INSTRUCTIONAL DESIGN - TECHNOLOGY

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The concept of the Open Learning Initiative (OLI) came from the idea of integrating Carnegie Mellon's expertise in cognitive tutoring into whole online courses that would stand on their own and enact instruction. OLI was established in 2001 and currently offers 23 free courses (foreign languages, biology, chemistry, computing etc.).

Carnegie Mellon University (CMU) is a private research university founded in 1900 and enrolling more than 12,000 students. The university is especially known for its programs in science and technology. The University has campuses in Qatar and Silicon Valley and degree programs in Africa, Asia, Australia, Europe and Latin America.

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OPEN LEARNING

The Open Learning Initiative is a research project at Carnegie Mellon University (CMU) and we are about 14 years old. Around the time that MIT was starting the OpenCourseWare project, which focused on access (materials from faculty are freely available to anybody on the web), CMU engaged with the Hewlett Foundation around a project to consider learning effectiveness. Therefore, we were not merely putting materials on the web, but we were putting out materials that demonstrably enact instruction for independent learners. Our goal was to take the areas of core expertise and strength at CMU – a deep understanding of cognitive psychology, science of learning, how human beings use computers – and to combine these things in order to build online learning environments designed in a scientific way and evaluated in a scientific way after the fact.

We were very rigorous in our design process to ensure that we were doing our best in; following current learning science principles and recognizing places where learning science is young or might not be up to the task of dealing with specific domain challenge we're trying to teach. Therefore, in those cases we formed a new hypothesis, tested them and got the environments out there into the world and used them. Though originally we were looking at supporting independent learners, we found out pretty quickly that if you take this careful design approach and focus on improvement, you can build resources for independent learners however; those same materials in the hands of an instructor become pretty powerful.

Therefore, our mission currently is to support both independent learners and also classroom instruction by building learning environments which capture data, use that data to drive feedback loops to either faculty or to students and ideally back to course developers who can improve the materials. Moreover, in the aggregate we are then sending this data back into the learning science community in order that we can collectively improve our understanding of how human beings learn. CMU currently have roughly 22,000 students in this fall semester who are making use of OLI courses in an academic setting and that represents 700 to 800 course sections. A section can be anything from someone homeschooling who has two or three students to a section in the University of California Davis campus with over a thousand students. Therefore, that measure of sections is a little bit nebulous.

On a very practical level within OLI we create and improve online learning environments and serve these out to students. This fall has been a record year for OLI enrollments. We distinguish between academic enrolments and independent learners. Therefore, an independent learner or someone who just needs to brush up on their statistics skills or wants to learn biology can come to our website and access the materials in an open and free manner. Open and free was part of our original Hewlett Foundation grant conditions and continues to be part of our larger vision for expanding the community of use and access.

However, we also speak about academic use. For example, a faculty member who wants to use an OLI course which either supplements their instruction or (as is often the case) uses it as a textbook replacement. This semester we're seeing about 22,000 individual students making use of different OLI courses. Furthermore, we have 20 to 25 full courses and an additional 20 mini-courses. The on-going maintenance and support of those users and content is something that occupies us continuously, along with creating new courses. Recently we have been collaborating with the U.S. Department of Labor grantees and colleagues at Stanford University on a CAHIMS course, which is the certified associate in health information and management – workforce credential. We have now created what is equivalent to a 20-week preparation course in that space (CAHIMS).

OLI has also been doing a lot of work in making use of the data we are gathering, therefore we are speaking a lot about analytics and just recently a learning dashboard has been implemented inside the system which was built off of the work of a CMU faculty member named Masha Lovett. That dashboard has been drawing a lot of attention and continues to drive a lot of the discussion in this learning analytics space, both open and closed. However, we're also looking beyond the dashboard and considering what a larger model for learning analytics might look like and how we can take an analytics approach and use it to drive course improvement and a better understand of learning design? These are the areas that we're working on currently.

