers as being at risk for failure do not appear to be benefiting from or responding to instruction in the classroom when compared to their peers. The "gap" in performance levels between students does not appear to be reduced by interventions, as the same students appear to continue to repeatedly access intervention and remedial programs over time. The delivery of interventions to only certain students clearly suggests that the student is the cause of the "gap." Concepts such as responsiveness to intervention (RTI) and treatment resistance, reduces difficulties with learning to a model of education that has teachers and peers contending with unresponsive, hard to teach students. In sharp contrast, Lytle and Clarq (2008) reported that students with exceptionalities often do not participate until the middle of the lesson, if at all, and that they often reported feeling left out. And even peers reported that students with exceptionalities were in fact left out of lessons or identified as being *different* (Lieberman et al., 2008).

It has been long argued that prevention, rather than remediation, of educational problems within the general education classroom would minimize the need to develop compensatory or remedial activities. Interestingly, Tomlinson (2003) argues that effective remedial programs, whether students are pulled out from classrooms or not, are meant to accelerate or boost students so that they can continue to participate in their classrooms. Regardless, McGuire et al. (2006) have concluded that the effect of remedial experiences

of many students with high incidence exceptionalities have resulted in continued low academic performance, high dropout rates, failure to obtain meaningful employment, and low participation rates in post secondary education.

Students with low incidence exceptionalities, those with significant cognitive exceptionalities (up to 1% of general population), are increasingly included in the mix of students in general education classrooms (Browder, Wakeman, Flowers, Rickelman, Pugalee, & Karvonen, 2007). In contrast to students with high incidence exceptionalities, research has consistently demonstrated that students with low incidence exceptionalities benefits from instruction in the general education classroom in primarily two ways: development of social skills and the acquisition of new skills (Browder et al., 2007). Browder et al. (2007) identify four reasons to promote access to grade-level curriculum for students with significant cognitive exceptionalities: facilitating adult competence, preparing for life in the local community, providing equal educational opportunities (e.g. reading), and developing self-determination skills or self-advocacy skills. The evidence does suggest that the needs of students with significant cognitive exceptionalities are better met in the classroom than in special programs that isolate them from their peers without exceptionalities, and from their community.

According to Bernacchio & Mullen (2007), the community of students in a UDL setting is actively engaged in education by using meta-cognitive skills and knowledge to guide their choices of activities. Furthermore, students' ability to gauge their own progress through reflections, self-evaluations, portfolios, and other tools of assessment creates active learners. Anecdotal evidence suggests that when students are able to use their preferred learning modality to access and respond to curriculum materials, their

sense of self and the perception of them by their peers is positively enhanced (Abell, 2005).

UDL suggests that factors external to the student may be contributing to the difficulties with learning. These factors include pedagogy, tools used for learning, curriculum, current knowledge and understanding of cognition and epistemology. Progress of individual students is valued in UDL rather than "tyranny of grade-level expectations as criteria to judge success" (Elkin, 2007, p. 397). All students are capable of learning (making progress) and progress needs to be valued. A responsive education system includes all students from the outset by making education accessible so that all students, particularly those with exceptionalities, can participate and demonstrate their progress.

Teachers and UDL

Teachers are becoming increasingly accountable for the education of *all* students (Pisha & Coyne, 2001). As society is changing, students "included" in general education classrooms are changing the profiles of classrooms. The debates concerning the benefits and costs to general education of inclusion continue (Waite, Bromfield, & McShane, 2005). Regardless of the debates, teachers are responsible to report on students' achievement levels (e.g. reading levels), as are all or most students expected to participate in standards-based assessments (e.g. EQAO). The inclusion of and impact of students with exceptionalities on classrooms and mandated assessments clearly indicates that teachers are expected to plan, prepare, and assess all students. Excluding students from mandated assessments is no longer deemed acceptable (unless detrimental to the child),

suggesting that excluding students from the instruction and activities that prepare students for such assessments is also no longer acceptable.

In addition, there are increasing requirements for teachers to demonstrate "inclusive methodologies, instructional and curricular accommodations, functional behaviour assessment, collaborative skills and knowledge of technologies" (Laarhoven, Munk, Lynch, Bosma, & Rouse, 2007, p. 442). These requirements reflect both research findings and the changes in education required by society. Nelson (2006) argues that the standards for teaching qualifications need to be changed to include language that refers to the knowledge of diverse learning populations, the use of technology, and the implications of the use of a variety of materials, approaches, and opportunities to demonstrate learning.

Nelson (2006) further argues that AT or IT needs to be embedded in teaching and learning. That is, teachers need to demonstrate the knowledge and disposition towards technology that makes its use inclusive. Teachers need to advocate for their students by integrating technology, especially AT, into their instruction and class activities. By failing to do so, Nelson (2006) posits that AT or IT skills taught in isolation limits the effectiveness of those skills in the classroom and for learning. That is, by not embedding technology into education, teachers are not practising inclusive education.

Differentiation

"The field of special education has debated the pros and cons of including students with disabilities in general education classrooms… In particular, concerns have largely focused on meeting students' needs through adaptations or modifications of the general curriculum and instruction" (Spooner et al., 2007). Lesson plan development is

often cited as the primary reason for the failure of students with exceptionalities to succeed in the general education classroom (Spooner et al., 2007). Without the evolution of education of children with exceptionalities from *no* access to general education to *access* through the differentiation (lesson plan development) of content, process, and product supported by the work of Tomlinson and others, UDL (lesson plan development) would surely be a daunting, if not impossible task. In fact, Blamires (1999, p. 158) defines differentiation as "the adoption and elaboration of universal design principles." UDL seen in this light, is the extension of and continued evolution of differentiation. The current configuration of UDL is based on, supported by, and made possible by brain research, technological advancements, as well as the changes in education that have developed over time. As advancements are made in our knowledge and understanding of issues relating to pedagogy, cognition, and epistemology, tools (e.g. technology) will also continue to be developed, applied to, and impact education.

Tomlinson (2003 p. 9) outlines six "Principles for Fostering Equity and Excellence in Academically Diverse Learners:

1. Good curriculum comes first.
2. All tasks should respect each learner.
3. When in doubt, teach up!
4. Use flexible grouping.
5. Become an assessment junkie.
6. Grade to reflect growth."

These principles reflect best teaching practices and the principles of UDL. Excellence in education is dependent on students developing these same values to develop an understanding of learning that is life long, to develop critical thinking skills, and to develop an appreciation of others as contributing members of their community. "Differentiation can reinforce status, or differentiation can liberate students from

stereotypical expectations" (Tomlinson, 2003, p. 11). Education, as communication, reflects and transmits ingrained values that can embrace democracy through the participation of all students in their classroom.

