Research Question 3: Key Trends

What trends do you expect to have a significant impact on the ways in which learning-focused institutions approach their core mission of teaching, learning, research, and service in STEM+ education?

- **The abundance of resources and relationships made easily accessible via the Internet is increasingly challenging us to revisit our roles as educators.** This multi-year trend from global report was again ranked very highly, indicating its continued influence, specifically in the UK. Institutions must consider the unique value that each adds to a world in which information is everywhere. In such a world, sense-making and the ability to assess the credibility of information are paramount. Mentoring and preparing students for the world in which they will live -- the central role of the university when it achieved its modern form in the 14th century -- is again at the forefront. (Carried forward from the 2011 Technology Outlook for UK Tertiary Education)
- **As Massive Open Online Courses are proliferating in STEM areas, the quality of free education is improving.** MOOCs such as MITx, Coursera, and the Code Academy have been launched by world-class institutions (including MIT and Stanford) as an alternative method to traditional in-class learning. Because of the heavyweights behind these initiatives, the quality of the online courses has been heightened, lending more credibility to MOOCs. Might be relevant for both formal and informa / life-long education. Very relevant. The pedagogy of MOOCs seems to be split into two broad camps: connectivisit/constructivist (Downes, Siemens, Cormier, Groom) vs instructivist (EdX, Cousera, Udacity, Udemy, etc). The latter seem to be more in the STEM area ... for now.
- **As schools and districts struggle with how to develop instructional materials related to common core, broad stroke changes are coming in how teachers approach STEM instruction.** Common Core - I think that there will be significant implications due to changes with standards. Common core for example asks students to not only regurgitate information, but also demonstrate understanding through application.
- **Computers as we know them are in the process of a massive reinvention.** The computer is smaller, lighter, and better connected than ever before, without the need for wires or bulky peripherals. In many cases, smartphones and other mobile devices are sufficient for basic computing needs, and only specialized tasks require a keyboard, large monitor, and a mouse. Mobiles are connected to an ecosystem of applications supported by cloud computing technologies that can be downloaded and used instantly, for pennies. As the capabilities and interfaces of small computing

devices improve, our ideas about when -- or whether -- a traditional computer is necessary are changing as well. (Carried forward from the 2011 Technology Outlook for UK Tertiary Education). The availability of 'phablet' type technologies for convenience and flexibility to access courses. Future generations will be skilled to use all forms of social media and technologies and the development and design of courses may be used more readily using smart phones, tablets, etc. I completely agree that this will have significant impact on teaching and learning.

- **Economic Conditions are causing schools and districts to get leaner and meaner.** This has impacted a whole host of education issues, including the above mentioned partnerships, BYOD as an economic solution, the types of resources that schools can afford, etc. - Agree & according to economies of scale, mobile devices are going to be cheaper & more available even for students in developing countries.

- **Education paradigms are shifting to include online learning, hybrid learning and collaborative models.** Budget cuts have forced institutions to re-evaluate their education strategies and find alternatives to the exclusive face-to-face learning models. Students already spend much of their free time on the Internet, learning and exchanging new information -- often via their social networks. Institutions that embrace face-to-face/online hybrid learning models have the potential to leverage the online skills learners have already developed independent of academia. We are beginning to see developments in online learning that offer different affordances than physical campuses, including opportunities for increased collaboration while equipping students with stronger digital skills. Hybrid models, when designed and implemented successfully, enable students to travel to campus for some activities, while using the network for others, taking advantage of the best of both environments. (Carried forward from the NMC Horizon Report > 2012 HiEd Edition) I see this as one of the most important aspects. Not only these, but also the inclusion (i.e., fostering and supporting) of informal learning and autonomous learning, and the bridging of all these forms of learning. The aim is to nurture a holistic and learner-centric learning culture which will eventually turn learners into life-long learners. This also relates to the increasing discussion about "flipped classrooms."

- **Educational Games -- for play and as student game creators -- are increasingly being used to not only master STEM concepts, but also apply and assess them.** Examples: BrainPOP GameUp wwww.brainpop.com/games/ and stemchallenge.org.

