Friesen, S., Clifford, P., Saar, C. & Gladstone, B. (2002). *Intelligence online.* Global Partnership Summit on Learning, Employability and Citizenship. Washington, DC, November 20-23, 2002.

Intelligence Online

Sharon Friesen, PhD. Galileo Educational Network
Pat Clifford, PhD. Galileo Educational Network
Candace Saar, Galileo Educational Network
Brenda Gladstone, Galileo Educational Network

Background

The Galileo Educational Network Association (GENA) is a charitable professional development and research organization focused on the fundamental changes to teaching, learning and staff development (K-12) that digital technologies both require and enable. Supporting teachers and administrators in schools and school districts across the province of Alberta, Canada, Galileo's mentors work in a number of different ways:

- *On site* to provide coaching and mentorship to classroom teachers and administrators that demonstrate new images of teaching, learning, student capabilities and staff development,
- *On line* through the Galileo website (www.galileo.org) and Intelligence Online (*io*) (www.myio.org) a web-based teaching and learning application for teachers
- *On target*, firmly grounded in current educational research and contributing to research with a peer-reviewed publication program.

The Galileo Educational Network has developed a number of strategic alliances with private, corporate, community and government organizations in order to operate autonomously from any one school district or division, and to pursue our mandate. The majority of Galileo's funding, both cash and in-kind, comes from a variety of government, private, corporate and institutional organizations. Each school division and/or individual school funds their participation with the Galileo Educational Network differently.

Galileo/Axia Partnership

In 1999, GENA started looking for a corporate partner with high quality technology expertise to explore innovative to design and create a rich, inquiry-based professional learning community. The founding members of Galileo Network (Patricia Clifford, Sharon Friesen, and Brenda Gladstone) met with representatives from many high technology companies. A clear problem arose from the outset: most of the high technology companies wanted to build a

computer application for us to market, or wanted to sell us a pre-built application that they saw as a possible fit for our objectives. However, we resisted the learning management, project management and courseware management systems or empty shell communication vehicles. We weren't interested in putting a course on-line. We were in search of a web-based application that was far more contextual and highly personalized.

Early meetings with Axia NetMedia were qualitatively different than those with other high technology companies. A trusting relationship between our two organizations grew out of initial discussions and a growing realization that Galileo Network and Axia NetMedia shared a common vision about teaching, learning, and effective on-line environments. The two organizations shared a commitment to finding innovative ways to foster an inquiry stance in integrating digital technologies into classroom teaching, student learning and in professional development. We started working with Knowledge Engineers at Axia NetMedia on development process in May 2000. It would be another nine months before a formal partnership could be worked out between Galileo Network and Axia Netmedia and in the meantime put into place Principles of Agreement. Creating a suitable partnership agreement for a charitable organization and a for-profit corporation took time. In February 2001, a partnership was established with Axia NetMedia (www.axia.com) to create Intelligence Online (*io*).

Developing IO

In May 2000, two Knowledge Engineers from Axia NetMedia and we began the most challenging and complex part of the development process. It was through these beginning meetings, while we explored beliefs about teachers and the teaching and learning process that we gained a deep respect for the strengths that each of us brought to the partnership. At this stage in the process it was essential to focus on the needs of the learner and to begin establishing boundaries for *io*. As we were interested in designing and creating an innovative learning environment, it was important in these early keep as much of our design independent of the end authorware. Therefore, we focused first on *what* we wanted to accomplish and then, much later, on *how* we would do it. We defined the target audience, the purpose of what we would jointly build and the outcomes we expected to achieve. Everything we did in future sessions was based on our initial work together. One of the outcomes of this stage was a clear understanding of the 'big picture' and the roles of both Galileo Network and Axia NetMedia.

The established purpose of *io* was to provide teachers with the knowledge, tools and support necessary to integrate teaching, learning and technology. This, we determined, would be achieved by:

- Engaging teachers in an inquiry-based, e-learning environment
- Demonstrating how to integrate learning and technology to create e-learning environments

- Providing support in designing, implementing, assessing and sustaining e-learning environments
- Facilitating and supporting a collaborative community of learners focused on technology implementation
- Strategically integrating technology with the overall learning experience of the students

Designing and building *io* took twenty-two months. The 'big picture' and the roles that we established early in the process guided us throughout this time. In addition to the ongoing development work, three of us from Galileo and two members of the development team from Axia NetMedia met weekly. *io* was finally ready for a 'soft launch.'

Testing io

By March of 2002, the Galileo/Axia partnership was ready to test the application with 60 teacher volunteers in five Alberta school districts. In addition, seven Galileo Educational Network mentors assisted teachers to design an inquiry that they would use with their students that term, or in the next school year. The primary focus of this test experience was to

- test the assumptions on which Galileo Educational Network and Axia NetMedia created plans for providing the ongoing, personalized professional development supports to teachers both online and onsite. These assumptions rested on a proven belief that effective professional development is ultimately about students and improving student performance, must be viewed as an ongoing and integral part of teachers' professional lives and must be focused on specific outcomes that are desirable to both teachers and stakeholders.
- better understand the impact of *io* on teaching and learning.
- inform future upgrades for *io.*

We asked the teacher participants to use *io* to design and implement an inquiry-based project. We wanted to determine to what extent the experience of creating an inquiry using the *io* design process had an impact on

- Teacher thinking and learning
- Student performance
- Supporting teachers effectively through a change process

Data was collected through surveys, interviews, written reflections, on-line exchanges within *io*, itself and samples of student work.

