Research Question 4: Critical Challenges

What do you see as the key challenge(s) that STEM+ education will face during the next 5 years?

- **Appropriate metrics of evaluation lag the emergence of new scholarly forms of authoring, publishing, and researching.** Traditional approaches to scholarly evaluation such as citation-based metrics, for example, are often hard to apply to research that is disseminated or conducted via social media. New forms of peer review and approval, such as reader ratings, inclusion in and mention by influential blogs, tagging, incoming links, and re-tweeting, are arising from the natural actions of the global community of educators, with increasingly relevant and interesting results. These forms of scholarly corroboration are not yet well understood by mainstream faculty and academic decision makers, creating a gap between what is possible and what is acceptable. (Carried forward from the 2011 Technology Outlook for UK Tertiary Education)
- **As new advances in technology move opportunities in education further, it is vital that we consider questions of inequity and inequality.** The tools that are supposed to provide more open access are more easily accessed and navigated by those who are already privileged with some set of resources. In many cases, we see that digital divides widen rather than narrow with technology interventions.
- **As the tools that we use to engage students increasingly become personalized and thus varied, we'll run into a different "flavor" of the digital divide.** Previously much of the digital divide conversation was around differences and limitations in what some districts could provide their students. Now the discussion will have deeper roots in family and community. There is potential for a much broader range in device capability moving forward as those devices shift, as the US economy struggles to "get back on track" and as we look more globally at access. - Agree & the same concept is applied globally - We need to consider the particular situation in emerging economies.
- **Augmented reality applications are not yet available to every teacher.** Currently, not enough affordable and user-friendly augmented reality authoring tools are provided to educators, which is preventing AR from approaching mainstream adoption. -Fully agree I think that this connects to larger issues related to the digital divide.
- **Commercial providers are delivering ever more credible educational content, providing a wide range of customizable offerings at quality levels**

that may dampen interest in traditional sources of scholarly work, such as university presses, and even open educational resources (OERs). Increasingly, publishers are either buying learning resource websites or creating their own virtual warehouses of digital textbooks and other educational content. iTunes University is a prime example of this, offering thousands of course materials for free from distinguished institutions and professors. This trend creates a related challenge for university presses that have traditionally been the publishers of much of the work of their faculties; there is a growing fear that they will become obsolete. Both OERs and university presses are at a critical juncture for different reasons, yet each is aggressively confronted with the need to adapt, evolve, or even reconstruct their roles in education over the next five years. (Carried forward from the 2011 Technology Outlook for UK Tertiary Education).

- **Cross-institution authentication and detailed access policies are needed to allow sharing of online experiments among institutions.** While teachers are more equipped than ever to produce online experiments, what they are creating is often not effective or scalable. There is currently not enough documentation on quality standards of online experiments to adhere to, and many institutions are being repetitive, creating the same types of experiments that could be otherwise shared across many universities. - Very important
- **The demand for personalized learning is not adequately supported by current technology or practices.** The increasing demand for education that is customized to each student's unique needs is driving the development of new technologies that provide more learner choice and control and allow for differentiated instruction. It has become clear that one-size-fits-all teaching methods are neither effective nor acceptable for today's diverse students. Technology can and should support individual choices about access to materials and expertise, amount and type of educational content, and methods of teaching. (Carried forward from the NMC Horizon Project > 2012 HiEd Short List)
- **The development of remote laboratories is challenging for teachers.** Those teachers who know how to create the interface to the lab hardware generally are not equipped with the skills to create an effective web infrastructure, which is the crucial step that makes the remote lab public, or available to a specific group of students. -Standard experiments and most common subjects could be easily shared by institutions; I do not see that this is a major problem rather than organizing learning experiences around the experiment.
- **Digital media literacy continues its rise in importance as a key skill in every discipline and profession.** This challenge, driven by a related trend, appears here because despite the widespread agreement on the importance of digital media literacy, training in the supporting skills and techniques is rare in

teacher education and non-existent in the preparation of faculty members. As lecturers and professors begin to realize that they are limiting their students by not helping them to develop and use digital media literacy skills across the curriculum, the lack of formal training is being offset through professional development or informal learning, but we are far from seeing digital media literacy as a norm. This challenge is exacerbated by the fact that digital literacy is less about tools and more about thinking, and thus skills and standards based on tools and platforms have proven to be somewhat ephemeral. (Carried forward from the 2011 Technology Outlook for UK Tertiary Education)

