CAPTURING, TRACING, AND VISUALIZING THE SPREAD OF TECHNOLOGY-ENHANCED INSTRUCTIONAL STRATEGIES

Daniel Davis[1], John Hanacek[1], Adam Myers[1], Susan Mulroney[1], Susan Pennestri[1], Yianna Vovides[1]

[1]Georgetown University (United States)

Abstract

The aim of this paper is to describe the process and results of capturing, tracing, and visualizing the spread and evolution of technology-enhanced instructional strategies within medical and graduate education. The paper shows the resulting network of influences in relation to the adoption of these strategies across individuals and communities within Georgetown University as well as beyond its organizational boundaries. The underlying framework used to guide this approach is that of knowledge exchange or peer-to-peer learning. The framing of this approach is based on the Art of Knowledge Exchange guide [1] which was developed by The World Bank Group. The paper concludes by proposing that a knowledge exchange framework may serve as an alternative to more traditional evaluation methods and return on investment models used in higher education.

Keywords: technology-enhanced learning, knowledge exchange, technology transfer, research

1 INTRODUCTION

Innovation in higher education institutions does not come easy, and when it does, it tends to be fraught with challenges. Many of the challenges relate to sustainability of the innovation which requires not only early adoption of the innovation but also early adoption of a solid implementation strategy [2]. We operate under Rogers' definition of innovation, which he explains as "an idea, practice, or object that is perceived as new by an individual or other unit of adoption" [3]. Rogers introduced an Innovation Adoption Lifecycle model (Fig. 1) that accurately speaks to the spread of technology-enhanced instructional strategies (TEIS) in our research. We define TEIS as technologies used in concert with pedagogical methods to support student learning. The technologies used to support student learning for this project included lecture capture (Echo360), digital whiteboards (SmartBoard), polling systems (i>clicker) and the Blackboard Learning Management System (LMS). With the Y-axis representing the number of people adopting and the X-axis representing time, the model illustrates the manner by which certain groups of people adopt a given technology. We identify the Principal Investigators (PIs) in our study as innovators.

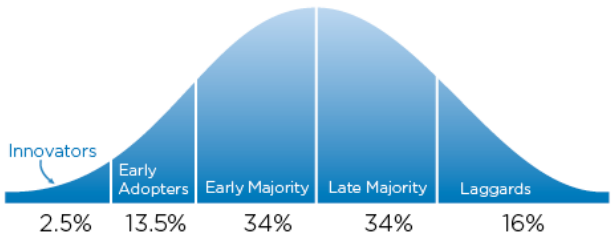

Fig. 1 Innovation Adoption Curve, based on Rogers, Diffusion of Innovations [3]

When considering the adoption of innovation as a sustainable implementation practice, it is critical that we account for the change that needs to occur at the individual level so that the individual becomes a

change agent to champion the innovation itself. As individuals connect with peers and form groups, the innovation begins to shift toward influencing the institution. Once the innovation becomes institutionalized it reaches a systemic change and becomes part of the operational environment. Figure 2 shows this path of influence from individual/group to system levels [1].

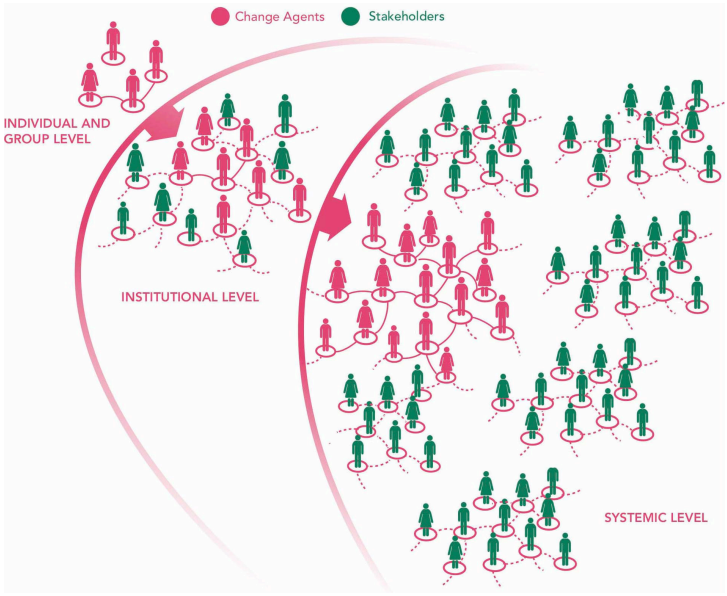

Fig. 2 The Direct Results and Influence Achieved from Knowledge Exchange [1]

