

# LESSONS LEARNED FROM EFFORTS AT INSTITUTIONAL CHANGE: CASE STUDIES OF SIX OCEPT INSTITUTIONS

---

T.G. CHENOWETH and M.K. KINNICK  
*Graduate School of Education, Portland State University*  
Portland, OR 97207-0751  
Chenowetht@pdx.edu; Kinnickm@pdx.edu

R.D. WALLERI  
*Research and Planning, Mt. Hood Community College*  
Gresham, OR 97030  
Wallerid@mhcc.edu

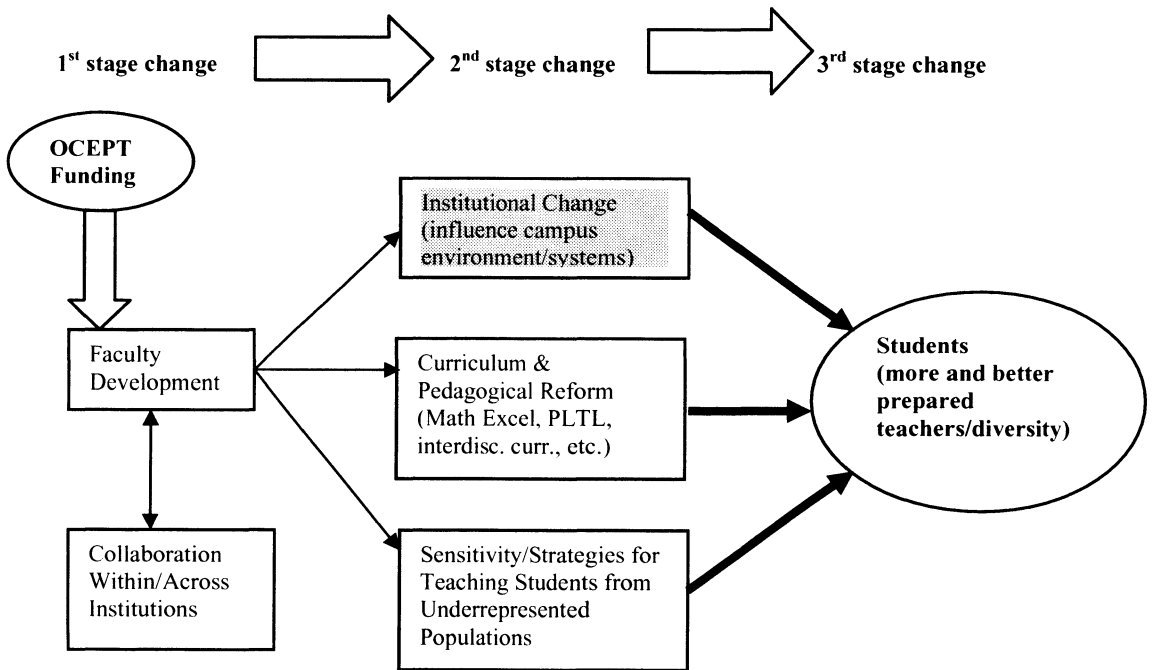
## Abstract

As one part of a multifaceted evaluation of the Oregon Collaborative for Excellence in the Preparation of Teachers (OCEPT), a case study approach was used to enable a deeper understanding of how a diverse group of six institutions attempted to achieve OCEPT goals and to learn more about factors that facilitated or hindered their efforts. Multiple sources of data were used, with heavy reliance on a series of on-site interviews. The analytical framework included a “depth” and “pervasiveness” typology of institutional change and a view of change as encompassing “meaning,” “organization,” and “effects.” While goals and accomplishment levels, as well as the depth and pervasiveness of change, varied across the six institutions, OCEPT-influenced changes most likely to be sustained included: new kinds and levels of faculty collaboration; peer-led teaching and learning approaches, and attention to evidence that these approaches positively affect student course performance; increased faculty awareness of their role in teacher recruitment, with related changes in classroom practices; and, continued strengthening of access to information and academic advising for those preparing to become teachers. These institutions, however, did not make significant progress on one major goal of the project—to increase the numbers of underrepresented groups interested in teaching careers. Change was affected by the compatibility of OCEPT goals with institutional and faculty culture, as well as by local collaborative leadership, the size and complexity of the institution, the presence of “boundary spanners,” and how OCEPT resources were used.

## Introduction

The Oregon Collaborative for Excellence in the Preparation of Teachers (OCEPT) is a statewide collaboration of institutions of higher education dedicated to strengthening the math and science preparation of future teachers and encouraging greater involvement of underrepresented groups in the teaching profession. Many other collaboratives funded by the National Science Foundation (NSF) have focused primarily on changes to specific courses

required for initial teacher licensure and involved a relatively small number of institutions. OCEPT’s strategy for change relied heavily on faculty development, including the introduction of teaching and learning strategies designed to further the goals of OCEPT, and involved 36 different institutions (public, private, two-year, and four-year). Figure 1 depicts OCEPT’s “theory of change,” derived by the authors from a review of OCEPT’s planning documents and reports. Expected outcomes, labeled as “3<sup>rd</sup> stage change,” are a greater number and a more diverse group of K-12 teachers better prepared to teach mathematics and science. These outcomes flow from a series of interventions. In “1<sup>st</sup> stage change,” the focus is on faculty development and formation of a series of inter-institutional disciplinary teams as well as several statewide interdisciplinary teams. In “2<sup>nd</sup> stage change,” the focus shifts to efforts to affect broader change in a smaller number of institutions, to bring about specific kinds of curricular and pedagogical reforms across institutions, and to increase faculty capabilities for teaching diverse learners.