- **Districts struggle to maintain a balance between providing each teacher with the exact same set of resources and also honoring those individual teachers who are willing to take risks and develop new approaches around new tools.** This poses a challenge. The district who chooses to provide the exact same set of equipment, guidelines, and trainings to each teacher in the district may risk missing the opportunity or the budget to support powerful pockets of innovation related to STEM instruction. Standardization of resources or a Push to support pockets of educational innovation.
- **Dividing learning into fixed units such as credit hours limits innovation across the board.** For a long time now, credit hours have been the primary way of marking the progress of students in earning their college degrees. This method implies that time is an accurate and effective measure for knowledge comprehension and skill. This industrial construct hinders the growth of more authentic learning approaches, where students and teachers might make use of more creative strategies not bound by such constraints. (Carried forward from the NMC Horizon Project > 2012 HiEd Short List) –Fully agree
- **Economic pressures and new models of education are bringing unprecedented competition to the traditional models of tertiary education.** Across the board, institutions are looking for ways to control costs while still providing a high quality of service. Institutions are challenged by the need to support a steady — or growing — number of students with fewer resources and staff than before. As a result, creative institutions are developing new models to serve students, such as streaming introductory courses over the network. As these pressures continue, other models may emerge that diverge from traditional ones. Simply capitalizing on new technology, however, is not enough; the new models must use these tools and services to engage students on a deeper level. (Carried forward from the 2011 Technology Outlook for UK Tertiary Education).
- **Education credentialing is being examined from every angle, and is certain to change over the coming years.** This may take more than 5 years to hit but discussions may start sooner that we expect. All the changes going on with different forms of educational provision (open/closed, free/paid) and

escalating costs may well lead to questions about ownership/authority for education credentialing. When this current generation of college and university students hits middle management and become responsible for hiring, they may not necessarily stick with 'the credentialing system they experienced'

- **The global drive to increase the number of students participating in undergraduate education is placing pressure across the system.** The off-cited relationship between earning potential and educational attainment, plus the clear impact of an educated society on the growth of the middle class is pushing many countries to encourage more and more students to enter universities and colleges. In many countries, however, the population of students prepared for undergraduate study is already enrolled — expanding access means extending it to students who may not have the academic background to be successful without additional support. Many in universities feel that these institutions do not have sufficient time and resources to help this set of students. (Carried forward from the NMC Horizon Project > 2012 HiEd Short List)
- **The growing choice that emerging technologies make possible — and how people navigate through this choice — is an on-going challenge.** When there are so many options for both educators and students on which technologies to use, it is easy to lose sight of how they will impact the teaching and learning process. In online learning environments in particular, there are a plethora of available communication, collaboration, and information management platforms. Individually, each tool or application may be effective, but when used all together, they can create a complex user interface where the focus is on the technologies rather than the learning. Navigating through the potential technologies and understanding how they will interact with each other to create a simple, easy-to-use environment is a pressing issue that must be solved at the conceptual — not implementation — level. (Carried forward from the 2011 Technology Outlook for New Zealand Tertiary Education)
- **If we are going to use technology we need to ensure the assessment processes.** Ensure assessment process. Who is making an exam or a practice?
- **Institutional barriers present formidable challenges to moving forward in a constructive way with emerging technologies.** Too often it is education's own processes and practices that limit broader uptake of new technologies. Much resistance to change is simply comfort with the status quo, but in other cases, such as in promotion and tenure reviews, experimentation with or adoptions of clearly innovative applications of technologies is often seen as outside the role of researcher or scientist. (Carried forward from the NMC Horizon Report > 2012 HiEd Edition). -Agree, change management & paradigm shift are needed.

- **Institutional complacency is a challenge.** For many universities, the challenges ahead are just too hard. Either they see themselves as simply having ongoing relevance because in the past they have, or they recognise change is needed but they are unable to achieve any meaningful consensus around what they need to change. Either way, they're likely to fade into irrelevance or founder altogether, whether they become conscious of their fate or not. Like most technological changes, their primary impact is to disaggregate systems that were once seen as coherent wholes. Once the components can be treated separately, the integrity of the entity that was the proponent of the prior system weakens. Publishing, manufacturing, software development, all have faced and lived through this fate. Higher education's time is soon to come.
- **Many published studies on the uses of new technologies in education do not address the pedagogical model used with the technology.** In other words, learning models are not fully considered when instructors adopt a technology. Just throwing some new technology into the mix doesn't mean the student learns better! Instead, the cognitive psychology of learning must be considered and technology integrated into the learning loop in appropriate ways. This area must become more of a collaborative focus for researchers in education and technology.
- **Most academics aren't using new and compelling technologies for learning and teaching, nor for organizing their own research - TPACK conceptualisation.** Many researchers have not undergone training on basic digitally supported teaching techniques, and most do not participate in professional development opportunities. This issue is due to several factors, including a lack of time, a lack of expectations that they should, and the lack of infrastructure to support the training. Academic research facilities rarely have the proper processes set up to accommodate this sort of professional development; many think a cultural shift will be required before we see widespread use of more innovative organizational technology. Many caution that as this unfolds, the focus should not be on the technologies themselves, but on the pedagogies that make them useful. (Carried forward from the 2011 Technology Outlook for UK Tertiary Education) -Faculty who have seen positive shifts in student engagement and achievement tend to be the ones who have taken the time to revisit the Scholarship of Teaching and explored how great teaching combined with the right technology can create new and more powerful learning experiences; the two variables interact so strongly that considering only one at a time (teaching or technology) does not result in the maximum effect (my general summary of 9 years of edtech grantmaking).
- **New modes of scholarship are presenting significant challenges to libraries and university collections, how scholarship is documented, and the business models to support these activities.** While the university library