Teachers and the Learning Environment

When high school students were asked to describe teachers they admired, they reported that the learning environment created by the teacher was crucial (Whitney, Leonard, Leonard, Camelio, & Camelio, 2005). "[T]hree major themes at the heart of good teaching [identified by students were]: (a) personal connections, (b) balance, and (c) universality" (Whitney et al., 2005, p. 31). Explicitly, students stated that, teachers who balanced effective classroom management with humour, patience and understanding, and expressed enthusiasm for teaching were the most effective teachers. Perhaps most interestingly, students described teachers who used multiple examples that provided opportunities student interaction and involvement during instruction, provided students with choice and timely feedback, and ensured that all students understood were amongst the "best" teachers. Furthermore, students described the need to have curriculum that was relevant and related to their lives, and teachers that were willing to link classroom materials with the lives of students outside school.

Citing Wolk, and Rose and Meyer, Whitney et al. (2005) argue that students are seeking an education that reflects the values of democracy and universal design. By designing cognitive access and learning opportunities for all students, teachers are creating opportunities for students' to develop skills such as self-determination, self-actuated learning, independent performance of higher level learning tasks, and end the cycle of learned helplessness (Nelson, 2006).

The classroom teacher, with the support of the special education teacher, is responsible to construct a positive learning environment by selecting and using resources that promote access to the curriculum for all students. Based on a literature review, Laarhoven et al. (2007, p. 444) recommend that teachers develop competencies in the following areas:

a) positive attitude and disposition toward individuals with exceptionalities
b) knowledge and practice of collaborative and teaming skills
c) knowledge of family issues and strategies for collaboration with families
d) knowledge and application of universal design for learning in lesson plan development for inclusive classrooms
e) knowledge and capability with assistive technologies, and
f) knowledge and application of positive behaviour support.

When general education teachers were provided instruction in these competencies, they performed similarly to their special education colleagues, but unfortunately still reported feeling that the special education teachers were better trained to teach students with exceptionalities (Laarhoven, 2007). Both general and special education teachers reported that while collaboration took time, it was planning time well spent (Laarhoven, 2007).

Inclusive Planning

Inclusion of students with and without exceptionalities, in all aspects of the learning environment, requires planning. In fact, Ryndack, Jackson, and Billingsley (2000) found that experts in the field of special education defined *inclusion* to be the collaborative planning, implementation, and evaluation of instruction, which meets the needs of all students, by classroom and special education teachers. Consideration of individual rights of all students, professional skills of teachers (e.g. in the areas of IT, AT, special education), school improvement plans, availability of resources, and the cultural

climate vis-à-vis inclusion are some of the core issues that impact planning for inclusion. Not an event, rather a process, inclusion requires a commitment to the values of accessibility and engagement (Blamires, 1999). Barriers to inclusion include the physical, social, and academic facets of the classroom. According to Rose and Meyer (2002), teachers need to consider multiple means to achieving curriculum expectations by providing multiple means of representing content, multiple options for expression and control, and multiple options for engagement and motivation (See Cognitive Neuroscience Underpinnings of UDL section of this paper). Consequently, responding to the diversity of needs in a classroom requires flexibility and innovation in planning.

Student and class profiles, using baseline data from reading assessments, samples of work, surveys, self reflections or reporting, observations, information contained in Ontario Student Records (OSRs) including IEPs and past report cards, provide teachers with a wealth of information for planning for individual students as members of the class (Browder, 2007; Curry, 2003; Lieberman et al., 2008). Planning includes the ongoing assessment of the functional ability of each student through out the school year. Evaluating feedback (e.g. student level of engagement, performance on an assessment task) on planning is critical for future planning. The needs of students, as well as lesson objectives need to be taken into consideration before planning (Lieberman et al., 2008). The needs of all students must be incorporated into all lessons at the planning stage, rather than retrofitting lessons and assignments. Interventions, such as accommodations and modifications, become outdated methods of engagement – outmoded methods of teaching practice. Accessibility, made possible through universally designed lessons and resources, is the intervention (Spooner et al., 2007).

Matching the attributes of students with goals should drive planning. Goals identified through student performance, IEPs, and curricula must be considered in the planning of lessons and units. Flexibility and creativity in planning to meet objectives allows for the range of preferences (interests), skills, and abilities presented by the range of learners in the class to be respected and built upon (Curry, 2003). Making class content accessible requires that teachers consider inclusiveness, physical access, multiple delivery modes, interaction with peers and adults, feedback to students, and multiple ways for students to demonstrate their knowledge (Lieberman et al., 2008). Spooner et al. (2007), having studied the effect of one hour of instruction on UDL on teacher candidates, concluded that knowledge of universal design concepts may in fact save teachers time in creating instructional lessons plans. However, more research is needed on the effectiveness of UDL instruction for teachers and the impact of UDL on students over time.

Universal design in instruction (UDI) requires that teachers teach all students and that the instruction that they plan for is integrative. Scott et al. (2003, p. 42) define integrative as "planning for student diversity." This is contrasted with an instructional approach that makes exceptions for different learners, and as such suggests that differentiated instruction simply is not enough. Instruction that is said to be universal in design is useful and accessible to all students, accommodates a wide range of abilities, is straightforward and predictable, conveys information effectively, anticipates differences in learning pace and prerequisite skills, minimizes physical effort, considers physical space and physical abilities of students, promotes interaction and communication, and is welcoming and inclusive, regardless of student's experiences, knowledge, language skills

or current concentration level (Scott, et al., 2003). Instruction needs to be linked to all students' activities, as well as assessment. Instruction becomes the model for inclusion and learning, as all students are instructed using the tools that they will use in their activities. Systemic issues not yet identified may come to light as teachers begin to use UDI.

Planning for All

It is imperative that teachers take the time to become acquainted with the resources within their school and within their school board. Resources, including technology, are often available on request, as is training. Accessing the programs available in computer labs before the planning process begins serves to inform teachers about resources available, but also resources that are lacking. The approach to IT, by IT department personnel and teachers, may be quite different. It is imperative that the goals for IT are in line with the goals of education, and in particular UDL. IT department personnel are well versed in the potential uses of various technologies, and are a wealth of information and support for teachers. The human infrastructure offers a wealth of opportunities to build a team, as well as to build knowledge within the team.

In planning for students with significant cognitive exceptionalities, Browder et al. (2007) recommend that teachers consider both the functional needs of students and grade-level curriculum. By using the student's assigned grade level as the point of reference, planning focuses on identifying academic content, selecting specific activities for instruction, the need for accommodations and supports, and teaching (providing instruction) to all, using a wider range of activities and materials. Teachers need to consider that achievement levels are linked to grade-level curriculum, but differ in

breadth or depth. “Out-of-level” achievements, earlier grade-level or life-skill expectations, develop across grade levels, or reflect the interests of the student (Browder et al., 2007). Regardless of the purpose of assessment, students need to demonstrate a level of understanding, rather than a rote response. The application of earlier grade-level skills to acquire grade-level content shows growth in the area of content, and reflects the need to plan for growth of skills and content knowledge across grades (i.e. change expectations to reflect grade level curriculum). “Overall, … research shows that this population can learn academic skills, but research to guide teaching academic skills linked to grade-level content is virtually nonexistent” (Browder et al., 2007, p. 7). Nevertheless, Browder et al. (2007) recommend that teachers prioritize skill development and use a variety of effective teaching strategies, including fading, prompting, applied behaviour analysis (ABA), differential reinforcement, direct and repeated instruction, communication systems (pre-symbolic, early symbolic, and expanded symbolic), and well-constructed simulations. Translating a curriculum standard or expectation to an expectation on an IEP needs to take into account instruction to include all learners, use of materials and resources, and assessment to ensure that expectations remain high for students with a significant cognitive exceptionality.