**Figure 1. OCEPT Theory of Change.**

During the third year of the project, a focus on institutional-level change was added to that of the initial focus on individual faculty development. This strategy was designed to bring about institutional change that could be sustained in furtherance of OCEPT goals. Six “core” institutions from among the 36 initially involved with OCEPT were selected for special attention and resource allocation over the final three years of the project.

A case study methodology, one part of the multifaceted formal evaluation of OCEPT, was designed to address two major questions: 1) did these core institutions achieve OCEPT goals, and if so, to what extent? And, 2) what helped or hindered their efforts? The case study approach was designed to enable a deeper understanding of how a diverse group of OCEPT institutions attempted to achieve OCEPT goals and to learn more about the process of institutional and faculty change and the major challenges to such change. Findings on “lessons learned” are aimed at leaders in institutions considering a similar change effort, prospective funding agencies of such efforts, and those involved in the reform of mathematics and science education.

The case studies are built on institutional documents, OCEPT participant project reports, and a series of on-site interviews with both OCEPT participants and others at the institution with an interest in or involved in activities related to the goals and objectives of OCEPT.

### **The Case Study Design**

Selection of Institutions — Using the criteria shown in Table 1 (not all of which applied to each of the institutions selected), the six institutions selected were: Oregon State University (OSU), Portland State University (PSU), Pacific University (Pacific), Portland Community College (Cascade and Sylvania campuses) (PCC), the University of Portland (UofP), and Western Oregon University (WOU). In the selection process, consideration was also given to the institution’s potential for moving beyond selected faculty and departments to a broader institutional effort in achieving the OCEPT goals. For example, Portland Community College was included since it has the highest enrollment level of minority students among OCEPT institutions. The result was a mix of types of institutions, including two private universities, one large urban community college, and three state universities. Among the three state universities, one began as a teacher’s college (WOU), another is the state land grant university (OSU), and the last is the state’s public urban university (PSU). Table 2 provides a brief overview of these institutions.

**Table 1**  
**Criteria Used to Select the Six Case Study Institutions**

- Critical mass of faculty fellows from OCEPT Years 1, 2 & 3
- Perceived presence of strong local leadership
- Diversity of institutional type (private-public, 2yr.-4yr., research-teaching mission)
- Relatively large teacher education program
- Diversity by level of teacher preparation program offered—a mix of undergraduate and graduate programs
- Likelihood that faculty fellows' courses/projects are serving, and/or will serve future teachers
- Potential for a significant number of students who enter their teacher education programs to have completed their lower division or undergraduate mathematics and science course work at the same institution or at a local community college

**Table 2**  
**Overview of the Six Case Study Institutions**

<i>Institution</i>	<i>Type</i>	<i>Annual Headcount Enrollment</i>	<i>UG/Grad Teacher Educ. Programs</i>	<i>Faculty Fellows &amp; Staff Funded</i>	<i>Total OCEPT \$s Received over 5 years</i>
Oregon State Univ.	public, land-grant univ.	~18,000+	Grad. level only	20	~\$290,000
Portland State Univ.	public, urban univ.	~20,000	Grad. level only	16	~\$260,000
Pacific Univ.	private, indep. univ.	~2,020	UG & Grad.	8	~\$166,000
Portland Community College(Cascade & Sylvania Campuses)	public, two yr.	Cascade-- ~17,200 Sylvania— ~24,900	Not applicable	13	~\$160,000
University of Portland	private, indep., Catholic univ.	~2,600	UG & Grad.	18	~\$200,000
Western Oregon Univ.	public univ.	~4,800	UG & Grad.	25	~\$260,000

Data Collection — The case studies offer observations on the status of each institution's involvement in the OCEPT project through June 2002. The focus is on activities conducted from Fall 1999 through Spring 2002. Each case study is based on a review of OCEPT documents (annual OCEPT project reports, as well as proposals and reports from OCEPT faculty fellows) and a series of yearly individual and group interviews on-site. The first wave of interviews was designed to acquaint the researchers with the institution, its specific plan of OCEPT-related activities, key participants and institutional leaders, and progress toward goals. A second set of interviews included additional participants as well as other administrators and faculty who were not directly involved in OCEPT, but had been identified by OCEPT participants as working on related issues or could be viewed as critical to the overall success of the institutional change effort. A final round of interviews included individuals previously interviewed to ascertain progress, as well as new participants or others seen as critical to the success of the project. This last round of interviews involved many small groups in addition to individual interviews.

The interviews with OCEPT faculty fellows followed an interview protocol designed by the authors, and was structured to identify key components of the institution's OCEPT-related plan, current success in implementation, and challenges in achieving OCEPT goals and objectives. Interviews with non-OCEPT personnel were more open-ended. A modified protocol was used in Year five interviews, and sought to identify what had changed and the degree of institutionalization of OCEPT initiatives. All sessions were tape recorded if approved by interviewees. The tapes were subsequently transcribed. Quotes or other information associated with a particular individual were not used without the individual's consent.

