Learning from the Best: How Award-Winning Courseware Has Impacted Engineering Education

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***Abstract*—This paper describes research to examine the impact of the *Premier Award for Excellence in Engineering Education Courseware* on the faculty members who developed and used award-winning courseware with their students and to examine how the rewards system within higher education has changed in its valuation of innovative teaching. A case study was conducted with the faculty members who won the Premier Award from 1997 to 2012. The research team also gathered data from related populations (engineering deans and administrators; courseware end users) to provide a nuanced perspective on successful dissemination methods for courseware and on changes in the reward and recognition system in higher education.**

Keywords—rewards; recognition; change; engineering education

I. INTRODUCTION

This paper reports the results of a case study to examine the impact of the *Premier Award for Excellence in Engineering Education Courseware*. The *Premier Award* was developed "to recognize high-quality, non-commercial courseware designed to enhance engineering education [1]." Courseware (a term that has been superseded by the more general "software") is computer-based educational material that can be used to assist engineering students in their learning process…[2, 3]. During this four-year study, the research team's priority has been to gain insight into factors that effect changes in engineering education and to identify shifts in how innovations in technology and teaching are recognized or rewarded.

The *Premier Award* (PA) was created after leaders of the Synthesis and SUCCEED Coalitions and the NEEDS digital library (initiatives funded by the National Science Foundation in the 1990's; [1]) identified the potential of courseware to contribute to reforms in engineering education. They also recognized the need to support and promote the development of *high quality* materials, which resulted in the creation of a set of courseware-specific review criteria. These criteria guided the PA review process and were eventually used by faculty members who wanted to design their own or to evaluate others' courseware [3, 4].

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The PA program followed a yearly cycle beginning with a call for submissions. Faculty members provided access to their fully developed courseware along with a written dossier describing the courseware (e.g., how it was used by learners; assessment activities; statements of reference; journal or conference papers). The PA Review Committee evaluated submissions according to the courseware-specific guidelines; winners were publically honored at a luncheon during the Frontiers in Education conference. PA winners also received a cash prize and assistance with national dissemination of their courseware, and their deans and department chairs were notified with a letter from the chair of the PA Review Committee. Ultimately, the PA program ran for 16 years, accepted 129 submissions, and recognized 27 award winners whose courseware ranged from case studies to computer programming environments to interactive simulations.

II. THE ROLE OF REWARDS IN ENGINEERING EDUCATION

When the PA was introduced in 1997, developing courseware was a "fringe" activity undertaken by a few engineering education faculty members who used nascent Internet and networking technologies to create educational materials that often varied in quality. Their colleagues did not know how to evaluate courseware for classroom use. And, administrators and peer committees did not value courseware development as an intellectual effort worthy of merit in promotion and tenure review [1, 2].

Instead, PA program leaders envisioned a future where computer-based, electronic teaching and learning materials *would* play a central role in engineering education [5, 6, 7, 8]. They believed a national award could provide much-needed recognition to pioneering educators and could create a venue for disseminating exemplary models of high quality courseware. They believed that rewarding and recognizing quality courseware materials would encourage more innovations from faculty members and would also interest textbook publishers in digital learning materials. They also believed that, in the long run, using high quality courseware would have a positive impact on student learning and would improve the teaching practice of engineering educators. They

believed that eventually these positive changes would be reflected in revised promotion and tenure criteria that valued courseware development.

A. Situating the Premier Award in the Research Literature

While educational leaders in the PA program saw great potential for courseware to reform engineering education, they did not examine then-current research about rewards and recognition to inform the PA program development. So, one of the earliest activities in this case study was to conduct a brief, post hoc literature review to find resources: 1) that identified the types of awards given by higher education institutions and their impact on faculty careers; and, 2) that identified the role of awards in changing the culture within higher education. The search encompassed all disciplines (not just STEM) within higher education institutions in the U.S.

