# The bigger picture - capturing value creation for an engineering school as it initiates engineering education research

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***Abstract:*** *To help those introducing engineering education research in contexts where there is no existing tradition for this kind of research, this paper looks at an approach to value capture based on a learning community cultivation model developed by Etienne Wenger which uses a five cycle assessment framework. The framework captures the value of this type of research more comprehensively than more traditional indicators like research output and can be useful both for preparing return on investment reports for administrators and for planning new research projects. Here we exemplify its application for a 3-year nationally funded project and compare this approach with an alternative one.*

## Introduction

When attempting to introduce engineering education research (EER) in an engineering school the challenges include a lack of legitimacy in relation to mainstream engineering research and the fact that there may be no tradition and little institutional support for such investigation. In addition it may be difficult to demonstrate clear gains in the early years so to justify the time and opportunity cost involved for faculty or institution. This may be mitigated in part by recognition gained through successful application for external research funding but even then it may not be easy to demonstrate the value of the introduced changes within the timeframe and often narrow framing of goals and milestones (journal articles, conference papers, patents or PhDs awarded) associated with such funding. For this reason, we have explored the potential of various approaches for measuring change (Kantor & Lehr, 1975, Ancona, Bresman, & Kaeufer, 2002) and for capturing value (Wenger et al, 2011) as a result of EER interventions in an institution.

This paper focuses on an approach to value capture based on a learning community cultivation model developed by Etienne Wenger which uses a five cycle assessment framework. It ascribes five stages or cycles of value in the evolution of a learning community and we believe they are relevant to the evolution of EER interventions. Wenger and his co-authors propose a progression through the following learning cycles of value creation:

1. Immediate value: activities and interactions

2. Potential value: knowledge capital

3. Applied value: changes in practice

4 Realized value: performance improvement

5. Reframing value: redefining success

### Background

In the work described here, we apply the framework to a recently completed three year nationally-funded research project which set out to use a community of practice approach to introducing active and cooperative leaning techniques in lecture classes through the design of a learner activity monitoring instrument.

# Methodology

We believe this is first time this particular framework has been applied as a lens in the field of EER and as this essentially exploratory research a qualitative methodology has been adopted.

## Research question

Can this framework be recommended as an instrument to capture the value of an EER project?

# Procedure

The information presented is based on data gathered from interviews with the engineering lecturers who formed part of the core group of the Active Learning research project and validated by inviting the respondents to comment on the transcriptions of their interviews at the end of the three-year period. This data is supplemented with other narrative and institutional data gathered during the time the project was underway.

The structure of the paper follows that proposed by Wenger et al for the five cycle assessment framework in that we exemplify each the cycles in the context of one of the schools participating in the project mentioned above.

### Cycle 1 Immediate value: activities and interactions

The most basic cycle of value creation considers networking and community activities and interactions in and of themselves.

In this case, activities of the core community included:

3 or 4 of meetings the core group per semester. Once the overall goals and tasks had been defined, these meeting were mainly design-focused to improve the LAMM and observation procedures;

observation of lessons of members of the group by group members (peer observation);

observation of lessons of members of the group by student grant holder;

recording lessons of members of the group using video camera;

participation in 13 international conferences – (involving 8 group members);

13 peer-reviewed conference papers, 3 other conference papers (5 group members);

3 poster presentations (5 group members);

holding monthly active learning seminars for other engineering faculty members in 2009 and 2010.

### Cycle 2 Potential value: knowledge capital

Not all the value produced by a community or a network is immediately realized. Activities and interactions can produce "knowledge capital" whose value lies in its potential to be realized later

Aside from its role in community cultivation, the concept of knowledge capital within higher education institutions has been the object of increasing interest on the part of economics researchers in recent years as R&D allied to the cultivation of positive network externalities and knowledge spillover are believed to contribute to increasing entrepreneurship and subsequent national growth in the long term (Acs et al 2009, Baptista et al 2011, Romer 1990).