Beginning in 2000, various drafts of the case studies were prepared and distributed to those interviewed and the OCEPT institutional leaders for feedback. Recipients were asked for feedback on the accuracy and completeness of the case write-up, and permission was sought for inclusion of quoted remarks. The drafts included a final section where the case study team member identified some "issues to be considered," issues that had to do with progress toward OCEPT and institution plan goals. The draft was intended to help local leaders review progress and strengthen their project. Sharing of the drafts was intended as an intervention; that is, to have an effect on local developments. While feedback was received, there is little evidence to suggest that sharing the drafts had any appreciable effect on the direction or progress of the OCEPT-related activities at four of the institutions. Exceptions were Pacific and the University of Portland where the feedback appeared to cause participants to become much clearer about what they were trying to accomplish. Further, at Pacific, feedback and subsequent discussions related to the feedback may have contributed to the creation of the Natural Sciences Advisory Group, a development occurring at the end of the project.

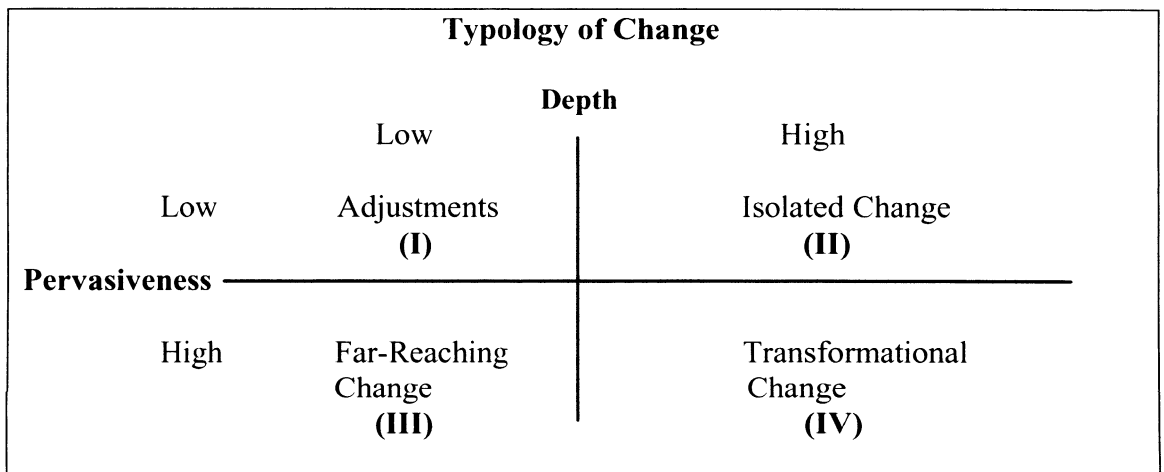
Analytical Framework — The analytical framework used for the study was shaped primarily by three sources. Chenoweth and Everhart [1] suggest three conceptual organizers as a useful way to learn about change:

- *Meaning*—what the change effort means to those involved, how they feel about what is occurring, the language they use to talk about OCEPT, and their beliefs, values and symbols associated with OCEPT and the change effort; when there is ambiguity and lack of clarity, there is often a lack of deep commitment to or motivation for the change effort.

- *Organization*—how the planned change is implemented and may be sustained, through what old and/or new structures, mechanisms and people, curriculum and instruction, sources of support, and timeframe.
- *Effects or Outcomes*—change in behavior, activities, perceptions, attitudes of faculty and students, and culture.

Interview protocol was developed to learn more about each of these dimensions of change.

Eckel, Green, Hill, and Mallon offer a useful two-dimensional “typology of change” in a higher education institution, one that considers both the depth (D) and the pervasiveness (P) of change (Figure 2) [2]. The result is four ways that change might be characterized: Type I—LowD/LowP=Adjustments made (tinkering, revising, revitalizing); Type II—HighD/LowP=Isolated Change (limited to one unit or particular area); Type III—LowD/HighP=Far-Reaching Change (pervasive, but doesn’t affect the organization very deeply); and, Type IV—HighD/HighP=Transformational Change (change touches the entire institution in deep and meaningful ways).



**Figure 2**  
**A Typology of Change**

Paulsen and Feldman offer a basis for evaluating the OCEPT change effort, one that focused heavily on faculty instructional practices [3]. In their framework, two factors play a

critical role in the instructional improvement process—the strength of the teaching culture of the institution and the nature of feedback to faculty about their instructional practices. Their model forces a consideration of both the organizational culture, and the motivation and learning processes of the individual faculty members in that organization [4]. Paulsen and Feldman suggest that the nature of that culture can serve to support or to impede efforts to improve instruction [3].

In addition to these three frameworks, Colbeck provides an analysis of a project similar to OCEPT with a focus on institutionalization of change [5]. In an attempt to assess an educational reform project in higher education institutions funded by the NSF, Colbeck developed an “institutionalization process model” that consists of three factors influencing the diffusion of reforms in curriculum and pedagogy. Diffusion is judged as occurring when “increasing numbers of individuals adopt the behaviors and attitudes associated with the innovation.” Her “regulative process indicators” correspond to the Chenoweth and Everhart “organization” dimension of change [1]. Her other two factors, “normative” and “cognitive” process indicators, generally correspond to the “meaning of change” dimension in the Chenoweth and Everhart schema. Reform diffusion in Colbeck’s model corresponds to “effects” in the Chenoweth and Everhart model. Colbeck found that normative and cognitive processes had greater effect than the regulative dimension on the diffusion of reform.

Limitations — Three limitations to the research design should be noted. The study relied primarily on interviews with OCEPT participants: faculty, staff and administrators. As indicated, an effort was made to identify and interview non-participants, but this was not conducted through any systematic sampling schema. Due to time and resource constraints, students were not interviewed except in one instance. Finally, the researchers relied on research and evaluation data generated by institutional faculty and staff about specific aspects of their projects, including effects on students. Some institutions received specific funding for such local research activity.