The timing of this test phase provides an important context for evaluating the positive impact teachers report in their use of *io*. First, Alberta teachers had just emerged from a protracted job action with the provincial government, and

teacher morale across the province was demonstrated to be very low[1]. Second, teachers undertook the design work late in the school year when their energy levels are often low, and when the pressure of external evaluations is most immediate. The enthusiasm for *io* that this test phase created is particularly noteworthy, given this challenging context.

Describing *io*

io is a complex learning and planning environment that has no counterpart in applications currently available. It discards the assumptions of distance learning, where courses, lectures and materials are still delivered, essentially in one direction, from instructors to learners. It goes beyond the interactive supports for such courses now provided by bulletin boards and chat environments. As a personalized environment, *io* pushes new edges to require learners (in our case, teachers-learners) to create something new. It changes the root metaphor of course or content delivery on which so much professional development is premised. In *io*, teacher knowledge is not delivered; it grows in unpredictable ways because teacher-learners move through this e-learning space according to their own needs, intentionally connected to others. Participation in the space makes it grow for participants, over time and through their use and interaction. For each learner, the space becomes what it is because each learner uses it in the ways that make most sense to them.

When we began designing *io*, research was just emerging that course management systems (CMS) and learning management systems (LMS) did not help teachers change pedagogy. At ED-MEDIA 2002 Hedberg 2002) reported research findings that CMS and LMS actually reinforce existing transmission pedagogies and assessment by replicating traditional classroom course delivery models in on-line environments. Thus, even if the content of these systems deals explicitly with changing teaching practices, the way such content is presented to teacher-learners reinforces old paradigms of teaching and learning.

io was designed to address this problem in two ways:

- Providing expert content about teaching and learning through inquiry, emphasizing pedagogy that is responsive to students' emerging needs, interests and purposes
- Creating experiences for participants that model responsive engagement with their own emerging needs, interests and purposes as they work with the expert content.

---

[1] In a study on teaching conditions conducted by The Alberta Teachers' Association 88% of Alberta teachers reported that their quality of life had suffered in 2002. This represents an increase of 6% from the previous study completed in 1999. 85% of the teachers, in the 2002 study, reported that they would not recommend teaching as a profession, representing an increase of 12% since 1999 and 80% said that they were not sure that schools were better places. This represents an increase of 13% in teachers dissatisfaction with schools.

Because *io* 's design is unique, it was important to establish what users, themselves, might say to others when they were asked to describe *io*. This allowed us quick access to whether our design intentions actually corresponded to user experience. The descriptions below capture the essence of *io* 's purpose to

- Help teachers focus on teaching and learning by designing and implementing inquiry-based learning experiences for students;
- Improve student performance and the quality of their learning experiences through more responsive pedagogy;
- Create a supportive environment for changes in teachers' thinking and practice;
- Provide teachers with the knowledge, support and tools necessary to integrate teaching, learning and technology
- Develop teacher and student fluency with technology through a culture of use rather than through a direct focus on technology
- Create a professional learning community

Given that *io* is a technologically sophisticated and complex web-based environment, it is important to note that teachers' descriptions of the *io* environment did not emphasize the technology, itself. Immersed in designing new experiences for their students, teachers used the technology in a seamless, transparent manner in order to learn other things. It also appears that the **way** in which they used *io* is inseparable from **what** they felt the application allowed them to accomplish.

- *"I found io, the online planning model that we used, to be an extremely thorough and robust tool for planning the unit. In the course of planning an inquiry-based unit of study, it took the designer through all the steps of bounding the inquiry, focusing the understandings, identifying possible resources, and moving deeper, looking at what it is that is essential for students to come away with at the end of the inquiry. As well, the design of the unit linked the mandated outcomes with the skills and concepts the students would develop through carefully crafted activities related to developing the inquiry. All this was achieved through a rigorous process that, when completed under the mentorship of an experienced end user, was designed to ensure the development of a high quality unit that would foster critical and creative thinking skills in students, and give the designer a fuller understanding of the process and the thinking behind the achievement of this goal."*

- [*io* is] "*planning, resources, help, collaboration all-in-one"*

- *"I think the best thing about io for us was the questions. The way it was set up made the process of developing a project very smooth. We were able to think about the right things at the right time. It also allows*

you to go through all the right and important steps of planning an in depth study of any topic"

As the designers of *io*, we hoped that our work would help to energize and transform teachers. It was important to us that the experience of working in new ways, not just the exposure to new content, would make a difference to people's lives. We had not anticipated, so early in implementation, that teachers, themselves, would also describe *io* in this way. The metaphor of a journey appeared in several responses as a way of talking about the impact of *io* on their lives as teachers. One teacher was particularly adamant that *io* not be described as a "process".

- *"I know processes; I've been through processes before. io is a journey. io is a journey of thinking. It puts a sense of purpose to it. I would say to other teachers, take the journey and you will change."*

The journey metaphor points to the success of *io* to move beyond the transmission of content, or even of the creation of a new instructional design process. Participants experienced the power of a highly personalized, responsive learning environment to change how they think and live their lives as teachers.