1) Types of Awards & Impact on Faculty Careers:

Approximately 3,700 articles that were published from 1994 to 2012 discussed awards for teaching excellence, which were/are mostly conferred at the campus level. Resources from the late 1990's focused on the role of teaching awards, how to implement them, and the *intended* impact on a faculty member's career. However, the PA rewards technology development, not teaching, and the PA is conferred at the national level. The literature search did not identify awards within engineering education for courseware development, specifically, or for technology development.

2) The Role of Awards in Changing Work Culture

The PA program began around the same time that the Scholarship of Teaching and Learning (SOTL) movement emerged in the 1990's. Articles from the SOTL literature discuss how providing rewards for teaching in higher education might balance exisiting systems that more often reward research [9]. Writing in 2000, Hattendorf-Westeney [10] described how novel it was to use information technology for teaching and scholarly publishing and how this affected faculty in the promotion and tenure process. Depending on the discipline, responses ranged from apathetic, i.e., "simply a means for information delivery" to positive, i.e., "recognized as a form of scholarship." Similarly, other studies about the impact of programs that reward teaching identified a lack of consistency in the criteria used for promotion and tenure review at all levels [11, 12, 13, 14]. Although the PA program review criteria provided a consistent benchmark for recognizing high quality courseware, in hindsight, faculty members who developed courseware were caught squarely in the middle of shifting perceptions about the role of technology in higher education. They were conducting research on their design and use of courseware – in the service of teaching.

3) Discussion of the Literature

The post-hoc literature review shows that the PA program designers found a unique niche in their focus on rewarding courseware development instead of teaching practice. But, this did not mean that the PA program designers did not care about teaching practice. Their priorities were codified in the PA program review criteria, which focus on the quality of learning materials and, importantly, the potential for re-use by other faculty members, not just the person who originally designed the courseware. Unfortunately, the literature from 1994 to 2012 only reported efforts to initiate (teaching) awards and did not identify any results from sustained, empirical research to identify the impact of rewards on faculty careers or student learning – a focus of this study.

III. Overview of Research Plan

The research design of this case study relied upon multiple methods for collecting and analyzing data from many sources to reflect the nuanced context of the PA program (Table I).

TABLE I. Research Questions & Data Sources

Research Question	Phase of Work: Methods, Sources
RQ1. How has receipt of the Premier Award impacted the awardees' career paths and why?	*Phase I*: Interviews with author(s) of winning PA dossiers; Content analysis of interview transcripts *Phase II*: Survey of engineering deans and administrators; Online focus group with self-selected survey respondents
RQ 2. How has the quality of the courseware submitted changed over time?	*Phase I*: Content analysis of dossiers from winners and a random sample of non-winners
RQ3. How has the award winning courseware affected student learning?	*Phase III*: Survey of courseware users
RQ4. What kinds of dissemination activities and mechanisms are successful in promoting successful adoption and use of courseware?	*Phase I*: Citation analysis of sources from: author(s) CV, courseware websites, winning PA dossiers, interview transcripts *Phase III*: Survey of courseware users

Content analysis of the semi-structured information found in the dossiers provided a foundation for developing interview questions with faculty members who were PA winners and also identified resources for the citation analysis (*Phase I*). Content analysis of interview transcripts informed the development of survey and focus group questions for engineering deans and administrators (*Phase II*), which further influenced the design of the survey with courseware users (*Phase III*).

Given the small data set (fewer than 30 dossiers and interviewees) and the qualitative nature of the case study, Glaser and Strauss's [15] analysis methods for theory-building guided the content analysis. Interview transcripts and dossiers were coded and analyzed with NVIVO. Surveys were administered using Survey Monkey. Online focus groups were conducted using Ideascale and WebEx.

This study generated enough data to report detailed findings for each faculty member and their courseware, but in this paper results are reported in aggregate. The rest of this paper briefly reports methods and results from *Phases I* and *II* and provides a more detailed report on *Phase III* of this study. This is followed by discussion of the findings for each research question and a synthesis noting implications for engineering education practice.

