



**ATLAST Research Report 4, Year 3**  
**Summary of Research Findings for:**  
**Achieving Technological Literacy in Arizona for Students and Teachers**

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**Report Dissemination**

This report is primarily intended for Grant Project Investigators and project leadership. Additional uses and distribution of this report or portions of the report may include: data sharing with participants, Annual Project Reports to the National Science Foundation, updates and planning for project research and training operations, and publications or presentations by Project leadership.

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## Research Summary

This report is provided to outline the background, functions, and outcomes of research that was conducted as an integral component of the *Achieving Technological Literacy in Arizona for Students and Teachers* (ATLAST) grant. Research was embedded within technology training to broaden our knowledge of technological literacy and current state of technology use in Arizona schools, and to assist in development, validation, and implementation of the ATLAST *Participatory Training Model*. ATLAST is planned for further expansion by offering technology training to all STEM teachers in Career and Technical Education (CTE) programs in Arizona. The new training effort (proposal submitted in October 2010) would further extend the training model to include selected students of each participating teacher. ATLAST research draws information and conclusions from established research literature, ATLAST training evaluations, and data collected to answer related questions. Research thrusts, data collection, and conclusions were tempered by established pedagogical principles, learning theory, and recent findings of published educational research. Qualitative and quantitative data were collected in a manner that facilitated triangulation across data sources and different types of research observations. Data was acquired from online and printed surveys, interviews and focus groups, training evaluation forms, and evaluation of teachers' implementation of new technology at participating schools. Most analyses provided here represent a composite of several research efforts conducted and reported across the Project's first three years, and discussed in detail in three previous ATLAST Research Reports.<sup>1,2,3</sup>

## Project Background

The ATLAST Project began in April 2008 and was planned to end in March 2011, but a Project extension is currently being requested to extend the effort for one year. Data has been collected at all stages of the training to support research and formative development of the Participatory Training Model. While some high school students have participated in the training with their teachers, the primary effort has been to build the technology skills of secondary teachers and their overall technological literacy and understanding of how to leverage technology to improve student learning—especially active, collaborative learning that prepares students for advanced degree programs and professional work.

ATLAST training goals and objectives were derived from a review of research on technology in education,<sup>4,5,6,23</sup> technological literacy,<sup>7</sup> and from technology knowledge and skill standards developed by national and state organizations.<sup>8,9,10,11</sup> ATLAST training content was mapped to selected standards from these sources. Since the standards prescribe a broad array of technology knowledge, skills, and topics, the ATLAST staff was able to design training content that both addresses the standards and the primary interests and immediate needs of participating teachers (e.g., skills for using technology recently acquired by participating schools).

ATLAST training methods reflect a design approach to teaching and learning in which instructional format is adjusted frequently based on training outcomes and continuous formative evaluation.<sup>12</sup> Learning takes place in a collaborative environment in which learners work together in small teams during direct training (at workshops) and self-mediated learning (at home schools). Training participants begin productive work with information and communication technology (ICT) tools immediately after being introduced to them and gaining basic knowledge of how they are used. Guidance from ATLAST trainers begins with close, face-to-face assistance by trainers, which is gradually "faded" as teachers gain confidence and momentum. Participants are tasked to increasingly utilize collaboration and communication ICT tools to work with trainers and team members virtually. This helps initiate a local community of tech-savvy teachers who are connected via ICT and common needs and interests. Although teachers are encouraged to complete as much face-to-face training as possible by attending workshops (13 provided to date), learning by collaboration with other teachers is equally important to ensure mastery of technology skills. Collaborative learning projects greatly expand opportunities to

continue learning between workshops and to implement the knowledge and resources gained from workshops. Virtual (remote) collaboration via ICT is rapidly becoming a critical skill area in both professional and educational settings. Thus, direct support to teachers was gradually transformed into a virtual, collaborative support system, whereby participants received technical help and shared new ICT resources as professionals do in the workplace. This also reduces place- and time-bound barriers to ongoing learning and helps teachers gain the competence and self-confidence needed to become more independent (self-mediated learners) and to exploit the powerful ICT tools and services now available for public and private use free of charge.

The selected ICT tools and devices introduced to teacher participants during ATLAST training have some common characteristics: ease of use; widespread or developing popularity; immediate and free access by most students; broad popularity and motivational appeal to users; integrated applications with multiple functions and capabilities (e.g., communication, collaboration, social networking, multimedia sharing); and devices and/or systems that participating schools have recently acquired but have less than adequate training for teachers and students.

### **General Research Findings on Technology in Education**

The ATLAST Project was inspired by recent technological advancements, increased use of ICT, research on educational reform, and the reports of Arizona education administrators who indicated an urgent need for secondary teachers to acquire skills for leveraging technology. The importance of technology in education is well documented and recognized at the highest administrative levels. A “*National Educational Technology Plan* (NETP) ([Transforming American Education: Learning Powered by Technology](#)) was released in March 2010 by the Department of Education. NETP calls for the improvement of pedagogy through the use of technology at all levels of K-12 education.

Survey findings from 1,300 U.S. teachers who use technology indicate it has increased achievement for student research (76%), understanding (64%), problem-solving (57%), and writing quality (59%).<sup>13</sup> Bransford states that “on-demand learning is now within reach, supporting learning that is life-long and life-wide.”<sup>14</sup> Yet, research by the Center for Educational Research and Innovation indicates that the potential impact of technology at schools is dependent on, first, increasing teachers’ competence and confidence for using it.<sup>15</sup> The positive effect of technology on STEM teaching and learning relies on robust and extended learning experiences for teachers and students in which ICT tools and collaborative exchange among peers are applied in the same way as in the 21<sup>st</sup>-century, technical workplace.<sup>16</sup> We know little about how students can use ICT to support the kind of extended problem-solving that is done in the technical workplace,<sup>17</sup> because students and teachers seldom engage in continued ICT tool use outside of standard classroom environments and standard formats for teaching (e.g., lectures and textbooks).<sup>18</sup> The gap in use of technology for learning at schools causes students to mentally partition their concept of school learning from the most common modalities of information gathering and learning that they, and the general public, now use (e.g., Internet resources and social interaction). This disconnect has convinced many young students that school learning is bogus, and that their teachers and teaching methods are naïve and antiquated. The direct result is a lack of trust in their teachers’ knowledge and a lack of motivation for learning when forced to use standard academic resources (e.g., textbooks, library).

While the ATLAST Project primarily addressed the needs of teachers, a number of students of these participating teachers were experimentally integrated into the professional development events and projects. We did this for three reasons: (1) Participating teachers expressed their wish to work directly with their students during training, thus providing them the same opportunities to develop ICT skills. (2) Teachers were aware that some of their students were very knowledgeable and skilled relative to digital technologies, and they enjoyed working with these students, who they described as “fearless of technology.” (3) Follow-up research verified teachers’ assumptions, and findings suggest a potentially

strong, positive effect for conducting joint technology professional development where teachers and students learn together in teams.

Many young students are ahead of their teachers in terms of ICT familiarity and how to use it to gather information, socialize, and acquire up-to-date knowledge of our technical world. Ledesma states that “students will use resources and technologies to meet expectations in ways that make sense for them—and sometimes in ways that were better than anything we [educators] had conceived.”<sup>19</sup> An extensive research study by the MacArthur Foundation found that young adults have pre-existing, high levels of confidence and skill for using ICT and technology-use behaviors that could be leveraged to improve learning at school.<sup>20</sup> Most young adults become familiar with ICT (e.g., cell phones, computers, Internet) at an early age and continue to use it during their teen years to express their identity, share opinions and information, network with friends, meet new friends, discuss and broadcast their opinions on global issues, collaborate to gather and digitally share information on common interests, and organize personal and social activities and events. They keep in constant touch; efficiently exchange visual, aural, and text communications; and quickly learn how to exploit new ICT capabilities. These naturally-acquired skills have yet to be systematically tapped to improve and sustain continuous learning at school and away from school.

There are other reasons for integrating students within teacher technology training. While many students are familiar with a variety of ICT and use it frequently, they are not necessarily increasing their understanding of the principles and practices of technology use as are employed in the professional world. Our target population is made up of teachers and students in CTE programs, so the curriculum is geared toward preparing students for professional careers. Technology use needs to be embedded in the context of the professional disciplines being studied, even at school. Students need to learn how to leverage their existing technology knowledge, gained from using ICT for socializing and entertainment, to acquire knowledge and skills that can be directly applied to their chosen field. Students’ frequent use of ICT produces enabling skills that can be consciously applied to learning new tools faster and more efficiently. This facilitative effect of prior knowledge and metacognition is defined in early studies of learning.<sup>21,22</sup> Metacognitive skills can be improved if learners are made aware of their own thinking processes and are shown how to better exploit them. This was a goal of the ATLAST training program, so trainers encouraged teachers and students to “think out loud” and collaborate with peers extensively when discussing ideas and plans for implementing technology.

The focus and structure of ATLAST training was strongly influenced by the research findings discussed above. Table 1 (next page) shows key Project thrusts, supporting activities, and impacts and outcomes that have occurred as direct result of ATLAST training and research.