Planning for Paraprofessionals

Lieberman et al. (2008) recommend that teachers plan for all paraprofessionals in the classroom. During the planning process, teachers need to know the schedule of paraprofessionals that will be working in their classrooms, as well as their skill levels or preferred methods of working. If at all possible, paraprofessionals should be included in the planning to develop a team approach to delivering education to all students. Few, if

any paraprofessionals have planning time built into their schedules so that time spent involved in planning and developing resources is often at the expense of time with students in the classroom. Training of paraprofessionals to use equipment is also another consideration, as is preparation of the wide array of resources that may need to be developed. The presence of special education resource teachers (SERTs), administrators, and other professionals (e.g. Speech Pathologists, Special Assignment Teachers) requires that classroom teachers understand the purpose for their presence in the room. The use of the expertise of professionals in the planning, instructional, student performance, and assessment processes should enhance the education of students, develop the understanding of the needs of students in the class, and provide professionals an understanding of barriers faced by students and teachers. By becoming contributing members of a team, education is itself enhanced.

In Ontario, the Ministry of Education has promoted the use of Professional Learning Communities (PLCs) and Teacher Learning and Critical Pathways (TLCPs). Typically, SERTs, classroom teachers, administrators, and others meet to discuss the achievement of students, barriers to achievement, selection of resources, and teaching practices. As such, these meetings may lead to the development of UDL within individual classrooms and schools.

Models of UDL in Research

There are relatively few models of UDL in practice reported in the literature. That is not to say that UDL is not being practised. The case reported earlier in this paper is indicative of some of the reporting on UDL in practice. The three models below provide

good examples of the focus of the research of UDL in practice. All occur at levels of education above elementary level. The focus of each model is similar, in that, teachers developed professional learning communities to implement UDL. This suggests that teachers recognized the challenges faced and their own needs vis-à-vis the implementation of UDL. It is clear from these models that teachers need to develop action based research practices to further their own understanding and practice of UDL.

A Model: Planning for All Learners

Using the four-step Planning for All Learners (PAL) process in a high school setting, Meo (2008) found that teachers' practices were positively changed. Special education, classroom teachers, and others work together to set goals, analyze current status of curricula and classrooms, apply UDL to lesson or unit development, and teach the UDL lesson or unit. The cycle continued and developed as teacher understanding of UDL and their roles in education developed. The focus on joint-curriculum planning appeared to have facilitated the development of UDL teaching practices in both special education and classroom teachers. As a research-based practice, UDL is rooted in research and requires teachers to adopt such an approach to their own practice and the impact it has on student performance. Issues involving leadership (Abell, 2005) and common planning time were reported as critical factors in the successful implementation of UDL (Meo, 2008). While the definition of UDL may appear to be a statement, it is clear that as a practice, teachers' understanding (e.g. of students, of pedagogy, of epistemology, of assessment), resource availability, and changes in technology will continue to impact the development of UDL so that it comes to be understood as a flexible approach to education.

Insofar as Ontario is concerned, the Teacher Leadership and Critical Pathway program (TLCP) adopted, supported, and mandated by the Ministry of Education clearly is in keeping with UDL. The financial support enables teachers' common planning time, as well as resources. As student performance and teaching practices are evaluated in terms of achieving goals related to literacy, the opportunity to develop UDL practices and resources appears to be possible. Identifying barriers to learning or performance may be an outcome of TLCP, as well as the development of UDL instructional and assessment materials. The correlation between students' learning and teachers' professional development becomes clearer through the *research-based* process of TLCP.

A Model: Participatory Action Research

Dymond et al. (2006) established a professional learning community (PLC) to make general science curriculum more accessible to students with significant cognitive disabilities (SCD). SCD was defined as students with "moderate or severe mental retardation" (Dymond et al., 2006, p. 295). One inclusive science course, at the Grade 9 level, was selected and the principles of UDL were applied. This course was taught in the traditional manner—whole group lecture, seatwork, and several labs—and the majority of students taking the course were identified as at-risk for failure.

The one year project applied participatory action research (PAR) to UDL. "PAR offers one method for helping school stakeholders engage in continuous learning that addresses real school problems and methods for evaluating the effectiveness of interventions with students with SCD" (Dymond et al., 2006, p. 294). The core group included the classroom teacher, a co-teacher (special education teacher), and three university researchers. The university researchers focused on research and design of the

project, and the teachers redesigned the course and implemented the newly designed course. The special education teacher was given a copy of each lesson for her input.

While the general education teacher worked to make general curriculum accessible to all students (with and without SCD), it is interesting to note that the newly designed course needed to be altered or revised by the co-teacher. This exercise in retrofitting establishes an interesting relationship between teachers, rather than establishing one based on equal responsibility for curriculum and the diversity of learners. The co-teacher appears to be more responsible for accessibility, whereas the classroom teacher appears to be more responsible for curriculum. In this case, the two tiers of education—special and general—are diminished, rather than eliminated. This is not surprising, given that UDL is a process that is based on the current knowledge and understanding, and the enhancement of the professional development of teachers through research-based designing. Simply put, teachers may not be ready or prepared to move towards UDL, and the research or teachers' awareness of research may support this.

In redesigning the course, curriculum, instructional delivery/organization of learning environments, student participation, materials, and assessment were all addressed in each lesson. Big ideas of Illinois State curriculum became the focus of each lesson. The instructional strategies employed were broadened. Choice for students was considered in groupings, as well as assignments and assessment. And adults, including paraprofessionals (educational assistants), were expected to adjust their roles to support students' participation and learning.

Before UDL was applied, co-teachers adapted for students in an impromptu fashion. Paraprofessionals did not receive instruction on how to include students, or if

provided a plan, often did not implement the plan. After UDL (intervention) was applied, the general education teacher reported feeling greater responsible for planning and teaching for all students. The roles of the co-teacher and paraprofessional expanded from working with students with exceptionalities to working with groups of students that included students with exceptionalities. Support for students with exceptionalities was expanded to include support from the general education teacher, co-teacher, and peers, rather than simply the paraprofessional. Issues that related to knowledge of course content, supervision, and responsibility for students with SCD, were negotiated with paraprofessionals and in one case, a paraprofessional was replaced. The co-teacher began to take more responsibility for planning, training paraprofessionals and the classroom teacher, embedding IEP objectives in lessons, and generally, assumed greater responsibility for students served in inclusive settings. Dymond et al. (2006) reported that 96% of teachers stated that students with disabilities should access general curriculum in general education classrooms, and that 84% felt qualified to make curriculum accessible to students with exceptionalities. Dymond et al. (2006) found that by clearly defining roles in the classroom responsibilities were better understood, and that by including paraprofessionals in training and planning that understanding was further enhanced. In the end, all adults recognized the need and importance of working together.