ORGANIZATION (4:40)

OLI actually as an organization sits outside of the academic departments and we report directly to the Vice-Provost for Education. It's a pretty good question (organization) because we are trying to span many different parts of the university. Originally OLI sat under the Office of Technology for Education (OTE), however about two years ago that office was merged with our Center for Teaching Excellence which was a new organization focusing on teaching excellence & educational innovation. That change was pretty exciting from our perspective as it recognized that; how you use technology and how you teach effectively are not separate things, therefore anytime we are talking about technological use we should also be talking about effectiveness. Therefore, as things have moved around OLI has come to sit directly under the Vice-Provost for Education and I think we're still considering where our long-term home should be.

There have been some changes at Carnegie Mellon over the past year or so because we have a new President. He has been looking at the landscape and recognizing that; because CMU doesn't have a College of Education there is no central home academically for this kind of work. Absent of that kind of home, we've ended up having smaller projects grow up in silos independent of one another. For example, we have got an amazing educational research group called PEER, we have the Pittsburg Science of Learning Center and OLI has also been very successful. Furthermore, we have lots and lots of smaller projects. Therefore, what the new CMU President has proposed is giving these different smaller projects common focuses in; how we collaborate with the outside world, how we perform research and how we use this new work to inform instruction at our own institution and that this should be a strategic priority for the organization. The CMU President has now created what we call the Simon Initiative and that will be the forward-looking face for combining these efforts. However, we're still figuring out how those pieces can be brought together? When we think about those elements; collaboration, research and instructional practice, OLI sits pretty clearly in the middle of them all. Therefore, OLI has been pretty active as that process is shaping out.

OLI have an introductory webinar for faculty just getting started with OLI and that walks them through the process mechanics; how to create a section, how do get more students enrolled and how to use the dashboard. Once faculty have had a chance to try that piece out or maybe even teach a little bit with the materials, we have a second tier webinar that talks a little more about how do you effectively integrate these resources into your practice. It's an area that I wish we were able to make a bigger investment in as I think that the integration of technology into teaching and instructional practice has huge potential. This field has not been studied enough and we still don't know enough about how to support people in doing that. That is really apparent in the K-12 space; however we can see it also in the higher education space as well. OLI also have a helpdesk where people can mail-in and get some answers, but I think the most important thing that we've done is on the dashboard side and there we have employed a very careful design process. For that purpose we have a very talented designer who has not just experience on visual design and information architecture but also has deep experience in the educational technology field. Judy Brooks was the designer for this project and from her prospective, 'if we're not building a dashboard that most faculties can use with only a minimal amount of orientation, then we probably haven't built the right tool'. I think that her touches in design, combined with a pretty thoughtful design committee around the dashboard, have led to a tool that's been thoughtful and pretty effective.

LEARNING OUTCOMES (8:25)

When we talk about learning, in reality we are talking about building a course and there are a number of things that we do. Within the OLI development process, part of that process involves bringing together a team to develop the learning environments. This is actually a fairly important distinction that sounds trivial at first. However, when you think about the normal online course development process it's often a single faculty member saying "I want to put my course online." What we (CMU) do in that case is to take a faculty (hopefully a group of faculty members) who has both domain expertise and teaching expertise and we say to them 'we honor and recognize your expertise but also recognize that there are additional inputs that are needed and we want to pair you up with learning scientists, human-computer interaction specialists, technologists and learning engineers'. Therefore, as a team they recognize that all of this different expertise has something to do with the development process.

The first step in that process is to clearly articulate the student-centered and measurable learning outcomes and we use those outcomes to carefully drive what it is we're building-out. Ideally an OLI course looks like a set of outcomes and a series of activities that will support students in achieving those outcomes, whether those activities are things that are asking students to do something in an active way, answering questions, solving problems or doing something in some other way which allows us to give the students appropriate feedback when they're correct along with identifying and helping them clarifying misconceptions where they're wrong and giving them the chance to ask for help.

