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Direction, Magnitude, and Constructive Chaos: Identifying the Vectors of Technological Change in a College of Education

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Abstract: The faculty of the NC State College of Education (CED) is in the process of transforming its organizational culture to better support educators as they deal with a changing technological landscape. We are developing and refining a model for change that will help twenty-first century teachers understand both the use and the potential of instructional technologies. Our panel (comprised of the CED Dean, the IT Director, and two CED faculty members) will describe the creation of a fertile landscape for change within our college that has resulted, in part, from our PT3 Grant, *MentorNet.* We believe there is a direct relationship between identifying the force vectors of our model and building order out of what, at times, appears to be organizational chaos.

Twenty-first century teachers face challenges that stretch beyond what was expected of their counterparts only a few decades ago. It is now necessary for teachers to develop a critical understanding of the use and potential of instructional technologies along with a lifelong capacity to refine that understanding in the face of ongoing technological innovations. Simultaneously, today's teachers must blend these innovations with rapidly changing class content. Finally, and perhaps most importantly, they must cultivate a similar capacity to accommodate to change in their students. With all of this in mind, the faculty of the NC State College of Education is transforming its organizational culture to better support teachers as they grapple with education's changing technological landscape. As we articulate our evolving model for change, we hope to turn a lens on ourselves to better examine what we are about so that we can provide experiential information to colleagues attempting similar transformations. We believe there is a direct relationship between identifying the force vectors of our model and building order out of what, at times, appears to be organizational chaos.

In an effort to describe the creation of a fertile landscape for change within the NC State College of Education (CED), we present the work of the CED College Dean, the CED IT Director, and two of our CED faculty members. The creation of our new landscape is, in part, a result of our PT3 grant, *MentorNet* (Preparing Tomorrow's Teachers to Use Technology, U.S. Department of Education).

Leadership through Collaboration

The administration of a college of education must make choices about the leadership framework it will use. At NC State's CED, we have chosen a culture of collaboration that includes visioning, building organizational capacity, and sustaining strong yet flexible programs. Looking at relationships as a source of strength in the midst of change, it is important to examine the structures that support these relationships. Relationships between faculty in the same departments, across departments, and within the wider university are key factors in the implementation of change. Collaboration releases excitement and energy that can be a primary source of creativity for new work. Our PT3 grant pushed us to work in teams of faculty from three of our college departments. Arts and science faculty joined with teacher preparation faculty from neighboring institutions to forge new ways of teaching in technology-enabled environments. To further these partnerships and relationships, we invited input from a wide group of experts in the field of technology and learning. We also reviewed the research and publications of our own faculty as background material for invited presentations from professional associations and as a means of assessing where we are in the change process and where we need to venture next.

The vision for an organization focused on such relationships needs to involve everyone and be a strand (or force vector) that works throughout the college. The NC State CED vision states: "The College of Education is committed to being a leader and innovator in research, application and dissemination of effective strategies for teaching and learning through technology-enabled environments with the ultimate aim of preparing educators who foster high achievement for all students." This vision is aligned with issues facing both our state and our nation as we prepare for the opportunities inherent in an emerging knowledge-age economy. This vision must be available to everyone in our college, whether they are in Adult and Community College Education, Educational Research and Leadership and Counselor Education, Mathematics, Science and Technology Education, or Curriculum and Instruction. When we allow for individual freedom in ways of approaching the vision, the overall identity of our organization will be sustained. (This paragraph and the next don't flow too well. I think we need a transition here but I'm not sure what you'd like it to be.)

To build ownership of our vision and its implications for future practice, we must share the creation process with the people who will implement the vision. We firmly believe that the best way to prepare our students, tomorrow's classroom teachers, is to create a climate that includes exemplary teaching with a variety of technologies and materials they will be expected to use when they graduate.

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We believe we have an opportunity to focus the power of current and emerging technologies to transform the way we teach and learn. But as Margaret Wheatley reminds us, the issues that trouble organizations most are chaos, order, control, autonomy, structure, information, participation, planning, and prediction (Wheatley, 1992). A college of education is not exempt from these issues. The NC State College of Education is setting forth on a path of change and transformation that will give our faculty the opportunity to innovate in the face of educational issues and challenges. By taking this opportunity to change and grow, we plan to be a viable and dynamic system that will welcome the challenges of the future.