IV. Methods & Results for Phases I & II

Phase I of the case study addressed RQ1, RQ2, and RQ4. Data collection and analysis occurred from 2010-2012. The summary of methodologies and results below are discussed in full elsewhere [16].

A. Methodologies: Content, Citation Analyses; Interviews

As noted above, work began with an in-depth *content analysis* of 29 dossiers, a sample comprised of the majority of winning dossiers and a subset of 10% of the non-winning dossiers (to ensure that findings were indicative of the broader field of engineering courseware submitted to the PA program). Two researchers iteratively developed a PA Dossier Codebook and tested its reliability by jointly coding two dossiers. At the conclusion of coding, the researchers reviewed one another's results and resolved any questions through discussion.

The content analysis allowed researchers to identify commonalities across dossiers and courseware, which subsequently informed the development of *interview* questions that could be asked of all interviewees but that could also be modified to elicit unique responses. The interview sample consisted of only PA winners; one person declined to be interviewed. Again, two researchers divided the work, and to ensure consistency, jointly conducted two interviews. Subsequent interviews were semi-structured, one-on-one conversations between a researcher and a faculty member and were transcribed in real time or after the event.

Gathering resource lists for the *citation analysis* began with the dossiers of award-winners and also included courseware websites, and transcripts. An initial search of the ISI Web of Science journals and conferences list, indicated that many of the publications where faculty members had published articles about courseware development, evaluation, or use are not indexed. Google Scholar and Scopus also do not consistently index these publications. Researchers then drafted a protocol to examine PA winners' courseware-related citations within the context of their entire body of publications. The protocol was tested with a sample of faculty members who had won the PA, but the process proved time consuming, the results were inconclusive, and this line of inquiry was stopped.

B. RQ1 Results: Impact on Faculty Career Paths

Interviews with faculty members were key to addressing RQ1, though results of the survey and focus group with engineering education deans and administrators (reported below) were also critical in triangulating the interview results.

Faculty members who were interviewed represent the continuum of academic career paths, from Associate Professor to Professor and Department Chair to Professor Emeritus. In their interviews, faculty members were cautious about reporting a link between receiving the PA and its impact on their career. However, a pattern that emerged through a content analysis of all of the interview transcripts reflects how faculty careers were shaped by different parts of the PA (e.g., CD's of courseware to distribute; award letters to administrators; publicity from the FIE luncheon). The benefits were not always immediately apparent at the time of receiving the PA, and sometimes the type of benefit to faculty members depended on the stage of their careers.

Faculty members reported that winning the PA represented “outside” confirmation of their teaching ability and gave them "street cred" with experts in their field. This confirmation and credibility proved valuable with peers and employers, with peer review committees, and with tenure and promotion committees. Faculty members more advanced in their careers expressed how proud they were of the award or gave a majority of the credit to students who worked to develop courseware.

For faculty members who won the PA when they were graduate students, one described how his articles and thesis about the courseware highlighted his expertise to future employers. Another said that working on the courseware and winning the award helped direct a research path in graduate school and ultimately a career.

However, some faculty members had negative experiences. For example, one interviewee was encouraged to pursue courseware development by a supportive administration, but when leadership changed, the work was discouraged, and the faculty member seemed to have been penalized. In this and another case, faculty members noted that it felt good, personally, to win the PA, but the honor was not acknowledged or rewarded by their administrations.

C. RQ2 Results: Changes in Courseware Quality D

In addressing RQ2, content analysis of the dossiers showed that faculty members developed a wide range of courseware types. It also revealed the types of evaluation and dissemination activities that faculty members undertook.