Analytics are employed for measuring student interactions whether in; low stakes types of learn-by-do activities, self-assessments, and higher stakes quizzes or exams and we use that data to drive some of the analytic measures. Therefore, for each of these measures what we're predicting is student success and mastery of an individual learning outcome as composed of any of the smaller sub-skills that might be factored in. But we also try to keep ourselves honest by doing evaluations with third party assessments. Therefore, the OLI study which gets the most press currently is the Accelerated Learning Study. That study was done in 2008 with a statistics course. The idea was that we were taking a group of Carnegie Mellon students; half of whom were going to be taking the statistics class in the traditional way and half of whom were going to be using the OLI statistics course to support their instruction. Both of these groups were given a pre and a post-test using the KAS Test – a fairly standard third party assessment instrument. The findings were pretty remarkable in that what we found was that students using OLI materials were achieving higher outcomes (at least according to this exam), and they were doing it in about half the time. Therefore, it was a shorter semester and within that shorter period of time they were studying less and they were attending class less. We went back a year later to check this result and in fact, students were retaining this information as well as their traditional peers.

That is one model for how we consider outcome achievement. Another model sits underneath the analytics platform in the learning dashboard. That dashboard has a cognitive model of the relationships between; learning objectives, sub-skills, parameters surrounding those sub-skills (difficulty to achieve the skill), background knowledge of students and how long a period of time they should take to acquire any given skill. The model gets tuned on a regular basis from the data that's coming in. Therefore, students come in and interact with learning activities in a live way and we're using a combination of the cognitive model and prediction engine (in this case the Bayesian and Tin Mark-up Model based engine) to predict mastery. Furthermore, once every every six months or so we also take that data in the aggregate and run it through a tuning process to see if the parameters that we assess or predict are appropriate and where they need to be tuned. This is a different way to consider outcome achievement.

A third tool that we use came to us from the CMU Pittsburg Science Learning Center. Their Data Shop tool has a number of different sub-tools but the one that is easiest to explain is a tool called Learning Curves. Learning Curves take student interactions against a specific sub-skill and charts out how much assistance or how many errors students are making in the achievement of that skill. What you expect is that when a first-time student encounters a problem for a specific skill, they should make a lot of mistakes. However, with subsequent exposure to that problem we should see a decrease in mistakes. When you combine those specific skills, Data Shop refer to them as 'knowledge components', when you combine these multiple knowledge components with real student performance the tools in Data Shop display a predicted set of student performance versus actual student performance. When these 'knowledge components' are diverging we know that we need to make some adjustments. Those adjustments can be either in our learning model (it is off-base and needs to be compressed-changed) or the activities that we have to support this 'knowledge component' are not appropriate. As a result of that finding we either; provide more scaffolding or consider if the questions employed were not useful or necessary. Therefore, we try to take a diverse approach to understanding how students are achieving learning outcomes. There is also another important feedback loop in this process on the qualitative side. Because we have faculty out there making use of these courses, they are able to give us additional insights into what's effective and where they see the students are struggling.

DESIGN ANALYTICS (14:00)

This is actually an area we're trying to put together a proposal on at the moment. Design analytics employ various philosophies and methodologies for informing how we put these different components together. Some studies have measured affect size and employed tools to say; "you should be adding some more examples, your course might benefit from some learn-by-doing activities combined with other activities and because we know that the affect side of this kind of work has been X or Y in the past, we can probably tell you if you're trying to make a round of improvements to your course but you have a limited time, this is the one thing you could do that would be most effective". Anecdotally, I think that the more opportunities we can provide students with active practice in which they can receive targeted feedback in the process of problem solving, the most effective we will be in enhancing their learning.

The ideal OLI course (Platonic ideal) is not one that exists, but that course would consist simply of learn-by-doing activities that give students feedback and give them the opportunity to ask for hints. Realistically, that's not an environment that you can build. What you can do is to have some pretty serious specialized activities that are domain specific, then lots of smaller opportunities for students to practice and ask simpler questions which are then interspersed with expository types of content: text, videos, examples, worked examples. That simple process combined with lots of embedded assessment opportunities, learn-by-doing or otherwise, can enhance learning.

The Data Shop model informs the creation and the findings of the Skills Model and that feeds the Dashboard. Therefore, in this case we have combined these together. Generally what we're looking for when we're trying to do some improvement on courses is to provide inputs for a development team. So it's very rare that I would actually expect the analytics system to indicate very specifically; 'these five questions about black spots are bad and you now needed to come up with some simpler questions'. What we do expect from the analytics reports is that it can highlight for this team; 'here's this knowledge component where students are underperforming and here is a set of assessments where students are assessing at a much lower level then their practice attempts would have indicated'. Following that finding, the team would then need to drill-in and make a hypothesis on why this isn't working, make some modifications to the course and get it back-out in front of more students to see if that round of improvements has helped to support the hypothesis made or whether they need some additional approaches.