Impact of io on Teacher Thinking and Learning

> " 'One of the enduring difficulties about technology and education,' according to Dr. Martha Stone Wiske, co-director of the Educational Technology Center at the Harvard Graduate School of Education, 'is that a lot of people think about the technology first and the education later' " (Schacter, 1999).

It is commonly thought that teaching involves the transmission of curriculum content to students. In this view teachers transmit knowledge, more or less successfully, depending on their own skills and also on their students' capacities and receptivity. On the whole, teachers in our test phase group expressed dissatisfaction with such transmission practices in the classroom. Several acknowledged their own expertise with traditional curriculum delivery, even as they knew there was something wrong. Others spoke of how in the past they had tried without success to make changes on their own, even when they had a strong sense of what they were trying to do differently.

In reality, most schools and classrooms continue to be structured in the same ways as they were a hundred years ago. A move from 19th century emphasis on curriculum delivery to inquiry-based learning "centers instruction on 'authentic tasks' that allow students to model adult professional skills and behaviors"

(Howell, 2002) and to use digital technologies effectively to design and create new knowledge. Learning how to create and implement authentic inquiries for–and with–students is a fundamental challenge for today's teachers, few of whom have actually experienced the kinds of learning environments they are now called upon to create for their students. Teachers in the *io* test phase were aware of the disconnect between what they are currently doing in their classrooms, and what they sought to do differently, and they praised *io* for helping them think differently about their classrooms.

Teacher Learning and Content Knowledge

Professional development and educational reform literature acknowledge the importance of teachers' building not only pedagogical expertise, but also content, or subject discipline knowledge (Garet et al, 2001; Lieberman & Miller, 2001; Stein, Smith, & Silver, 1999). Most often, however, this need is addressed by providing workshops and courses with a "just-in-case" orientation: learning to know "without an emphasis on how or when this information is to be used" (Howell, 2002), what one can **do** with what one knows, or the relationship between what teachers are learning as they build content knowledge and the processes they are designing for students. As Eisner (2002, p. 579) notes,

> On the whole, schools are highly answer-oriented. Teachers have the questions, and students are to have the answers. Even with a problem-solving approach, the focus of attention is on the student's ability to solve a problem that someone else has posed. Yet the most intellectually demanding tasks lie not so much in solving problems as in posing questions. The framing of what we might oxymoronically call the 'telling question' is what we ought to care much more about.

The ability to develop "telling questions" is intimately related to what teachers working in *io* came to understand as essential concepts in the discipline(s) on which their inquiry was based. The journey of learning subject content as part of the *io* design process became far more than acquiring information to transmit to students, or around which to structure activities or lessons. This journey of learning became about understanding that every subject discipline today is changing not only the knowledge base that used to be regarded as secure but also teachers' own experiences as learners. The design process made problematic an aspect of teaching that often goes unexamined: that content knowledge acquired in the past may no longer be relevant to the questions, issues and emerging understandings in all disciplines. As one teacher put it, teachers must now become inquirers of their own topics–lifelong learners.

Putting soul into teaching

The professional development literature (Lieberman and Wood, 2001) on changing teacher practice points to the difficulty of both implementing and sustaining changes that have traditionally been introduced in workshops and courses that are not intimately connected to the actual work that teachers want to

carry out in their classrooms. Much in-service, particularly in technology, is a relatively impersonal and functional exercise in learning applications and skills in the hope that the phase of implementation will fall naturally into place once teachers return to their classrooms. Such in-service almost always fails to address the teachers' intellect, imagination, heart and spirit–yet it is precisely in those domains that teachers' enthusiasm to try new things, and their commitment to persevere in the face of difficulty, are found.

It is our experience that efforts to introduce and foster change in teaching practice must energize teachers on these levels if genuine transformation rather than superficial change is to result. At the conclusion of the test phase of *io*, all participants indicated that they wanted to work with *io* again. A number of teachers were emphatic that they wanted to begin work on new projects almost at once. After reading some of the user feedback from the first test phase of *io*, the director of the project from the Axia team said, “We wanted to create an application with soul, and it looks like we have done just that”.

Four elements appear to underlie teachers' declared intention to continue using *io* to design inquiries next year:

1. the satisfaction of a creative process whose questions prompt participants to look at teaching and learning in new ways
2. student engagement and enthusiasm when teachers introduced new ways of learning in the classroom
3. teachers' developing a responsive pedagogy through intense and highly personalized preparation
4. collegial support

Creative process

A number of teachers commented on the way in which *io* required them to focus on what was really important about the topic they were planning to introduce to their students. A high school teacher who we thought had "disappeared" for about three weeks noted that the fundamental question, "Why should kids love poetry" and what she called "the overwhelming support" she got from colleagues in the Community Section of *io* forced her to radically rethink what she had always done with her students. She said, *"They need to see more connections between what we do in school and their lives",* and was surprised at how difficult it was, in fact, for her to say why her students should fall in love with the ideas she wanted them to work with. She spent several weeks mulling the question and possible answers over in her mind, and realized that for too long she had been focusing on what she called *the trivial parts* of teaching poetry. She was one of the teachers who did not finish designing her inquiry, but the process of really engaging deeply with her fundamental purposes was exciting as she thought about planning for next year. She stated:

- *"I really love io, I love how it forces you to decide what you want to focus on, and to really nail it down, it really forces you to do that. You have to keep repeating it. I am going to change what I was going to do now."*

Others also identified the sense of "circling back" through engaging questions as an important part of the application. Another commented on how much she loved designing through essential questions, one component of the design process identified as crucial in creating inquiries for students. This participant was able to articulate the way in which *io* brought to life the same learning for teachers as it emphasized for students: deep engagement with questions and issues that really matter to the learner, that make them love their topic and love what they plan to do with it.