1) Changes in Courseware Types

During the early years of the PA program (1997-2003), many courseware submissions were designed as whole curricula; submissions from 2002-2003 were labelled "learning hubs." These stand-alone courseware environments included content modules of varying lengths and were delivered on a CD-ROM. The researchers have interpreted this to mean that, at that time, the Internet was not a viable distribution channel for education materials and that the pedagogy associated with multimedia materials involved going *to* a place to learn.

From 2004 until 2010, courseware types shifted toward software tools, games, and simulations. These innovations were tool-like and focused on discrete concepts while moving away from platform-dependent modules focused on multiple concepts or pedagogical approaches. The researchers have speculated that this shift in courseware differentiation and sophistication could indicate a new or better understanding of pedagogical approaches using multimedia, or it could be the result of faculty members' increasingly sophisticated programming skills or increased access to flexible, advanced software. To fully address these ideas would require studying a a much larger population.

2) Changes in Evaluation & Assessment

As the PA program matured, the dossiers documented how faculty members became more adept at using the language of assessment and evaluation. However, an analysis of evaluation methods indicated that faculty members relied upon student satisfaction or usability studies as indicators of courseware success; also, few empirical assessments were conducted to identify changes in student learning. But, content analysis of all interview transcripts indicated that evaluation and assessment activities were more integral to courseware development than the dossiers reported. In one case, applying for the PA

prompted a round of evaluation that took the courseware "to the next level."

3) Changes in Dissemination Strategies

Perhaps not surprisingly, there was less change in faculty members' dissemination strategies as there was an expansion of their efforts that combined old and new. They used the Internet consistently for dissemination; every award-winning dossier, save one, included a web address. However, URLs alone might not provide a permanent solution. Link rot was pervasive even for websites that were 2-3 years old at the time. But, content analysis indicated an overwhelming use of "traditional" scholarly dissemination methods such as writing journal articles and presenting conference papers. This behavior is consistent with other research on dissemination [17, 18].

D. RQ4 Results: Successful Dissemination Strategies

The content analysis data on dissemination for RQ2 identified changes in faculty practice over time. The goal of RQ4 was to identify the types of dissemination activities that were successful as a result of these practices.

Because previous research has demonstrated that faculty members rely on publications as a primary dissemination method, the first step in addressing RQ4 was to analyze the citations of PA winners to determine whether faculty members continued to publish about their courseware after winning the PA and whether their articles were further cited. Researchers assumed that continued publication and increased citations about courseware would demonstrate "uptake" – tangible evidence of success with journal publishers and with end users. The researchers also had hoped that continued publication might indicate a change in culture towards broader acceptance of research on courseware development and use.

Unfortunately, researchers' initial efforts at citation analysis encountered a barrier to the idea that publishing about courseware would be a successful dissemination method. Namely, popular reference databases do not index journals that publish articles about courseware. This will not lead to successful dissemination *or* promotion and tenure. This also meant that the end user survey (Phase III) would provide the only source of data about successful dissemination methods.

E. Discussion: Phase I and II Results

While faculty members would not say that winning the PA had a direct effect on their careers, when the research team placed individual responses within the context of the content analysis of all interviews and, to some extent, the citation analysis, it was easier to identify the arc of career trajectories. Researchers observed that *the career stage in which a faculty member won the PA did have some effect on the extent of the impact* of the award on faculty members' careers.

Through the content analysis of dossiers, researchers also observed (but could not identify directly the causes for) the increasing sophistication in faculty members' activities with regard to developing courseware, writing about (if not conducting) evaluation and assessment activities, and employing a range of dissemination methods. After reviewing the shifts highlighted in the data, one researcher speculated that *winning the PA was more a predictor of faculty members' future success* because of the many skills required to successfully develop, document, and disseminate courseware.

V. METHODS & RESULTS FOR PHASE II

This summary of *Phase II* addresses RQ1, and is reported elsewhere in full [19]. As noted above, the content analysis of interview transcripts from *Phase I* informed the development of survey and focus group questions for the target audience: engineering deans and administrators. The goal for gathering data from this population was to triangulate their responses with faculty members' interviews about the impact of the PA, at the department and/or campus level, and to identify any change in the culture of higher education towards rewarding teaching with and using technology in classrooms. The assumption was that the more faculty members' activities were valued (and therefore rewarded), the more any impacts at the individual and institutional level would be apparent.

