CASE STUDY: THE NASHVILLE CENTERS

South East Advanced Technology Education Center For Communications Technology & Tennessee It Exchange Center/Center For Information Technology Education

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EXECUTIVE SUMMARY

A progression of ATE projects and centers in Nashville Tennessee supported multiple innovations to define a new model for technological teaching and learning – a model that would contextualize technological content for students and teachers within pedagogy grounded by the latest knowledge in cognitive science. The Tennessee IT Exchange Center (later known as the Center for Information Technology Education, CITE) was organized to disseminate and scale the innovations developed through two previous ATE grants (TEFATE and SEATEC) and a concurrently funded companion ATE project (The Case Files). A groundbreaking partnership between faculty at Nashville State Community College and researchers at Vanderbilt University opened a new perspective for educators from both institutions. Each grant was leveraged to solve another piece of the puzzle of skill development for the technical workforce.

RE-ENVISIONING THE EDUCATIONAL NEEDS FOR A TECHNICAL WORKFORCE

In 1990, Saturn Corporation, a partnership effort of GM and The International Union, United Automobile, Aerospace, and Agricultural Implement Workers of America, better known as the United Auto Workers (UAW), opened its new automobile manufacturing plant in Spring Hill, Tennessee. The state-of-the-art plant, which brought 5,000 new jobs to the Nashville area, was based on a merging of advanced manufacturing with new workforce models that relied on semi-autonomous small work teams. The plant required workers that could not only support a highly automated computer-controlled manufacturing process, but also have strong teamwork, critical thinking, and problem-solving skills. For the local educational institutions, this exemplified what skills industry was looking for in new hires and was a huge jolt that challenged many of the traditional paradigms of teaching and classroom experience.

The technological advances that came with the Saturn Corporation in Nashville highlighted and widened the gap between the skills that employers needed for the workplace and the way students were being prepared in educational settings. Employers were looking for employees with both technical skills and the ability to problem-solve – workers for this new world of work would need to come to work prepared with higher-level thinking skills.

In 1975 when I arrived at Nashville State Technical Institute, hiring practices at the college required all new faculty to have three years of relevant industry experience. The intent of the policy was to ensure that teachers understood the workplace and therefore would be able to structure student learning based on current workplace practices. As rapid change due to technological advances took hold in the next two decades, the workplace experiences of teachers became woefully out of date. Sometimes, the experience teachers were relating to students was so old it became a negative in the student's educational experience. We were looking for a way to address this when the first ATE solicitation was released and the idea of the teacher externships was funded.

—Sydney Rogers, PI and Dean for Technology in 1995 at Nashville State Community College.

Business leaders at the Nashville Area Chamber of Commerce were beginning to see that the workers they employed possessed industrial era production line skills, and that workers with higher cognitive skills necessary for the new automated environment did not exist. The business leaders approached the leaders at Nashville State Community College to ask for help to prepare more students for a rapidly changing workplace and do a better job preparing students with skills that couldn't be outsourced or automated. It soon became clear that to better prepare students, faculty would need to be prepared first. PI Rogers commented that "It was a huge shift and what the employers were saying they needed in the workforce, well, we weren't producing it."

Many teachers were offering traditional courses that relied on rote memorization without context. The educational institutional infrastructure included strict one-hour classes that, according to PI Rogers, meant "neatly lined rows of forward facing desks, a dearth of options to move the classes outside the formal classroom, and many other structural and cultural factors hindered the ability of individual teachers from creating engaging and effective learning environments that would produce the results our local industry needed."

Changing teaching and learning to include a rich environment with contextualized workforce skills and active participation from students was a bigger challenge than anticipated and involved much more than a focus on the instructors in isolation. The team had to develop an infrastructure within the institutions that would support the new change, create long-term partnerships with business and industry to provide the needed context in real-time, partner with educational institutions from pre-k through college, and build and maintain a structure that would connect all the partners in a way that would be sustainable. A systemic change was needed.