1.1 Background

In Fall 2013, as part of Georgetown University's Initiative on Technology-Enhanced Learning (ITEL), the Center for New Designs in Learning and Scholarship (CNDLS) awarded Dr. Adam Myers, Professor of Pharmacology and Physiology, a 3-year grant to strengthen teaching and learning in the broad discipline of physiology. Since physiology content has traditionally been delivered in lecture format with some additional problem solving exercises and clinical presentations, the objective of the project was to improve student learning outcomes by implementing various technology-enhanced instructional strategies in graduate courses and medical school modules.

As part of this project, PIs Dr. Adam Myers along with participating faculty member and Co-Investigator, Dr. Susan Mulroney, and CNDLS staff decided to capture, trace, and visualize the spread and evolution of TEIS across individuals and communities within the medical center and beyond. The key motivator for implementing this approach was to better understand how instructional strategies spread within a higher education institution and the role that peer-to-peer exchange plays.

2 METHODOLOGY

In this section, we describe the methods and procedures that enabled the capture, tracing, and visualization of the spread and evolution of TEIS. We followed a grounded theory methodology for data collection and analysis. According to Holstein and Gubrium [4l] "these methods give researchers tools for analyzing data as well as for obtaining additional focused data that inform, extend, and refine emerging analytic themes. Thus the interviews that grounded theory researchers conduct are focused; grounded theory methods create a tight fit between the collected data and analysis of those data." By analyzing the interviews from the initial phases of our research, we were able to identify relevant actors for further interviews.

2.1 Capture

To capture the interactions within and across communities, we conducted a series of interviews with multiple stakeholders including faculty, staff, and students. All names other than PIs have been anonymized by utilizing randomized initials.

The approach for the interviews was open-ended, focusing on eliciting narratives related to the outward communication efforts of instructional strategies. The prompt used to begin the interviews was: “Please tell us about your project, in particular about the project aims and your outreach efforts.” These interviews were recorded using a digital audio recording device. Based on the initial interviews, first order actors were identified and then one-on-one interviews followed to uncover if and how new knowledge was applied.

For sampling we began by interviewing the PIs, Myers and Mulroney, to determine their first degree of connections. Based on relevance and weighted frequency of mentions in the PI interviews, we determined the next interviewees. This led us to Interviewee #3 (QC) and then Interviewee #4 (EU); this group functioned as our core sample cluster for social network analysis. We asked the following interview questions:

1. Please tell us about your project, in particular about the project aims and your outreach efforts.
2. Who have you reached out to in regards to sharing your strategies in this project? (Any emails, contacts, other interaction records, etc...)
3. Who has reached out to you inquiring about your strategies from this project?
4. Through what media or forum have you shared your strategies from this project?
5. Where, to your knowledge, have these strategies actually been implemented? Which strategies? Who facilitated the processes?
6. What have you seen suggesting that these strategies have increased student learning?

2.2 Trace and Visualize

We constructed a preliminary social network visualization as we progressed through data collection. Then, to construct the data-driven social network, the resulting audio files from the interviews were coded using a qualitative data analysis tool, NVivo 10, with the following coding criteria:

- frequency of name mentions (social influence within and across communities)
- number of connections made
- frequency of conversations/interactions
- instructional technology tool(s) used
- instructional strategies used
- instructor intent
- instructor prior knowledge

These codings generated matrices of mentions, which showed who mentioned who, what, and how frequently. We created word trees focusing on specific words such as “smartboard” to see the personal and conceptual links between interviewees.

3 FINDINGS AND DISCUSSION

This section describes the key findings from the analysis. The initial interviews were with the grant recipients, Drs. Myers and Mulroney. Through the initial interviews a network of key actors emerged who were primarily responsible for fielding the TEIS. This enabled us to identify subsequent interviewees who were integral to the network. A total of six interviews were conducted.

The following model (Fig. 3) demonstrates the innovation process of TEIS from trigger (ITEL Grant in 2013) to feedback and iteration. The ITEL grant triggered the innovation of Myers’ and Mulroney’s TEIS which they then introduced to their students and shared with their colleagues (Fielding). QC aided the fielding process by providing technical support to both faculty and students in an ongoing loop. At the end of each semester, module, or unit, Myers and Mulroney would seek feedback from students, which would inform and drive the innovation and iteration process for the next cycle (Feedback).