A. Methodologies: Survey & Focus Groups

In Spring 2013 the researchers distributed a 17-question *survey* to engineering campus leaders and administrators via an email listserv managed by ASEE. The survey gathered qualitative and quantitative data about: respondents' experience developing or teaching with courseware; familiarity with the PA; methods their respective institutions used to recognize the use or development of courseware; and, changes in the past five years regarding the use of courseware. Researchers conducuted a content analysis of the results of open-ended responses and also analyzed Likert scale items to develop the focus group outline.

The survey was followed by two online *focus groups* in Fall 2013 that were mediated through WebEx and IdeaScale, an online idea generating and discussion site. The research team first seeded Ideascale with declarative statements designed to elicit an agree or disagree response. Following the same process and content outline for both focus groups, the research team reviewed the survey results using WebEx, and at structured intervals, participants were invited to use Ideascale to comment on or make observations about the results and to ask questions. They were also encouraged to vote (agree/disagree) on other ideas or comments. Participation varied widely and did not necessitate extensive analysis.

B. RQ1 Results: Impact of Rewards on Campus and Beyond

The goal of surveying engineering deans and administrators was to gather information about their perceptions of how creating or using innovative courseware was valued. Of the with 1,854 listserv members, 236 responded for a 13% response rate. Almost all of the respondents (n=233) were affiliated with four-year colleges or universities in the U.S. Of these, fewer than five percent knew about the PA or knew an awardee. However, respondents were quite familiar with the use of courseware; more than half had taught with it. And about a third of the respondents reported that they had developed courseware.

TABLE II. VALUE OF USE AND DEVELOPMENT OF COURSEWARE

Overall Perception of…	1 Little or No Value	2	3	4	5 Very High Value
…how courseware for teaching and learning is valued (N = 196)	7.1%	8.7%	43.4%	30.6%	10.2%
…how development or creation of courseware for teaching and learning is valued (n = 196)	9.7%	14.8%	43.9%	26.0%	5.6%

Respondents reported that the use of courseware was valued more highly than its development (Table II). However, when given a chance to comment on this difference, many respondents did not distinguish between development and use, lumping the activities together. They also indicated that campus level teaching awards were the primary way in which faculty members were rewarded for the creation or use of courseware, though approximately 20% of the sample did not know if either activities were rewarded on their campuses. Overall, respondents noted that the use of and access to courseware has risen dramatically in the last five years. But, expectations about the use and adoption of courseware and rewards for its use have changed little in that same time period.

The research team chose the virtual focus group format specifically to allow all participants to voice their opinions, which does not always occur in face-to-face focus groups. In addition to discussing the survey results, the research team hoped to spark discussions around the role of technology in the future of engineering education and to elicit ideas about effective methods for motivating faculty members to continue or expand their use and creation of innovative teaching materials and methods. While 92 survey respondents expressed an interest in participating in an online focus group, approximately 10% did. Of those, only two focus group participants wrote comments or submitted ideas. Voting (on the research teams' comments) generated the most participation. Unfortunately, there was not enough focus group data to provide any additional insight to the survey responses or to the larger research question.

C. Discussion: Phase II Results

The survey results confirm findings from a content analysis of interviews in *Phase I*: that *courseware development and use was most closely associated with teaching (rather than research)*; and that *the reward system has shifted little from when the PA program was initiated* for faculty members who pursue developing or using innovative practices or tools in engineering education. Rewards, when given, were awarded at the campus level; little recognition, even informal, was given at the departmental level, though researchers were surprised at how many survey respondents (20%) indicated they did not know how faculty members on their home campus were rewarded for innovations in teaching. However, survey and focus group comments noted that rewards, at whatever level, are still necessary for changing the valuation of the scholarship of teaching with technology and with courseware in particular.