**Table 1. Summary of ATLAST Project Thrusts, Activities, and Impacts**

Key Project Thrust	Supporting Activities	Impacts and Outcomes
<p><b>Training/Research/Evaluation Integration:</b> Exploration and verification of training methods and venues for building technological literacy among practicing teachers and future teachers</p>	<p><b>Training:</b> Long-term workshop series for in-depth and continuous learning and skill development  <b>Research:</b> Identifying student (young adult) intrinsic motivation to impel self-regulated learning and application of skills  <b>Evaluation:</b> Blending formative evaluation and research tools and methods to fine-tune training</p>	<p><b>Immediate implementation</b> of new tools and skills by teachers at schools by integrating ICT with their normal curriculum and discipline standards  <b>Reporting/sharing key findings</b> with other projects (NSF), government programs (CTE), and education research community  <b>Deliver validated Participatory Model for Technological Literacy</b> professional development</p>
<p><b>Implement a new technological literacy training program</b> for CTE Education Professions teachers and students</p>	<p><b>Launch, test, and validate ATLAST workshops and Teacher Summer Institute</b> within Phoenix region and across a representative sample of districts and high schools</p>	<p><b>Immediate impact and positive feedback from participants:</b> 94% teacher cohort actively implementing new skills, tools, and/or collaborating online; 99% positive ratings on the training by teachers and students</p>
<p><b>Maximizing broad-scale impact and dissemination</b> of technology curriculum by targeting future teachers</p>	<p><b>Integrating secondary students into the professional development</b> from the <i>Arizona Education Professions</i> Program, most of who will become K-12 educators</p>	<p><b>Impact expands exponentially</b> as Education Professions students join workforce and pass on technology enthusiasm, knowledge, and skills to their own students</p>
<p><b>Leveraging high motivation</b> of teachers and students for using interactive Web-based tools, cellular communications, social networking, and multimedia</p>	<p><b>Assessing wants, preferences, needs and shaping training to match motivators:</b> Topics, issues, concerns, and emerging acquisitions and trends at participants' home schools</p>	<p><b>Identified high-motivation elements within established tech literacy standards and ICT tools:</b> Improved recruitment and retention and shaped training content, format, and learning environment</p>
<p><b>Raise awareness of tech-related career opportunities</b> and increase teacher ability to prepare students for a technology-driven world</p>	<p><b>Focus on multi-purpose technology teaching &amp; learning tools</b> to accelerate knowledge and awareness of emerging technologies, behaviors, and their impact on society</p>	<p><b>Expand and extend knowledge of high-tech industry</b> via site visits, scientist and engineer presentations, field trips, and student and teacher research and portfolio projects</p>

### ATLAST Research Findings

For the last three years, ATLAST has engaged CTE teachers in a series of professional development workshops and guided collaborative learning projects with ICT tools. The ATLAST Research Leader, External Evaluator, and Research Assistant collected and analyzed qualitative and quantitative data to define the effects of the ATLAST *Participatory Training Model*, active learning strategies used by ATLAST trainers, student participation in teacher professional development, and initiating a collaborative, ICT-enabled learning community. Overall results indicate many strengths in the Model and for its components (e.g., blending direct and demonstrative instruction, self-initiated and self-mediated learning to extend learning between workshops). Teachers have demonstrated consistently more advanced knowledge and skills, as well as motivation that continues to increase with greater competence and self confidence. As ICT skills were gained, teachers' ability to collaborate virtually increased, because time- and place-bound barriers were removed (e.g., learning resources were exchanged without time/place limitations). As with many new NSF technical training, participants learned by doing—teachers learned ICT by using it to produce and deliver instructional content and to initiate and manage interactive learning among their students. ATLAST teachers continue to advance their skills

independently, and many continue to attend as many workshops as their schedule allows as the ATLAST Program continues.

### **General Findings and ATLAST Participation**

Almost all the teachers who completed ATLAST training rated the quality of training highly (99%), indicated the training was relevant to meeting their teaching needs (95%), and implemented the ICT curriculum in their CTE courses (94%). A State Supervisor from the Arizona Department of Education observed that ATLAST teachers were very excited about the training and that student involvement produced an additional “comfort level” for them. Unfortunately, though most participating teachers (80% of those surveyed) wanted to directly include their students in the training, only a small number of students could be accommodated by this grant. Students who attended ATLAST training were reported by trainers to learn ICT faster than their teachers; demonstrated immediate and strong motivation toward ICT and the peer-based, collaborative learning format; and appeared to leverage more pre-existing ICT skills and experiences than teachers. The Director of the CTE student program, *Future Educators of Arizona* (FEA), commented that students who did participate won most of the FEA technology competitions, and this encouraged other teachers to seek ICT training.

Training participants for ATLAST were recruited from a small population of secondary teachers in Arizona who teach education courses through the CTE *Education Professions Program*. ATLAST participants who received training included 34 teachers and 25 students from 16 school districts in Arizona. Students begin participating in the training (on an experimental or tryout basis) during Years 2 and 3, but teachers remain the primary participants of ATLAST. Individual participants have completed from 1 to 10 workshops, while students have completed one to five workshops since the Project’s inception. Workshops have included as few as two teachers and as many as 20 on different occasions to accommodate pressing needs of schools, differing schedules of teachers, and different school and district locations throughout the Phoenix Metro Area. Near the end of Year 3 (June 2010), 10 workshops had provided training to 182 participants. However, research observations have indicated that most teachers have shared their new knowledge and skills and have implemented technology training with a substantial number of peers and students within and outside of the target CTE program.

CTE Education Professions teachers were targeted for training recruitment for several reasons. First, the grant performing unit, the *National Center for Teacher Education*, had developed an ongoing partnership with CTE program supervisors and administrators to extend their support and outreach to public schools and practicing teachers. Second, there is a potential for greater training impacts from these teachers. A “first-level” impact is realized by increasing Education Professions teachers’ ability to use technology to improve learning in their own classrooms. A second-level impact is realized when their students—many who will become Arizona K-12 teachers—are employed by local schools, apply their technology skills in their courses, and pass along their knowledge and enthusiasm for technology to their own students. A third-level impact is realized when students, who do not become educators, continue to leverage technology skills in other professions as they join the workforce. More immediate impacts have occurred from participating teachers, who begin sharing their new knowledge and the ICT tools introduced in workshops with peers and students almost immediately. After completing only the second workshop, the most enthusiastic participants had trained 50 teachers from a variety of subject areas (outside of the Education Professions program) and 117 students on the use of digital tools that were introduced in ATLAST training. This was an early indication that the largest impacts to occur via peer-to-peer sharing and implementation with students would be produced by a small percentage of participating teachers. These enthusiastic teachers have a more immediate and stronger interest in continued learning and a willingness to expend additional effort. Two or three of these individuals surpassed their colleagues and became “champions” of the ATLAST program. They also tended to lead self-initiated learning between workshops, helped trainers guide less-experienced participants or those who felt reluctant to “strike out on

their own” to explore and discover public-access Internet tools. ATLAST Champions have also been invaluable to the recruitment and retention of other teachers as the program matures. They have helped to build enthusiasm among colleagues and have assisted trainers in establishing the most attractive training format and environment for their peers. Their presence has also increased program recognition by school administrators. Project leaders have wisely chosen to directly involve these teachers in their plan to expand training to include teachers from all Arizona CTE programs. As a general practice, it is important to identify such “champions” early during training, leverage their enthusiasm and drive, and place them in leadership positions if possible.

### **Data Collection and Sharing**

ATLAST data was collected in a manner that facilitates triangulation across several sources of observation. This strengthened and helped validate conclusions and added credibility to our conclusions. Data was acquired from surveys, discussions with teachers, participant feedback on evaluation forms, focus group activities, reports of trainers, student and teacher interviews, and evaluations of teachers’ implementation of new skills and ICT resources gained from training. ATLAST researchers disseminate findings and share results of needs assessments, workshop evaluations, and surveys with participating teachers and students. This has promoted greater trust and openness among teachers and created a community-oriented focus on the purpose and benefits of the training program. Transparency seems to build trust very quickly among teachers and students alike, and it also serves to elicit feedback that helps identify and leverage expectations to fine-tune training to the participating population. ATLAST training staff members openly share their experiences, perceptions, and ideas with teachers, and they encourage participants to do the same, and to collaboratively define technological literacy as it applies to their discipline and program. This type collaboration and information sharing helps build local communities of technology users who are members of specific programs like the CTE Education Professions Program.

### **Needs Assessment**

A pre-training needs assessment revealed that most teachers from the target population (88%) have seven or more years teaching experience; are mostly white, non-Hispanic origin (92%); perceive themselves as intermediate-level computer users (92%); and most (85%) have high-speed Internet access at their schools. About half reported having some familiarity with ICT tools that are commonly used by students for entertainment or information gathering (e.g., podcasts, 58%, wikis, 58%). Most (79%) identified heavy teaching workloads and stringent schedules as barriers to improving their technology skills via direct training. Many also expressed a reluctance to leave their students with a substitute teacher to attend workshops. However, teachers overall expressed a strong interest in receiving technology training. A detailed survey of ICT tool use and special applications and areas of interest of CTE teachers, and results were combined with these factors to design the most appropriate training agenda, develop training content, and provide the best format and support plan for the workshops. Considering the difficulty that most teachers have in leaving their students to attend workshops, strategies to stimulate learning between workshops were considered a major concern for trainers. Teachers were provided with guided learning projects and assignments that would result in immediate implementation of the ICT tools and technology learning for students at participating schools. These activities were facilitated by ongoing technical support and guidance that was provided in-person via school visits and online using some of the first ICT tools covered in the training. Therefore, ICT was leveraged to enhance the effectiveness and efficiency of training as well as being the focus of the professional development.