### **Findings: What Changed?**

Viewing the six case studies as a whole, major findings were identified in four areas: peer-led team learning (PLTL), professional networks/collaboration, advising and dissemination of information related to teaching careers, and diversity. Sustainability of change in these areas is considered in a final section.



Peer-Led Team Learning — A primary effect of OCEPT at the six institutions featured in our case studies has been the successful development of Peer-Led Team Learning (PLTL) and Excel programs that spread to a number of the gateway or introductory courses in mathematics and the sciences. These courses include biology, chemistry, physics, and mathematics.

PLTL is designed for *all* students in large lecture classes and began as workshop chemistry at the City College of New York. In PLTL, students who have successfully completed the course serve as mentors to small groups of students in weekly discussion and problem solving sessions. Each student works with the same small group for the duration of the course. This approach personalizes instruction by opening up discussion to those reluctant to ask questions in the larger lecture format, and also has become a powerful means of enticing mentors into considering teaching as a career option. As one faculty member said, until this program, our students “didn’t understand the inherent satisfaction in helping someone learn.” Sample faculty comments corroborate the efficacy of the PLTL model:

The main benefit, everyone agreed, is what happened to those wonderful team leaders. And they just learned so much more chemistry and developed, you might call them teaching skills, but just being able to impart their knowledge. I set it up so there was a 2 – hour optional workshop...It turned out to be more than just the chemistry questions. I think it helped with retention and just a feeling of community within the class. A number of them have talked about teaching and that they had never considered it before...They were held in such high esteem by both the students and the faculty that it became an honor to be chosen.

I have been here for 25 years and I don’t know of anything that I have had the opportunity to participate in that I feel has been so significant in changing for the better the academic culture for faculty, students, and peer mentors themselves. It is kind of a simple idea.

Excel, a similar program that originated with the work of Uri Triesman and his development of Math Excel for minority students in Texas and California college calculus

classes, provides a supplemental curriculum usually offered as a separate and optional workshop attached to a course. In the workshop, one or more student mentors monitors several small groups of students at the same time while the students work at problem solving. Faculty comments indicate very positive experiences with Excel:

I think that it was very successful. We had only nine students the first term. But everybody who ended up taking the class did really well in their regular lecture, as expected. But everybody was interested...we had people at the beginning who were really against it, a couple of students didn't like the group work, thought it was a waste of their time. And at the end, they were the strongest advocates. It was really kind of funny so I had them write some evaluations. They have all been really positive. We'll see. I think that it is really valuable. They have been encouraging other students to sign up for it the next term. So I think it was a really positive thing. I think it was really valuable for our peer leader, too. She really got a lot out of it.

It's so easy to see students who are naturally good teachers when they are working with Excel groups. They're all teaching one another. The natural ability to teach and explain things and to not just tell how to do it, but to actually teach and draw out and coach and draw out things from their peers. It's so obvious in working in those Excel groups. It's a place where we can encourage students to think about teaching as a career.

Two faculty members from one of the institutions, one in chemistry and the other in biology, described the effects of PLTL on mentors based upon mentor journals, student evaluations, and general observations [6]. They suggest that PLTL has five benefits for mentors: 1) better content mastery; 2) improved teaching skills; 3) fun (a surprise to many); 4) an opportunity for service and to feel valued; and, 5) the consideration of teaching as a career. Other data suggested that it was of great benefit for students as well. One biology student, for example, wrote in her course evaluation:

I really enjoyed the workshops and feel they are a big part of my improvement in this class. On the first exam, I did horrible...I jumped up 30 pts on the 2<sup>nd</sup> test...

Workshop leaders are so wonderful and nice. Always willing to help and answer questions. I give them an A+.

Other assessment data also indicate strong effects on faculty and students (both mentors and regularly enrolled students). For example, faculty members, in describing their relationship with mentors, reported, “they really blossomed as colleagues.” Faculty members found their interactions and exchanges with mentors to be more time consuming, but extremely rewarding and very worthwhile in terms of their own professional growth and development as teachers. Mentors found their discussion and dialogue with professors about the challenges they were facing as teachers to be extremely motivating.

Serving as mentors clearly became the most powerful vehicle for attracting students into the teaching profession. Virtually all of the mentors found their experience to be profound, and many have begun to give consideration to teaching as a career. Even those, for example, who have decided to maintain their pre-med focus walk away with higher regard for the teaching profession and greater admiration and support for those who teach. It should be noted that the student culture typically frowns upon career choices that lead to teaching. There is a perceived status and economic differential that discourages students from following their hearts.

Evidence is convincing that the PLTL program has led to improved instructional techniques, powerful and increased rates of learning (especially for freshmen mid range—C and D students), higher grades, a personalized learning community, improved and collegial relations with peers and faculty, and the consideration of teaching as a possible career choice for a great number of the mentors. One faculty member, for example, reported that five out of six of her first graduating mentors went into some kind of teaching position or program. It should be noted that one of the authors of this study had lunch with a group of nine mentors and personally felt their enthusiasm for teaching as well as how they were wrestling with career decisions that would lead to teaching opportunities. Their interest in teaching as a career was not necessarily limited to high school, but also included the possibility of college and career-related training and professional development.

One OCEPT leader shared that while this impact on the mentors was envisioned by program planners, faculty came to perceive and value this outcome as the program developed.