- *"Having observed both teachers and students work through the planning and design process as well as the actually implementation of inquiry-based units, I feel that it's important to note that people who want to plan this way, who want to implement inquiry-based learning as a way to go deeper, to develop those critical and creative thinking skills in their students and themselves, must first have a firm foundation as to what is important in the design process. It's not about the activities, it's not about the technology, it's about the learning, about the deeper understandings that are at the heart of the inquiry. It's about education as opposed to schooling, learning as opposed to training."*

Student engagement and enthusiasm

When teachers were able to complete the entire design process and introduce inquiry-based teaching and learning within the test phase time parameters, they reported that student enthusiasm and engagement provided a strong motivation for them to persevere, especially in the face of the inevitable difficulties that learning to teach in new ways present. This new way of planning became important to teachers' sense of pride and meaning in their work. Feelings like these are an integral part of the personal transformation that so many teachers report from their experience of using the *io* process:

- *"I was shown astounding examples of student work that captured my interest and re-ignited my fire for teaching. '*
- *"I feel quite overwhelmed by what the students and I have learned from participating in this project. I'm amazed to see their attention to detail, as well as the growth in their ability to question and interpret information. The telecollaborative aspect allowed the students both an occasion to share their learning with a real audience and the opportunity to broaden their understanding by making comparisons and drawing conclusions. We still have many questions and things that we wonder about the Stoney people and their culture but when we walk on the hills overlooking [name of town], we have a heightened awareness of our land and feel a strong connectedness to its heritage."*

Developing responsive pedagogy

Teachers noted a fundamental shift in how *io* helped them think about daily planning. Prior to using *io*, they had thought about preparation in terms of creating lesson plans and material that they would deliver, or to which students could respond. When they designed an inquiry using *io*, they felt far more secure about maintaining a clear focus on fundamental concepts while becoming increasingly confident about what one of them described as "improvisation", and what we have characterized as responsive pedagogy. They felt that no matter what difficulties or insights students might have as they conducted their inquiry, as teachers they would be prepared to respond attentively and effectively.

For such teachers, these changing paths were a source of satisfaction, not frustration. Teachers saw this as quite different from preparing interesting activities and lessons to which students either would (or would not) respond. As one said, "*Every single day I now ask myself, 'What do I want my kids to understand?" Not what will I deliver today".* In this mindset, teachers saw themselves as far more strongly oriented to using whatever students said or did as grist for the learning mill, either to uncover misunderstandings, to build further understanding, or to direct even more fruitful and interesting routes of inquiry than the teachers, themselves, had imagined. Several teachers and students reported that students thought more about their thinking, and that their classrooms became livelier places for everyone. Their observations accord with what Eisner (2002, p. 582) describes as essential to educational transformation:

> The kind of schools we need would encourage deep conversations in classrooms. They would help students learn how to participate in that complex and subtle art, an art that requires learning how to listen as well as how to speak…How do we help students learn to become listeners? How do we enable them to understand that comments and questions need to flow from what preceded and not simply express whatever happens to be on one's mind at the time? How do we enable students to become more like the members of a jazz quartet, whose interplay good conversation sometimes seems to emulate? …
>
> Of course, all of us need to learn to engage in deep conversation. In many ways, we need to model what we expect our students to learn. But I am convinced that conversation about ideas that matter to students and teachers and that occupy a central place in our curriculum can be a powerful means of converting the academic institutions we call schools into intellectual institutions. Such a transformation would represent a paradigmatic shift in the culture of schooling.

As many participants noted, they became "hooked" on the energy generated by lively conversation and meaningful inquiry. Once they had experienced such student enthusiasm and engagement, they stated that they would not go back to their old ways of teaching.

Collegial support

During the test phase, we wanted to explore the relationship between face-to-face and on-line support for teachers as they designed an inquiry. Teachers had access to Community Discussions, where all participants could talk to one another. They could create Private Discussions with colleagues whom they invited to share their planning. Some participants met monthly in face-to-face groups to plan, share and reflect on their work, and all had some degree of individual access to a mentor, both on line and face-to-face.

> This networking approach to professional development, involving teachers as primary actors in their own development, is becoming increasingly significant. Unlike professional development strategies that have a 'one size fits all' orientation, educational reform networks provide opportunities for teachers to commit themselves, in small and large ways, to topics that are of intrinsic interest to them and that arise naturally out of their work… Participating in learning communities built around shared understandings, where peers learn to give and receive critical support, helps teachers to enrich their classroom practices while providing the intellectual and emotional support necessary for personal and enduring growth. (Lieberman and Wood, 2001, p. 175).

io participants valued the opportunity to work with colleagues in both face-to-face and on-line environments. Some teachers most valued the opportunity to share with others who taught the same discipline, while others actually built collaborative projects together.

As teachers gained confidence in themselves and trust in their colleagues they started to share their inquiries with their mentors and their colleagues through the sharing features of *io*. Teachers who used these sharing features of *io*, even with initial trepidation, said it helped them build an even stronger sense of preparedness.