### **Research with Participating Students**

While students were not the primary recipients of ATLAST training, the research team took advantage of the opportunity to collect data on their perceptions of ICT and technology-related topics. A focus group was conducted for this purpose that included both students and teachers together. This promoted cross

discussion in a non-intimidating environment where students were encouraged by their teachers to speak out and share their knowledge and ideas. One topic discussed was the so-called “digital divide,” which has become a major focus of research on technology in education. Teachers and students agreed that this is somewhat of a misconception, or at least an oversimplification of existing conditions among teachers and students. They generally agreed that the “divide” was more a set of complex factors that don’t necessarily tie directly to technology. Some of these factors are: age difference (i.e., generation gap), differing motivation dynamics, different levels of freedom of choice relative to behavior at school, and cultural differences that divide students from teachers. Focus group participants also questioned the common belief that young students are more technologically savvy than their teachers. In particular, students in the focus group questioned this assumption. These findings suggest that teachers and educational researchers should be aware that relationships among teacher and student use of technology are highly complex and are not accurately defined by such catch phrases as “digital divide.” However, published findings and results of ATLAST research indicate that many students are far less intimidated by technology and learn new ICT tools more quickly than older adults, including many teachers.

A set of “probe” topics and questions was used in the focus group to stimulate thinking on technology capability, school policies/restrictions governing technology use, and their own personal use of digital tools and the Web. One of the broader topics was introduced by describing how digital technologies expand human capacity for perception and environmental awareness. This helped participants think about how their behaviors and technology use have expanded their outreach and connections to a larger world of friends, peers, professionals, and entertainment and informational resources using cell phones and computer networks. The goal was for participants to generate their own ideas on how to reduce potential distractions to learning (which lead to restrictive school policy), while generating new learning capabilities via ICT that is already familiar to them. An emphasis was placed on leveraging existing student behaviors exhibited at school and after school. Probe questions were continuously generated and revised as a function of ongoing feedback from participants. Table 2 shows a summary of the ideas, opinions, and concepts that were expressed by students and teachers as they discussed probe questions.

**Table 2. Focus Group Probe Topics and Questions and Participant Feedback**

<b>Probe Topics and Questions</b>	<b>Participant Feedback, Opinions, and Ideas</b>
What are the most prominent technologies students use or should be used in school?	Expose students to technology at younger age (flash drives, smart boards, etc.)
How do students use different modes of communication for school?	Blogging, discussion board assignments (online homework)
How can the most popular tools or technology capabilities that students use be leveraged to promote learning?	Post assignments online; Encourage online peer review, comments, and discussion.
How and what ICT should be implemented at schools?	Assign reflection exercises from videos viewed.
	Use Webcam pen pals with Skype.
	Teachers should get creative with their assignments using tools like Google Apps and YouTube videos.
How can course assignments leverage technology to facilitate peer-based learning, collaborative learning, and promote social behaviors that enhance learning?	Ask students what can be done to increase productive use from their end—tap student ideas.
	Assignments given to students affect what they will do and learn with technology and if they will begin using technology to help their learning.
How can teachers increase the frequency of using technology to enhance learning, and why don’t some teachers want to do this?	Teachers’ lack desire to change and learn new methods; they tend to do “what’s always been done”
	Lack of up-to-date tools to work with in the classroom
	Management policies are restrictive to use of technology—state and district level

### **Effects of ATLAST Training Strategies and Format**

The ATLAST training program encourages teachers to attend a long-term series of integrated workshops and engage in self-mediated learning with their peers between workshops. This comprehensive format provided more opportunities for learning and networking and promoted collaborative environments that resulted in new friendships among participants. It facilitated initiation and sustainment of a technology-enabled collaborative community of technology learners. Teachers were comfortable in sharing information and helping each other learn in this context. Social interaction also proved to be a strong catalyst for building a community, so the Project Investigators and Training Coordinator placed a good deal of effort in organizing events where learning and ICT demonstrations could be integrated with more personal and social interaction. For example, commiserating on the lack of technology and technology support by schools was a major icebreaker and topic of conversation among participants! While such topics may be considered inappropriate in formal training environments, the power of ordinary social interaction and informal situations, to connect learners to a common and worthwhile cause, should not be underestimated. Teachers who formed bonds among peers in the training program also tended to readily cooperate by completing surveys and volunteering information that was useful to researchers and trainers. For example, a follow-up survey administered after the first few workshops resulted in a 90% return rate. This is a higher return rate than can be expected for most research and evaluation efforts. Teachers also seemed to feel more obligated to help in such data-collection efforts, because of the personal attention and technical support they initially received at their schools when first recruited for training. Initial recruitment and community-building strategies are defined in greater detail later in this report in a discussion of the Participatory Training Model.

### **Teacher Preferences for ICT Tools**

A follow-up study of implementation indicated that teachers were most attracted to: (1) ICT tool suites that use a common interface but provide multiple communication and information functions instead one specific application (e.g., Google Aps); (2) ICT that facilitates communication with peers and students and enables easy sharing of pedagogical products (e.g., learning objects), ideas, teaching experiences, and collaboration (e.g., blogging and social networking Web sites); and/or (3) ICT that enables development and delivery of teaching and learning activities that are interactive, dynamic, and/or audiovisual in nature (e.g., YouTube). Teachers appreciate ICT tools that they can learn how to use quickly and immediately apply to their normal teaching duties and objectives. They are impressed by the power of dynamic media like video and are eager to test their capability to gain and hold student attention. They see the value of Web sites and portals that provide a common interface for performing multiple functions, because once learned, they can use the site to support different types of teaching and learning activities. Social network sites like Facebook and tool suites like Google Aps are examples of such ICT. Teachers also expressed excitement over being able to communicate better, more often, and more efficiently with their students inside, and especially outside, of the classroom. After completing ATLAST training, several teachers now post assignments online and encourage their students to communicate with them and peers via Web sites or email. Teachers show strong preferences for certain ICT tools introduced in ATLAST workshops, and these preferences are firmly based on their immediate teaching needs and the learning objectives and standards they must address in the courses they teach. Most of the tools they have chosen are those that their students can learn to apply individually and collaboratively to enhance their learning and build discipline-specific knowledge and skills.

### **Barriers to Technological Literacy**

Although all ATLAST participants come from schools that have Internet access, a few of the participating schools block large portions of the Web or deny students access to the Internet in classrooms. Many of the schools restrict students from carrying standard digital ICT such as cell phones and iPods due to

potential legal complications associated with theft and behavior that is disruptive, distracting, or even dangerous (e.g., Internet predator issues). Unfortunately, while serving the purposes of security and pedagogical discipline, these policies stifle teachers' and students' interest and motivation to apply ICT to learning at school. Several ATLAST participants have subsequently petitioned for and obtained more ICT or greater access to online services at their schools. This indicates some progress on negotiation is being made across school departments and functions that can result in safe and productive use of ICT. However, the consistent push to bring technology to schools still seems to be embattled with almost as much enthusiasm to ban any technology that could facilitate crime or reduce safety in our schools.

### **Effects of Intensive Training Events**

Bringing participating teachers together for intensive training sessions that extend over two or more days can be a strong catalyst for improving retention and initiating a learning community, especially when participants are from different school districts that serve different populations and differ in their use and adoption of new technology. ATLAST conducted a 3-day *Teacher Summer Institute* which joined three separate workshops into a single, intensive training event. This was planned and executed after the first two workshops, so that trainers were more familiar with teachers, were better informed of their expectations, and had adjusted their training format and pace according to formative evaluation results for the first two workshops. The training environment and careful scheduling of events is important for such lengthy sessions to ensure teachers continue developing confidence in the trainers and the program. The ATLAST Summer Institute was conducted in a computer lab equipped with modern learning stations, high-speed Internet access, large-screen projection, and high-resolution multi-media systems that are designed for training purposes. Breaking up intensive lab-based training with diverse learning activities and opportunities for networking with other teachers is also important for maintaining motivation and minimizing fatigue. The Summer Institute included strategically scheduled breaks for open discussions, collaborative sessions, short field trips and tours at technology companies (e.g., Rainbow Studios, gaming software) and special college learning centers (e.g., campus Planetarium with programmable audiovisual), interactive discussions with industry experts, and technology demonstrations of state-of-the-art, digital teaching tools. These activities also broadened participants' understanding of the range and capability of technology and the impact that technological literacy can have on their students. Finally, the demonstrations, guest speakers, and discussions with professional technologists provided teachers with exciting and substantive information they could share with their students—careers and local technology jobs that are available to successful graduates with technology skills.