Materials used for instruction and student engagement changed as a result of implementing UDL. Teachers began to include use of overheads, demonstrations, CDs, TV, LCD projectors, and VCR, as well as text books and worksheets. While paper and pencil continued to be used, materials available to students were expended to include visual organizers, games, construction materials, laptops, the Internet, and other

technologies. Students were provided with greater options for participating, becoming more active in learning by using hands-on activities, working on team projects, and through peer tutoring. Students still had the option of working independently. Differentiation became common practice. The delivery of instruction, in any one lesson, was expanded to include methods, such as teacher-directed, student-directed, technology-driven, and interactive, rather than only lectures. The teacher reported that there were fewer materials to prepare, as students assumed greater responsibility for learning. Not surprisingly, on-task behaviour was reported as having improved.

Seating arrangements moved students with SCD from the back of the class to be seated with their peers. All students were seated to promote interaction and active learning opportunities, creating a noisier and more functional classroom. Teachers observed and assessed students' working relationships, and adjusted seating arrangements when warranted. Roles were assigned to students when working in groups, and the teachers found that students with SCD benefited most when paired with two other students without exceptionalities, so that peer support was maximized for the student with SCD.

Students with SCD were reported to have made greater progress in regards to IEP goals, as well as social skills and interpersonal relationships (Dymond et al., 2006). Students without SCD were reported to demonstrate improvements in the areas of class participation, personal responsibility, work completion, grades, and year-end tests (Dymond et al., 2006). Teachers developed greater understanding of the importance of lesson and team planning, as well as including IEP goals in planning (Dymond et al., 2006). Time for collaboration, to get to know students (developing individual and class

profiles), to redesign lessons, and to collaborate with co-teachers and paraprofessionals became a key issue in implementing UDL (Dymond et al., 2006). The need to be more organized, to plan better for instruction, and to create adaptations prior to class (include in lesson plan) were all identified as lessons learned by the teachers (Dymond et al., 2006). Clearly identifying goals, funding for resources, and availability of IT also were identified as other issues to be addressed. (Dymond et al., 2006) found that the shift from a traditional model of education to a UDL model of education required took far more time than originally projected. More research is required to understand this process of change (Dymond et al., 2006).

A more inclusive and collaborative model of education was produced by changing the roles of teachers and students, developing high learning expectations for all students, and increased interaction of students without exceptionalities with students with exceptionalities. Once teachers recognized the difference between implicit content (e.g. skills necessary for learning) and explicit content (e.g. specific information) of curriculum, the implementation of differentiation and UDL was made possible (Dymond et al., 2006). By providing a variety of opportunities to develop skills for learning, as well as providing various methods of accessing information, support for growth in both skills and content is simultaneously achieved.

A Model: Collaboration

Bernacchio, Ross, Washburn, Whitney, and Wood (2007), five university colleagues worked together to try to improve equity, access, and inclusion in higher education and reported their experience. Of importance are the tools they used, the methods of collaboration, and the challenges that they faced. The use of the Internet to

communicate with students increased. Communication took the form of posting class notes, assignments, and so on. Benefits of using the Internet included the ability of students to translate class notes on-line, and students being able to focus on lectures when in class rather than taking notes. The Professors allowed for student choice of products to demonstrate their understanding, as well as developing clearer and more consistent rubrics for assessment. Bernacchio et al. (2007, p. 60) describe the impact of the process:

> Just as we think we have grasped a strategy that we hope might be considered best practice, we encounter a student for whom that particular approach simply will not work. Just as we think we have discovered "the right way" to run our meetings, something goes wrong and we realize we need to critique our group … processes. Our collaboration has forced each of us to make explicit what we teach, why we teach, and who might find our courses inaccessible.

The balance between pedagogy and epistemology became an issue for the group. What was found was a need to construct or re-construct the curriculum to meet the new understandings of what it meant to teach and what it meant to know something. Standards came into conflict with students' interests and development of strengths. Control over the classroom/group and the provision of background knowledge to students/colleagues became another issue. By making expectations explicit and scaffolding student learning, professors became concerned with limiting student choices. Similarly, issues related to supporting or nurturing student learning appeared to conflict with making the course work challenging or the development of skills necessary for learning.

Time to build a professional learning community required that the professors spend time learning about what each other was doing in their class, as well as building trust, but this detracted from the time that they had to discuss or debate professional issues as they related to equity, access, and inclusion. The balance between professional development and professional development of teaching skills became an issue as time

from one took time away from the other. Sharing the experiences of the group with other members of the faculty failed to bring about the responses that were hoped for and indicated that the experience in and of itself was paramount. Until such time as others are willing to undertake such an endeavour, their understanding of these issues (i.e. equity, access, inclusion) is rooted in traditional concepts of pedagogy and epistemology. In the end, Bernacchio et al. (2007, p. 64) concluded that "professors who inquire into their practice and make adjustments as they go are inevitably forging a difficult path."

Technologies: Assistive and Otherwise

McKenna and Walpole (2007) use the American *Individuals with Disabilities Act Amendments, 2004* definition of assistive technology (AT) as "any item, piece of equipment, or product system, whether acquired commercially off the shelf, modified, or customized, that is used to increase, maintain, or improve the functional capabilities of a child with a disability" (p. 140). . Whereas, Judge, Floyd, and Jeffs define AT as promoting "children's learning and development by allowing children to more effectively participate in activities and routines in their natural environments" (2008, p. 121). Both definitions focus on the improvement in the functioning of children, but the authors discussion of AT reflect a debate in special education surrounding inclusion. That is, the discussion presented by McKenna and Walpole (2007) relates the use and issues of AT to students with high incidence, low needs—for example, children with LD, ADHD. Conversely, Judge at al. (2008) discuss the need and issues related to use of AT by students with low incidence, high needs exceptionalities—for example, children with Fragile X. What is particularly interesting is the rather limited debate on the impact of the

use of technology in education to facilitate the functioning of all students in the 21st century. The discussion should include the impact of technology on education and the degree to which all students need to become proficient at using technology, whether it includes AT or not.