Over the next 15 years, multiple ATE grants built a model for education that would, through real workplace experiences, prepare technicians to be able to identify and solve real-world problems. The model required partners from business and industry to provide up-to-date context, K-12 education partners to build a continuum of educational experiences, community organizations to support underserved students so that they could be successful, and universities to offer the students continued learning opportunities. To create and sustain all these partnerships, an infrastructure was needed that would formalize communication, strategy and tactics. In Nashville, an extensive set of community partners, both nonprofits and businesses, helped to organize and train business partners so that they would be consistent and effective partners for teachers and students across all of the high schools.

BUILDING INSTRUCTOR CAPACITY

Tennessee Exemplary Faculty for Advanced Technological Education (TEFATE)

In 1996, the Tennessee Exemplary Faculty for Advanced Technological Education (TEFATE) project was funded during the first round of Advanced Technological Education (ATE) funding. The aim of TEFATE was to provide current workplace experiences for community college instructors in engineering technology.

TEFATE served to highlight the need for more extensive professional development for an interdisciplinary group of technology faculty in the integration of science, mathematics, language, and cognitive science – a vast departure from the highly focused technical engineering content they were accustomed to receiving in past professional development activities. A primary product of this project was a set of case studies designed to deliver academic content and develop problem-solving skills in engineering technology courses. Though case studies were used in business, law and education courses, they had not been used in technological education. Thus, the collaboration with business was essential. In a paper presented to the American Society for Engineering Education (ASEE), Susan Randolph, a faculty participant, commented that "Clearly, without businesses willing to participate in providing information about their real-world problems and

South East Advanced Technology Education Center (SEATEC)

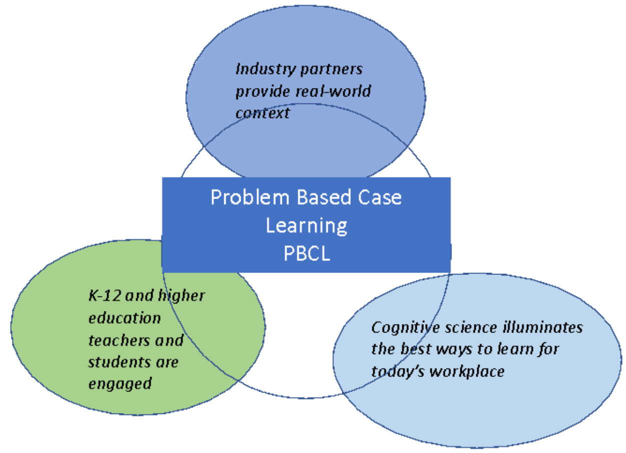
The South East Advanced Technology Education Center (SEATEC), a large ATE project, was awarded as a follow-up to the TEFATE project to better prepare faculty to create a work-based learning environment in support of the IT and telecommunications industry. The leadership team sought to change the way teaching and learning happens in the classroom, specifically to provide a more current workplace knowledge base and context for the teachers so that they could in turn deliver more current and relevant learning for the students. Through the TEFATE grant, the team learned that they needed a professional development approach that supported interdisciplinary teams. As a result, SEATEC developed interdisciplinary teams from six community colleges across Tennessee. Each team consisted of seven to ten members, including faculty from academic and technology departments and representatives from industry, four-year universities and secondary schools. An important feature of the project provided faculty with industrial externships. The outcomes resulted in a system of strong linkages among secondary schools, colleges, industry, and government within the IT and communications technology discipline. In 1998, the without their willingness to assist in proofing drafts for technical accuracy, there would be no case studies."[1]

Center was renewed and expanded to continue to build the novel approach to faculty development.