Most faculty interviewed came to regard this program outcome as the most significant. Faculty are currently involved in further assessment activities to determine “what’s working, what needs to be changed, and how mentoring has impacted career choices.” Faculty will learn more from mentor journals and follow up observations to determine if students who have participated in peer learning have retained more in science. One research study completed at OSU found that Excel math students outperformed and attained higher grades than non-Math Excel students [7]. Two other research studies at OSU provide similar evidence of student performance, one involving students from the Educational Opportunity Program (a program that serves first generation and significant numbers of African-American, Hispanic, and Native American students) in mathematics and another of students in an introductory chemistry sequence.

Professional Networks/Collaboration — OCEPT has led to numerous professional development and learning opportunities for faculty across the institutions featured in the case studies. Most of the institutions have seen increased levels of collaboration between arts and sciences and education faculty, as well as increased levels of collaboration with colleagues at a statewide level leading to the emergence of a powerful statewide professional network. There are in fact many success stories. Virtually everyone interviewed reported numerous opportunities for collaboration with colleagues both on campus and at other institutions around the state. These collaborations have brought together community college and four-year institution faculty from the same discipline, K-12 teachers (as teachers-in-residence, supported by OCEPT) working alongside and collegially with university faculty, and math/science and education faculty together reviewing national and statewide standards that affect teacher licensure and developing new lower division courses.

People are very excited about team teaching and about interdisciplinary studies in the sciences... I think that OCEPT was a facilitator.

I think that the involvement that I’ve had with colleagues around the state would not have happened anywhere near the extent it has as a result of OCEPT.

I think one of the things that has been most valuable for me...is making contacts with other people that I wouldn’t normally have done. Often through the various meetings like the Showcase meetings and the Oregon Academy of Sciences...So

really developing some connections with other people at other institutions. That has been very useful for me.

Prior to OCEPT, there was little connection in most of these institutions between the school of education and the college of arts and sciences. One arts and sciences dean reported that, “In some ways, faculty are like farmers: this is my field; that’s your field; his field is over there; you don’t tell me to plant beets and I won’t tell you what to do with your corn.” Using the image of the field, OCEPT has had a significant impact on developing a “shared field.”

It [OCEPT] gave us permission to talk to each other...and gave us permission through funding support to think that change is not a bad thing...I think one of the biggest successes with OCEPT was the conversation, the dialogue that was started between liberal arts and sciences and education...I think those chains of communication between math and science and education are excellent. We have young faculty, maybe not chronologically, but newer faculty who are talking to each other.

Thus, there have been increased instances of team teaching, cross-disciplinary curriculum planning, faculty sharing and learning from one another, and the inclusion of K-12 teachers as colleagues working alongside faculty. There has been increased networking and sharing of innovative ideas at: statewide OCEPT-sponsored summer institutes, showcases, disciplinary team meetings, writing retreats and assessment retreats; annual meetings of professional associations; and, statewide meetings of mathematics, science and technology councils, two of which were founded with OCEPT leadership. All of this type of work was encouraged and greatly enhanced by OCEPT’s financial support for professional development in ways not normally covered (i.e., release time, travel, lodging, etc.).

Advising and Dissemination of Information Related to Teaching Careers — OCEPT has also had a significant effect on beginning efforts to improve advising and the dissemination of information related to teaching as a career possibility. Several new education clubs have been founded and are growing. And, although the numbers are low, minority students are beginning to be actively recruited by faculty at several of the institutions to serve as peer mentors for PLTL and Excel programs. This approach may well become a very powerful advising and recruitment tool.

Other advising changes across the institutions include: changes in student handbooks and bulletin descriptions of careers in teaching; linkages with community foundations, student enhancement programs, and community colleges for supporting and mentoring K-12 and community college students toward university admission; improved articulation with community colleges through web-based information dissemination; the development of introductory classes in education for those considering careers in teaching; and, growing awareness by faculty of state and national K-12 standards in math and the sciences, as well as specific state requirements for teaching licensure.

Notably, one of the smaller private universities developed a natural sciences educational advisory group made up of representative faculty members from physics, chemistry, math and biology. A faculty member, with joint appointments in education and physics, facilitates the group. A mathematics professor reported:

The most significant outcome of OCEPT is the Natural Sciences Educational Advisory Group...It has had an impact on the material that we have available to students in terms of which classes they should be taking, what resources are available on this campus, and how students should go about preparing to become a teacher.

At one of the larger state universities, new student orientation procedures now include the identification of new students interested in teaching as a possible career path and subsequent regular communication with them through a listserv maintained by the college of science. Over 400 students are now on the list. A new education club communicates with prospective new members using a listserv. In general, greater attention is now being devoted to the advising of prospective teachers, much like what traditionally has been done in pre-medicine and other health-related fields.

Diversity — A primary goal of OCEPT across the institutions featured in the case studies was to increase the numbers of underrepresented minorities in math and science teaching. This was a challenging goal given Oregon's relatively small minority population—16.8%. Perhaps reflecting this challenge, in the two private institutions studied and one of the public institutions, there appeared to be a sense of faculty resignation that recruiting a more diverse pool of math and

science teachers was currently beyond their capabilities. Although a number of promising initiatives have been developed, for the most part this goal has not been met. Faculty awareness of and a desire to attract underrepresented students, however, appear to have increased as a result of OCEPT participation.

Promising diversity initiatives identified include: partnerships with foundations and school districts; targeted scholarships; the mentoring and coaching of local middle and high school students; new advising structures, publications, and websites; the creation of a multi-cultural resource center; the creation of an education and science club; new linkages with community colleges; service learning opportunities in local schools; and, institutes aimed at helping high school students meet state standards.