- *" io builds a sense of awareness because you must share….The way to watch and listen to other teachers is the same way that you watch and listen to the children. I am prepared."*

Teachers in *io* were very clear that they valued the presence of mentors in their teaching lives. What they discovered, however, was that using *io* made the face-to-face support previously available more focused and increasingly "in time". Teachers became very specific about the places in which they needed help, and were able to schedule face-to-face time more effectively. As one teacher noted, "*Questions to the mentor are much more focused."* This teacher described the specific places in which she needed her mentor to be in the school, particularly for "*the technology parts."*

As another said, " *io makes face 2 face time really efficient: 'great you are here, I need help with this rubric'."* Teachers were placed strongly in the drivers' seat. They were able to work through *io* whenever they wanted, could clarify their own thinking, and put plans in place on their own, and with support from other

teachers in their Private Discussions. When they hit roadblocks, they had a better sense within the larger context of the design process of precisely the kind of help they needed, and when they needed it. Instead of waiting for mentors to show them the next steps, or postponing decision-making until the scheduled day for a mentor visit, they, themselves, were now increasingly able to set these directions.

The Sharing feature became very important to mentors. Two of them required that the teachers with whom they worked share projects as they developed. They described how *"recognizing where people are at is so very important and also so delicate."* One spoke of how difficult it could be in face-to-face situations when teachers had no idea of why the topic they were about to develop should actually matter to students. This mentor noted that *io* gives you *"a window into how teachers are thinking and where they are at with their ideas…. I learned how to see or hear something really positive in what they had given me and then I was able to build on that. I could help in the place where they were at."* Noting that she had not been as effective before in her face-to-face work, the mentor quipped, *" io is smarter than IM or WeR. No matter how great a day we were having, we were never as smart as io ".*

We were surprised by what some mentors described as the increasingly personal tone their face-to-face work took as they introduced *io* into their repertoire. Our own surprise was an index of the pervasiveness of society's assumption that on-line environments are, of necessity, less intimate than face-to face-ones. As teenagers' experience with merging chat environments and their "real" social lives demonstrate, however, there is something more complex at play. One mentor noted,

- *The tone in io is so personal, I found that I needed to develop a mentoring tone that was just as personal as io. I needed to learn to mirror the io tone. I think that I am doing that now.*

A teacher who had had some experience of working face-to-face with one of the *io* designers, said that working in the site was like having that person speak softly into her ear. *"I can hear your voice talking to me,"* she said. "*It's just like having you there."* Another participant spoke about how, after her initial experience with *io*, she went back and read everything on the site, seeking first to understand the ideas and then "*to take them into my heart.*

Not all teachers in the test phase actually drew upon face-to-face mentoring. For these teachers, *io* itself offered enough guidance to permit them to create engaging projects. Although these teachers could have availed themselves of face-to-face support, they did not need it in order to be successful.

Student Performance

> "Teachers estimate their effectiveness in reaching the aims they set by attending to their students' performances… Performances of understanding are therefore teaching's medium—in the same way that sports plays are coaching's medium, and drafting is writing's medium (McDonald, 2001, p.211).

In assessing professional development initiatives, teachers' experiences and satisfaction are obvious measures of effectiveness. Traditionally, in fact, these have been the primary (and sometimes even the sole) means of determining whether a particular approach to teacher development works. A number of recent studies (Andrews & Rothman, 2002; Clifford & Friesen, 2001a; Garet, et.al., 2001; Hiebert, 1999; Jacobsen, 2002, 2001a, 2001b; Lieberman & Wood, 2001; Meltzer & Sherman, 1997; NorthWest Regional Laboratory, 1997) have indicated that effective professional development shares certain features. The first of these is that high quality professional development programs have an explicit goal of improving student learning.

In one sense, this finding should not be surprising, nor should it seem to present particular challenges. Schools are supposed to be about making students better learners. However, getting at whether professional development experiences that teachers **like** actually impacts what their students **learn** is not as straightforward an enterprise as it might at first seem. Based on three years of face-to-face mentoring within the context of teachers' classrooms, the Galileo Educational Network has documented examples of what student learning can look like in inquiry-based classrooms (Jacobsen, 2002; 2001a; 2001b). Given the short time frame of the *io* test phase, there are few available examples of the actual work that students produced as a result of conducting inquiries designed in *io*. What we do have are statements from some teachers, parents and students about the ways in which changed student experiences in classrooms resulted in deeper, more engaged and increasingly creative learning, even in a short space of time. These statements point in a preliminary way to the directions that further research must take.

For the moment, however, we can say with some confidence that when teachers plan using *io*, they structure different learning experiences for students, and the results are often unexpectedly pleasing. Teachers spoke about being *"amazed"* and "*overwhelmed"* at what even very young children accomplished; about the *"unique"* quality of work and effort; about both the *"depth and breadth"* of student work; about how young learners mastered process skills of "*problem solving, communication, decision making and project management"* in ways that teachers would normally expect only of much older students; a about how students *exceeded expectations, learning more than I could actually 'teach' them;* and how students learned to *"search for answers outside what is conventional."* A student put it this way: "*Now I have to think. Before, I could get high marks without doing*

homework or really ever thinking. Now it's not like that. I really have to think about things."