- **Enhanced electronic books are increasingly being used instead of traditional textbooks.** As e-book technology advances, digital textbooks contain more dynamic content, including audio, videos, and other interactive features. Traditional textbooks are cumbersome and can take years to update and reprint when there is new information and discoveries to be added. However, e-books can be easily revised and disseminate as often as needed, and the cost to produce one is significantly less than that of a print book.

- **The federation of online experiments allows the creation of new markets where institutions can share, buy, and sell access online resources.** These experiments

may be based in any variety of LMS, KMS, CMS or websites, and promote the creation of a single resource that can satiate the needs of many universities. The best federated online experiments are able to be easily integrated in a range of environments and allow single sign-on.

- **The growing availability of bandwidth will dramatically change user behaviors in teaching, learning and research over the next five years.** The advent of cloud computing has alleviated the burden of storing software, email services, and other applications locally. Major resources are now accessible via web browser in just one click, no longer bogging down computer speed. Students and educators can now connect and collaborate with more ease, transfer files and information quicker, and store more new content. (Carried forward from the 2011 Technology Outlook for UK Tertiary Education).

- **Increasingly, students want to use their own technology for learning**. As new technologies are developed at a more rapid and at a higher quality, there is a wide variety of different devices, gadgets, and tools from which to choose. Utilizing a specific device has become something very personal -- an extension of someone's personality and learning style -- for example, the iPhone vs. the Android. There is comfort in giving a presentation or performing research with tools that are more familiar and productive at the individual level. And, with handheld technology becoming mass produced and more affordable, students are more likely to have access to more advanced equipment in their personal lives than at school. (Carried forward from the 2011 Technology Outlook for UK Tertiary Education) - This is for me very relevant and important as well. BYOD (bring your own device) is fueling the deployment of virtual desktops for both traditional PCs as well as tablets. I suspect this will become the delivery mechanism of choice to tablets for heavy apps that otherwise wouldn't run on them (or run well). There is research out there on personalization of devices and its impact on use.

- **Increasingly, tagging is being standardized so that it can be more easily shared and located across space boundaries.**

- **Institutions are increasingly exploring technologies that allow teachers and students to better collaborate.** Social networks and cloud-based tools and applications are changing the ways teachers and students communicate with each other. Open resources such as wikis and Google Apps also enable the free exchange of ideas and prompt insightful discussions between teachers and students. The result is more opportunities for collaboration, and a change in the dynamic of the teacher-student relationship that promotes more of an equilibrium. (Carried forward from the NMC Horizon Project > 2012 HiEd Short List)

- **Labeling what we do as teachers - Tech vs. STEM vs. General Education, etc. has become a trend.** We're coming out of a period where we tended to segment ourselves as educators and the professional organizations that supported us fell into those similar buckets. For example, when technology resources first appeared in the

classroom, there was a push to network with likeminded trailblazers related to the use of technology to teach. We went to technology related conferences, joined technology focused discussion forums, etc. Recently and moving forward, I expect the conversation to shift back to a broader view of general education. How do these evershifting tools help us engage, inspire, and teach our children. The conversation will shift back to best practices, attaching a megaphone to those best practices, and technology will increasingly been seen as the tool rather than the anchor for those discussions.

- **Lecture capture, podcasting, and cheap personal video recorders increasingly make it much easier to prepare lecture-style content for students to see/hear before coming to class.** There is an ever-growing cadre of professors posting lectures, pre-lectures, and other video-based reflections online. Similar to how students would prepare for class by reading a book, they can now watch or listen to educators exploring the course material beforehand. This frees up time during class to engage in responsive activities and collaborative problem-solving. The driving forces behind this trend are popular models such as Khan Academy, which contains thousands of brief video tutorials that convey material. (Carried forward from the NMC Horizon Project > 2012 HiEd Short List) and BrainPOP www.brainpop.com

- **Micro-credits and the proliferation of short course modules are leading to the loss of the university as the sole certifier of learning.** This is actually a derivative outcome of the badging movement and MOOCs. As learning modules are developed with demonstrable outcomes, following the develop of badge technologies and approaches the certifications that are given to the student upon completion of these learning activities open up the question of how they will be aggregated and assessed in comparison to more traditional semester-based offerings by traditional university programs. This opens the door for a third-party (or parties - plural) to provide new validation services and a credit metric that industry and business may well honour given the direct evidence of the learning claimed. Once the monopoly around certification is questioned, the university lock on that market begins to crack and a new learning order has the potential to rise. MOOCs, badges and the increasing demand for relevant and authentic CPD have the potential to drive this toward a tipping point.