Capacity Building through Adaptation and Adoption

The introduction of technology into any organization -- whether it is business or education -- is directed in part by the dynamic forces of the potential of change through technology and the inertia of established practices

(Bruce, 1993; Cuban, 1986). Successful integration of any new technology involves a number of changes (Casson et al., 1997). The process usually starts with a few early adopters who are willing to work on changing larger organizational attitudes towards the technology. Change needs to happen in a number of ways to make this conversion successful. It means changes budgetary policy to make way for purchasing of the technology and setting up the infrastructure. It means budgetary and organizational change to make way for adequate service and support staff. And it means changes in work habits so that the technology is adapted and integrated into the mainstream activities of the organization. While businesses and educational institutions share this same basic evolutionary process, primary, secondary, and higher education all have unique characteristics that shape and influence the introduction of new technologies.

Through a slow evolution during the 1980's and 1990's, the College of Education at NC State University has grown from a single small lab of Apple IIe's to five labs each having between 15-25 student computers, computer-interfaced ('smart') marker boards, an instructor's computer, and a projector. These desktop computers -- both Macintosh and PCs -- are arranged in a variety of row configurations, with the instructor's computer at the front of the room. These labs are reserved for classes and otherwise available for open lab use. This computer resource model is not only typical of undergraduate education, it is also reflects the model used by many of the elementary and secondary schools in NC and the rest of the nation: classrooms with minimal computer infrastructure and a few (or one) fixed computer labs and media center.

Growth in computer facilities at the College of Education was hampered for many years by the lack of a continuing budget for computing resources. With computers treated as a capital expense, funding was low, uneven, and unreliable. The instituting of a university-wide student fee for computing meant both the establishment of a steady revenue stream and a larger change in organizational attitude that led to the funding of infrastructure improvements and paid support staff from other budgetary sources. Public schools in NC, however, continue to lack reliable funding sources in many counties, leading to uneven support for continued upgrades of computing technology and paid staff to maintain it.

Even with a generous level of funding for computer technology in the College of Education, integration into the core activities of the College continues to be an ongoing challenge. While administrative and research activities readily moved to the use of desktop computers for word processing, spreadsheet, and database management, integration into instructional activities has been slower. In institutions of higher education, the traditional lack of central authority means that this conversion typically happens one on one with individual faculty. There is the added fact that for most faculty there is no compelling and obvious reason why desktop computers would be particularly useful in a traditional classroom setting. Not surprisingly, the biggest use of the computer labs is by those instructors and curricula that were already heavily lab-based and teach activities centered on the development of computing skills. These same patterns can be seen played out in public schools for many of the same reasons.

Rapid advances in mobile computing technology has meant that laptop computers no longer are substantially more expensive with less computing power. Larger, higher quality screens, large hard drives and plug and play capabilities with numerous peripherals have made laptops near equal in quality to similarly priced desktop computers. Better battery life and wireless networking technology means that mobility no longer has significant disadvantages in these areas. While the technological hurdles for mobile computing has largely been overcome,

the organizational barriers mentioned earlier are still there. Effective use of mobile computing means shifting from College-owned, fixed computer labs to student-owned, mobile computing. This shift means a change in budgeting that requires students to come to school owning their own computers. Current College funding would then go into increased staff support, enhanced wireless networking, and more specialized computing peripherals. While the technical barriers for bringing computers into a traditional classroom setting have been largely removed, there is still the need to develop compelling models for how computing can be used in instructional settings other than traditional labs (e.g., Griffioen, Seales & Lummp Jr., 1999). Public schools, which has never been able to fully fund traditional computer labs and an adequately trained staff, face stiff hurdles in adopting new mobile computing technologies. Unlike institutions of higher education, they cannot mandate that students purchase laptop computers. They also have weaker networking infrastructure to build upon and less paid technical staff available for support.

Many of these issues came into play in a pilot project with sophomore and senior science education students the author participated in. These classes made use of wireless networked laptop computers owned by the College and brought into the class on a daily basis on a specially designed cart. The students were instructed on how animated graphics could be used to support science instruction. Students then created their own animations using Flash software for use in clinical teaching experiences out in secondary schools.

Because the students did not own their own laptops, the process of bringing the laptop cart down to the classroom, setting it up and having students take and set up their computers used up valuable time in the classroom. The use of laptops without a full range of removable media options also added to the difficulties of transferring files to the computers at the beginning of class. While the instructors of the class had considerable experience in teaching in traditional computer labs, there were many lessons learned about the instructional possibilities when computers are no longer rigidly fixed and dominating the classroom environment. These changes altered the ebb and flow between whole class instruction and individual work and the interactions between instructors and individual students and pairs and triads of students working together.