Both teacher and student comments from the test phase indicate that teachers are more likely to structure tasks for students that require effective team or group work than the individual seat work of traditional classrooms. Sometimes these teams were classroom based. In other cases, students shared their work with peers in other schools. Two groups undertook a telecollaborative project that required students to actually work in teams at a distance to complete all or part of a task. One was a group of teachers who began their planning with a paper version of *io* earlier in the year, and completed their work together on-line. One of these teachers sees that the end of this year's work may well simply be the jumping off point for even more extensive collaboration next year: "*as a group we are intent on continuing to expand this web site, hopefully bringing other schools into our study".* The other, a group of two teachers who taught in different towns and with different subjects, planned an inquiry together that required students from their schools to exchange data and complete the task together. Both of these teachers faced resistance to their work from colleagues in their own schools. They came to talk about one another as their real partners, even though most of their work was done at a distance, and they came to depend on that collegial support to keep going when things got difficult in their face-to-face encounters with their staffs as they introduced new ways of working into their schools.

One of the possibilities inherent in inquiry-based learning is that student work becomes increasingly real. Too often, student work reaches only the ears and eyes of their teacher, and perhaps other classmates. Some teachers in *io* discovered the power of encouraging students to take a stand on actual public issues, bringing their own perspectives in the expectat n that others will listen and learn from the work they have done.

As we examine the *io* test phase data provided by those teachers who were able to complete inquiry projects with their students, themes about the changing nature of student performance begin to take shape. This data points to our own experience in other contexts and echoes research literature that students involved in well-planned inquiries

1. become more deeply engaged and enthusiastic about learning
2. cultivate stronger habits of mind through inquiry. They
    - develop an appreciation for the importance of multiple perspectives on complex problems
    - become increasingly independent and self-directed
    - become critically aware of their own strengths and weaknesses as a learner
3. learn to function effectively in teams in both face to face and on-line environments

4. engage in tasks and activities that are increasingly oriented to the real world, and to adult capabilities, skills and roles.

Teachers and technology: Using the *io* Space

As we assessed the extent to which *io* moved teachers beyond familiar ways of thinking, we were struck by this passage from de Castell, Jensen, & Bryson (2002)

> Like an endlessly rehearsed mantra, we hear that what is essential for the implementation and integration of technology in the classroom is that teachers should become 'comfortable' using it.
>
> We might well stop a moment and consider the absurdity of such a demand. We have developed a powerful means for reshaping human knowledge, communications, educational structures and relations, epistemic concepts and practices. We have incalculably increased the amount and kind of information available to ordinary people worldwide. We have a master code capable of utilizing in one platform what have for the entire history of our species thus far been irreducibly different kinds of things - writing and speech, images and sound. Every conceivable form of information can now be combined with every other kind to create a different form of communication. And what we seek is comfort and familiarity?

In conventional professional development practice, it is assumed that teachers will become comfortable with digital technologies by learning to master them before introducing them into their classrooms. Workshops and training are often directed specifically at creating a sense of familiarity by teaching teachers how to use the technology. Sessions are offered in such things as word processing; spreadsheets and data bases; taking pictures with a digital camera; Power Point presentations; searching the web, etc. It is assumed that teachers will then be able to figure out what to do with this plethora of tools when they sit down to plan.

However, starting with technology in this way can actually create the sense of panic this approach is designed to alleviate. How, one participant wanted to know, can possibly outrun the changes in technology if you feel you have to somehow "master" it before you introduce digital technologies to students? And the answer, of course, is that no one can outrun the technology. Just as we "master" one application or device, it is upgraded, sometimes beyond recognition, or replaced by something almost completely new.

Data from this test phase supports our earlier research findings (Clifford & Friesen 2001a, 2001b; Jacobsen 2002, 2001a,2001b) about teacher planning in a face-to-face environment. When teachers use an inquiry approach to planning and teaching, they begin by coming to terms with an inquiry topic that is actually

engaging and worth doing in the first place. We were struck by how often participants in *io* spoke either about how hard this was for them to do, or how unusual it was for them to focus directly on engaging students in something worthwhile:

We do not think it is possible to overstate the importance of teachers' surprise at what happened when they were asked to make their first decisions, ones about the value of the inquiry they were about to create. It speaks volumes to the pervasiveness of the traditional paradigm of content delivery, in which curriculum topics are accepted as unproblematically "given", and planning becomes largely a matter of how to implement them. Even activity-based, hands-on approaches to teaching can suffer in this way. Neat, or interesting, or fun activities can become the focus of attention, and questions about what matters about the topic remain unaddressed. Two teachers, one who taught in a primary classroom and one, in high school also compared what they did in *io* with what they used to consider "project work". Both spoke about how they used to do what now seem to them to be "little projects", and they indicated that inquiry-based learning is quite different from other approaches they had used, even when though the language might make it sound the same:

Test phase participants found different ways of saying the same thing about their planning in *io*: "*It's not about the activities, it's not about the technology, it's about the learning, about the deeper understandings that are at the heart of the inquiry."* Teachers found the *io* **process** quite straightforward and easy to use. What they acknowledged as difficult was coming to grips in their own thinking with fundamental issues about their topics. But even as they said that it was hard to do this apparently straightforward thing, that is, to think about why their topic should matter to students, they did not ask that we change the process to put something easier, more comfortable or more familiar at its heart. They acknowledged how important it was for them to make this shift in their own thinking.