PROVIDING A WORKPLACE CONTEXT IN THE ACADEMIC ENVIRONMENT USING RESEARCH ON COGNITIVE SCIENCE

Problem-Based Case Learning

Problem-Based Case Learning (PBCL) was the major innovation from the first two ATE grants. PBCL is a model based on Problem-Based Learning (PBL). PBCL structures a learning environment that includes a workplace context, an interdisciplinary focus, and a specific emphasis on research-based cognitive science. Unlike Project-Based Learning, where students are given a project to deliver, in PBCL, students create solutions based on expected outcomes and needs. The end result is not previously defined but rather, a solution created based on the contextual environment as the student understands it.



Though there are similar models of contextualized learning, PBCL is unique in that the context is directly aligned with workforce need, and cognitive science principles support knowledge transfer in the PBCL process. In PBCL, students learn to understand the success criteria of the stakeholders, and then make decisions on how to best address them and how to compromise. Design principles and systems thinking are embedded into the process. Forming at a time when the dot-com bubble burst, many IT-related jobs were being filled internationally. There was a growing realization among those in the IT community that offshoring wasn't going to work for all of the nation's IT needs, and the job opportunities that remained would require a contextual understanding. TNIT Exchange Center PI David McNeel said that this approach develops students who are "better prepared to move into industry, rather than graduating technically competent but contextually naive students." For more about PBCL, see: http://www.makinglearningreal.org/index.html

To meet today's need and at the same time build a workforce that meets tomorrow's needs, we must move beyond traditional curriculum development methods that focus on silos of content with little context. We need to develop teaching and learning methods that foster learning, thinking, and problem solving in the context of the real world. Not only do workers need to know how to use their knowledge "in context" but educational research has shown us that such methods produce great improvements in learning and that students prepared in this way more easily transfer what they know to new and different situations.
—Sydney Rogers, 2004 congressional testimony

Learning Technologies Center- Vanderbilt University

At the same time that SEATAC was working on PBCL at the community college through the ATE grant, John Bransford's team of cognitive scientists at Vanderbilt were deeply involved in developing curriculum, materials, and professional development for K-12 teachers (and some engineering classes at the university) with other NSF funding. Closely aligned, the researchers were developing learning environments for traditional academic environments, and the ATE teams were developing learning environments that would bring a workplace experience to the students and teachers at the community college. Both groups were focused on real-world contexts, but in very different contextual environments. Program officer Gerhard Salinger connected the two Nashville-based organizations. Through the partnership with the cognitive scientists at Vanderbilt, the Nashville State Community College team came to realize that all learning should be based on what we know from research in teaching and learning. This meant that all students on the continuum of learning from early childhood through college needed to experience learning in similar ways for the best outcomes. The work of the Nashville State Community College teams gained an academic and

[1] Randolph, S. (1999, June). Case Study Development Under the TEFATE Project. Paper presented at 1999 Annual Conference, Charlotte, North Carolina. https://peer.asee.org/7996

research lens that could strengthen the integration of academic subjects in a workplace environment, while the Vanderbilt teams gained a workplace lens that could strengthen education and training programs for industry. Through the experience, the team discovered that a support structure to keep all of the partnerships going would be essential to ensure the changes would last.

SCALING PBCL

Tennessee Information Technology (TNIT) Exchange Center → The Center for Information Technology Education (CITE)

In 2002, building on the partnerships and results established by the TEFATE and SEATEC projects, the Tennessee Information Technology (TNIT) Exchange Center (rebranded after award to The Center for Information Technology Education, CITE), led by PI David McNeel, was formed to continue the work by engaging faculty and students in long-term relationships with experts from industry. Student, faculty, and industry expert teams created real-world scenarios based on industrial needs to be used as the basis for instruction in IT courses. Model cases and learning strategies were developed in workshops with the Center for Learning and Teaching at Vanderbilt University.

A very early ah-ha moment came when we began to introduce "case studies" in the community college classes. The case studies (we called them "The Case Files") were formulated based on the externships the teachers had done. When students in the community college were challenged to be really involved in their own learning rather than passively sitting in a lecture, their first reaction was to revolt. "This was bad teaching," they said. After all, they explained, the teacher is supposed to do all the work and the teacher is making us do all the work. This is one of the many reasons we began to realize the change had to be systemic, all the way up and down the educational continuum. Students needed to expect it was their job to learn, and it was the teacher's job to create the right environment for learning.