When it came time for students to take their projects out to their sponsoring secondary school, there were a number of factors that complicated their novice teaching experiences (Parkinson, 1998). The lack of computing infrastructure at the sponsoring schools made it mandatory students bring the College's laptops out to the schools for their lesson. While many schools had a projector the students were supposed to be able to use, access issues often made it difficult for the sponsoring teacher to borrow the projector for the presentation. Students who were already nervous about teaching their lesson now had the added burden of setting up and troubleshooting a laptop and projector in a classroom where the sponsoring teacher often had little experience with this equipment. In some classrooms, there was the added difficulty that the sponsoring teacher was either indifferent or mildly hostile to the use of computing technology in his or her classroom.

As with desktop computing, the integration of mobile computing into institutions of higher education will be a long-term evolution (Carlson, 2001). While computing is well established in many aspects of college and university life, faculty will need to be convinced on a one-on-one basis that mobile computing can be an effective tool in both the classroom and the lab. Colleges of education have the added burden of helping to facilitate the integration and coordination of this technology into both its institution and in the primary and secondary

schools. Reflection and lessons learned from the integration of desktop computing into organizations will provide valuable guidance as we move through the integration of this new generation of technology.

Creating a Collective Faculty Research Agenda

Research initiatives within the CED faculty are varied, reflecting a wide range of professional contributions and interests. Currently, approximately 35% of the faculty are engaged in research involving some aspect of the impact of instructional technology on education. These CED research agendas are predominantly aligned with specific discipline areas; however, collaborative, interdisciplinary research teams are emerging. For example, a team of faculty from three discipline areas, (i.e., social studies, science, and IT) within the College are studying the use of GIS on student learning. Additionally, a team of educators from three separate schools, (i.e., Computer Science, Design, and Education) are teaming to examine the effects of animated pedagogical agents on science and literacy learning. As our research agenda evolves and as we continue to build our College infrastructure for external funding, we anticipate that our capacity to support more complex interdisciplinary research agendas will increase.

In an attempt to recognize existing research on instructional technology within our College, we have synthesized particular lines of inquiry into the following broad-based questions.

- How can instructional technologies lead to students' understandings of math and science concepts? (Specific lines of inquiry include: scientific visualization, geometric and algebraic transformations, probability software, web tutorials for environmental science, animated pedagogical agents for botany concepts, technology beliefs and practices of math educators.)
- How can instructional technologies enhance reading and language arts teaching and learning? (Specific lines of inquiry include: developing phonological awareness through computer software, technology infusion in LA methods classes and teacher prep programs, literacy and web-based instruction, animated pedagogical agents for narrative learning.)
- How can instructional technologies enhance the school counseling process? (Specific lines of inquiry include: research and development on *Career Key*, a web-based career counseling tool [English and Chinese translation]; IT and elementary and middle school counseling.)
- How do new IT pedagogies enhance the learning of culturally, economically, and academically diverse students?
- How can GIS affect student learning in social studies, science and IT?
- How can instructional technologies enhance Technology education? (Specific lines of inquiry include: Internet learning systems, spatial visualizations, and computer-aided drawing and assessment.)
- How can middle school teaching and learning be augmented through a technology-enabled curriculum integration model?

Synthesizing the current research within our College serves a twofold purpose: 1) to recognize, articulate, and validate strands of current and projected research interests, and 2) to use this existing research platform as a catalyst for developing a more synergistic community of researchers. We believe that moving from disparate, individual lines of inquiry to a unified, college-wide research agenda has the potential to enact a sense of collective human agency. Such agency through community building can create what Sergiovanni (1994) refers to

as "a community mind," which exists when people feel connected to each other and work together for common goals.

Our goal is to create research-based models that lead to instructional practices that address both the efficacy of technology-enabled environments for teaching and learning and critically examine the impact of emerging technologies on contemporary educational practice. Ultimately, such a goal has the potential to yield a more equitable and excellent education for all children.

Facilitating Technological Change in the Classroom

Middle School Teacher Preparation**.** At times my efforts to integrate technology in my own teaching career, infuse it in the courses that I teach in middle grades teacher education and balance its use with what I know to be good teaching and learning practices for students, has me flying by the seat of my pants. I seem to be always in a state of development, designing and implementing lessons and projects that finish with a BANG, but are still in need of the follow-up reflection. Ask me where I am going and the signpost on the MASH television show springs to mind, arrows pointing in every direction. Recently, I paused to examine what I had recently done and where my students and I were going. I knew I wasn't off course, but which course? Here's what I found:

- a service learning curriculum integration project replete with GIS, PowerPoint, internet research, spread sheets, digital photograph undertaken with preservice teachers and a team of eighth graders and their teachers had become a component of another technology application in a graduate course that focused on building a website on curriculum integration. Amazingly, we spiraled the curriculum across two semesters and 130 learners.