### **Teacher and Student Perceptions of ATLAST Workshops and Learning Events**

Teachers and students completed evaluations forms each day of training at the Teacher Summer Institute. The evaluation instruments and protocols for data collection and analyses were designed for ATLAST and were administered throughout the training program. They employed single-response items, open-ended questions, and requests for comments, ideas for improvement, and topic preferences. Findings from evaluations of this 3-day training event were very similar to those produced in later workshops. Response data were combined across training days (workshops) and across similar inquiry items on the evaluation forms. Items that references specific training sessions and the topics presented (e.g., introduction to specific ICT, applications, and resources) were grouped to express participant perceptions of seven different types of training outcomes and indications of training quality. Two of the categories (Categories 5 & 7) address the capability and performance of ATLAST trainers and overall satisfaction with the training experience. The other five categories address specific outcomes and impacts of the training in terms of knowledge and skills gained. Table 3 (next page) shows the composition of each category (e.g., inquiry items included in the category). Table 4 (page following Table 3) shows the proportion of aggregated responses to Likert statements (i.e., strongly agree, agree, disagree, & strongly disagree), ratings of topic relevance (i.e., highly relevant, relevant, & not relevant), and ratings of the pace

of the training (i.e., too fast, correct pace, too slow). (Pace ratings were also described in the evaluation forms as “too much information” and “not enough information” as provided in each training session.)

**Table 3. Composition of Rating Categories**

<b>Inquiry Category</b>	<b>Composition of Inquiry Category: Combined Evaluation Items</b>
<p><b>1:</b> Improved knowledge on selecting/using Web 2.0 applications to benefit teaching and student success.</p>	<ul style="list-style-type: none"> <li>• I learned how Web 2.0 applications (e.g., Flickr, VFT, mobile blogging) can better connect me to my students.</li> <li>• Today’s training helped me understand how my ability to use Web 2.0 technology on my students’ success.</li> <li>• I learned how Web 2.0 applications can improve teaching and student learning.</li> <li>• I learned how to consider certain “trade-offs” (e.g., accessibility to students, cost, and limitations) among the many Web 2.0 applications, and this will help me select the best ones for me and my students.</li> <li>• I learned more about how students use technology today.</li> </ul>
<p><b>2:</b> Improved knowledge of electronic information access and uses to improve learning and communication.</p>	<ul style="list-style-type: none"> <li>• I learned how information can be accessed, communicated, and formatted in different ways.</li> <li>• I learned how expressing information and ideas in new ways can improve learning and understanding.</li> <li>• I learned how communication vehicles (e.g., Twitter) are used for many purposes (e.g., inform, persuade, entertain, educate).</li> </ul>
<p><b>3:</b> Improved knowledge of impact of industry, technologies, careers, and economy.</p>	<ul style="list-style-type: none"> <li>• Today’s events helped me understand more about technology industry and career opportunities it affords.</li> <li>• The training improved my understanding of key relationships between different types of technology.</li> <li>• Today’s training helped me appreciate the impact that technology knowledge and skills have on my students’ success.</li> <li>• I learned about the impact of communication technologies on Arizona’s economy and job market.</li> <li>• I learned the importance of teaching my students about Arizona’s technology industry and its impact on their future.</li> <li>• After today’s training, I know about key technologies that are producing rapid growth in Arizona industry.</li> </ul>
<p><b>4:</b> Improved skills for producing learning objects and eportfolios.</p>	<ul style="list-style-type: none"> <li>• The training increased my knowledge of Collaborative Learning Objects (CLOs).</li> <li>• I improved my ability to create CLOs.</li> <li>• This training will enable me to expand/improve my eportfolio.</li> <li>• Today’s practice and one-on-one guidance by trainers helped me progress on my new technology knowledge and skills.</li> <li>• I will be able to incorporate the information and tools presented in my classroom.</li> </ul>
<p><b>5:</b> Knowledge and effectiveness of trainers and speakers.</p>	<ul style="list-style-type: none"> <li>• Facilitators demonstrated ample knowledge of technology and its value to teachers.</li> <li>• The presentations and speakers were effective in engaging my attention.</li> <li>• Facilitators gave good advice on how to begin implementing the tools at my school.</li> </ul>
<p><b>6:</b> Improved understanding and ability to implement technology.</p>	<ul style="list-style-type: none"> <li>• The goals and outcomes of the ATLAST Summer Institute were explained clearly.</li> <li>• The training activities helped me understand what I was expected to do and why.</li> <li>• Materials provided will assist me to implement the technology in my classroom.</li> </ul>
<p><b>7:</b> Overall satisfaction with training, networking, and collaboration.</p>	<ul style="list-style-type: none"> <li>• I would recommend this training to other teachers.</li> <li>• This training enabled me to network with other teachers who are also building their technology knowledge and skills.</li> <li>• By participating in the ATLAST Summer Institute, I was better able to connect with technology experts.</li> <li>• This training helped me work collaboratively and team with others to build my technology literacy.</li> </ul>

**Table 4. Aggregated Responses Across Inquiry Categories by Teachers (black text) and Students (blue text)**

Inquiry Category	<sup>1</sup> Likert Statements					<sup>2</sup> Training Relevance				<sup>3</sup> Training Pace			
	SA	A	D	SD	n	HR	R	NR	n	CP	TF	TS	n
1: Improved knowledge on selecting/using Web 2.0 applications to benefit teaching and student success.	75%	23%	2%	0%	60	82%	13%	4%	67	75%	23%	2%	57
	71%	29%	0%	0%	21	46%	46%	8%	26	65%	31%	4%	26
2: Improved knowledge of electronic information access and uses to improve learning and communication.	66%	29%	3%	3%	38	82%	13%	4%	45	84%	16%	0%	37
	67%	27%	7%	0%	15	63%	38%	0%	16	65%	29%	6%	17
3: Improved knowledge of impact of industry, technologies, careers, and economy.	70%	30%	0%	0%	86	70%	21%	9%	70	88%	2%	10%	60
	67%	33%	0%	0%	30	42%	50%	8%	24	60%	24%	16%	25
4: Improved skills for producing learning objects and eportfolios.	66%	31%	3%	0%	64	78%	19%	3%	36	77%	23%	0%	30
	63%	38%	0%	0%	24	57%	29%	14%	14	71%	29%	0%	14
5: Knowledge and effectiveness of trainers and speakers.	84%	16%	0%	0%	45	No relevance items included.				No pace items included.			
	67%	33%	0%	0%	15								
6: Improved understanding and ability to implement technology.	82%	18%	0%	0%	45	77%	18%	5%	57	88%	6%	6%	50
	53%	47%	0%	0%	15	50%	41%	9%	22	57%	33%	10%	21
7: Overall satisfaction with training, networking, and collaboration.	92%	8%	0%	0%	60	No relevance items included.				No pace items included.			
	70%	30%	0%	0%	20								

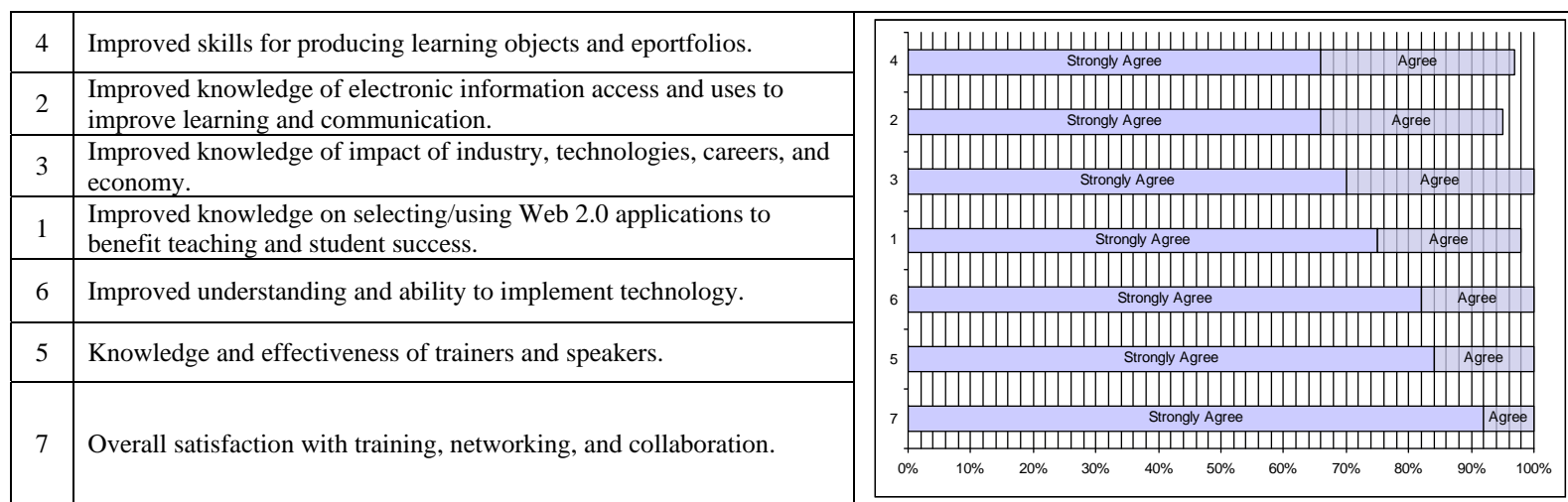
1. Response range: SA=strongly agree, A=agree, D=disagree, SD=strongly disagree, n=total ratings