VI. METHODS & RESULTS FOR PHASE III

The final phase of the case study consisted of surveying courseware users to address RQ3 (how has award-winning courseware affected student learning) and RQ4 (what dissemination methods encourage courseware adoption).

A. Methodology: Survey of PA Courseware Users

In Spring 2014, the research team developed a 13-question online survey that was distributed to current and past users of award-winning courseware in April 2014. The survey gathered data about: respondent demographics; how respondents learned about the courseware and used it (or didn't); how or if the courseware had an impact on the structure of their courses and student learning; and, how the value, use and rewards for using courseware have changed in the last five years.

To identify the survey population, the research team culled past user names from written dossiers and asked faculty members who developed the courseware to provide names and email addresses for current users. However, the resulting list was skewed for several reasons. Some courseware websites required registration to access the software and so had extensive user records. In contrast, some faculty members had few (or no) user records because their courseware was not available on the web, sometimes because they won the PA so long ago. Several faculty members were unable to share user contact information because this would violate their sites' privacy agreements.

The research team did not try to correct for the lopsided survey population. The priority for this research is to identify the use of courseware in general and its impact on student learning. Given the disparity in size of the user populations, the data were analyzed qualitatively and are reported withoout referencing specific courseware.

B. Results: Demographics

Since the PA program was targeted at improving undergraduate engineering education it is no surprise that the majority of respondents' 'Type of Institution' reflects the intended audience for PA courseware (i.e., four-year colleges and universities; see Table III). The relatively high number (8%) of respondents from middle and high schools illustrates how the use of award-winning courseware has moved beyond its originally intended audience (as noted by interviewees).

Courseware that could be used by a multi-disciplinary audience was more likely have more users than courseware targeting a specific and smaller audience. The courseware that received the largest number of responses was designed for a multi-disciplinary audience. It was not bound by content or topic and instead supported a pedagogical approach that transcended discipline and attracted users beyond engineering. Other courseware focused on content for a specific discipline, mainly engineering and computer science. Regardless of the courseware, respondents tended to be quite experienced instructors.

TABLE III. DEMOGRAPHICS OF RESPONDENTS

	% Respondents (n = 556)
Institution Type	
- Middle or High School	8.3
- Technical, Vocational or Training	0.4
- Community, 2 year or Junior College	2.7
- 4-year Bacc., Liberal Arts College or University	20.1
- Master's Granting University	11.5
- Doctoral Granting University	57.0
Teaching Experience	
- None / not an instructor or teacher	4.7
- 1 – 5 years	23.7
- 6 – 10 years	20.9
- More than 10 years	50.8

C. Results RQ3: Effect on Student Learning

While the survey results were dominated by users of two recent PA winners, around 13% of respondents used courseware that had received the PA between 1998 and 2008, and almost half of these respondents reported that they were still using the courseware. Almost 20% of respondents indicated they would no longer use courseware or had stopped using it prior to the survey, most respondents (81%) were currently using their respective courseware (Table IV). Most respondents indicated that usability and lack of campus technology support were critical factors in their decision to discontinue courseware use.

TABLE IV. REASONS FOR USING COURSEWARE (OR NOT)

No longer use courseware because…	Continue to use courseware because…
• It was not user friendly; the technology was outmoded. • There was no support at the campus level. • [I am] teaching something different, no longer relevant. • Students didn't like, or resisted, the courseware.	• It helps with course management. • It increased or added student interactivity with the course content. • It helped collect assessment and grading data.

Table V reports how respondents rated "Changes in outcomes associated with using courseware" on a five-point Likert scale ("1" indicates the outcome was significantly worse; "5" indicates the outcome was significantly improved). In the aggregate, respondents' indicated that the following three outcomes were most improved: attitude towards the course, engagement with course content, and motivation to learn. The postive impact of courseware on student engagment may require more analysis since it is possible that the effect of courseware being engaging to students has decreased as technology has become ubiquitous in higher education.