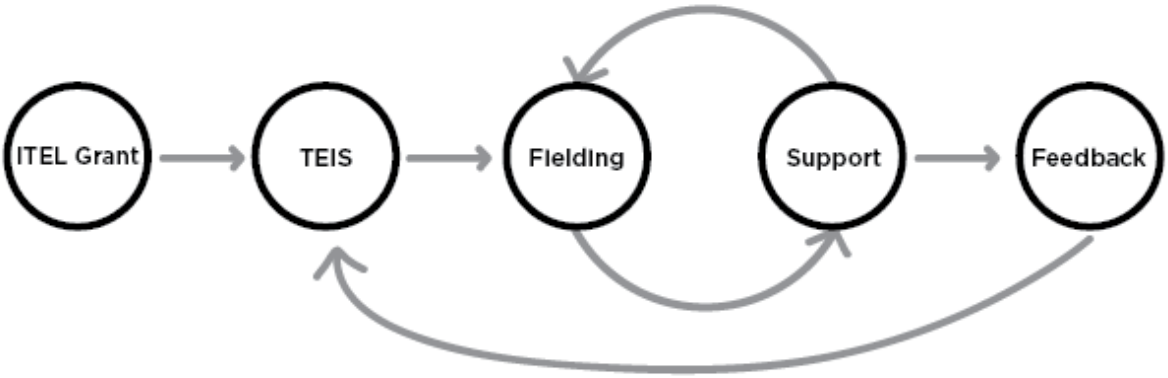

Fig. 3 Implementation Model for TEIS

The table below shows a relational matrix from four of the six interviews. This formed the core of our analysis as these were the most connected and knowledgeable individuals. The columns are interviews, and the rows are names of actors mentioned within each interview. The numbers refer to the frequency of mentions within each interview.

According to our coding of the interviews we conducted with Myers, EU, QC and Mulroney, we could better characterize the relationships between these core actors. In coding the interview transcripts we utilized NVivo and generated a relational matrix (Table 1).

Table 1 Relational Information Matrix

	Myers	EU	QC	Mulroney
1. Myers	11	5	5	15
2. BV	0	0	2	0
3. DT	7	0	2	4
4. EU	0	12	0	0
5. JH	1	0	0	4
6. KC	0	0	2	0
7. KK	0	2	0	0
8. QX	1	5	2	1
9. QC	4	1	1	10
10. KX	3	0	0	2
11. TT	4	2	5	2
12. Mulroney	12	4	6	1

From the coding data we identified a strong connection of Myers to Mulroney, which is to be expected. In addition, QC and successor DT are mentioned with high relative frequency. However, the directional relationship between Myers, Mulroney and QC to EU is more puzzling. While EU mentions them, they do not mention EU. We surmised from this that EU was in a position to see students benefit from Myers' and Mulroney's efforts, but was not directly involved in the spread of TEIS.

Other actors emerged as co-innovators, JH, QX, and KX. TT was mentioned by all interviewees as a force of change.

3.2 Tracing the Spread

Prior to the ITEL grant in 2013, starting in 2011, the Myers/Mulroney/QC (MMC) team fielded lecture capture technology, beginning with the use of Camtasia by TechSmith before deciding to switch to

Echo360's lecture capture. QC was responsible for technical implementation and interfacing with the professors and students whose classes were being recorded.

The strategy spread rapidly due to strong student response. Students quickly began routinely incorporating the lecture capture content into their study strategies. Some chose to use the captured lectures to reinforce their time in the physical classroom lecture, and others chose to replace physical attendance with the captures. Others designed a blended approach between the two.

Lecture capture supported by the MMC team was piloted in the first year medical school courses (M1) in 2011. One year later in 2012, the students transitioning from M1 to second year (M2) found themselves without the robust, high quality lecture captures they had come to expect and depend on from their M1 classes. Student feedback to this situation prompted the medical school to create the internal political economy necessary for the deployment of the TEIS. The TEIS technologies of lecture capture and SMART Boards were installed in response to the student demand. TT was able to navigate the internal environment of the medical school in order to get SMART Boards installed in the main classrooms where M2 lectures were held.