2. Response range: HR=highly relevant, R=relevant, NR=not relevant, n=total ratings

3. Response range: CP=correct pace, TF=too fast, TS=too slow, n=total ratings

Note: Percent calculations to nearest 1% (round off errors may result in totals greater or less than 100%)

**Figure 1. Teacher Ratings of Training Quality and Outcomes Ranked by Inquiry Category**



The descriptive data in Table 4 indicate that, overall, teachers and students perceived the training activities to be very effective in helping them understand the meaning of technological literacy and acquiring specific knowledge and skills for using ICT tools. Participants chose the “strongly agree” option on Likert statements more often than “agree;” they seldom chose “disagree;” and there were no “strongly disagree” responses at all to any of the inquiries. Since all Likert statements expressed a positive inclination toward the training, results verify strong and positive perceptions across both teachers and students who participated. Also, teacher and student ratings were similar across outcomes (knowledge/skills gained) and training elements (trainer competence & overall satisfaction). Teachers did rate the training higher in categories 5, 6, and 7 than students, yet no “disagree” or “strongly disagree” responses were made in any of these three categories by teachers or students. Teacher ratings were also higher for relevance of training topics and correct pace of the training compared to student ratings. Even though trainers noted that students seemed to “catch on more quickly” than teachers when being introduced to new ICT tools, the Summer Institute was the first ICT training that students received. Also, students had not been able to participate in prior explanatory discussions and interactions with trainers as did their teachers. Finally, Education Professions students had only recently been introduced to pedagogical theory, strategies, and practices—unlike their teachers, who have been teaching for several years or more. Thus, their lower ratings of topic relevance and greater proportion of ratings indicating the training was delivered “too fast” were not surprising.

Figure 1 (previous page) shows rating results ranked by inquiry category. Only responses for “strongly agree” and “agree” are included in the graphed data. Ratings were highest in Category 7: *Overall satisfaction with training, networking, and collaboration*, closely followed by Categories 5: *Knowledge and effectiveness of trainers and speakers* and 6: *Improved understanding and ability to implement technology*. Category 2: *Improved knowledge of electronic information access and uses to improve learning and communication* and Category 4: *Improved skills for producing learning objects and eportfolios* received lower ratings, but teachers seldom disagreed with Likert statements (1.3%) in these two categories. Results of a review and analysis of qualitative data (e.g., teacher written comments), indicates that the lower ratings for Category 4 were likely due to the high level of challenge associated with mastering all the tools needed to produce high quality learning objects and e-portfolios. Lower ratings for Category 2 may be due to the abstract nature of electronic information concepts and the complexity of data communications services and digital information vehicles.

Table 5 (next page) further collapses participant response data collected across the seven inquiry categories and all responses to inquiries on topic relevance and training pace. Collapsed data clearly shows the preponderance of positive responses of participants. Teachers agreed with the Likert statements that expressed successful learning outcomes 98.7% of the time and disagreed only 1.3% of the time. Calculations of proportion are based on 393 teacher responses. Similar results were found for students who participated in the same training and evaluations (99.3% agreement and 0.7% disagreement based on 139 responses). Blue text identifies student data in the table.

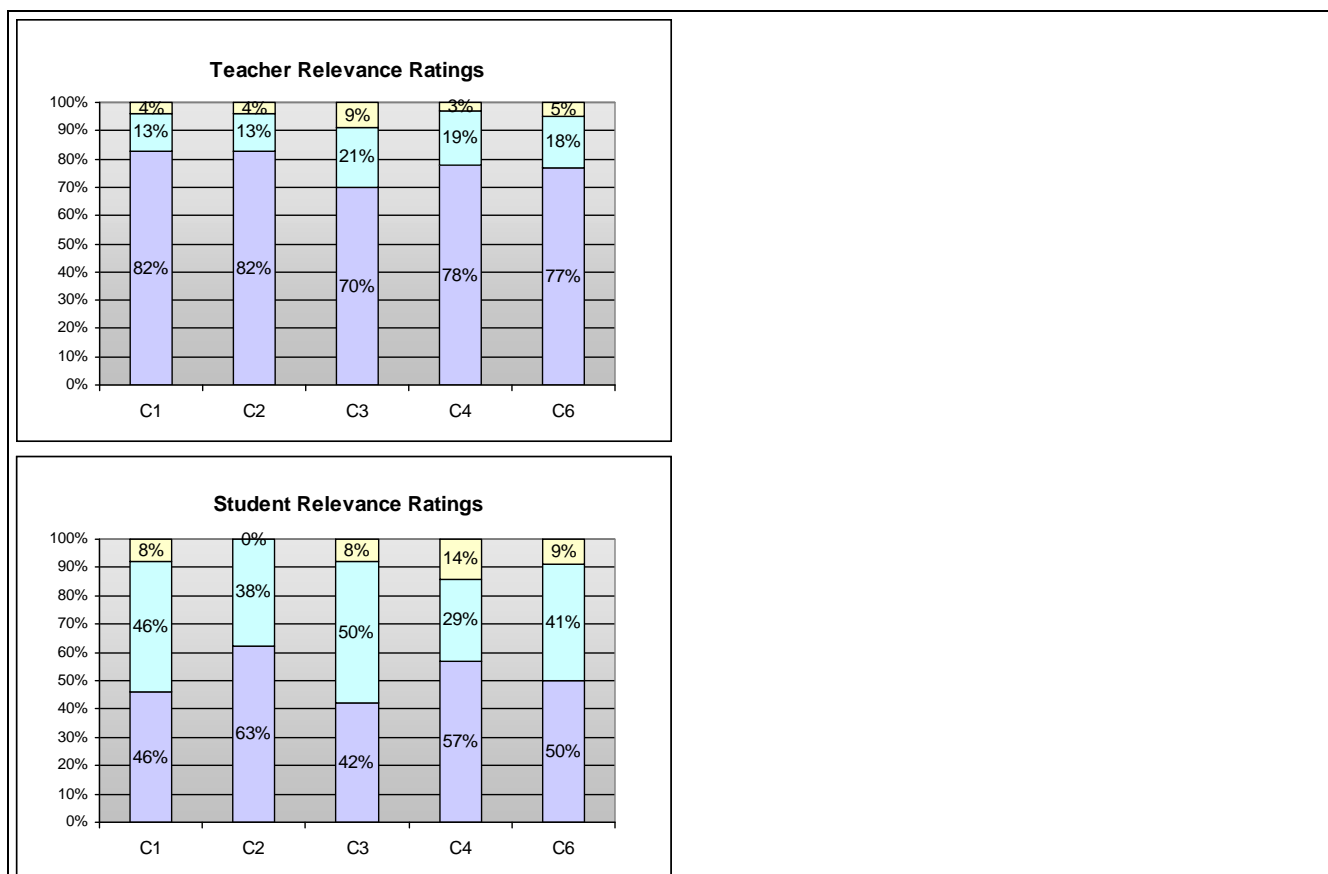
Figure 2 (next page) further illustrates the degree that participants viewed training topics as relevant to their training and teaching needs. The stacked bars show proportion of responses for “highly relevant” (purple), “relevant” (green), and “not relevant” (yellow), respectively. While there were some differences in teacher and student rating means, there is too little student data at this time to make further conclusions or to even assume that real differences exist. Plans to include more students in future technology training may reveal more information on differences between student and teacher perceptions.

**Table 5. Rating Data Collapsed Across Inquiry Categories**

<b>Likert Statements</b> (Teacher total responses = 398) (Student total responses = 140)	<b>Strongly Agree</b>	<b>Agree</b>	<b>Disagree</b>	<b>Strongly Disagree</b>	<b>Total Agree</b>	<b>Total Disagree</b>
	76% (302) 66% (92)	23% (91) 34% (47)	1% (4) 1% (1)	0% (1) 0% (0)	98.7% (393) 99.3% (139)	1.3% (5) 0.7% (1)
<b>Ratings of Training Relevance</b> (Teacher total responses = 275) (Student total responses = 102)	<b>Highly Relevant</b>	<b>Relevant</b>	<b>Not Relevant</b>		<b>Total Relevant</b>	<b>Total Not Relevant</b>
	77% (213) 50% (51)	17% (47) 42% (43)	5% (15) 8% (8)		94.5% (260) 92.2% (94)	5.5% (15) 7.8% (8)
<b>Ratings of Training Pace</b> (Teacher total responses = 234) (Student total responses = 103)	<b>Correct Pace</b>	<b>Too Fast</b>	<b>Too Slow</b>		<b>Total Correct Pace</b>	<b>Total Incorrect Pace</b>
	83% (194) 63% (65)	13% (30) 29% (30)	4% (10) 8% (8)		82.9% (194) 63.1% (65)	17.1% (40) 36.9% (38)

Note: Percent calculations to nearest 1% (round off errors may result in totals greater or less than 100%)

**Figure 2. Teacher and Student Ratings of Training Topic Relevance**



**Category 1:** Improved knowledge on selecting/using Web 2.0 applications to benefit teaching and student success.

**Category 2:** Improved knowledge of electronic information access and uses to improve learning and communication.

**Category 3:** Improved knowledge of impact of industry, technologies, careers, and economy.

**Category 4:** Improved skills for producing learning objects and eportfolios.

**Category 6:** Improved understanding and ability to implement technology.

Purple (bottom) bar: proportion of “highly relevant” responses.