Although the work described here was originally seen as focused on improving teaching and learning in the classroom, it did also lead to ancillary research and collaboration with innovative engineering companies as will be described below.

The framework we are employing has five sub categories for the knowledge capital cycle which will now be outlined in relation to the case under study:

### 2.1 Personal assets (human capital)

This can take the form of a useful skill, a key piece of information, or a new perspective and included the following:

Running pedagogy sessions for peers not involved with the project. This peer sharing process involved participation from all the 7 core members and additionally 3 other colleagues who became involved as the project progressed;

Experience speaking to peers (in Portuguese) about a new area of competence;

Experience speaking in public (in English) about a new area of competence;

One external graduate student and two undergraduate students of the school received grants to participate in the research – the latter not being common practice in Portugal;

New classroom teaching techniques;

Relating to students in the classroom in new ways;

Experience in observing and being observed in a systematic way in the classroom;

Experience in design-based research;

Using the LAMM tool;

Using videoconference and web 2.0 tools;

Using Skype for audio conference.

### 2.2 Relationships and connections (social capital)

When one considers knowledge as a collective good distributed across a community or network, then social relations and connections are a form of knowledge capital. These included:

Participating in a nationally funded research project (albeit not "engineering research" which in the national context is seen as the most important in terms of career progress)

Recognition within the engineering school as doing something related to teaching and learning

Opportunities for members of the team to speak, correspond and share ideas with international colleagues in the field of EER from a range of international institutions which included the University of North Carolina, the School of Engineering Education of Purdue University, Bucknell University, Universidad Politécnica de Madrid and Universiti Tun Hussein Onn Malaysia.

### 2.3 Resources (structural capital)

Participating in a community or network gives one privileged access to certain resources. This includes specific pieces of information, documents, tools and procedures, but also increasingly networked information sources, tag clouds, mindmaps, links and references, search capabilities, visualization tools, and other socio-informational structures that facilitate access to information. In this case the artefacts included:

The LAMM instrument for classroom observation

Papers and posters (in English) produced and published in international conferences

Power-point presentations (in Portuguese) produced collaboratively by team members for the in-house pedagogy sessions

### 2.4 Collective intangible assets: reputational capital

Over time, a successful community of practice will gain a reputation as a place where important knowledge is being produced. This reputation can give the community some authority in its field and a new voice in organizational contexts. Such reputation and authority in turn increases the legitimacy of individual members as practitioners. Examples included:

Group members invited to speak and represent the engineering school, institution in national and international events (e.g. International Week, Quality Assurance conference);

Invitations to group members to speak at other national institutions;

Invitations to group members to speak at international institutions (Spain, Malaysia, Thailand and Australia).

### 2.5 Brokering knowledge of the learning process: learning capital

An additional value of being part of this community is that people are learning to learn in new strategic ways that will hold good across other contexts. Examples were:

Learning about research funding proposals;

Learning about research conference participation and organization;

Learning about the use of learner activity as a learning proxy in lecture classes (Use of learner activity as a learning proxy in lecture classes (Williams and Carvalho 2010)

Learning about submission of research articles (in English) to international journals.

## Cycle 3 Applied value (changes in practice)

It is useful to follow the value of the learning of the community as members apply their knowledge to their practice in their own context: how do members of the group leverage that knowledge capital as they adapt and apply it to specific situations in their practice? Some examples follow:

One member of the community used the reputational and knowledge capital acquired during the project to build partnerships with national technology firms who are recognized innovation leaders and this in turn led to new lines of research, research partnerships with two international universities and a nationally funded research grant in the field of engineering practice (Williams and Figueiredo 2010);

Data from the interviews with participants show that all believed that the way they taught lecture classes had altered in that they integrated more active learning (AL) techniques. The Activity Index and Participation Parameter data collected in 96 observed classes during the three years supported this.