IT Tools

Many "universal" IT tools are being purchased by education facilities for use in classrooms and for use in distance learning environments (Ferdig & Harshorne, 2002). These tools include SMART Boards, WebCT, and clickers. However, Ferdig & Harshorne (2002) caution that the application of current educational research on recent psychological models of *thinking* and *learning* (e.g. Gardner, Vygotsky) suggests that IT tools would be most effective when they are created with pedagogical goals in mind. Using technology to create an authentic learning environment requires that the relationship between knowing (e.g. facts) and doing (e.g. how to approach a problem) be understood in the social context of education. Teaching technology and teaching with technology do not embody a model of education that provides students with the necessary experiences to develop the skills to function in the 21st century. According to Ferdig and Harshorne (2002, p. 93), the goals of the application IT in education include: authentic content, a sense of ownership, active participation, collaboration, opportunities for the creation of artifacts, publication, and feedback. Using various technologies or tools to create a framework or IT toolkit (See Media, Technology, and Other Resources in this paper) that then is used by both teachers and students in the process of education, focuses on pedagogy, training in the use of IT, and production of tools on which to build future instruction and learning.

Students with Exceptionalities and Technology

Advocates for children with high incidence, low needs typically argue for an education system that may include specialized instruction and placement so that these students reach their potential, perhaps going on to post secondary education. In contrast, advocates for students with low incidence, high needs typically argue for inclusion in general education to meet educational needs and social acceptance of persons with exceptionalities. In prescribing AT for students, the difference between the clinical (medical) model and the functional model is similarly reflected in the differences of these two groups of students (Hoppenstad, 2006). Regardless, advocates of both groups of students recognize the potential role of AT in meeting the needs of students with exceptionalities.

Not surprisingly, given the history of special education, students with low incidence exceptionalities (e.g. visual impairments) have had greater access to assistive technologies as the result of the work of strong support organizations (e.g. Canadian Institute for the Blind) (Hoppestad, 2006). However, Hoppestad (2006, p. 4) argues that "prescribing AT devices is an intrinsically difficult procedure that is prone to failure." Ofiesh, Rice, Long, Merchant, and Gajar (2002) argue that the following impact the decision to prescribe AT: possible applications of AT for student fails to recognize that AT that was designed for one population is increasingly being used for populations it was not designed for (e.g. text-to-voice software); interpretation of functional limitations of disability by the diagnostician can be inaccurate; compensatory factor of AT given student's functional strengths and weaknesses is under or over stated; and the demands or potential future demands of the learning environment. Unfortunately, abandonment of AT

is reported to be between 30% and 80% (Hoppestad, 2006, p. 10). Insofar as students with high incidence exceptionalities (e.g. LD, ADHD, PDD) have not benefited from support organizations, there does appear to be an increasing support and readiness to provide this group of students with AT. Understanding the difference of the impact of AT on learning for these two groups of students is the difference between *access to information* (compensatory aspects of AT) and *access to learning* (prosthetic aspects of AT) (Boone & Higgins, 2007).

While Boone and Higgins (2007) state that AT (e.g. word prediction software) has proven to be an effective tool for many students, with and without exceptionalities, instructional design elements that are suitable for one disability population are not necessarily appropriate for another disability. Similarly, educators reported that educational software was found to be lacking in the incorporation of higher order thinking skills, relationship to pedagogy and educational research, and "inclusion of a variety of skill levels to meet the needs of individual students" (Boone & Higgins, 2007, p. 138). Wehmeyer et al. (2004) suggest that effective technology needs to be flexible, simple, intuitive, and provide information in various formats, as well as incorporate a high tolerance for errors. The mere access to content through AT or IT is inadequate for learning. Access also needs to be mediated with instruction that is designed to meet the specific needs of learners (Boone & Higgins, 2007).

AT Current Use

Edyburn (2004) describes AT according to the level of support it provides. AT may become a prosthetic, in the case of students with visual impairment. Ability to function is determined, at least in part, by AT. Alternatively, AT may be considered a

scaffold when the effect of technology enables students' performance to be enhanced in the short term and independent skills developed in the long term (Salomon, Perkins, & Globerson, 1991). The issue in this case becomes that of transfer of skills—in the case of literacy, decoding or comprehension strategies. By addressing skills, such as decoding, the use of AT may enable the learner to develop higher order thinking skills, including comprehension skills. Without AT scaffolded decoding, comprehension may not develop. It is clear that the impact of AT on the development of and transfer of decoding skills is critical to the use of AT as a scaffold to develop decoding and/or higher order thinking skills. However, the impact of AT on the development of cognitive processes is not yet understood.

Others suggest that that AT becomes a crutch for learners, or that it is unfair to those who do not use it. Its use delays or prevents the acquiring of skills. As RTI is an ongoing issue in instruction, the use of AT complicates the impact of instruction on skill development. Does the use of AT more accurately target skill deficits, making intervention more effective? When do persistent chronic reading difficulties impact the functioning and participation of students within a class, so that AT is required in order to facilitate growth of the student? Can AT impact the Matthew Effect—good readers read more, while poor readers read less (Stanovich, 1986)? How effective is AT at leveling the playing field or narrowing the performance gap? When should AT be introduced so that higher order thinking is facilitated and the student is not left behind, trying to catch up?

Parette et al. (2005) state that the boundaries between AT and IT are becoming blurred. The roles of technology are defined as instructional—to aid in the development of skills of students,—or compensatory—to enhance the performance of students or

individuals over the life span. At any given time, any piece of technology, combination of technologies, or conventional instruction supported by technology has the potential to simultaneously develop or enhance the performance or understanding of individuals differently. Wehmeyer et al. (2004) identified seven areas that technology may enhance the functioning or quality of life of persons with disabilities: communication, mobility, environmental control, activities of daily living and community inclusion, education, employment, and recreation and leisure. Understanding of the potential of technologies, especially for use in the classroom by teachers and students, is as yet not well understood. More importantly, the implications of the use of AT in instruction for all students, student learning activities, and assessment need to be better understood.

AT – A Way Forward?

Lahm, Bausch, Hasselbring, & Blackhurst (2001) developed seven areas of research to evaluate AT services in schools, and to develop AT policies and practices for students with exceptionalities. The areas of research are:

1. status of AT use in schools
2. AT policies, procedures, and resources
3. AT decision-making when developing IEPs
4. AT training and technical assistance
5. planning and implementing AT services
6. effectiveness of AT devices and services
7. status of AT instruction in personnel preparation programs

(Lahm et al., 2001, p. 21).

Lahm et al. (2001) argue that while the availability and use of AT appear to have increased in recent years, the extent to which devices and services are implemented in schools is not known. Further, that while policies and procedures are stated in government and other documents, the interpretation and implementation of these rules and guidelines may impact the delivery of services. While Lahm et al. (2001) recognize

the improvements of in-service training for AT use, the effect of limited AT training for teachers and including those preparing to become teachers, lack of AT equipment and devices, insufficient evaluation services, and lack of administrative supports are all identified as potentially negatively impacting the IEP process for learners. Wehmeyer et al. (2004) further identified high cost of devices and limited teacher knowledge as additional barriers to technology use for students with exceptionalities. Research is needed to identify the types of knowledge, skills, and resources that teachers need to effectively implement AT in the classroom. As Lahm et al. (2001, p. 23) correctly conclude that when AT is not correctly selected or implemented, "the apparent failure of AT can lead to the under-use of the device, device abandonment, and the perception of stakeholders that AT is a costly risk."