Green (middle) bar: proportion of “relevant” responses.

Yellow (top) bar: proportion of “not relevant” responses.

Note: Percent calculations to nearest 1% (totals not always 100%).

### **Observations of Knowledge Transfer and Implementation of ICT at Schools**

A follow-up survey was administered to participating teachers in the Spring semester of 2010. The survey inquired about using new ICT introduced during training, increase in personal use of ICT, training students to use the ICT tools, and the degree that teachers have extended impacts of the training by training others and sharing new technical knowledge and tools. Thirteen teachers volunteered to complete the survey, and results are shown in Table 6 (next page). These teachers probably represent some of the most active and motivated teachers in the program, but their feedback suggests that, at least similar (although possibly reduced) impacts occurred for the other ATLAST participants. Most teachers appear to have increasingly adopted ICT for personal use, even though the training stressed educational applications. A large proportion of teachers trained have trained their students, so the expectation of second-level impacts of the training are being realized.

**Table 6. Results of Follow-Up Survey on Implementation and Impact**

Have you utilized technology for <b>personal use</b> , specifically as a result of participation in an ATLAST workshop?	62% yes	38% no
Have you utilized technology <b>with students</b> , specifically as a result of participation in an ATLAST workshop?	85% yes	15% no
*Please estimate the total number of <b>Education Professions</b> students with whom you have implemented classroom technology activities as a result of participation in the ATLAST Project.	Range: 15 to 48	Mean: 25
*Please estimate the total number of <b>other</b> (non-Education Professions) students with whom you have implemented classroom technology activities as a result of participation in the ATLAST Project.	Range: 0 to 150	Mean: 70

\* Some participants teach courses that are not part of the Education Professions Program

### **ATLAST Participatory Training Model**

The ATLAST Participatory Training Model was developed, evaluated, and improved incrementally as CTE Education Professions teachers progressed through a series of workshops that begin in January 2009 and continue today. The Model places teachers in a shared leadership role in which training agenda, objectives, and training format are strongly influenced by the needs and interests of participating secondary teachers. The active participation of teachers and the flexibility of the training staff in shaping the program to meet specific needs of participating schools and teachers have strengthened recruitment and retention. Enabling teachers to attend any of the workshops in the series that they can accommodate with their teaching and personal schedules, and providing ongoing learning and ICT skill development support in between workshops, has resulted in continuous increases in their technological literacy without disrupting their curriculum or services as full-time teachers. Providing such a flexible training program is very challenging and has some drawbacks. It is not possible to design such a workshop series so that each one advances to the next level of ICT expertise, nor is it practical to limit each ICT tool introduction or technology topic to one workshop. Some repetition and some additional support is needed to accommodate all participants, because there are always new folks attending, who have not been able to attend previous workshops. However, having teachers work together in diverse, collaborative teams generates much of this support spontaneously via peer-to-peer interaction. Teachers bring newcomers “up to speed” fairly quickly, and perhaps more efficiently than trainers. Thus, trainers are not faced with the impossible challenge of constantly “switching gears” (levels of learning support) for teachers with

widely varying technology skills and experience. Teachers feel less intimidation and anxiety toward “breaking into” the training and toward new technology being introduced in collaborative setting.

The Model stresses immediate ICT tool implementation by participating teachers even before they have mastered tool-specific skills and before they have learned the scope and limitations of the tools. This situates teachers in a “problem-solving” and “discovery learning” condition that would be daunting for those who have minimal technology expertise if they were working alone. Teaming with peers removes much of the hesitancy new learners feel. This is especially true when at least some peers in the learning team have more technology skills, are willing to share and describe their own early experiences with technology, and willing to provide patient assistance to newcomers. Collaborative learning and the integration of goal-oriented projects (e.g., implementing new ICT at school) with technology training are some of the most critical components of the Participatory Training Model. Applying what is initially learned at the workshops to actual curriculum preparation (e.g., creation of digital learning resources for students) or to real teaching tasks (e.g., teaching students how to use the same ICT tools introduced in the workshops) firmly anchors teachers’ new knowledge within the particular discipline they teach. This is a direct application of situated learning and cognition as described by the educational research literature.<sup>24,25,33</sup>

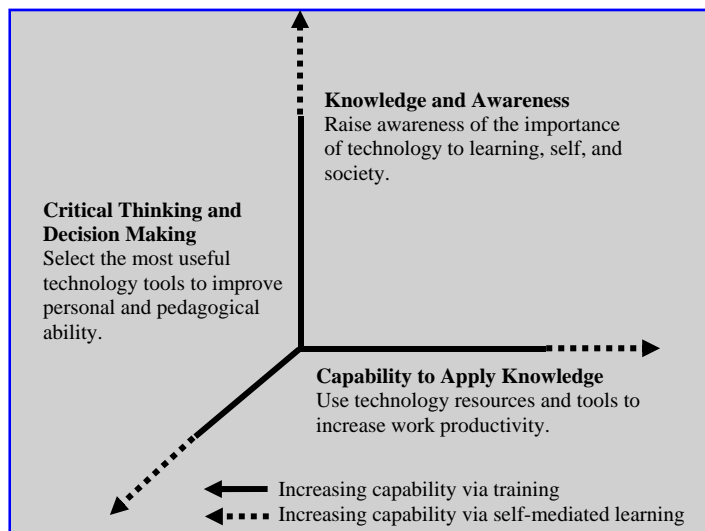
Since ATLAST participants were recruited from the CTE *Education Professions* Program, learning teams use ICT tools to develop Web-based instructional products in the form of interactive learning objects or presentations for K-12 students. The learning products are designed with features and functions that reflect pedagogical principles, learning objectives, and standards of the Education Professions program, so they could be immediately implemented within teacher’s courses without special approval for change of specified curriculum. Matching technology training format, content, and output of learners to the discipline and established curriculum they teach is another important component of the Participatory Training Model. Technology skills are then more likely to be conceived by participants as tools and resources that can improve their ability and capacity to teach rather than a separate or additional skill set. This strategy and its theoretical foundation is described as “technological pedagogical content knowledge” (TPCK) by Mishra and Koehler.<sup>23</sup> TPCK recommends that teacher professional development be designed to fully integrate technology curriculum with the respective subjects and courses that participants normally teach. The theory is well supported by research on situated cognition, which emphasizes the importance of learning in the context of learners’ personal goals and their professional workplace.<sup>24,25</sup>

Training strategies embedded within the Participatory Training Model also mirror active learning methods such as design-based learning (DBL), which has proven especially effective for teaching in the STEM disciplines.<sup>26</sup> DBL has been successfully applied to teaching STEM disciplines such as math,<sup>27</sup> engineering,<sup>28</sup> and bioscience.<sup>29</sup> DBL is especially well suited for technology training, whereby teachers and students learn by actively working together on projects that further understanding and learning in the discipline that they know best and care about most. Psychological and educational researchers have thoroughly examined and supported the teaching methods embedded in our Model. Supporting research has examined the effectiveness of DBL and collaborative inquiry for teaching and teacher professional development.<sup>30,31,32,33</sup> We have applied these theory-supported applications and added to this work by leveraging recent developments in social networking, collaborative ICT, and web-based media. ATLAST teachers research, learn, and leverage technology capabilities and methods that most teachers only here about secondhand.

Figure 3 (next page) shows a general model that influenced design and development of the ATLAST Model. Solid lines indicate learning progress via direct training at workshops, and dashed lines indicate continuing progress through self-initiated learning. Guided support of learning is gradually faded as learners achieve a foundation of ICT knowledge, skills, and self-confidence—at which point they are

comfortable and motivated to continue exploring and exploiting ICT on their own. The main goal of the Participatory Training Model is to assist teachers in reaching this point, where they have the resources and ability to continue independently.