## Cycle 4 Realized value: performance improvement

Although it may be clear that members feel more confident and are applying their capabilities in a number of ways, the ultimate test of the value of a community lies in its effects on performance and results. Performance improvement is often difficult to verify empirically but some indicators have been able to provide pointers:

LAMM data: as described above the data gathered showed learners became more active in lecture classes of participating lecturers during the period of the project and this contrasted with much lower levels of learner activity in lecture classes of traditional colleagues who had not participated. As shown in Table 1, we noted that the AL-oriented classes featured considerably more activities than the traditional ones (as we would expect) and our data showed that even when the former employed more traditional lecturing the level of student participation was also considerably higher as represented by the number of questions and answers during the class.

LAMM Results

| Lecturers | Activity index | Participation parameter |
|---|---|---|
| ALP oriented (n = 92) | 45,39 | 17,1 |
| Traditional (n = 15) | 30,2 | 9,5 |

Table 1

Assuming for simplicity that the class time recorded in column 1 of the LAMM to represent "lecturing", Table 2 shows a comparison between the % time engaged in lecturing for both AL-oriented and traditional lecturers in our study (Williams and Carvalho 2010).

LAMM Results

| Lecturers | % lecture time |
|---|---|
| ALP oriented (n = 92) | 62 |
| Traditional (n = 15) | 93 |

Table 2

This tallies with findings by Cox and Cordray who used the VOS observation system to study 28 bioengineering courses in the US that "although courses are designed to be innovative, the dominant pedagogical practice is still lecture";

Student data: pre-post test data on student expectations, subject level evaluation marks and student attendance data are being calculated at subject level and results so far do indicate a positive evolution in all three in the AL classes monitored (Neto et al 2009, 2010, 2011);

Instructor self-efficacy data: all but 2 of the participants indicated at the outset that they had no training in pedagogy and did not feel able to make a presentation to peers about such a topic. At the end of the first year all of them reported in interviews that they felt sufficiently secure to be able to make a presentation about pedagogy to peers and subsequently all members did go on to run one or more peer-sharing sessions as indeed did an additional 3 lecturers who became peripheral participants in the course of the project.

### Cycle 5 Reframing value: redefining success

In some cases, the value of a community goes beyond improved performance and results with regard to existing metrics and indicators. The learning of the community compels it to reconsider the very definition of what matters and what constitutes success. This can often lead to a recalibrating of existing metrics and indicators, and sometimes to entirely new ones.

The original goals of the project could be summarized as the creation of the LAMM tool, 6 conference papers, 2 journal articles and dissemination to other institutions. The first two have been achieved the third was not achieved during the project lifetime, but is forthcoming, while the final objective has not been fully realized to date.

However, on approaching the end of the project it was as we wrote up the formal report for the funding agency that it started to become obvious that a broader framework was needed to capture more effectively the value created and hence it was only in the final stages that the Wenger framework began to be used.

## Discussion

Overall the Wenger framework appears to have been useful as a tool to capture the value produced by this particular project and the authors believe it can be recommended for other researchers confronting similar issues. For value-capture purposes we believe it is clearly more appropriate than the Four-Player Model proposed by Kantor and Lehr. On the other hand, if one needs a framework which focuses more on the dynamics between the group members and how this may affect change introduction, the latter framework handles this well (Venasup et al 2009) whereas the Wenger approach does not give it prominence.

## Conclusions

To capture the value of an EER project we describe how we have adapted a five-cycle assessment framework developed by Etienne Wenger for learning communities. We believe this framework captures the value of this type of research more comprehensively than more traditional indicators like

research output and for this reason it can be useful both for preparing return on investment reports for administrators and for planning new research projects. This being said, it is to be recommended that such a broad value assessment framework be defined from the outset so as to get the benefit from continuous reflection and if necessary re-design throughout the process – if we had done this at the outset we could probably have reaped more benefit from the approach.

Although the project in question has now formally come to an end, we intend to continue monitoring its outcomes over time using this approach and hope to be in a position to publish a more detailed value report in the future.

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