—Sydney Rogers, PI and Dean for Technology, Nashville State Community College[2]

The Case Files

"The Case File" companion project to the TNIT Exchange Center was funded in 2002 to nationally disseminate the professional development programs developed jointly with the Vanderbilt cognitive scientists. Co-PIs served on both grants to ensure the cross-pollination of efforts. Through the Case Files, around a dozen workshops were held throughout the country each year for community college faculty serving hundreds of faculty and dozens of community colleges.

The final evaluation report notes that "The three-year sequence of workshops, design events, institutes, seminars and conferences devoted to understanding, developing and disseminating substance and process related to learning environments featuring problem-based case studies...has gone a long way to establish a recognized community of practice among community colleges, colleges & universities, and high schools...one can discern a flow of events – each event building on a prior happening – that grew steadily in sophistication, participation, output and acceptance."[3]

Our contextual and problem-based methods all share some common characteristics. First, they are all based on authentic workplace problems. To bring these authentic workplace problems into the classroom requires a close and consistent working relationship with our business and industry partners. Just as technology and the workplace are changing constantly, these authentic experiences must also change. By implementing these experiences for students we are also building a curriculum that adapts and changes with changing technology and situations. Using these methods, then, we can create an educational system that builds a closer link between the content taught and the actual workplace application while also developing workers who are more able to adapt the knowledge they have to a rapidly changing world. Finally, to effectively teach using these methods, faculty must learn to function as highly skilled facilitators who guide students to discover and understand the appropriate scientific and technical knowledge.

—Sydney Rogers, 2004 congressional testimony

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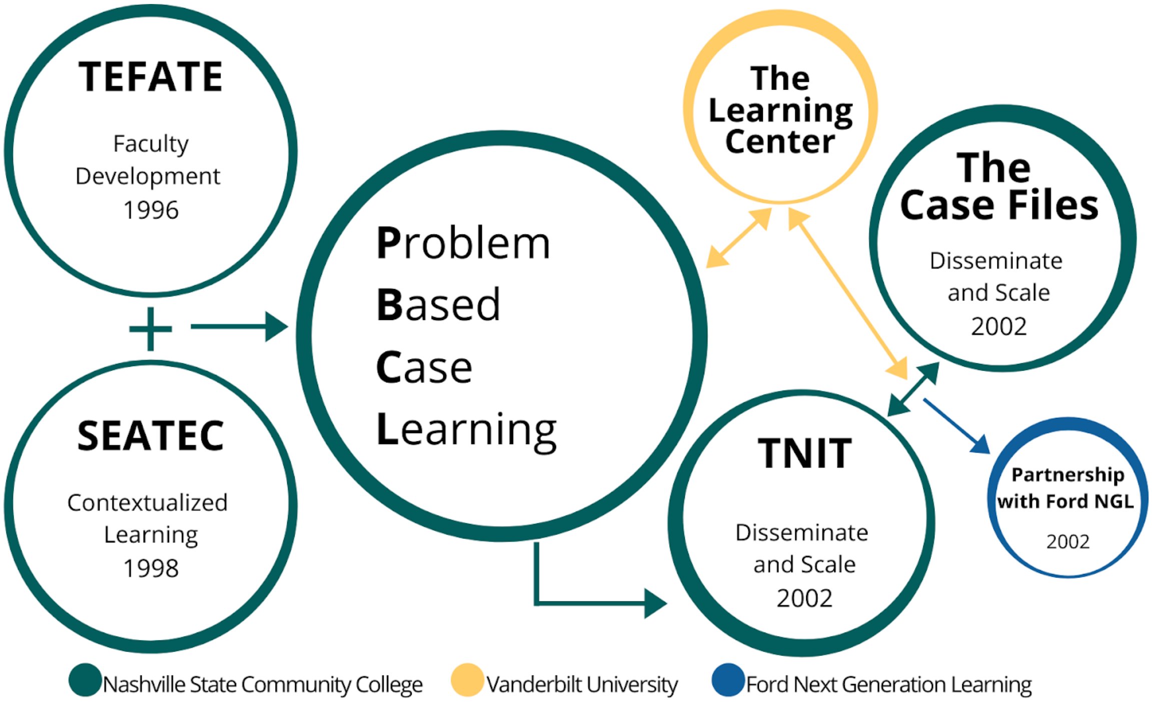
[2] Sydney Rogers and George van Allen, "Transferring Teaching and Learning Research to the Classroom," *Community College Journal*, 2003, pp. ss15-ss16.