As the passage from de Castell, Jensen, & Bryson (2002) quoted at the beginning of this section notes, digital technologies have given teachers powerful means for reshaping human knowledge, communications, educational structures and relations, epistemic concepts and practices. In what seems the blink of an eye, even very young children are able to do what has been impossible for humans until very recently: combining every conceivable form of information with every other kind to create a different form of communication. Technology is making it possible for experts in every subject discipline to make fundamental discoveries that are forever shaping what we know and how we see our world.

It is not surprising, then, that if making teachers comfortable and familiar with technology means leaving old structures of knowledge intact while adding new delivery systems on top of essentially teacher-centric lessons, classrooms and labs equipped with computers end up still looking pretty much the way they

always have, which is an emerging complaint in the research literature. Critics who complain about the expense of providing high power computers that end up being used mainly for students to type good drafts of research reports, or find on-line information to answer pre-set teacher questions are supported by research literature about the relatively restricted use teachers make of computers in their classrooms when their primary orientation to instruction is content delivery (Becker, 2000).

Our test phase suggests that one of Becker's major findings is correct: when teachers approach their classroom in a more inquiry based (or constructivist) way, they are more likely to use a wider range of technologies in increasingly interesting and effective ways. We have noted both how difficult and energizing teachers found it to focus their planning on the construction of more engaging and meaningful learning environments for students. Despite its challenges, however, this way of working is the most promising approach to technology if the presence of computers in schools and classrooms is actually going to make a difference to students (Grégoire, R. & Laferrière, 2001). Another of Becker's findings is pertinent. Teachers with a constructivist orientation are also more likely to use technology in their classroom if they use it for their own professional purposes. Citing teachers' comfort levels with using word processing, spreadsheets (mainly for record keeping, and internet searches), Becker points to teachers' comfort and familiarity with technology in a way that is consistent with the design of *io*.

We constructed *io* to give teachers the experience of working in high-end, web-based technological environment in order to accomplish professional purposes that were important to them–planning inquiry projects. Our intention was to make this application so easy to use that teachers would focus most intently on the design of their inquiries, not on how to navigate through *io* and use its features.

Teachers often spoke of *io* as *"easy"* and *"user friendly".* They liked the ability to go back and make changes whenever they wanted. As one said,

- *As I was in the planning stages, I was able to get the basics down for the project and then more ideas would pop into my head on things to add or change. The project was constantly changing and improving*

Another noted that "*the planning is so perfect for my style of planning. I want to try all sorts of ideas out…".* Teachers remained focused exactly where they needed to be–on trying things out, and on the creation of engaging inquiries for students–not on how to use *io*. Even those participants who had never worked in an on-line environment before found *io* so easy to use that they went almost immediately to talking about their projects when they were asked to comment on their experience using *io*. Teacher comfort in the environment had been a major focus in the design of the application. At every stage we wanted its use to be intuitive and simple. We wanted any difficulties teachers encountered to be ones that had to do with how intense their thinking about inquiry-based learning

needed to be. In this sense, we set out to create in *io* the kinds of experiences we wanted teachers to create for their students: ones in which the technology permitted new kinds of thinking and communication. With Becker, we assumed that including this kind of professional experience with technology in teachers' experience would create a very different kind of comfort and familiarity with new ideas and new ways of teaching and learning. Test phase responses indicate that we were correct in this assumption.

Launching io

In September, 2002 *io* was officially launched. There are a number of different ways in which teachers are accessing *io*. In some cases individual teachers are purchasing their own annual license for *io*. In some cases school jurisdictions are purchasing annual licenses for a pilot group of their teachers. In other cases schools are using their funds to purchase licenses for teachers in the school. In some school districts Galileo Educational Network is working with school district leaders to develop and implement a district-wide plan to make the inquiry process and support available district-wide over the next couple of years. Galileo Network provides some onsite mentorship, face-to-face symposia and graduate courses in addition to the online mentorship. The major role of Galileo Network in these districts is to help build the capacity of district personnel in the inquiry teaching process and to help build collegial support networks for teachers and district leaders all of which is measured by the impact on student performance. In each place the basic tenant of Galileo Network to work with the willing and rigorously study the results continues. *io* was launched simultaneously in two Canadian provinces and one American state and the impact will be carefully measured and studied before expanding to large numbers of users.

Conclusion

Designing, creating, testing and launching *io* has been an exciting journey. What began as an initial search for a partner has developed into a profoundly respectful professional and personal relationship and the launch of a successful and innovative web-based learning support system for teachers. The Galileo/Axia Development Team created a style of working in which sound ideas about teaching, learning and professional development could grow. As educators, we were intrigued, and ultimately extremely impressed, with the Knowledge Engineering process that Axia used to help us articulate what we had learned about working effectively with teachers in a face-to-face environment. We had access to tremendous computing expertise for the design and programming of the application that grew out of this Knowledge Engineering process. Intently focused for almost 8 months on what the *right* things were to do in supporting teachers as they learned how to use technology effectively in

classrooms, we relied on Axia to translate what was right in face to face to what was possible in an on line environment.

The Galileo Network contributed content expertise about inquiry based learning and the effective infusion of digital technologies in classrooms. We also led ongoing work by accomplished researchers who knew how to study newly enabled classroom environments while they were being created. The result is a deliberately planned, highly robust personalized teaching and learning environment for teachers—Intelligence Online.