By this time the TEIS developed by Myers/Mulroney was sufficiently modularized for fast rollout, with QC able to support implementation and troubleshooting immediately -- oftentimes sitting in on lecture sessions for on-site support.

Myers/Mulroney have not only inspired technological adoption but demonstrated effective pedagogical strategy for students, which in turn gives students a benchmark that they use to hold other professors accountable. In course evaluations, Mulroney scored high for her lecture style which relies heavily on her seamless use of smartboard technology.

A common thread in interviews was the transitionary tension between professors' previous non-captured lecture style and adapting to a lecture capture style. Laser pointers were often utilized in the past to highlight features of slides. However, laser pointers do not show up on lecture capture, which is gathering audio from the room, video from the computer screen, and digital annotations on the smartboard. Students took a forward-facing role in nudging professors away from using laser pointers and toward using the SmartBoard–if professors forgot to use the smartboard when demonstrating something, often a student would speak up and ask them to use the Smart Board.

Students quickly became used to having lecture captures to refer to, with the majority of student course evaluations in the first year expressing appreciation for the lecture capture. As optimization continued in the TEIS, students became accustomed to high quality audio and video made available within a day of the lecture. When it took any longer, the instructors' inboxes would quickly fill with student emails asking where the lecture capture was. Technical issues, when they arose, became more noticeable as the quality of lecture captures increased.

For the GeorgeSquared (George2) Biomedical Sciences programs, an academic partnership between the Georgetown University Medical Center and George Mason University, the lecture capture videos needed some polishing and editing in post-production because these videos were the main mode of delivery for medical modules at George Mason University. Myers and Mulroney found that the students at George Mason did not want to hear all of the announcements before each class that did not apply to them. Trimming down the lecture videos to only the important, relevant moments served two key purposes: providing a polished product for the George2 students and reducing the size of the video files. George2 utilized lecture captures created in Georgetown medical school courses, including courses taught by Myers and Mulroney, and displayed them at George Mason for students in physical classrooms and offered them online through Blackboard. This joint program has since disbanded, but the strategy of edited lecture captures as primary lecture content will continue in the Georgetown Downtown program, along with facilitated flipped classroom sessions, and make future development/spread more efficient.

The MMC team had parallel innovators in the medical school, notably BV, who developed a variant of the TEIS by drawing on a handheld tablet computer; the tablet is linked to Echo360 to capture the sessions. BV is an example of a member of the Medical School community not only accepting and adopting the TEIS introduced by Myers and Mulroney; BV used it as a platform to build new TEIS specifically catered to BV's own lectures on gross anatomy. JH is another example of this elaboration.

JH created original animations to share with students via the Blackboard platform for the embryology lectures. A reciprocity emerged between JH and Mulroney when Mulroney took interest in JH's content and worked with JH to develop videos so that she could make them available to students in the medical Gastrointestinal module.

In Fig. 4 to 5, we observe the changes in the network of implementers and programs. Fig. 4 shows the actors who were engaged in fielding the TEIS in the initial stages of the ITEL grant. Fig. 4 shows the actors who are currently engaged with supporting the TEIS implementation as of June 2015. QC has moved to a position with UIS, which means that knowledge of TEIS implementation is now connected to the broader Georgetown campus. QC is a key spread agent taking the TEIS developed with MM and instructing other departments on how to utilize lecture capture and Blackboard, along with retaining knowledge of Smart Boards and their integration.