These efforts are all promising but their payoffs appear to be years away. At least three of the institutions are located in centers of Hispanic populations, but very few inroads have been made into these communities. Beyond faculty awareness and some promising initiatives, systemic efforts to recruit and support students from underrepresented groups into math and science teaching appear to be absent. To date, only a relatively small number of prospective math and science teachers has been identified through direct efforts related to OCEPT; and, even fewer students from underrepresented populations have been recruited or identified. Although diversity has become an institutional initiative and priority at many of the institutions, how it relates to mathematics and science, and the recruitment and preparation of future teachers remains unclear.

Sustainability — PLTL and Excel workshops appear to be sustainable. They have been very successful, as documented through formal research, in terms of changing the academic culture about how teaching and learning can occur successfully, and in the “hearts and minds” of faculty. While the PLTL or Excel models have been adapted to fit the situation at each institution, faculty across the institutions have become more reflective about their teaching and clearly realize the advantages of using peer mentors in a workshop format for the development of smaller learning communities. Learning for students has become more personalized and thus more meaningful. PLTL- and Excel-organized courses have become institutionalized through a variety of means (i.e., PLTL-like workshops replacing traditional recitation sections, Excel workshops financed through regular departmental budgets, etc.), and it appears highly unlikely that instruction will revert back to the traditional lecture and recitation section format. The likelihood of

sustainability is great because the new course structures have become embedded in the culture of the institutions. Moreover, it's more cost effective for institutions to work retaining and supporting students than it is to recruit them. One of the deans interviewed reported:

I think that we are all very convinced that this [PLTL] is helpful for the students and it is helpful for the peer instructors and it is helpful for us. That combination means that we really have a commitment to try to maintain it.

The development of professional networks and increased collaboration was another significant outcome of OCEPT. Most faculty interviewed reported that they would maintain their new relationships with colleagues both on and off campus. This may be a challenge, however, without OCEPT funds that enable their coming together (through release time, travel, lodging, and conference registrations). Moreover, in the future, new faculty may not have a specific structure or mechanism like OCEPT to encourage their collaboration and the development of professional networks.

Finally, all of the institutions studied have made promising efforts to improve their advising function and to disseminate more and clearer information about the possibility of teaching as a career. These efforts have deepened the knowledge base and awareness of advising issues. New structures have been created ranging from advising centers to coordinating groups to education clubs to new websites. At one university, a series of new formally approved education options associated with chemistry, botany, and environmental science have been developed for undergraduate students. Better and more accessible information on teaching as a career option has spread across all of the institutions.

Dealing with student diversity issues and the recruitment of underrepresented minorities remains a considerable challenge. There appears to be institutional commitment to dealing more effectively with the recruitment and support of increasingly diverse student populations. Furthermore, faculty awareness and a desire to be responsive is strong. However, there is a general sense of resignation or powerlessness about what can actually be done. What's lacking is systemic institutionalized support and a laser-like focus on the recruitment of underrepresented



minorities into math and science teaching. Many interesting and promising initiatives are in the works, though, that could pay dividends in the coming years.

### **Findings: What Helped and Hindered the Change Efforts?**

In this section, the Eckel, et al. framework is used to characterize the depth and pervasiveness of the change [2]. Then, using the several other analytical frameworks identified for use in this study, findings are identified and discussed regarding factors that appear to have helped or hindered the change efforts.

Depth and Pervasiveness of the Change — Using the Eckel, et al. framework, we found it difficult to place each case study institution—in one typology—high or low on *pervasiveness* of the change, and high or low on the *depth* of the change. Change at Western Oregon University and the University of Portland, and at Pacific University to a somewhat lesser extent, seems best characterized as Type IV or “transformational change,” high on both depth and pervasiveness. Change was evident in teaching and assessment practices, curricular structure, relationships between arts and sciences and education faculty, and recruitment and advising structures. Considerable evidence of change was found in faculty culture having to do with how things are done and with whom they are done.

OSU’s efforts were more difficult to categorize. One aspect of change, the recruitment and advising of prospective teachers, might also best be characterized as “transformational,” affecting many undergraduate science programs through the addition of education options and information made available to prospective teachers, including those at community colleges. However, another aspect of change, in teaching and learning practices in mathematics and the sciences, might best be characterized as “isolated change,” high on depth and low on *pervasiveness*, since the most significant change took place in parts of the mathematics, the chemistry, and the biology curriculum. Still, there appears to be some promise for the spread of these teaching and learning practices to additional parts of the curriculum in these departments and in physics.

At PSU, which also served as administrative agent for the grant, change in teaching and learning practices might also best be characterized as “isolated change,” high on depth (in mathematics and chemistry) and low on pervasiveness. Change may broaden, however, with the

recent receipt of a multi-year, NSF grant to support the Center for Teaching and Learning West (CTLW). CTLW will continue PSU's efforts at changing teaching and learning practices in the sciences and in education, and through the initiation of a special mathematics and science pre-service education cohort in education. Changes related to the recruitment and advising of undergraduate students might be described as either "mixed" or tenuous.

Finally, at PCC, change in curricular and teaching practices were either confined to one faculty member (at Cascade campus) or are too formative at this point to characterize (at Sylvania campus).