[3] Final evaluation report, p. 34.

The Nashville ATE Ecosystem - Scale to K-12



EXPANDING THE TECHNICAL EDUCATION PATHWAY INTO K-12

Recognizing the Need for STEM Pathways

A 2000 S-STEM grant at the college provided scholarships to underrepresented students in STEM. These grants were intended to provide a full scholarship for the targeted students, yet the college struggled to give away all the scholarships. Academic counselors at the community college were able to convince only a handful of entering underrepresented students to enroll in engineering and technology majors. During the admissions and advising process at the college, the counselors developed an understanding of the extent to which math, science and engineering came across as boring and uninteresting to children in K-12 education. PI Rogers said that "we speculated that the primary reason was because the teaching methods were not engaging or interesting for most students. **As students came to the college to register, the vast majority of students who chose the engineering and technology majors were white males. What good would it do to make teaching and learning more relevant and engaging when we still could not attract a diverse group of students?"**

At that point PI Rogers realized "there was very little interest in the STEM programs amongst the targeted population of those coming out of high school." Model academies in the high schools were born as a way to generate interest among high school students. (A Perkins Tech Prep grant funded the first experimental model IT academy at the Middle College High School, located at the community college.) The vision included a new high school structure that embraced the PBCL model (career academies), business partners that helped interdisciplinary teams of teachers develop

Role of Research and Evaluation

Throughout the efforts there was a close relationship with the evaluation firm supporting the grants. The evaluations clearly focused on the goals of the grant, both providing a mechanism for tracking progress and assessing outcomes. For example, the evaluation reports contain a timeline of key milestones and significant events that helped justify the logical progression of the work. Formative surveys and interviews with stakeholders helped set priorities. Finally, quasi-experimental design contextualized programs, and industry certifications in IT for students graduating from the high school career academies. These efforts were packaged and funded through an NSF ATE center grant "focused on teaching and learning and creating a pathway for students from high school career academies to the community college." The PBCL examples were tailored for use in high school academies to interest high school students in IT careers and expand the pipeline into IT careers.

studies demonstrated significant differences in student learning. The data made available helped shape the direction of the projects over time.

BY 2005, CITE had developed a clear K-12-14 educational system by:

- Engaging K-12 students by developing three IT academies
- Introducing students to IT careers through summer workshops
- Developing working relationships and articulations between K-12 and local community colleges
- Providing professional development workshops for IT faculty from eight of the area colleges
- Developing trusting partnerships with several local educational organizations including public school departments, nonprofit organizations and area businesses
- Using evaluation data to monitor the impact on students and value to the partners

A Collective Impact Approach to Pathway Support Alignment Nashville

In 2005, the broad base of stakeholders organized into a new organization, "Alignment Nashville," with the express goal to "strategically coordinate the work of community-based organizations that work with the public schools and to align them toward a single agenda – the agenda of the school district." The US Department of Education was also investing heavily in Nashville, particularly through the 2006 "Smaller Learning Communities" grant supporting the career academies. An infusion of philanthropic support further diversified the Alignment Nashville portfolio. For more information, see:
https://sydneyrogersconsulting.com/writing/high-school-transformation

With the private and public investment, a rigorous curricular approach, teacher professional development, a structural model for the schools, and the urgency of crashing achievement and graduation rates, the team had all the pieces to make systemic change. As PI Rogers noted, "the academies are the structural part, the PBCL is the meat on the bones."