Andrews, K. & Rothman, M. (2002). Cultivating innovation: How a charter/district network is turning professional development into professional practice. *Phi Delta Kappan*, *83*(7), 506-512. Available online: http://www.pdkintl.org/kappan/k0203and.htm.

Becker, H. (2000). Findings from the Teaching, Learning, and Computing Survey: Is Larry Cuban Right? *Education Policy Analysis Archives*, *8*(51). Available: http://epaa.asu.edu/epaa/v8n51/

Clifford, P. & Friesen, S. (2001a). Bringing Learning to Learners: The Galileo Educational Network. Proceedings from *ED-MEDIA 2001: World Conference on Educational Multimedia, Hypermedia and Telecommunications*. Tampere, Finland.

Clifford, P. & Friesen, S. (2001b). The Stewardship of the intellect: Classroom life, educational innovation and technology. In *Issues in the Integration of Technology into Teaching, Learning, and School Culture(s)*. B. Barrell (Ed.). Detselig Enterprises Ltd.

Cochran-Smith, M. & Lytle, S.L. (2001). Beyond certainty: Taking an inquiry stance on practice. In Lieberman, A. & Miller, L. (Eds.), *Teachers caught in the action* (pp. 45-58). New York: Teachers College Press.

de Castell, S., Jensen, M., & Bryson, J. (2002). Object lessons: Towards an educational theory of technology. *First Monday*, *7*(1). Available online: http://firstmonday.org/issues/issue7_1/castell/index.html

Eisner, E. (2002). The kind of schools we need. *Phi Delta Kappan, 83*(8), 576-583.

Garret, M., Porter, A., Desimone, L., Birman, B., & Kwang Suk Yoon. (2001). What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal*, *38*(4), 915-945.

Grégoire, R. & Laferrière. (2001). Canada's Schoolnet: Project-based collaborative learning with networked computers. Teachers' Guide. Available online: http://www.tact.fse.ulaval.ca/ang/html/projectg.html#anchor1501309

Hedberg, J. (2002). Designing high quality learning environments: Reflections on some successes and failures. Proceedings from *ED-MEDIA 2002 World Conference of Educational Multimedia, Hypermedia & Telecommunications*, Denver, CO.

Hiebert, J. (1999). Relationships between research and the NCTM standards. *Journal for Research in Mathematics Education, 30*(1), 3-19.

Howell, K. (2002). Radically improving how we learn: Seizing the opportunity. *The Journal of the Federation of American Scientists*, *55*(3). . Available online: http://www.fas.org/faspir/2002/v55n3/learn.htm

Haughey, M. (2002). *Canadian research on information and communication Technologies: A state of the field*. Prepared for 2002 Pan Canadian Research Agenda Symposium, Information Technology and Learning. April 30-May 2, Montreal, P.Q.

Jacobsen, D. M. (2002). *Building different bridges two: A case study of transformative professional development for student learning with technology*. Paper presented at AERA 2002: Validity and Value in Educational Research, the 83rd Annual Meeting of the American Educational Research Association, New Orleans, LA: April 1 - 5.

Jacobsen, D. M. (2001a). *The Galileo Network - Case-Specific Report Executive Summary*. A Report on the Galileo Network Case Study for the Office of Learning Technologies (OLT) Evaluation Of Learning Technologies Initiatives In Continuing Professional Development (CPD). Principal Investigators: Dr. Bert Einsiedel & Dr. Stanley Varnhagen, University of Alberta. Available online: http://www.ucalgary.ca/~dmjacobs/papers/gena_olt_exec.html

Jacobsen, D. M. (2001b). *Building different bridges: Technology integration, engaged student learning, and new approaches to professional development*. Paper presented at AERA 2001: What We Know and How We Know It, the 82nd Annual Meeting of the American Educational Research Association, Seattle, WA: April 10 - 14, 2001.

Lieberman, A. & Miller, L. (Eds.). (2001). *Teachers caught in the action: Professional development that matters.* New York: Teachers College Press.

Lieberman, A. & Wood, D. (2001). In Lieberman, A. & Miller, L. (Eds.), *Teachers caught in the action: Professional development that matters.* New York: Teachers College Press.

McDonald, J.P. (2001). In Lieberman, A. & Miller, L. (Eds.), *Teachers caught in the action: Professional development that matters*. New York: Teachers College Press.

Meltzer, J. & Sherman, T.M. (1997). Ten commandments for successful technology integration and staff development, *Bulletin*, January, pp.23-32.

NorthWestern Regional Educational Laboratory (1998). High-quality professional development. Available online: http://www.nwrel.org/request/june98/article5.html

Owston, R.; Breuleux, A.; & Erstad, O. (2001). *SITES-M2 and OECD International Studies of ICT in Schools: Preliminary Findings*. Presented at TeleLearning 2001: The future of (e)learning. November 10-13, Vancouver, B.C., Canada.

Peck, C., Cuban, L., & Kirkpatrick, H. (2002). Techno-promoter dreams, student realities. *Phi Delta Kappan*. *83*(6), 472-480.

Schacter, J. (1999). The impact of education technology on student achievement: What the most current research has to say. *Milken Exchange*. Available online: http://www.mff.org/pubs/ME161.pdf

Stein, M.K., Smith, M.S., & Silver, E.A. (1999). The development of professional developers: Learning to assist teachers in new settings in new ways. *Harvard Educational Review, 69*(3), 237-269.