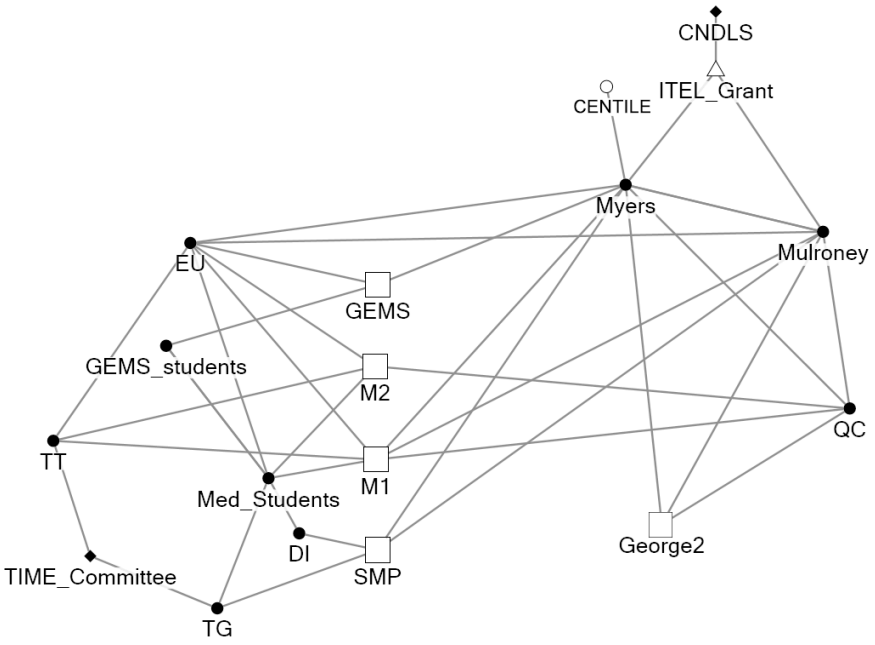

Fig. 4 Implementation Network: 2011 - 2014

Solid diamonds represent organizations, solid circles represent people, squares represent programs. The grant is depicted as a triangle. The CENTILE conference is depicted as an open circle.

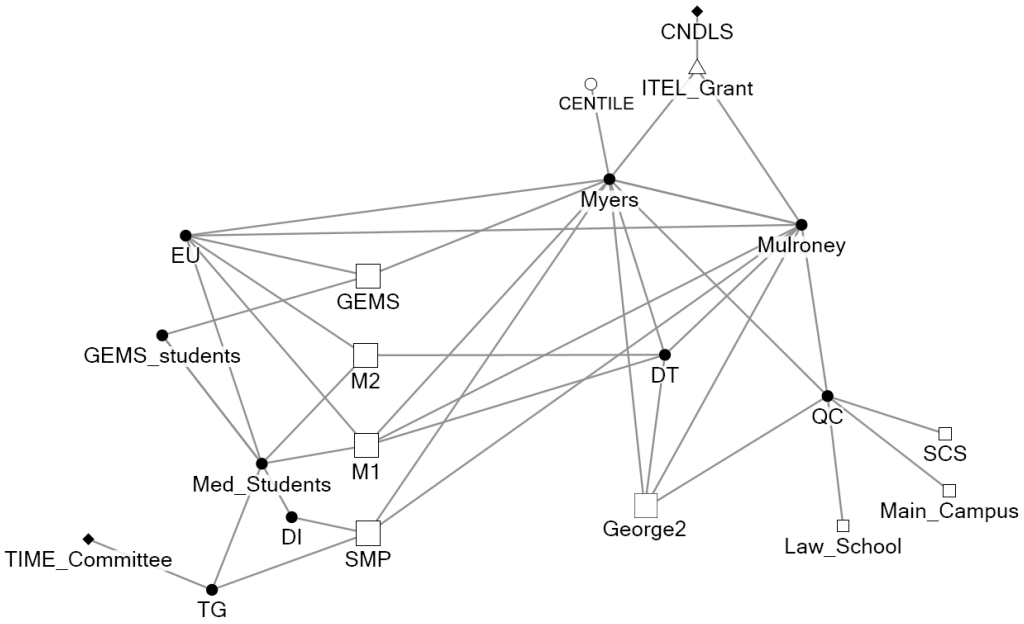

Fig. 5 Implementation Network: 2014

Solid diamonds represent organizations, solid circles represent people, squares represent programs. The grant is depicted as a triangle. The CENTILE conference is depicted as an open circle.

According to our analysis TT was a bridge between the TIME (Technology in Medical Education) committee's students and implementation of changes in the Medical School. At this writing, a replacement for TT is not yet in place, suggesting that communications between students and those responsible for implementation in the Medical School must occur through other pathways.

TG and DI were our sample students. They were identified as points of contact during our initial interviews with Mulroney, Myers and QC. They provided some details from the student perspective and highlighted the importance of the Medical Note Taking Service to students' learning.

In Fig. 5 we see that DT has replaced QC in the role of logistical and technical support. QC's connections to M1 and M2 are largely severed, but QC retains social and professional ties with Myers and Mulroney, in addition to gaining new connections with the broader campus.

Squares represent programs within the Medical School. Diamonds are organizations. The annual CENTILE conference is a forum for presentation of educational research and innovation at the Medical Center, but because it is not an ongoing channel for communication, it is represented as an open circle to distinguish it.