Every high school in Nashville has since been transformed into an academy, and they have led the state in academic improvement. Students in these schools receive contextualized learning in STEM, increasing their awareness of STEM education and career opportunities, as well as increasing their academic preparedness. At the first IT Academy, the PBCL approach had a measurable impact on attendance, where 98% of students in the IT Academy attended school compared to 83% of the general student population. At another IT Academy, the retention in the IT track went from 10% to over 70% once PBCL and faculty development were put in place.[4]

Alignment Nashville receives so many inquiries from other communities that it now provides information and consulting to help establish similar initiatives in 10 other cities through Alignment USA.

Scaling through Partnerships with Ford Motor Company

The Ford Motor Company Fund invests in communities to improve STEM education from K-12 through community college. Though active since SEATEC, the partnership with Ford Motor Company Fund deepened in 2010. The positive student outcomes in Nashville led the Ford team to expand their work to include partnerships and professional development in teaching and learning. The addition of professional development focused on best practices in teaching and learning and research-based cognitive science was an important improvement in the Ford Fund's work. Ford released a new curriculum that embraced the PBCL model, complete with teacher professional development. Today, Ford Next Generation Learning is working in more than 40 communities across the country. (See https://www.fordngl.com/ for more information.) However, as Ford scaled the PBCL model to more communities, some of the "purity" of the original work was diluted and actually lost in some cases.

Scaling Leads to Adaptation

Introducing this new approach to teaching and learning at a very large scale necessarily introduces hundreds and even thousands of new teachers, administrators, business partners and others who control the implementation in their own

[4] 2005 CITE final report to NSF, p. 10.

communities. Factors such as politics, control, resources, and funders always negatively impact the fidelity of the implementation. Specifically, the PBCL model builds on the cognitive science research base developed through Vanderbilt that facilitates knowledge transfer from faculty to students based on the workforce context. Many of the partners lacked the resources, motivation, or structures to fully invest in this element of the model.

> **Even though the Nashville team knew that some of the features of the original model would be diluted or lost, they recognize that the extensive involvement of business and industry partners and active learning practices would certainly move the needle toward improved experiences for students. As PI Rogers said, "My only regret I do have is that as we scaled we lost some of the integrity and rigor of the model. You take pieces out of a system and still get some benefit, but you don't get the full benefit. There were just too many people, too many hands in the pot, too much politics, too many people controlling it, too many superintendents and others involved.**

People would look at the model and pick and choose the parts they wanted to keep. We never got as far as we could get, and the 'how people learn' research brought in through the Vanderbilt partnership was really embedded in all of this but hard for people to fully understand the importance and adopt it."

LESSONS LEARNED

- "Learning is a social process and experience is an essential element of the process."[5] This lesson applies to both the PBCL model integrated into the schools and also to the efforts that the Tennessee ATE work took over time.
- To effectively transform teaching and learning, changes in the teaching and learning structure and culture must also be addressed.
- Learning in context, and especially in the context of the workplace, is a characteristic consistent with effective practice as defined by research in teaching and learning.
- Collaboration, through partnerships with employers, other educational institutions, and community organizations, will strengthen and sustain the educational transformation.
- To achieve real systemic change, the entire pipeline of education, from pre-k through higher education, should be addressed.
- Educational transformation will be most effective if teachers and partners understand the lessons we have learned from research in cognitive science.
- Leveraging multiple grants and funding sources can help expand and sustain the work started by a single project.
- To scale positive outcomes to others, partner with organizations with capacity for scaling and a passion for the work (Ford Next Generation Learning).
- Planning time is important. Initiatives that are given careful consideration and solicit input from an array of stakeholders are more likely to meet the needs of the community and can take advantage of existing structures and resources when possible.

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[5] Evaluation report 2006, p. 85.