**Figure 3. General Model for Training and Technological Literacy Outcomes**



The Model encourages goal-based work and collaborative projects, whereby teachers and students use ICT to develop their own discipline-specific products. For a student in Education Professions, such products are pedagogical (e.g., Web-delivered exploratory learning on topics relevant to education). For STEM students, topics and projects are chosen based on the specific discipline and domain of application. Bioscience students might apply ICT to produce lab protocols for conducting genomic research. The Model can also accommodate collaborative learning across disciplines. Interdisciplinary “learning teams” may

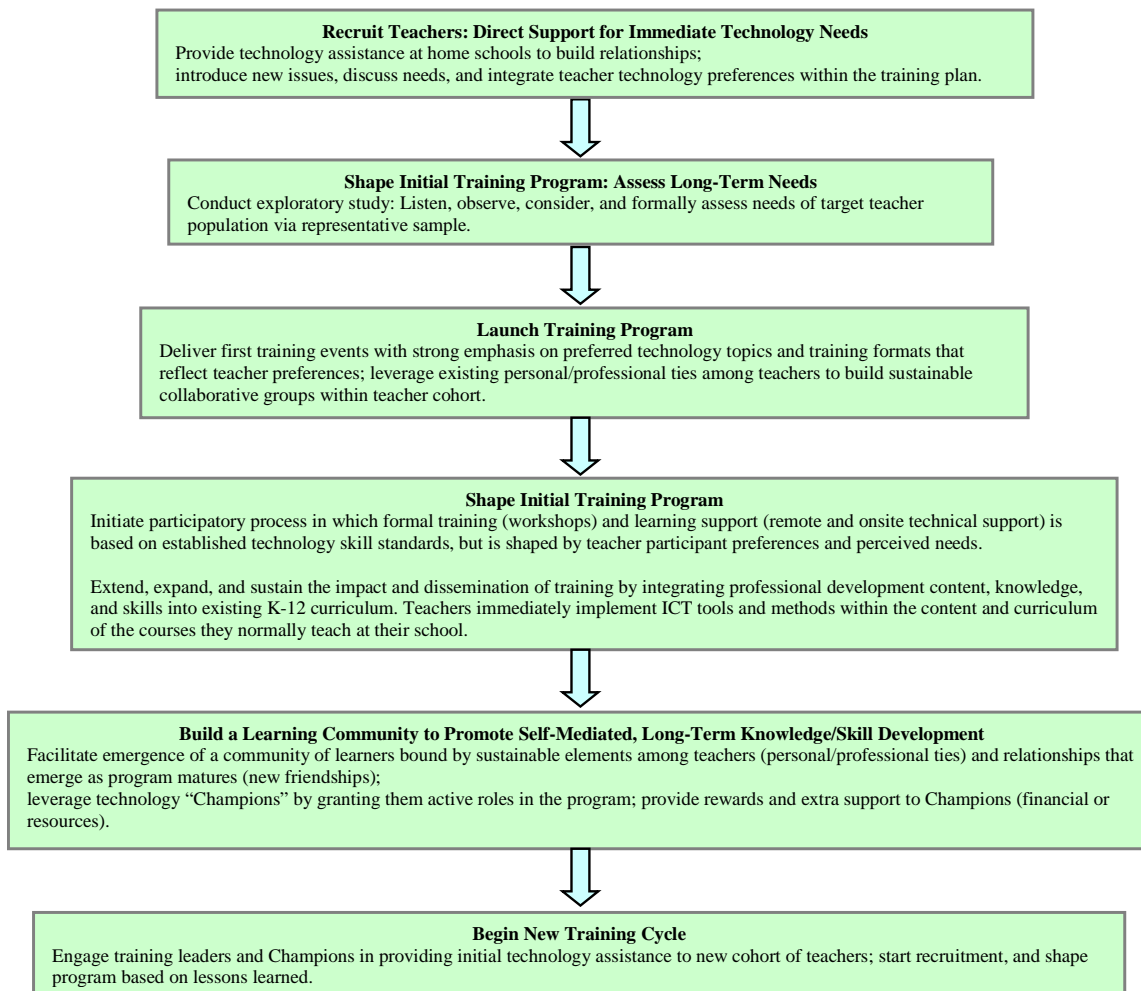
consist of teachers and students from different STEM areas, or collaboration can occur across teams that represent distinct disciplines. For example, a bioscience instructor may choose to include information technology (IT) students on her team to design a Web portal that facilitates online, collaborative research via genetic databases and other digital tools. This would call for an interdisciplinary team consisting of members from bioscience and IT. Table 7 presents selected components of the Model and impacts that can be expected from each.

**Table 7. Model Components and Associated Impacts**

Model Component	Associated Impact
Provide initial technology support to teachers as needed by each individual and school (e.g., training for newly purchased technology).	Teachers who received initial support tended to help others at their schools with technology and collaborate more in the workshops.
Conduct needs assessment to determine perceptions of participating teachers on technology needs, training expectations, and pedagogical goals.	Training is tailored to serve specific needs of target population and is delivered in a format that maximizes participation and retention.
Learners immediately apply ICT tools and new knowledge and skills by implementing them at home schools within their normal courses and curriculum.	Learners better understand the purpose and function of ICT and acquire initial skills in a meaningful, context-relevant environment—this improves knowledge/skill transfer.
Apply established, active learning methods: DBL, inquiry-based learning, and collaborative, goal-oriented learning at technology training events (e.g., workshops).	Learners acquire greater depth of knowledge of technology and build skills for applying technology tools and resources to discipline-specific tasks.
Reduce level of guidance (e.g., tech support) as learners gain a foundational understanding of ICT and skills for exploring and acquiring new ICT tools on their own.	Participants become independent learners and continue seeking new tools individually and collaboratively with their peers. Sustained, self-mediated learning enables leveraging of emerging technologies with minimal training intervention.
Provide intensive, long-term learning events and related social events to build a community of technology-savvy teachers.	Learning communities, with a focus on technology, ensure continuing progress toward greater technological literacy and growth of technology-enhanced learning across education.

Figure 4 shows the general sequence and flow of events and strategies that are implemented according to the ATLAST Participatory Training Model.

**Figure 4. Participatory Training Strategies**



### **ATLAST Training Format and Activities**

Trainers have covered many ICT tools and technology topics in ATLAST training with varying but positive results. Teachers were introduced to Web 2.0 applications that facilitate collaborative, goal-oriented activities. They engaged in collaborative projects in small teams and produced learning activities and resources for Education Professions courses using the Web tools introduced at workshops. The products of learning teams featured online, interactive presentations that focused on key topics of their courses, so they could be directly implemented at their schools and shared (via the ATLAST Web site) across schools that offer the same courses. Often, the same ICT tools used to produce the digital presentations or learning activities were part of the main content of the pedagogy they produced, because administrators of the Education Professions Program have increased their focus on student readiness to use technology. One student learning team developed a Google map that revealed the technology capabilities of local schools. Education Professions students who use the map will learn: (1) the capabilities of the Google Maps tool and how to use it to manipulate information (ICT knowledge and

skills) and (2) factual information on the dissemination and density of technology within the Phoenix educational system (discipline-specific knowledge). Thus, technology knowledge is firmly anchored within the discipline, the learning process, and in the memories of learners. This integration strengthens memorial links between abstract knowledge (i.e., learning about the tool) and concrete skill via personal experience and use of the tool (i.e., learning how to apply it for specific purposes).

Each ATLAST training workshop is taught by at least two trainers who take turns presenting new ICT tools and providing help among learning stations as learning teams engage in collaborative projects. Each workshop is typically organized around one to three “big ideas” that are explored by teachers and applied in the context of collaborative, goal-oriented projects. For example, one workshop focused on Web 2.0 image sharing, using “virtual field trips” as learning objects. Teams begin producing and demonstrating their own virtual field trips during the workshop and continued work on their projects at their schools. Many implemented the learning objects immediately in their own classes. Learning about methods and tools for mobile blogging was also followed up by “homework assignments” that engaged teachers in collaborating with their peers and teammates in the ATLAST training program. This led to more sharing of ideas, and perhaps more importantly, discovery of the power of electronic collaboration across geographic and institutional boundaries.

The ATLAST Participatory Training Model has some challenges relative to the level of flexibility needed in the training program. First, organizing topics, focus, and scheduling based on participants’ needs and preferences calls for some additional frontend work. Content development is based on assessments of current needs, so an examination of the intended audience, their curriculum, and their availability must be done prior to setting up logistics and workshop schedules. After training begins, additional fine tuning of content and focus are guided by formative evaluation and ongoing interaction with participants. Evaluations are conducted for each training event, and results of evaluations and proposed improvements are shared with teachers prior to implementation. Because the Model calls for participants to immediately apply their new knowledge and ICT resources at their schools, much effort and resources need to be allocated to helping teachers at their schools via school visits and by remote support provided online or by phone.

Technology must be integrated with the specific curriculum being taught, so trainers should have some expertise within the disciplines taught by participating teachers, or some other support mechanism must be in place. One method is to have technology trainers team with college faculty who teach in the same discipline areas as the participating secondary teachers. These faculty can help teachers integrate technology into the target discipline, and also help them connect secondary curriculum to college pathways. This strategy is best, if participants teach Science, Technology, Engineering, and Math (STEM) courses. Since our trainers have strong backgrounds in education and pedagogy, they were ideal for training Education Professions teachers. However, the ATLAST team’s plan to disseminate technology training to STEM CTE programs includes a mentorship component, whereby each STEM area is supported by a community college instructor with a strong industry background. These mentors will help teachers connect technology to the respective discipline they teach, and identify technical skill sets that are especially important for high school students to master in preparation for advanced study at college and the professional STEM workplace. These comprehensive elements require more time and resources than short-term training that teachers normally receive for professional development. However, impacts of the ATLAST Participatory Training Model are more extensive, longer lasting, and serve to create and expand sustainable communities of technology-savvy teachers.