- a virtual field trip project whose beginning was an actual trip supplemented by after-the-fact website construction grew into a follow-up trip in which preservice teachers journaled back in real time from Russia and has now grown a virtual field trip in which thousands will be able to participate because technology can take them there with us. This research project that examines how using the curriculum integration approach in a technology enabled environment affects student learning.

Other examples will be shared that show that some of the best teaching and learning in a technology enabled environment demands flexibility and imagination. You might not be able to always chart a straight course, but with technology you can go anywhere.

Social Studies Teacher Preparation. Driven by a new technology portfolio requirement for initial teacher licensure, Methods classes—already pressed for time—now expanded to include a computer lab component.Over the three years that the requirement has been in effect, we have

responded by creating a computer lab component in Social Studies Methods. Based in an undergraduate fall course divided into two main components; the first eight weeks of Methods and the second eight weeks of full time student teaching, a Friday computer lab has become an exciting component. I do not use the term exciting lightly—students are happily attending a 3:30-5:30 computer lab session. The hours are strange, but that was originally when the lab was free, and oddly enough, it's a time that has stuck and become very workable.

We designed modules and tutorials to set students onto tasks that were directly related to their student teaching practica. As a former Social Studies teacher who often used the computer lab (even in the 80s), this was not a foreign concept, and for future Social Studies teachers, computer integration cannot be. I describe this approach as expanding the landscapes of learning; that is, expanding to other parts of the school building, of the world (virtually) and into the greater community. The landscapes of teaching Social Studies should be broad, not isolated. The Internet helps to facilitate that expansion.

While I am expanding the landscapes, however, the time constraints remain the same, so the labs I designed had to be extremely time efficient. Below is a representation of the first eight weeks of Methods class with the computer labs highlighted. I will discuss student responses to the labs.

Date	Topic	Readings	Assignment DUE
8/22	What IS/ARE Social Studies?	Course Description	Writing: Some Questions to Begin with
8/23	History of Social Studies	Davis/ NC COS: Social Studies	
8/24	***Computer Lab***	***Web searches: Lesson plans*** DPI Technology Competencies	**2 Lesson Plans** from the Internet Skills of Beginning Teachers/DPI
8/29	Observing Learning & Teaching	Elements of Effective Teaching	HOW does the teacher make these things happen?
8/30	Learning & Cognition	HowardGardner: Frames of Mind	Reflections on ourselves as learners
8/31	**Computer Lab:** Technology Portfolios	*Introducing WebQuests*	**Observing** for ***learning:*** Hand in and discuss
9/5	Principles of Learning/	Cognition	HowardGardner: Frames of Mind
9/6	Observing Learning Discussion	Freire; Barr, Barth & Shermis;	Observing for Learning & Teaching:
9/7	***Computer Lab***	Power Point	Select a Module from UVa for testing
9/12	Planning: Methods Workshops	Unit Plan Format (Alibrandi)	Wigginton discussion
9/13	Whose History?	Akutagawa, Zinn, Wigginton	Hand in & discuss observations & Computer Lab reports
9/14	***Computer Lab***	**Constructing Class Websites‡**	http://www.ncsu.edu/ced/clt/workshops
9/19	New Perspectives on	Takaki, Brown	**Book reviews** and discussion

	History		
9/20	Practice for equity	Delpit, Sadler & Sadler	**Observing** for equity
9/21	**Computer Lab**	Technology Portfolio project construction	Developing **Teaching units** for presentation
9/26	**Methods Workshops:** Geography	**Alibrandi**	Hand in **Observing** for equity assignment
9/27	Geography	Student Presentations "	**Observing** for Planning
9/28	Economics	" ***Computer Lab Time***	
10/3	Legal & Political Systems	"	
10/4	World History/ World Cultures	"	Hand in **Obs.** for Planning
10/5	US History	" ***Computer Lab Time***	**Observing** for Management
10/10	Psychology, Sociology	"	
10/11	Law & Justice	"	
10/12	Civics	" ***Computer Lab Time***	Hand in **Obs**. for Management

After the second week of the computer lab sessions, I asked students to reflect on their learning about instructional technology integration. Some of their comments are very telling about the level at which they had ever considered integrating technology into their teaching practice. This should be prefaced by the fact that this particular undergraduate program is housed not in the College of Education, but in the College of Humanities and Social Science. Students take their 'professional' education classes in our college, bt for the most part are educated as History department majors. These comments come from a group of thirteen students, ten of whom were placed in practicum settings. Most of the students were unfamiliar with the concept of a Boolean search. Our first lesson was how to find teaching resources on the web to support Social Studies topics.