- **New pedagogical models will be mainly focused, not in the technology itself, but in the way we use that technology in order to facilitate new models of education to be developed and implemented.** Another key factor will be how to avoid that technology widens the digital gap, specially the gap that still exists between digital natives and digital immigrants.

- **Organizational forms of education -- in particular on tertiary level -- will change.** Students will are about to compile lectures from differnt universities / online corses according thier interests. globalized learning and collaboration over boarders and continents will raise significatly. open lectures such as from MIT will increase this

situation. new forms of assessment and certificates are requested. - Is this happening? How is APL and credentialing being handled?

- **Partnerships are changing the way we do business.** Rethinking the Way in Which Educational Institutions harness partnerships . Whether it's between schools, between states, with business and district....One example is how BrainPOP has reached out to best of breed game developers like Filament Games, iCivics.org, NCTM, eLine Media and more to bring educational games to teachers and kids for FREE.

- **Pedagogical approaches that have long been identified as valuable and promising, but were not feasible due to time or cost constraints, are now possible thanks to the evolution of technology.** In many ways, emerging technologies enable the facilitation of new pedagogies. Teachers are now able to leverage new tools to apply their creativity to different learning activities. Tablet computing, for example, allows students to engage in more challenge- and project-based learning, as they can now explore and collect data from various environments on-the-go outside of the classroom. The technology also makes it easier for educators to devise and test new pedagogies before implementing them. - Agree & I would like to refer to the cross-cultural aspect of learning which has been facilitated via emerging technologies.

- **People expect to be able to work, learn, and study whenever and wherever they want to.** This trend, noted in several recent NMC Horizon Reports, continues to permeate all aspects of daily living. Life in an increasingly busy world where learners must balance demands from home, work, school, and family poses a host of logistical challenges with which today's ever more mobile students must cope. A faster approach is often perceived as a better approach, and as such people want easy and timely access not only to the information on the network, but to their social networks that can help them to interpret it and maximize its value. The implications for informal learning are profound, as are the notions of just-in-time learning and found learning, both ways of maximizing the impact of learning by ensuring it is timely and efficient. (Carried forward from the NMC Horizon Report > 2012 HiEd Edition) - There has been much discussion about several topics related to this: 1. the yin and yang of "formal" and "informal" learning and 2. Increased partnerships with community institutions like museums to make learning easier and more potent. There was a wonderful discussion about this last piece at CoSN last year led by Milton Chen.

- **Recognition and acceptance by tertiary educators of the potential of new technologies is increasing.** On many levels, what used to be considered emerging tools and new teaching and learning approaches have now reached mainstream adoption among educators. Maximizing online opportunities is one of the most notably accepted concepts. More than ever, teachers and administrators are embracing new technologies because there is now so much well-documented research on the positive outcomes they generate. Collaborations between other educational institutions have yielded lists of best practices and other tangibles that

prove the worth of technology in learning. Communities and networks of practice are supporting educators as they experiment with new ideas and share their results. (Carried forward from the 2011 Technology Outlook for New Zealand Tertiary Education). –Fully agree.

- **Social media is changing the way people interact with each other, present information to each other, and judge the quality of contributions made by others** (the like / dislike paradigm that has startled so many researchers). Free social media tools have the ability to disseminate academic content to not only current students, but also alumni and the general public. Social media is changing how institutions recruit and retain students also.

- **STEM courses and subjects are being gamified to bolster student engagement.** Institutions and individual educators are using badges, levels, karma points, and role-playing to provoke deeper interest from students in STEM learning. In many cases, this is proving to be more successful and cost-effective than developing and incorporating video games.

- **Students are engaging in more STEM practice activities online.** Virtual and remote labs are becoming increasingly valuable as high quality laboratory web applications and remote professional equipments are enabling students to perform experiments as many times as they like from wherever they are. These online labs are being further enhanced by learning objects, or a collection of content, practice, and assessment items that help the student achieve a particular learning objective.