Typical AT applications in education and particularly in literacy, includes text-to-speech, speech recognition, and spell checker technologies. The selections of technologies for any particular child are as of yet, based on hunches (McKenna & Walpole, 2007). Research on the effectiveness of AT, coupled with research in various areas of learning difficulties (e.g. LD), are suggestive and point possible ways forward. Functional assessments of AT in each particular case establishes the effectiveness of that AT in *that* particular case. Caution needs to used in making such a determination, as training to use AT effectively by teacher and student, as well as time to become proficient with the use of the technologies has to be considered when establishing the effectiveness of AT. Further, Rose (2001) cautions against placing the emphasis on the intervention (AT) and individual differences, rather than environmental barriers. Regardless, additional demands on teachers' time, limited understanding of possible outcomes of AT

use, and limited understanding of the instructional and assessment use of AT, all suggest that successful implementation of AT may be problematic in any given classroom (McKenna & Walpole, 2007; Parette et al., 2005).

Today, AT is increasingly being developed in the context of hypermedia. This context has significant implications for learning, including the development of new strategies that do not exist in the context of reading print (McKenna & Walpole, 2007). McKenna and Walpole (2007) present three models for the use of AT to address reading difficulties. First, AT is used to support decoding so that the student can apply comprehension strategies. Second, AT be used to track students' reading so that difficulties with sight vocabulary, phonics skills, and phonemic awareness, as well as reading fluency, be identified and instruction be focused accordingly. Third, that AT presents a context for learning and that as a context, AT may address skill deficits in reading. Comprehension, and for that matter reading, may need to be redefined to reflect the richer context of reading using AT or IT—technologies are influencing the format of the "text" and the skills used to access it.

McKenna and Walpole (2007) strongly advise that AT not be used to compensate for specific reading deficits or for reading instruction (intervention). Interestingly, McKenna and Walpole (2007) recognize that as reading skills may continue to be developed separately from AT, the use of AT may, in fact, support the development of reading skills. On the other hand, Parette et al. (2005) suggest that the use of AT or IT may free up working memory to focus on higher order thinking skills in students with learning disabilities. The goals of instruction need to be clearly defined as either reading to develop reading skills or reading to develop understanding of a subject. Regardless of

the goal, awareness of the impact of the use of AT on the ability of a student to participate in class discussions needs to be carefully assessed. Additionally, AT and conventional approaches to instruction should not be considered isolated methods of addressing learning difficulties, but rather may be seen as a repertoire of tools available to educators to address a variety of learning needs. Similarly, as conventional approaches provide a variety of tools for use by students to demonstrate their understanding, so does AT.

Texts, Instructional Materials and Methods

Materials selected for use by students need to consider the needs of students when accessing the content to be covered as prescribed by curriculum. Consideration of multi-sensory opportunities to participate in instruction, assignments or activities, and assessments serve to enhance the learning opportunities of all students. The possible range of abilities of students in a class to see, hear, speak, move, read, write, count, compute, understand language of instruction, attend, organize, engage and remember must be considered when selecting resources to be used for instruction or for use by students (Lieberman et al., 2008). Generating barriers to education, students' edition of inflexible texts usually offer few accommodations, and little or no built-in differentiation (O'Connell, 2001).

Rose (2000) and Patterson (2005) suggested that ideally materials should be varied and diverse, including digital and online resources, and not one common single text. Multiple learning modalities, such as those outlined by Gardner's Multiple Intelligences, should be considered in the selection of resources and the planning of

instruction (Curry et al., 2006). To learn, students need to relate information presented to their own experiences, make connections to prior knowledge, to construct or develop their understanding (Curry et al., 2006). The use of malleable digital materials and online resources add to the richness of the variation of resources available for education. The support provided by digital texts and other technologies allows for individualization of resources, is discrete and promotes individual responsibility for learning.

Typically, it is the teacher edition that provides for accommodations and differentiation. In a review of a small sample of texts, O'Connell (2001) found that accommodations and differentiation targeted "below level learners," gifted and talented learners, and ESL/bilingual learners. Suggestions for including students with exceptionalities were usually contained in general statements on a few pages at the front of teacher's manuals, with little or no direction for specific activities or for specific activities for any given exceptionality. Resources that were provided often did not match the populations described in the general suggestions. Research-based resources found to be useful in educating students with exceptionalities were sometimes included in student or teacher texts, but were not identified as such. Support for students with exceptionalities were primarily limited to suggestions to modify or adapt assignments, provision of additional activities at a simpler level, or provision of audiocassettes, leveled libraries, blackline masters, CDs or videos. Most activities that were directed at students with exceptionalities assumed that students could not complete activities at the high, gifted, or challenge level. The lack of activities throughout a text for students with exceptionalities further complicates planning and instruction. O'Connell (2001) concluded that digital textbooks, rather than printed texts, that allow for differentiated

curriculum delivery is the way ahead. Students could choose to manipulate the information in a way that made it accessible to them.

Pisha and Stahl (2005) also recognize that the appropriateness of core instructional textbooks to meet the needs of students with exceptionalities needs to be addressed. Equal learning opportunities require that access to content requires that texts and other resources used in schools be accessible (Pisha & Stahl, 2005). The opportunity to learn is dependant on the selection of curriculum-based resources that meet the needs of all students. Print disabilities include students with visual impairments, learning disabilities, sensory or motor disabilities, cognitive disabilities, attentional and organizational difficulties (Pisha & Stahl, 2005). The requirement for standards-based achievements for all students is impacted by the inherent barriers of instructional materials. Teachers need to adapt materials for instruction, as well as for accessibility (Pisha & Stahl, 2005). "Consuming teacher time, … [or that of others], with the process of retrofitting (or re-creating) curriculum materials detracts from preparation, planning, and, in the worst case, instruction" (Pisha & Stahl, 2005, p. 70).

Many supporters of UDL, such as Rose and Pisha, argue that digital text allows for access to content that is otherwise "trapped." Curry et al. (2006) discuss the potential of digital text in that it is malleable. While, the impact of digital texts on learning is not fully understood at this point in time, it appears that all supporters of UDL strongly support the use of digital materials. However, acquiring digital texts is a challenge, if in fact copies of print texts are available in digital format. Copyright laws prohibit the "universal" copying and reformatting of print texts that would allow for the wide dissemination of materials suggested by UDL. Time and costs associated with the

digitizing of printed textbooks and related instructional materials are issues that need to be addressed by publishers and purchasers of educational materials. Demand for UDL products is expected to influence publishers. However, Copy Right Laws are a federal matter and education is a provincial matter. At this point in time, publishers seem unconvinced of the human rights aspect of digitizing materials—educational or otherwise.