### **Future ATLAST Research Efforts**

The ATLAST team would like to further expand the impacts of technology training by implementing the Participatory Model within Arizona's CTE STEM programs. STEM program administrators and teachers have already expressed a strong interest in receiving this training. The use of ICT is especially important for STEM disciplines in which technological advancement is rapid, and secondary curriculum has fallen behind recent scientific discoveries and new technologies. Web-based ICT enables teachers to seek out, tailor, and implement their own curriculum based on the latest information, which is now distributed online by NSF Projects and Centers as well as established STEM education websites like NOVA,<sup>34</sup> *Discoveries*,<sup>35</sup> *Science*,<sup>36</sup> and *EurekaAlert*.<sup>37</sup> Our team's plan focuses on enabling teachers and students to exploit ICT tools to keep up with the latest STEM advancements, academic and career pathways, and opportunities to connect with professionals in the field. The ATLAST team has received positive feedback from NSF Panel Reviewers on a preliminary ATE proposal that describes such an effort. This project would enable our team to further improve and implement the Participatory Training Model and the active, collaborative teaching and learning strategies that have proven most effective for secondary teachers and students. A research component for this effort has been proposed and would support training effectiveness and increase technological literacy of secondary teachers in a similar manner as achieved by the ATLAST grant.

### **References**

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- <sup>1</sup> Mattoon, J. S. (2008). ATLAST Research Report 1: Needs assessment, analysis, and implications for training (Report No. 1). Achieving Technological Literacy in Arizona for Students and Teachers (ATLAST), National Science Foundation Grant No. 802487, Tempe, AZ: Maricopa Community Colleges District, National Center for Teacher Education.
- <sup>2</sup> Mattoon, J. S. (2009, August). Achieving technological literacy in Arizona for students and teachers: Teacher summer institute and model development for technological literacy in secondary education (Research Report No. 3). Grant No. 802487, National Science Foundation, Advanced Technological Education Program, Tempe, AZ: Maricopa Community Colleges District, National Center for Teacher Education.
- <sup>3</sup> Mattoon, J. S. (2009, May). *Achieving technological literacy in Arizona for students and teachers: Implications of technological literacy research* (Research Report No. 2). Grant No. 802487, National Science Foundation, Advanced Technological Education Program, Tempe, AZ: Maricopa Community Colleges District, National Center for Teacher Education.
- <sup>4</sup> Di Benedetto, A. O. (2005, June). *Does technology influence teaching practices in the classroom?* Paper presented at the National Educational Computing Conference, Philadelphia, PA.
- <sup>5</sup> Mattoon, J. S., Agrawal, A., & Rodberg, S. (2006, March). Technology, teacher education, and electronic portfolios. Policy Brief Special Edition. Tempe, AZ: National Association of Community College Teacher Education Programs.
- <sup>6</sup> Project Tomorrow. Preparing today's students to be tomorrow's innovators, leaders and engaged citizens. Accessed 4/14/09: <http://www.tomorrow.org/index.html>
- <sup>7</sup> Pearson, G., & Young, A. T. (Eds.) (2002). Technologically speaking: Why Americans need to know more about technology. Washington, D.C.: Committee on Technological Literacy, National Academy Press.
- <sup>8</sup> Arizona Department of Education (2000). *Arizona Academic Standards: Technology Education Standards*. Accessed 4/20/09: <http://ade.state.az.us/standards/technology/>

<sup>9</sup> ISTE (2008). *The ISTE National Educational Technology Standards (NETS•T) and Performance Indicators for Teachers*. Accessed 4/20/09: <http://www.iste.org/AM/Template.cfm?Section=NETS>

<sup>10</sup> ITEA (2000). *Standards for technological literacy*. International Technology Education Association. Available online at: <http://www.iteaconnect.org/TAA/PDFs/xstnd.pdf>

<sup>11</sup> ITEA (2005). *Developing professionals: Preparing technology teachers*. Reston, VA: International Technology Education Association. Available on CD: ITEA, 1914 Association Drive, Suite 201, Reston, VA 20191-1539, 703-860-2100 or online: [www.iteaconnect.org](http://www.iteaconnect.org)

<sup>12</sup> McCandiss, B. D., Kalchman, M., & Bryant, P. (2003). Design experiments and laboratory approaches to learning: Steps toward collaborative exchange. *Educational Researcher*, 32(1), 14-16.

<sup>13</sup> Department of Education (2010, March). Learning powered by technology. Washington D.C.: Department of Education, Office of Educational Technology. Available: <http://www2.ed.gov/about/offices/list/os/technology/netp.pdf>

<sup>14</sup> Bransford, J. D., Barron, B., Pea, R., Meltzoff, A., Kuhl, P., Bell, P., Stevens, R., Schwartz, D., Vye, N., Reeves, B., Roschelle, J., & Sabelli, N. (2006). Foundations and opportunities for an interdisciplinary science of learning. In K. Sawyer (ed.), *Cambridge handbook of the learning sciences* (pp. 19-34). New York: Cambridge University Press.

<sup>15</sup> Venezky, R. L., & Davis, C. (2002). *Quo vademus? The transformation of schooling in a networked world*. Paris: Organization for Economic Co-operation and Development.

<sup>16</sup> Prensky, M. (2006). *Don't Bother Me Mom—I'm Learning! How computers and video games are preparing your kids for 21st century success—and How you can help*. St. Paul, Minnesota: Paragon House.

<sup>17</sup> Adelman, N., Donnelly, M. B., Dove, T., Tiffany-Morales, J., Wayne, A., & Zucker, A. (2002). *The integrated studies of educational technology: Professional development and teachers' use of technology*. Washington DC: SRI International.

<sup>18</sup> Department of Education (2010, March). Learning powered by technology. Washington D.C.: Department of Education, Office of Educational Technology. Available: <http://www2.ed.gov/about/offices/list/os/technology/netp.pdf>

<sup>19</sup> Ledesma, P., & Jarosz, S. (2009, June). Adding a touch of technology. *Teacher Magazine*, Available: [http://www.teachermagazine.org/tm/articles/2009/06/24/062409tln\\_ledesmajarosz.h21.html?tkn=NNWFLdwRvyFFHL5i9s6aNmzISeYPEPY4JoK%252B](http://www.teachermagazine.org/tm/articles/2009/06/24/062409tln_ledesmajarosz.h21.html?tkn=NNWFLdwRvyFFHL5i9s6aNmzISeYPEPY4JoK%252B)

<sup>20</sup> MacArthur Foundation (2008, November). *Living and learning with new media: Summary of findings from the Digital Youth Project*. Chicago, IL: MacArthur Foundation.

<sup>21</sup> Corno, L. (1986). The metacognitive control of components of self-regulated learning. *Contemporary Educational Psychology*, 11(4), 333-346.

<sup>22</sup> Salomon, G., Globerson, T., & Guterman, E. (1989). *The computer as a zone of proximal development: Internalizing reading-related metacognitions from a reading partner*. *Journal of Educational Psychology*, 81(4), 620-627.

<sup>23</sup> Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A new framework for teacher knowledge. *Teachers College Record*, 108(6), 1017-1054.

<sup>24</sup> Anderson, J. R., Reder, L. M., & Simon, H. A. (1996). Situated learning and education. *Educational Researcher*, 25(4), 5-11.

- <sup>25</sup> Choi, J., & Hannafin, M. (1995). Situated cognition and learning environments: Roles, structures, and implications for design. *Educational Technology Research & Development*, 43(2), 53-69.
- <sup>26</sup> Wiggins, G., & McTighe, J. (2005). *Understanding by design* (2nd ed.). Alexandria, VA: Association for Supervision and Curriculum Development.
- <sup>27</sup> Silk, E. M., Higashi, R., Shoop, R., Schunn, C. D. (2010). Designing technology activities that teach mathematics. *The Technology Teacher*, 69(4), 21-27.
- <sup>28</sup> Schunn, C. D. (2009). How Kids Learn Engineering: The Cognitive Science Perspective. *The Bridge*, 39(3), 32-37.
- <sup>29</sup> Ellefson, M., Brinker, R., Vernacchio, V., & Schunn, C. D. (2008). Design-based learning for biology: Genetic engineering experience improves understanding of gene expression. *Biochemistry and Molecular Biology Education*, 36(4), 292-298.
- <sup>30</sup> Doppelt, Y., Mehalik, M. M., Schunn, C. D., & Krysinski, D. (2008). Engagement and achievements in design-based learning. *Journal of Technology Education*, 19(2), 21-38.  
<http://www.lrdc.pitt.edu/schunn/research/papers/Doppelletalengagements.pdf>
- <sup>31</sup> McCandiss, B. D., Kalchman, M., & Bryant, P. (2003). Design experiments and laboratory approaches to learning: Steps toward collaborative exchange. *Educational Researcher*, 32(1), 14-16.
- <sup>32</sup> Sawyer, R. K. (2004). Creative teaching: Collaborative discussion as disciplined improvisation. *Educational Researcher*, 33(2), 12-20.
- <sup>33</sup> Zech, L.K., C.L. Gause-Vega, M.H. Bray, T. Secules, and S.R. Goldman. 2000. Content-based collaborative inquiry: A professional development model for sustaining educational reform. *Educational Psychologist*, 35(3), 207-17.
- <sup>34</sup> NOVA. Web site sponsored by the Public Broadcasting Service: <http://www.pbs.org/wgbh/nova/rss/>
- <sup>35</sup> Discoveries. Web site sponsored by the National Science Foundation: <http://www.nsf.gov/discoveries/>
- <sup>36</sup> Science. Web site sponsored by the American Association for the Advancement of Science and available at: <http://www.sciencemag.org/>
- <sup>37</sup> EurekaAlert. Web site sponsored by the American Association for the Advancement of Science and available at: <http://www.eurekaalert.org/>