- **The technologies we use are increasingly cloud-based, and our notions of IT support are decentralized.** The continuing acceptance and adoption of cloud-based applications and services is changing not only the ways we configure and use software and file storage, but even how we conceptualize those functions. It does not matter where our work is stored; what matters is that our information is accessible no matter where we are or what device we choose to use. Globally, in huge numbers, we are growing used to a model of browser-based software that is device-independent. While some challenges still remain, specifically with notions of privacy and control, the promise of significant cost savings is an important driver in the search for solutions. (Carried forward from the 2011 Technology Outlook for UK Tertiary Education) -I think the fact having device independence is more important than emphasizing the buzz world cloud-based; it will be an institution's decision where and how they organize applications, content and data.

- **There is a new emphasis in the classroom on more challenge-based and active learning.** Challenge-based learning and similar methods foster more active learning experiences, both inside and outside the classroom. As technologies such as tablets and smartphones now have proven applications in higher education institutions, educators are leveraging these tools, which students already use, to connect the curriculum with real life issues. The active learning approaches are decidedly more student-centered, allowing them to take control of how they engage with a subject

and to brainstorm and implement solutions to pressing local and global problems. The hope is that if learners can connect the course material with their own lives, their surrounding communities, and the world as a whole, then they will become more excited to learn and immerse themselves in the subject matter. (Carried forward from the NMC Horizon Report > 2012 HiEd Edition) -Couldn't agree more that students must relate themselves to 'Learning' and learning must be applicable and valuable to students. Learning must be connected with the industry that the students are progressing towards their profession. Learning must incorporate international perspectives and learning must also include intercultural and ethic perspectives. -I would add to this that the emphasis includes more authentic learning, both in terms of the framing of the context for learning as well as the expression of it in the settings and kind of problems students are being asked to do. Cookbook labs are and should be relegated to the trash heap of procedurally focused teaching.

- **The tools for creating technology itself are being put in students' hands.** Coding for all: In building on the point above, I think there can be a distinction in the new focus on providing the knowledge and tools for new coders to program their own tools. From OLPC's early focus on providing an activity that would teach child users basic program commands to the recent announcement of the Khan Academy [http://www.khanacademy.org/cs] announcing a big push to teach computer science, the tools for creating technology itself are being put in students' hands. - I might perhaps add to this the maker movement. -Cant agree more, but not only at child level. Programming is a great strategy to analyze problems and synthesize solutions. Which means understanding! App development can be a fun way to study some physical process and produce a model, perhaps running in a mobile.

- **What were previously thought of as new and disruptive forms of scholarship are now becoming the norm for scholarly communication.** Blogs, open textbooks, electronic journals, and forms of expression embodied in new media formats have challenged notions of scholarly writing and communication for several years. Yet these techniques are increasingly common and are readily accepted as informal outlets for scholarly work. A more gradual trend toward official acceptance is moving slowly, but its stirrings are visible in the adoption of electronic content, experiments with crowd-sourcing, and open, online peer review of scholarly work. This trend is related to the challenge of developing metrics for evaluating such work, noted in the 2010 Horizon Report, as well as again in 2011. (Carried forward from the 2011 Technology Outlook for UK Tertiary Education)

- **The world of work is increasingly collaborative, driving changes in the way student projects are structured.** As more and more employers are valuing collaboration as a critical skill, silos both in the workplace and at school are being abandoned in favour of collective intelligence. To facilitate more teamwork and group communication, projects rely on tools like wikis, Google Doc, Skype, and online forums. Projects are increasingly evaluated by educators not just on the overall

outcome, but also on the success of the group dynamic. In many cases, the online collaboration tool itself is an equally important outcome as it stores -- and even immortalizes -- the process and multiple perspectives that led to the end results. (Carried forward from the 2011 Technology Outlook for UK Tertiary Education). One of the challenges in leveraging group work and collaborative teams is teaching what it means to work in teams, as well as providing feedback that allows team members to reflect on their, and their teammates contributions to group projects. This is being addressed by the emergence of teamwork software (e.g., TeamWork in Action) and collaborative per assessment software WebPAf developed as part of the project Proactively Ensuring Success In Higher Education Student Teams, developed by Assoc. Prof. Lydia Kavanagh based on open source software from the Loughborough University.