TABLE V. CHANGES IN OUTCOMES ASSOCIATED WITH COURSEWARE

Outcome	Mean	SD
Attitude towards the course	*3.71*	*1.90*
Completion of homework	3.41	1.78
Faster learning	3.43	1.73
Assignment grades	3.51	1.68
Test grades	3.26	1.67
Course grades	3.44	1.82
Engagement with course content	*3.86*	*1.93*
Motivation to learn	*3.68*	*1.84*
Retention in the course	3.39	1.65

D. RQ4 Results: Successful Dissemination Strategies

When asked about how they learned about courseware, the most frequent response (61.6%) was that a colleague had told the respondent. The next most frequent response was learning about courseware via a conference paper, poster or presentation (16.3%), followed by a general online search (11.3%). Face-to-face workshops and journal articles (8%, respectively) were also fairly popular methods for learning about courseware. While PA sponsors hosted an awards ceremony at FIE annually during the course of the PA program, fewer than two percent of respondents learned about courseware at this event.

Finally, respondents were asked about their perceptions regarding any change in how the use of innovative courseware was valued in the service of teaching since 2009. The research team chose five years in the past as the dividing line because significant technological changes occurred during that period (e.g., the rise of social networks; the use of instructional videos on YouTube; the implementation of MOOCs) but was also recent enough that respondents would be able to adequately judge the level of change. Respondents noted that while value of, access to, use of courseware and positive impact on student learning was much more than five years ago at their school, they observed little or no change from five years ago with respect to being rewarded or recognized for being involved in those same activities.

E. Discussion of Phase III Results

The survey results reflected the over sampling of several pieces of PA-winning courseware, that were mainly classroom management tools, and a low response rate from users of content-focused courseware. The research team observed of the respondents still using older courseware that once instructors find something that 'works for them' they find ways of continuing to use the courseware even if it is no longer current with more recent technology. Further analysis may show some correlation between years of teaching experience and reasons for using or abandoning courseware and pursuit of additional user populations may provide more insight into how faculty adapt courseware to meet their needs.

VII. RESEARCH FINDINGS AND IMPLICATIONS

The purpose of this research was to examine the impact of the *Premier Award* on the faculty members who developed and used award-winning courseware with their students and to examine how the rewards system within higher education has changed (or not) in its valuation of innovative teaching. The research was conducted as a case study of the population of faculty members who won the Premier Award from 1997 to 2012. The research team also gathered data from related populations (engineering deans and administrators; courseware end users) to provide a more nuanced perspective on successful dissemination methods for courseware and on changes in the reward and recognition system in higher education. Below, the research team reports the findings from all phases of the research, organized by research question.

A. RQ1 Findings: How has receipt of the Premier Award impacted the awardees' career paths and why?

Because developing or using courseware was a new activity, in the 1990's, that did not fit easily into the categories of research or scholarly publishing, there was (and is) a tendency among higher education administrators to associate this activity with teaching (as reported in *Phase I* interviews). Results from the literature search were reinforced by survey responses, which indicated that developing and using courseware was valued differently, and inconsistently, across departments and institutions. This inconsistency was not limited to the discipline of engineering, and it did have some effect on why the winning the PA did not always positively impact the career of faculty members. However, the interviews demonstrated that for some faculty members, the PA *did* provide a critial path to legitimize their work, bearing out the hopes of the PA program founders.

B. RQ2 Findings: How has the quality of the courseware submitted changed over time?

As the PA program and award-winning courseware matured, faculty members and the PA Review Committee placed more emphasis on documenting the evaluation of courseware impact on student learning. This shift highlighted a change in how quality was defined, from "something that's not buggy," to rewarding courseware that led to promised improvements in terms of teaching and/or learning. Content analysis of dossiers in *Phase I* reflected how, over time, courseware evolved to embrace better learning design. However, results of the end user survey in *Phase III* suggest that "applicability" of courseware (i.e., topic relevance; appropriate to student learning level) is as important to end users as quality.