Factors Enabling Deeper and More Pervasive Change — The Everhart and Chenoweth conceptual schema for accounting for organizational change (the dimensions of "meaning," "organization," and "effects") and the Colbeck framework for accounting for the diffusion of reform in curriculum and pedagogy ("normative" and "cognitive" process indicators and "regulative" process indicators), provide a basis for identifying the conditions facilitating the change effort [1,5]. The "transformational" change observed at WOU, the University of Portland, and Pacific appears due to a combination of both "meaning" (similar to "normative" and "cognitive" process indicators) and "organizational" (similar to the "regulative" process indicators) factors. The nature of the OCEPT-promoted change, having to do largely with teaching and learning, was compatible with the existing faculty cultures in these three institutions, cultures reflecting the primacy of the teaching mission. While a similar faculty culture was present at PCC, many organizational factors were not and significant change has yet to occur. Table 3 offers a summary of the six conditions identified as enabling the deeper and more pervasive change at the three institutions.

**Table 3**  
**Six Conditions for Transformational Change at OCEPT Institutions**

1. *Relatively small size*—less organizational complexity, more focus, greater cross-disciplinary interaction
2. *Strong collaborative leadership*—not only administrative support, but active encouragement and involvement on the part of administrators
3. *Undergraduate teacher education program*—facilitates strong connection between math, science and education faculty
4. *Boundary-spanners*—credible and active cross-disciplinary facilitators
5. *Strong teaching mission*—faculty culture where teaching is valued and rewarded
6. *Resource use*—providing opportunities for faculty to become engaged in the project and work with other faculty within their discipline as well as with faculty from other disciplines and from other institutions; a necessary, but not sufficient condition for change

*First*, the size of these three institutions, in terms of enrollment, is considerably smaller than the other three case study institutions. Change simply may be easier in smaller institutions where there is greater cross-disciplinary interaction, both formally and informally.

*Second*, strong local and collaborative leadership was enacted at all three institutions. As someone once said, “If you want change, you have to be the change.” Each of these institutions had individuals who were consistent advocates of and champions for the change and who were also involved directly in the change process. One institutional leader was a dean of arts and sciences and, notably, a biologist, who provided leadership at her own institution, as well as to the statewide OCEPT biology team, meeting regularly with her institutional OCEPT team. Another was a dean of education committed to change in teacher education, including standards-based teaching and assessment. Before OCEPT began, she had initiated conversations with faculty in *liberal arts and sciences* that led to increased subject matter requirements for prospective teacher educators. The efforts of this individual were coupled with that of two education faculty members with deep roots in the sciences and a new dean of arts and sciences who became a co-leader of the project. The third served as the coordinator of the teacher education program who at one time held a position in the physics department. This individual was also committed to standards-based teaching and assessment changes in math and science, and regularly convened her local OCEPT team to review activities and progress. Interestingly, the three key leaders are women.

*Third*, all three institutions have an undergraduate teacher education program. PSU and OSU have only fifth-year teacher education programs. While these programs serve some students from their own institutions, most come from other institutions. This structural condition appears to make more difficult connections between undergraduate math and science faculty and faculty in education. At the three institutions with undergraduate teacher education programs, many more students begin as freshmen, completing their math and science course requirements there. Faculty may be more apt to share responsibility for undergraduate education and to come together more easily around shared issues of teacher preparation. Notably, OSU and PSU, with fifth-year programs only, initiated significant efforts to help students identify an undergraduate career pathway to prepare to become teachers of mathematics and science. These efforts took the form of new student “clubs” and creation of new databases listing students expressing an interest in becoming teachers. These lists could be used to invite students to various events, club memberships and other activities. OSU’s expansion of “education options” for undergraduates majoring in a variety of science fields is a notable change and another way to help these students find a pathway into graduate level teacher education programs.

A *fourth* condition was the presence of individuals who might be called “boundary spanners,” those who enjoyed the respect of colleagues in mathematics, science, and education. Each of these boundary spanners played several critical roles, helping to convene planning groups and providing leadership for curricular change efforts involving cross-disciplinary teams. Three of these individuals were education faculty members. All three exerted enormous informal influence to help bring about change and were held in very high esteem by their mathematics and science colleagues. While such a “boundary spanner” existed at PSU, the “meaning” and other “organizational” factors were insufficiently present to enable the same level of change. No such “boundary spanner” was identified at OSU. Several of the Teachers-in-Residence (former or current K-12 teachers) at these three institutions, funded in part by OCEPT, also served as “boundary spanners” and in addition helped the university faculty come to understand more about the challenges facing K-12 teachers.

*Fifth*, each of these three institutions has a strong teaching mission and a faculty culture where teaching is highly valued. Indeed, at both Pacific and UofP, their very existence depends in large part on their ability to attract and retain their students. In the tenure and promotion process, high regard is given to teaching excellence, teaching and curriculum innovation, and related-

research and scholarly writing. Compared with WOU, UofP, and Pacific, few new tenure-track faculty at OSU and PSU became involved and/or sustained their involvement in OCEPT. Promotion criteria at OSU depends largely on research and publications; and at PSU, norms may be changing, with greater emphasis placed on research and publications for faculty advancement.

Paulsen and Feldman suggest that the instructional improvement process is strengthened where a strong teaching culture exists in the institution and faculty receive feedback about their instructional practices [3]. The second condition appears to have been present through increased opportunities for faculty to work collaboratively with other faculty in order to bring about course and instructional practices changes, as well as the initiation of formal inquiry into the learning of students associated with these changes. Faculty at all three institutions qualitatively and quantitatively received more feedback related to their efforts to change curriculum and instruction.