Starting in 2003 in Kentucky, publishers have been encouraged to digitize texts through legislation and then these texts are available to *eligible* students (Abell, 2005). Text readers were purchased by 85% of schools in Kentucky for reading and writing support for all students in general education settings, allowing students to personalize their learning environment (Abell, 2005). Simply addressing the needs of students with exceptionalities with regards to printed materials does not address the concept of universality of access to education. As a ramp into a building, universal access to content recognizes that universally designed tools may be used differently to participate in achieving the same goal or a comparable goal. The impact of the tools used for learning may change more than simply access to content, but rather change our understanding of each other and what constitutes education. The outcomes of digitized texts have yet to be realized, just as the outcomes for ramps could not have been envisioned in the late 1900's.

Literacy and Technology

The continuum of learners uses a continuum of tools to access the content prescribed by the curriculum. The use of technology to modify or enhance a printed text to make it more accessible is intended to address the perceptual, conceptual, and

comprehension needs of students (Anderson-Inman & Horney, 2007). The typology of features to be included in the development of e-texts that are suggested by The National Center for Supported eText (NCSet) include: presentational, navigational, translational, explanatory, illustrative, summarizing, enrichment, instructional, notational, collaborative, and evaluational features (Anderson-Inman & Horney, 2007). By adding these features to texts it is expected that the reading process and comprehension will be supported, making content more accessible to more students. The impact of e-text on learning, and which additional features best meet the needs of learners, is not yet well understood.

There is some research which supports the addition of both static and dynamic (interactive) graphics as it appears to promote engagement and that increased engagement may improve the learning of content (Anderson-Inman & Horney, 2007). However, the use of graphics needs to address concepts, principles, and processes outlined in the curriculum in order to be most effective. Cognitive overload should also be considered in the use or overuse of graphics (Anderson-Inman & Horney, 2007).

While text-to-speech software has transformed education for students with vision impairments, research on the impact of this technology on other students is inconclusive at this point in time. The issue of how technology compensates for cognitive impairments is of the utmost importance for Edyburn (2007). The impact of text-to-speech technologies on reading fluency, vocabulary development, reading comprehension, or learning academic content, as well as developing decoding skills, requires further research. Matching knowledge of exceptionalities with technologies effects both skill development and accessibility to content. These issues are further compounded when

access to this technology is expanded to include ESL students, and students with different ethnic, racial and socio-economic backgrounds. The impact of technologies on fostering interest, motivation, engagement, as well as skill development is not well understood (Edyburn, 2007). Depending on students to select or make consistent use of technologies that enhances their learning, assumes that students have developed self-advocacy skills, sufficient meta-cognitive skills or that they are sufficiently motivated to do so (Anderson-Inman & Horney, 2007). The intended purpose of a specific technology, a particular students' use of that technology, and the impact of that particular technology on a particular text may be context specific. Furthermore, Edyburn (2007) posits that the benefits of the use of technology for readers at all levels are not at all understood. It is clear that research lags practice when it comes to the increasing use of IT in classrooms (Anderson-Inman & Horney, 2007).

Edyburn (2007) further argues that there is a need to shift thinking from performance indicating the need for remediation (e.g. more instruction) to performance indicating the need for compensation (e.g. AT). Compensation may address the barriers to learning in the system (e.g. classroom, textbook), as a result of cognitive impairments, or a combination of a number of factors. The fact that some students are not performing as well as their peers suggest that the way forward is not to make a u-turn and repeat, but to do it differently. The decision to move towards compensation suggests that each individual student's ability to think and contribute to the class is valued.

Media, Technology, and Other Resources

Computer labs and other technology are or have been available in schools for quite some time. The presence of technology does not guarantee that it will be used or

how it will be used by students and teachers. As Patterson says, a worksheet is a worksheet whether it is on a computer or on a desk. Citing Kajder, Patterson (2005) argues that teachers have not been trained on the use of computers to meet curricula objectives or how to integrate technology into instruction. Mulholland (2006) surveyed teacher candidates regarding the availability and use of technology in the classrooms in schools in which they were practice teaching. Her findings support Kajdar and suggest that many teachers (special education and classroom teachers) require training. However, research indicates that with increased opportunities to practice and use technology, teachers are more likely to use it in their classrooms (Michaels & McDermott, 2003). "The human infrastructure" needs to be developed (Patterson, 2005) through training, as well as time for preparation and planning.

A proposed short-cut to training and planning is a technological toolkit. Parette et al. (2005) and Judge at al. (2008) describe technological toolkits that provide teachers and students with resources that promote participation of all students and allow for the seamless integration of technology in the classroom. Included in the toolkits are low-tech solutions, as well as high tech solutions. Focusing on improving the quality of inclusion, Judge et al. (2008) describe tools according to the following categories: movement and sensory tools (e.g. positioning devices for sitting), communication tools (e.g. picture communication symbols), and learning tools (e.g. switches, adaptive keyboards). The list proposed by Parette et al. (2005) includes: pencil grips, raised line paper, portable word processors, talking word processors, talking spell checkers, word prediction software, computer based organizational tools (e.g. SMART Ideas), speech recognition software, line guide for reading (e.g. bookmark), audible text, text-to-speech software, symbol-

supported text, electronic math worksheets, electronic measuring tools, calculators, colour coded folders and binders, electronic organizational tools, agendas, and so on. Up and coming technologies recommended included by Parette at al. (2005): blogs, wickis, and web-collaborators. It is clear that Parette et al. (2005) argue that the technologies that are part of the culture of the students be used not only to assist students in functioning in school, but in making school relevant to their lives. As such, technology should be used to instruct, as well as to demonstrate understanding of content (Patterson, 2005). Implicit in the concept of the toolkit is teachers' knowledge of and acceptance of the use of technologies in the classroom. Further, there is an assumption that the technology will be both available and effective in meeting the needs of students.

Potential of Technology

Blackhurst (2005) suggests that we need to develop a better understanding of the application and impact of technologies on learning and education, especially for students with LD. Interestingly, teaching is defined as a technology that uses "instructional approaches that are systematically designed and applied in very precise ways" (Blackhurst, 2005, p. 175). Technology is described according to the function it performs for the user: instructional technology (e.g. videos, the World Wide Web), assistive technology (e.g. mechanical, electronic, non-mechanical, and non-electronic aids, materials, services, and strategies), medical technology (e.g. respirator, tube feeding), technology productivity (e.g. computer hardware and software, and related systems), and information technologies (e.g. internet provides access to information and resources). In the context of the history of the use of technology, Blackhurst (2005) argues that the 'state of the art' of technology needs to be weighed against the 'state of the science' of

technology. That is to say, that the selection and use of technology needs to be determined according to the effectiveness in the classroom and for each individual learner. Technology, in this light, may in fact be the *education* that is required at this time in history. It is through technology that we are learning information, learning about effective teaching practices and learning (about ourselves as humans), and learning about technology.