C. RQ3 Findings: How has the award winning courseware affected student learning?

Results from the survey of courseware users (*Phase III*) suggests that the largest impact of using courseware in the classroom has been seen in increased student engagement in a course's content, in improved student motivation to learn, and in improved attitude towards the course. While these outcomes are not directly associated with learning course content, they are critical components of learning. The researchers observed that faculty members' evaluation of their courseware was often limited to determining student satisfaction. One avenue for further research could involve examining this, and other, student data in detail, over time, to learn more about the impact of courseware on student learning.

D. RQ4 Findings: What kinds of dissemination activities and mechanisms are successful in promoting successful adoption and use of courseware?

When the PA program was initiated, one of its key purposes was to help faculty members disseminate their award-winning courseware in order to make availabile high quality materials and thereby support positive changes in engineering education. Award-winning faculty members described their extensive and continuual efforts to disseminate their materials and encourage broad adoption. The results from research in *Phases I* and *III* indicate that there is no one best method to successfully disseminate courseware; in fact, multiple dissemination methods seemed most effective, despite sometimes significant barriers. For example, major databases do not index the publications where faculty members report about courseware. This has led the researchers to speculate that there has not been a significant enough change in valuing the scholarship of teaching, and it remains, as in the 1990's, a fringe activity. Interviews also provided a great deal of insight into barriers to dissemination, particularly the sustained level of effort required to encourage courseware adoptions. Researchers were not able to determine exactly what encouraged end users to adopt and use courseware, though a combination of "right tool, right time" might be a factor as well as the usability and applicability of courseware across multiple learning settings.

E. Synthesis & Implications for Engineering Education

Has PA-winning courseware had an impact on engineering education? The use of courseware, as one measure of the PA program's success, has been tempered by time and by rapid changes in technology. Maintaining and improving courseware requires a sustained effort; there is no guarantee that courseware developed even five years ago will 'work' technically or pedagogically in the future. Likewise, funding for courseware development projects is not guaranteed, and innovative faculty members often move on quickly to the next challenge. Based on the results from this case study, the researchers believe that PA-winning courseware is more widely used even than the original developers intended, which they would count as a success. However, the sustainability of courseware poses challenges for its long-term role in engineering education.

Has the PA program had an impact on the culture of rewards and recognition within engineering education? The research team found that winning the PA had a positive impact on faculty members' careers. But, the researchers also recognized that the PA program was one of many factors that had an impact on, but was also shaped (and buffeted by), the changes in educational culture in the past fifteen years. The PA program emerged in a time of increased emphasis on ABET standards, SOTL research, and huge shifts in campus and personal technology. Within this milieu, it is perhaps impossible to identify one single factor that effected change in engineering education. However, for some innovative faculty members, the PA program provided validation and support for continuing to identify and develop innovative approaches to teaching and learning with technology.

F. Limitations of the Research

Upon reflection, the research team observed that it was difficult to examine the impact of the PA because no one and nothing that we studied remained constant or untouched by a multitude of contextual factors for which there was no control. Each year, faculty members progressed in their careers, the design and use of courseware became more nuanced, and the role of technology within higher education exploded. With regard to this study, the research team recognizes that some of the data collection methods (interviews; surveys; content

analysis) yielded more information than others (citation analysis; focus groups), perhaps presenting lopsided results for some of the research questions. As a case study, the findings from this research are limited in their generalizability.

But, this study has demonstrated that it is possible to use qualitative and reflective research practices to examine the impact of innovations in higher education. A unique contribution of this research has been its focus on examining impacts over the entire duration of the PA program, which fills gaps in a literature rife with short-term studies.

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