Finally, the *sixth* condition was the opportunity for faculty to meet and work with other faculty, both within their own discipline, but equally importantly, across disciplinary and institutional boundaries. Here is where OCEPT played a critical role, enabling these opportunities through making release time available, providing funds for travel and professional meeting attendance (including the OCEPT Summer Institutes held during the first three years), and money for student assistants and mentors, as well as for supplies and materials. The six case studies suggest, however, that financial support, in the absence of the other five conditions, could not have brought about the depth and pervasiveness of change observed at these three institutions and the considerable promise of the sustainability of this change.

## **Implications**

This section identifies implications of the study for three different audiences: institutions interested in implementing a similar change effort, public and private funders, and mathematics and science reformers.

Institutions — Results from this study suggest that curricular and instructional change that can be categorized as “transformational,” and, by definition, sustainable, will be more likely in institutions that have a strong faculty teaching culture and a promotion and tenure system that values faculty involvement in these kinds of change efforts. The presence of individuals with

special collaborative leadership skills is also critical, and in particular, those who can “boundary span” mathematics, science, and education and bring these diverse academic sub-cultures to work together. Support from key deans appears important as does at least a lack of interference, if not full-scale support, from higher administrators. In this study, the buy-in, support, and active involvement of key institutional leaders, particular key deans, was critical to enabling deeper and broader change.

In institutions with a teaching mission, faculty teaching loads can be heavy. Time is scarce for faculty to work together to plan for curricular and instructional change. Funding is needed to provide release time during the academic year, summer stipends, and travel to professional meetings. The development of new professional networks, both inside and outside the institution, can help to sustain change efforts. Support for Teachers-in-Residence from the K-12 community also appears to help the change effort, in particular to help mathematics and science faculty come to see the critical role they play in teacher preparation.

Finally, the experiences at these six institutions suggest that efforts to increase the involvement of underrepresented groups in the teaching profession requires a more focused and sustained commitment by more individuals in an institution than a handful of faculty in mathematics and science. Such efforts most likely need to be multifaceted, including initiation of outreach and recruitment efforts, and targeting funds to minority students.

Funding Entities — The study suggests that preference in funding similar initiatives should be given to institutions that evidence an institutional culture supportive of the values underlying the planned change. This suggests that funding be targeted at institutions with strong teaching missions and a faculty culture that rewards efforts to improve teaching and learning. This is not to say that significant change, particularly in certain courses or in certain departments, cannot occur at institutions with a strong research mission; broader institutional change, however, appears to be much more difficult in these institutions.

Where a goal of the funding is to increase the representation of African-American, Hispanic, Native American, and Asian American students as future mathematics and science teachers, preference in funding should be given to institutions that have already developed a track record for outreach to these groups.

Mathematics and Science Education Reformers — Efforts by faculty at each of the case study institutions provide evidence, both research-based and anecdotal, that peer-led teaching and learning and Excel models that involve undergraduate and graduate peer mentors have considerable promise for increasing student learning in mathematics and science. Such curricular and instructional innovation has the additional side benefit of increasing interest in teaching careers among the peer mentors.

### **Conclusions**

Sufficient local incentives must be in place to encourage faculty, new tenure-track faculty, and tenured faculty to become involved in the reform efforts. Promotion and tenure norms must value curriculum and pedagogical change, represented by new curriculum, new instructional and assessment practices, presentations at professional meetings, as well as articles in professional journals.

Efforts at deeper and broader change seem to be enhanced when faculty from mathematics, science, and education work together. Individuals who serve as “boundary spanners” can play critical leadership roles in these change efforts. These new collaborations can transcend debates about the relative importance of “process” versus “content” and result in new conversations and initiatives that can facilitate student learning in mathematics and science and the shared development of future teachers.

### **Bios**

Thomas G. Chenoweth is Professor and Mary K. Kinnick is Professor Emerita in the Department of Educational Policy, Foundations and Administrative Studies, the Graduate School of Education, Portland State University, Portland, Oregon. R. Dan Walleri is Director of Research and Planning, Mt. Hood Community College, Gresham, Oregon.

They served as members of the OCEPT Core Institution Case Study Team from 1999-2002, and shared equally in the development of this article. The individual case studies may be accessed Fall 2003 from the OCEPT website: [www.mth.pdx.edu/OCEPT](http://www.mth.pdx.edu/OCEPT). ■

## References

- [1] T. Chenoweth and R. Everhart, "The Restructured School: How Do You Know if Something Is Happening?" *Planning & Change*, **22**(3/4) (1991) 178-190.
- [2] P. Eckel, et al., *On Change III: Taking Charge of Change—A Primer for Colleges and Universities*, American Council on Education, Washington, DC, 1999.
- [3] M.B. Paulsen and K.A. Feldman, *Taking Teaching Seriously: Meeting the Challenge of Instructional Improvement*, ASHE-ERIC Higher Education Research Report No. 2, George Washington University, Graduate School of Education and Human Development, Washington, DC, 1995.
- [4] M. Kinnick, "Review—*Taking Teaching Seriously: Meeting the Challenge of Instructional Improvement*," *The Journal of General Education*, **50**(1) (2001) 75-80.
- [5] C.L. Colbeck, "Assessing Institutionalization of Curricular and Pedagogical Reforms," *Research in Higher Education*, **43**(4) (2002) 397-421.
- [6] A. Tenney and B. Houck, "In Their Own Words: Student Leaders in Portland, Oregon Comment on PLTL," *The Workshop Project Newsletter*, **3**(1) (2001) 8-9.
- [7] H. Duncan and T. Dick, "Collaborative Workshops and Student Academic Performance in Introductory College Mathematics Courses—A Study of a Treisman Model Math Excel Program," *School Science and Mathematics*, **100** (2000) 365-73.