> "Prior to this class I was still somewhat [computer] illiterate…I have learned how to set up a webquest, which is pretty amazing to me and is baffling to my parents…I have not seen a lesson [] that directly brought the kids into a lab [at my practicum site]"*
>
> " I found out about lesson plans, student activities, role plays, simulations and webquests in my two lab sessions."
>
> "I've only had one lab session so far, but already I came out of it with a little more confidence about where on the web I can find SS lesson plans, info, databases, etc…It's nice to know with google, PBS, etc that I can pull up opinion pieces or factual info ad nauseam. I also learned how to pull up two pages at the same time and how to cut and paste websites [URLs into a webquest]."
>
> "I had no training in incorporating technology into a class…what have I learned? How to build a web page for a class."

> "I've learned several good methods of searching for good activities & lesson plans on the net…The webquest using Filamentality really helped me get a strong idea of how to build a web page that will contain several web pages with the same major content area … The only SSIT that I have seen in my setting is the showing of a video." [x 6 students]*
>
> "I feel I have learned so much about technology in the few sessions we have had so far. First, I never knew lesson plans could be found on the internet…The webquest was a new animal to me as well…This is wonderful because teachers can construct such great assignments using new technology."

These comments typify those from the remainder of the group. The two respondents * asterisked presented technology portfolio products to a (MentorNet, PT3) group of professional IT educators in a partnership workshop after five weeks of computer lab sessions. All of the students presented their technology portfolios at a reception at the end of their eight weeks of student teaching and each had implemented at least one of the products into their practice during those eight weeks.

Conclusion

We have explored solutions to complex challenges related to organizational and technological changes. This exploration and examination is an ongoing process. The vectors for technological change include the relationships between faculty, the autonomy and individual degrees of freedom for programs and faculty, the planning and prediction that a vision can enable, and participatory information and interpretation of the organization members.

References

Berger, C. F., Casey, R. L., Belzer, S. J., & Voss, B. E. (1994). Research on the uses of technology in science education. In D. Gabel (Ed.) Handbook of research on science teaching and learning. New York: Macmillan Publishing.

National Middle School Association. (2001). A 21st century research agenda: Issues, topics & questions guiding inquiry into middle level theory & practice. Westerville, OH: National Middle School Association.

Quinn, D.M. & Valentine, J.W. (2001). NMSA research summary #19: What impact does the use of technology have on middle level education, specifically student achievement? Retrieved August 30, 2001. Westerville, OH: National Middle School Association. http://www.nmsa.org/services/ressum19.htm

Sergiovanni, T. (1994). *Building community in schools*. San Francisco: Jossey-Bass.

Weller, H.G. (1996). Assessing the impact of computer-based learning in science. Journal of Research on Computing in Education, 28, 4, 461-485.

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Wheatley, M.J. (1992). Leadership and the new science: Learning about organization from an orderly universe. San Francisco: Berrett-Koehler Publishers, Inc.

Bruce, B. C. (1993). Innovation and social change. In B. C. Bruce, J. K. Peyton, & T. Batson (Eds.), Networked-based classrooms: Promises and realities, (pp. 9-32). London, UK: Cambridge University Press.

Carlson, S. (2001, March 21). Researchers Conclude That Wireless Technology Is a Double-Edged Sword. Chronicle of Higher Education.

Casson, L., Bauman, J., Fisher, E. R., Lindblad, M., Sumpter, J. R., Tornatzky, L. G., & Vickery, B. S. (1997). Making technology happen: Best practices and policies from exemplary K-12 schools (<http://www.southern.org/edtech/>): Southern Technology Council.

Cuban, L. (1986). Teachers and machines. New York, NY: Teachers College, Columbia University.

Griffioen, J., Seales, W. B., & Lummp Jr., J. E. (1999). Teaching in real-time wireless classrooms. Journal of Engineering Education, 88, 397-402.

Parkinson, J. (1998). The Difficulties in Developing Information Technology Competencies with Student Science Teachers. Research in Science and Technological Education, 16(1), 67-78.

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