has traditionally housed collections of scholarly resources, social networks and new publishing paradigms, including open content initiatives, are challenging the library's role as curator. Students and educators are increasingly able to access important, historic research in web browsers on devices of their choosing. As such, libraries are under tremendous pressure to evolve new ways of supporting and curating scholarship. (Carried forward from the 2011 Technology Outlook for UK Tertiary Education) The textbook industry has massive budgets right now, and they feel threatened.

- **Online educational resources must be mobile-friendly.** Today's students want to be able to learn from wherever they are with whatever device they prefer. As smartphones and tablets gain more traction in educational settings, there is a demand for online content to keep up and load fast, look high quality, and be easy to use across the growing array of mobile devices. -agree, however mobile and conventional PC will blur more and more, and the problem will become minor
- **Organizations are challenged to ensure quality while engaging in the use of rapidly changing, ever-evolving technologies.** As new information and new technologies are readily available, at the fingertips of learners, educational institutions must find ways to intervene and remain a part of the relationship between the technology and the student. These organizations must make wise, up-to-date decisions when investing in and implementing technologies. To do so, they must conduct extensive research and regard technologies and their potential applications from all angles. Collaborations between institutions in the exploration of emerging technology provide them with opportunities to exchange ideas, success stories, obstacles, and develop best practices. (Carried forward from the 2011 Technology Outlook for New Zealand Tertiary Education)
- **Resource and service interoperability is key, but most of current developments do not include it.** The ability for various programs, devices, and systems to work together is important for an educational resource to be shareable and easy to integrate into different educational platforms and environments. Unfortunately, checking for and understanding a resource's interoperability is a skipped that is often skipped in the development process at universities.
- **The role of the tertiary/higher education educator is changing.** As the focus in tertiary education shifts from teacher-centred, lecture-based classrooms to open educational resources (OERs), educators must adapt to the role of online facilitator. Because these OERs are loaded with pre-developed materials, teachers must sift through the resources and identify what is credible and revise the materials often as new information arises. In this sense, they will be online resource managers, but they also must develop creative ways to

digitally interact with students in regards to those resources — otherwise they risk becoming dispensers of course materials rather than scholarly guides and instructional designers. (Carried forward from the 2011 Technology Outlook for New Zealand Tertiary Education) - There is now a revolutionary change to education. Students learn differently with a short span of attention, flicking from screens to screens, swiping on phablets, texting approx. 300 sms a day - these students need to be engaged, motivated and enticed to learn from an exciting pool of resources. There are competing demands and the challenge for educators is to meet the need of these students. Professors are good at what they do, they profess, research, teach and are experts in their discipline areas but they are not usually skilled in the instructional design aspects of a course. Investment in extra resources is required to empower professors to do their job effectively which is to profess, research and teach.

- **Simply staying organized and current presents a challenge in a world where information, software tools, and devices proliferate at the rate they do today.** New developments in technology are exciting and their potential for improving quality of life is enticing, but it can be overwhelming to attempt to keep up with even a few of the many new tools that are released. User-created content is exploding, giving rise to information, ideas, and opinions on all sorts of interesting topics, but following even some of the hundreds of available authorities means sifting through a mountain of information on a weekly or daily basis. There is a greater need than ever for effective tools and filters for finding, interpreting, organizing, and retrieving the data that is important to us. (Carried forward from the NMC Horizon Project > 2012 HiEd Short List.)
- **Some emerging technologies are not mature enough to be applied to mainstream STEM education.** While universities are experimenting with various technologies, many of these technologies, such as robotics, are only in the development and research stages. It is risky to implement a new technology without standard implementation guidelines and sufficient research to back it up.
- **There is evidence that students in school face problems in understanding and applying math concepts.** ICT-based approaches can support to learn and train math competences as well as can help to apply it in different context. support should include symbolicas well as numeric support. some advanced systems already can assess students calculation, even stepwise and provide feedback and support.