Figs. 6 and 7: While Mulroney and Myers are professors in the Medical School and teach medical and graduate students, EU interfaces with many students. QC and successor DT are categorized as support experts, while Myers, Mulroney, EU and the Students are implementation experts. MNTS stands for Medical Note Taking Service, a student-run initiative of high importance discussed more in the next section. In Fig. 6 we see that QC has gained a connection with the students, as his work required him to sit in classes and interface with students directly.

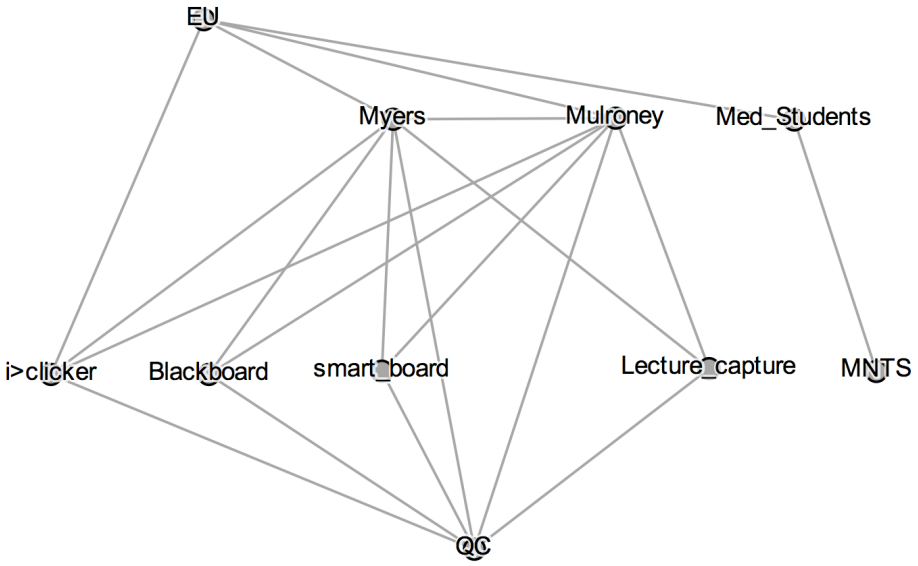

Fig. 6 Bimodal TEIS "Expert Cluster" 2011-2014

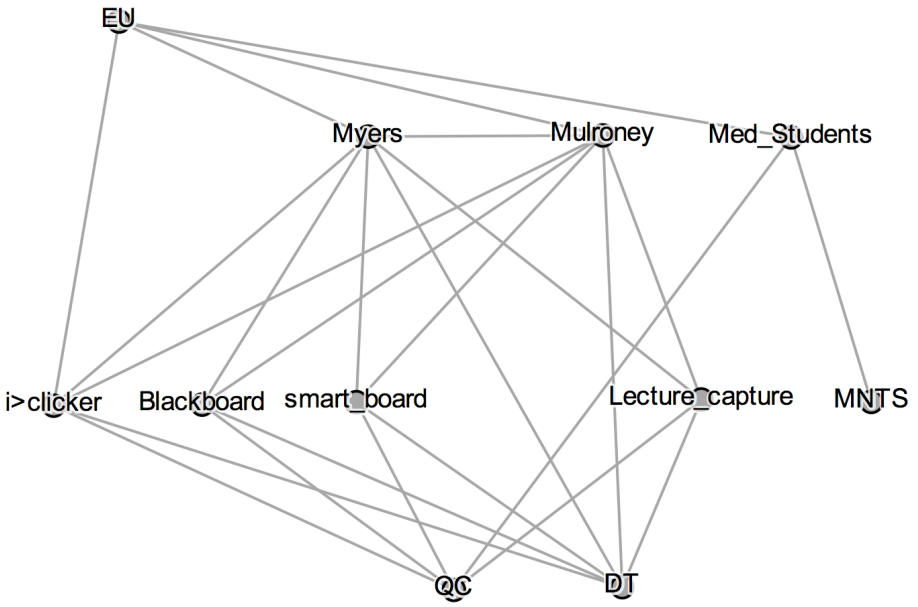

Fig. 7 Bimodal TEIS "Expert Cluster" 2014

3.3 Existing Groundwork

The "long nose of innovation" is scaffolded by concurrently emerging technologies that make exponential growth possible. The popularity and resulting spread of lecture capture was not only made possible, but catalyzed by a rich history of innovation at Georgetown's School of Medicine.