Content media not only represent the information that is communicated to learners, as Curry et al. (2006) state, but are the method or tool of communication from the teacher to the students and from the students to the teacher. Using a single class as a model, Curry (2003) argued that technology allows individual students to work independently on products that match their abilities. This assumes that the issues that impact learning using paper, pencil, and printed text are minimized or eliminated through the use of technology. While Abell (2005) found that software (i.e. e-Text Reader) is persistently most often used by teachers and students for literacy, he also found that over time it comes to be increasingly used across all subject areas. Nevertheless, teachers report that they do not have enough computers, have limited access to computer labs, software does not run on some computers, there is insufficient time to scan materials, student reading levels or IT skills impact student use, and that the quality of class discussions is diminished (Abell, 2005). Use of shared network folders to disseminate information, students without exceptionalities benefit from IT use, and bridging the *gap* between knowledge and skills are included in the list of benefits reported by teachers as positive outcomes of using IT (Abell, 2005). Furthermore, Curry et al. (2006) argue that websites need to be accessible—easy to read, use simple and clear language, have

intuitive navigation, as well as being well laid out. The likelihood that technology will be used in the classroom is enhanced when the teacher is comfortable with the technology and it can be used confidently (e.g. troubleshooting is relatively easy). Issues of accessibility and usability are of paramount importance when selecting media and technology for use in the classroom.

Braddock, Rizzolo, Thompson, and Bell (2004) argued that while emerging technologies may potentially alter the lives of many persons, especially those with cognitive disabilities (e.g. intellectual disabilities, traumatic brain injuries, dementia), there are several barriers to the continued development and implementation of those technologies. These barriers included consumer abandonment, design and development of devices, financial support for development and implementation, effective needs analysis across groups of individuals that might benefit from IT, and so on. Technologies are grouped according to emerging technologies: personal support technology (e.g. PDAs – personal digital assistants, computer assisted learning and communication, universally designed products), assisted care systems technology (e.g. smart houses and transportation/tracking, personal robots), and virtual technology (e.g. virtual reality simulations). Braddock et al. (2004) pointed out that technologies will increasingly be needed to operate seamlessly across the real world environments of home, school, work, and community. Today, some of these technologies are already in place (e.g. Blackberry), but that does not necessarily increase accessibility—unless accessibility is to come to be defined as similar to inclusion, being a place.

Assessing the effectiveness of technology must be weighed against the effectiveness of the resources already available. Wehmeyer (2006) focused on the

instructional and non-technology based resources that also promote access to curriculum. He was primarily interested in developing UDL strategies to meet the needs of students with mild mental retardation (MMR). His suggestions include the use of advance organizers, graphic organizers, outlines, tables, chunking, mnemonic devices (imagery and word based), student-directed learning strategies (e.g. self-evaluation), differentiation, scaffolding, cooperative learning, direct instruction, and behavioural interventions. Supported by his own research, Wehmeyer (2006) found that students, with MMR in self-contained classrooms, were far less likely (50% as opposed to 90%) to be engaged in activities related to the curriculum and were much more likely to be working at a lower level work than their peers in a general education classroom. He argues that students gain access to the curriculum and are more likely to participate in standards-based education by attending general education classrooms. Access needs to incorporate exposure to curricula based instruction, as well as the means of instruction—technology.

The understanding of the potential of learning through the use of technologies, such as video, appears to be growing rapidly. For example, programs on television address cooking, exercise, home décor and renovation, and a myriad of others subjects. Closed captioning of video improves accessibility for many learners, including ESL students and those with hearing impairments (Curry et al., 2006). The potential to use current technologies (e.g. MP3 players) for educational purposes appears to be a good idea. It is the need to develop these technologies with pedagogy, cognition, and epistemology in mind that is beginning to be understood. The effectiveness of the use of commonly used technologies for education that were developed for purposes other than education needs to be evaluated in light of the current research. Future research must

focus on developing a better understanding of the impacts of technology on pedagogy, cognition, and epistemology, such that technology will be developed with that knowledge in mind.

The Tool of UDL

The "over arching tool" of UDL is technology (Curry, 2003). Technological resources are considered to be universally designed when they allow for multiple representation of information, allow students multiple ways of expression, and create opportunities for multiple means of engagement for students (Wehmeyer, 2006). According to Curry (2003), technology allows for physical access, facilitates the social construction of knowledge, and offers multiple means of assessing learning. IT is physically accessible, or easily adapted through AT (Curry, 2003). Software, programs, and the Internet can provide collaborative and interactive learning opportunities. According to Curry (2003, p. 58), "… educators [need] to select technologies that not only support best teaching practices but also allow the greatest number of learners to participate in the same curriculum."

The physical design of technologies is advancing all the time. AT is best designed to meet a variety of physical needs to access technology. Switches, voice activation, touch screens, enlarged keyboards, and so on, all make technology user friendly. Interactive boards, such as the SMART Board, allow students to manipulate information directly. Students who are able to use language and working memory to manipulate information may be introduced to more advanced ideas and concepts, whereas students who challenged by such manipulation (i.e. physical or cognitive) may now have a tool to

facilitate these sorts of academic activities, thereby making the big ideas in curricula accessible.

Accessible software allows the learner to control and learn from the product. The layout and organization of the interface, keyboard access, and intuitive functionality must all be considered in the development of "UDL" software. Visual mapping software, such as SMART Ideas, integrates organizing, brain storming, comparing, classifying, outlining, summarizing, and other instructional strategies. Presentation software, such as Notebook, allows teachers to consider the needs of students when preparing for instruction, as well as the potential to integrate video and websites into instruction. Teachers model the use of the software during instruction so that students are able to use the technology in preparing their own presentations, as well as to complete assignments (e.g. Web-quests). Students authentically use technology to learn and to communicate that learning has occurred.

Discussion

Universal design is an evolutionary step in education. Founded on research, UDL is influenced by, and shapes research questions. The many fields that influence UDL and its development, as a concept and in real terms, are developing in their own right. As such, the definition of UDL is somewhat dubious and subject to change, as well as interpretation.

As a process of making curriculum more accessible to more learners, UDL fundamentally changes what it means to be a teacher or a student. In fact, as UDL is founded on the principles of research or inquiry, the teacher is at once a facilitator and a

researcher. Concerned with effective teaching practices, issues related to epistemology (what constitutes knowing), and the use of technologies, UDL demands that the teacher be a reflective practitioner. As a student in the education system, both teachers and students are responsible for their own learning. Both are responsible for communicating their learning, so as to contribute to their respective learning communities, and indirectly to each other's learning communities. In the process, teachers and students will change UDL, in form and content.

Similarly, advances in AT and IT serve to change society and UDL. As AT and IT influence practices in the classroom, the classroom itself will change. The reconstructed classroom impacts ***how*** we come to understand, and ***what*** we understand. Further, as AT and IT become less distinguishable from one another, the differences amongst individuals are expected to diminish as individuals come to use the same tool in different ways or for different reasons. As the ramp into the building has changed who can enter the building and how we might enter the building, we are just beginning to understand that we may all be engaged in the building quite differently, or maybe not. The potential of UDL lies in the engagement with one another.

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