As I said earlier, I think learning science is pretty young and we're still in early days. The phrase 'learning analytics' brings to mind some very nice highly-polished sets of tools that we can apply very easily however, in many cases we're out on the bleeding edge. We're building this stuff with spreadsheets and scripts and things that don't lend themselves to easy combinations. However, the learning dashboard is a real-time process. That is something that faculty can use instantly to identify which outcomes students seem to be doing well on and where they are struggling. From that data we can then consider if there are misconceptions to be addressed? The dashboard is really a tool for helping teachers consider; how to best spend their classroom time and what are the activities that might be best spent doing? However, the iterative improvement of analytics tend to happen in a much slower pace, let's say maybe once a year or twice a year, and only then are we able to go back to either refine the models or to identify places for course improvement. Part of that is governed by the academic calendar and part of that frankly is governed by funding. One of the strengths of being a research organization is that we can look for external funding however, one of the weaknesses is that we're entirely dependent upon external funding. We know that this approach to the course-development process is incredibly effective but we also know it's pretty expensive. This is a very intense process that requires a lot of human beings and technology investments.

The dashboard gives faculty a view into their course. For each of the learning objectives there is a student aggregate view indicating; how many students were in the green (successful), how many are in yellow (struggling), how many are in the red (don't seem to be getting it) and what part of the population is in the grey (have not made enough interactions or we don't have enough data to make a prediction). From this view a faculty member can; select a specific learning objective, drill-down to see what individual sub-skills constitute this objective and observe the student's success rate against those sub-skills. Furthermore, if there are variables that really seem to be standing out one can drill down a step further to see what are the questions that are contributing to that skill and what are the kinds of answers students are giving.

This is a place (dashboard) where we're really trying to support more effective use of human creativity and ingenuity in order to identify 'oh, I understand now these are the misconceptions my students are exhibiting and I can walk into the class and do some different things'. In addition to these efforts we are also trying to provide some information around who's (students) been actively engaged and who hasn't been. Sometimes it's just a simple completion score of how many activities they have worked through. We've got this notion of an open-response, that there are things that are not easily categorized or easily summed up on a quantitative side and we want faculty to be able to go in and see what student free-text responses look like. And then finally, we provide a separate view into the high stake assessments.

LINKS

Open Learning Initiative- OLI:
http://oli.cmu.edu/

Carnegie Mellon University-CMU:
http://www.cmu.edu/index.shtml

MIT OpenCourseWare project:
http://ocw.mit.edu/index.htm

Hewlett Foundation:
http://www.hewlett.org/

UC Davis:
http://wheel.ucdavis.edu/hybrid-online/

CAHIMS course:
http://www.himss.org/health-it-certification/cahims

Masha Lovett:
http://www.eberly.cmu.edu/people/lovett

CMU Office of Technology for Education-OTE:
http://www.eberly.cmu.edu/

CMU Center for Teaching Excellence & Educational Innovation:
http://www.cmu.edu/teaching/

CMU PEER Program:
http://www.cmu.edu/acadev/programs/

CMU Pittsburg Science of Learning Center:
http://www.learnlab.org/

CMU Simon Initiative:
http://www.cmu.edu/simon/

K-12:
http://en.wikipedia.org/wiki/K%E2%80%9312_%28education%29

CMU, Judy Brooks:
http://www.eberly.cmu.edu/people/jmbrooks

CMU Accelerated Learning Study:
http://oli.cmu.edu/get-to-know-oli/see-our-proven-results/

Tin Mark-up Model:
http://masumbillah.tripod.com/thesis/016.htm

CMU Pittsburg Science Learning Center: Data Shop Tool
http://www.learnlab.org/technologies/datashop/

Open Educational Resources In U.S. Higher Education:
http://www.onlinelearningsurvey.com/reports/openingthecurriculum2014.pdf

2015 Grade Level: Tracking Online Education in the United States
http://www.onlinelearningsurvey.com/reports/gradelevel.pdf

FURTHER INFORMATION:

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