Based on 25 years of experience, EU recounted this history. The first step towards today's lecture capture system happened many decades ago when medical students created their own note-taking service called Medical Student Note Taking Service (MNTS): "the way everything started, of course, is

in many medical schools and graduate schools there is a note taking service," EU elaborated. Students would attend class, take clear, detailed notes, and sell them to any students who either missed class or wanted to fortify their study materials. In order for their notes to be more thorough, MNTS-employed students used audio recordings of the lectures to fill in any gaps they missed during the live lecture. Eventually, in approximately 2008, MNTS went digital, and students no longer had the choice to purchase hard copies of notes; instead they would receive them as an email attachment in PDF form.

Audio recordings of lectures were originally made available in the the 1970s to students in the form of cassette recordings on loan from the library. In the beginning of the 21st century, MP3 recordings replaced cassette recordings and these, along with Powerpoint decks from lectures, were posted to Blackboard for students on a routine basis. Some students then began to manually sync the MP3 files with these lecture slides in order to reconstruct the lecture for their reference. It was at this point Dr. Myers and Dr. Mulroney decided to implement Smart Board classroom technology to use in conjunction with lecture capture because "they thought it would be more engaging in terms of teacher delivery," according to EU. This would provide a perfectly-synced lecture capture that includes live annotations and highlights made by the professor during lecture that would otherwise be lost in the previous model. These lecture captures could be used by students at Georgetown, as well as students in the new George2 program. At the time of our interview with EU it was claimed that anywhere from 30-35% of faculty use the Smart Board technology on a regular basis.

4 CONCLUSION

From our findings we see opportunities for more sustained bridging of M1 and M2 as united by TEIS usage. We see that technical support staff, QC and later DT, form a strong link between the previously siloed communities which served to provide learning continuity for the students as they moved from M1 to M2. However, this continuity was only established in 2012 when those students arrived at M2 and realized how much they had grown to depend on and appreciate the TEIS.

We see the role of students as key change agents in this network. While at the university level, TEIS were initiated by the Myers group, we found that the implementation and spread were driven by student demand after being exposed to the TEIS and finding it unavailable upon their arrival at M2. Since Georgetown's School of Medicine has technologically progressed, development has hinged on student interest. If the students like something, they have three key platforms through which they can communicate that to the administration: committees, such as TIME, course evaluations, and directly communicating with faculty and support. Our interviews revealed that, in general, the administration takes action and is responsive to student demand.

CNDLS acted as a catalyst for broader knowledge transfer by facilitating technological options and financial support to Myers and Mulroney in their effort to implement and optimize the use of TEIS. CNDLS availed their own learning and instructional designers who have experience with the technologies.

Visually mapping the spread of TEIS in networks offers a window into beneficial externalities that can arise from focused initial inputs. Once inside the network, TEIS diffuses without the direct need of intervention from the PIs, the initial inputs. New niches for adoption outside of the initial network emerge as key actors migrate to new positions. We identified structural holes that, if filled, could better integrate the Medical School network. With this knowledge, organizations will be more aware of possible bottlenecks, disconnects, or general inefficiencies within their social fabric, and grant providers will be able to assess the macro reach of their contribution at a more granular level.

Enabled by actors like QC, TEIS is on track to reach a systemic level across the broader Georgetown campus. This research focused on year one of the ITEL grant implementation and we plan to continue documenting the adoption of the innovation.

REFERENCES

[1] Kumar, S. and Leonard, A. (2012). The Art of Knowledge Exchange: A Results-Focused Planning Guide for Development Practitioners. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/11983

[2] Hudson, J. N., Farmer, E. A., Weston, K. M., & Bushnell, J. A. (2015). Using a framework to implement large-scale innovation in medical education with the intent of achieving sustainability. *BMC Medical Education*, *15*, 2. doi:10.1186/s12909-014-0282-1

[3] Rogers, E. M. (2010). Diffusion of Innovations. Simon and Schuster. pp. 12

[4] QUALITATIVE INTERVIEWING AND GROUNDED THEORY ANALYSIS. (2003). In James A Holstein, & Jaber F. Gubrium (Eds.), Inside Interviewing. (pp. 311-331). Thousand Oaks, CA: SAGE Publications, Inc. doi: http://dx.doi.org/10.4135/9781412984492.n15