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Smart Learning Environments

COMMENTARY

Smart learning futures: a report from the 3rd US-China smart education conference

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Abstract

The third day of the third US-China Smart Education Conference featured a discussion with 27 thinkers representing higher education, business and industry, vocational training, and policy making. Researchers from the fields of artificial intelligence, computer science, educational technology, neuro-science and the learning sciences from many countries actively participated and are collectively the co-authors of this report. After two short presentations on computational neuropsychology and the next generation of artificial intelligence by two of the participants (Thomas Parsons and Yang Yang respectively), the participants were divided into four groups led by Phillip Harris (AECT Director), Joseph South (ISTE Chief Learning Officer), Chee-Kit Looi (NIE Head of the Learning Sciences Lab), and Maiga Chang (School of Computing and Information Systems, Athabasca University). The groups were asked to consider the following four questions: (a) What are the 5 most promising technologies likely to transform education in the next 10 years? (b) How do/will advanced learning technologies impact the future of education? (c) What challenges do advanced learning technologies bring to education? (d) What are the new demands for education in the future of society? The groups could focus as they deemed appropriate, modifying adding questions or ignoring any question. This report is a synthesis of those discussions.

Keywords: Artificial intelligence 2.0, Augmented reality, Computational neuropsychology, Education systems, Human intelligence 0.2, Information overload, Value-driven decision making

Background

The third US-China Smart Education Conference was held in Beijing March 18–20, 2018. The general purpose of the conference is to bring together leading scholars and influential decision-makers to discuss plans and challenges for the effective integration of emerging information and communications technologies in education, industry and government. One of the features of this third meeting was the release of *the 2018 Technology Outlook for Chinese Vocational Education: A Horizon Report* (Huang et al. 2018), which began while the New Media Consortium was still active and viable and was completed with the support from the Smart Learning Institute at Beijing Normal University. Consistent with how Horizon Reports ae developed with broad representation from leaders in different countries, disciplines and contexts, the last day of the conference included a half-day devoted to a forum entitled *Smart Computing and Intelligence Summit*.

At least 27 leaders representing 13 regions of the world (e.g., Australia, Bangladesh, Canada, China, India, Italy, Romania, Singapore, Sudan, Sweden, Taiwan, USA, Uzbekistan) working in a variety of contexts (e.g., higher education, business and industry, vocational training) were invited to that session (their names are listed in the footnote as co-authors and members of the Smart Learning Futures Group - SLFG). The time was arranged around two prompting presentations, one focusing on computational neuropsychology and the other on the next generation of artificial intelligence. The idea behind those two short presentations was to establish a frame of reference for two important developments (one in brain science and one in computer science) that have implications for learning and instruction.

After the two presentations, the participants who were already arranged in four groups in the four corners of the large room at the Smart Learning Institute, were asked to spend the next 2 h discussing any, all or none of these four questions: (a) What are the 5 most promising technologies likely to transform education in the next 10 years? (b) How do/will advanced learning technologies impact the future of education? (c) What challenges do advanced learning technologies bring to education? (d) What are the new demands for education in the future of society? Following group deliberations, each group would be given the opportunity to report its discussions to all. The motivation for the discussion was to provide insights and directions for the effective integration of promising technologies in education and training to learners and professionals around the world. More specifically, three outcomes were targeted: (a) a published report of the meeting, (b) the formation of ongoing collaborations among the various participants, and (c) the basis for the fourth Smart Education Conference to be hosted by the University of North Texas in 2019. This report represents the first targeted outcome of the meeting. The discussions were lively with everyone actively engaged for that half day. All of those who participated are co-authors of this report, as agreed to at the meeting. The group adopted the name Smart Learning Futures Group and the members are shown in a footnote, listed alphabetically as everyone is considered an equal contributor.

The following four sections represent summaries of each of the group. Each group had a senior member as group facilitator and reporter (noted below with each group). As agreed at the meeting, the four group leaders would have final say on a final version of this report to be submitted to *Smart Learning Environments* for publication, with authorship credit given to all those who participated and who comprise the Smart Learning Futures Group (SLFG). Surprisingly, all four groups emphasized values, and learning and teaching improvements in addition to innovative technologies.

Group a report (Phil Harris)

Group A was led by Phil Harris with Patrick Perry reporting back to the plenary session. The group followed some of the four questions offered at the opening of the session, but focused primarily on challenges (see; NMC 2017; South 2017; Woolf 2010). Among the challenges the group discussed were some involving technical limitations and some focused on values, substance and priorities. For example, a technical challenge involves the issue of available bandwidth, especially in remote areas. Another technical challenge involves the trend towards cloud-based platforms and resources, which is somewhat connected with the bandwidth challenge but which also involves control, management and security issues. The latter provided the group with a bridge to value-centric challenges, including security and privacy. While one potential of advanced technologies and a second generation of artificial intelligence technologies is the realization of individualized and personalized learning activities and support, there are some concerns with regard to the protection of individual data and using individual records to create adaptive learning activities and support for others. Realizing adaptive personalized learning seems more possible in China than in the USA for example as there are many barriers to such use of individual data in the USA.

This group also noted that some subject matter and learning objectives do not lead themselves easily to virtualization and the application of adaptive virtual reality. The examples mentioned by the group were in the area of vocational training. While some vocational training subjects can and have been supported by virtual systems (e.g., air conditioning repair, automotive systems diagnosis, etc.), others are less easily virtualized, especially subjects in the area of what some call soft skills training (e.g., counseling workers, interacting with clients, leading project teams). While one can find example applications in soft skill training areas, the many variations in human interactions make it difficult to generalize and create robust virtual training solutions.

Group A also discussed the current emphasis on competency and credentialing that is likely to change the nature of higher education and vocational training. Certificates and reliable competency-based badges may replace courses, degrees and diplomas; this represents a challenge to many educational institutions.

This group found promise and potential in the areas of adaptive learning and the integration of biometrics and natural language processing in spite of the challenges that were the focus of Group A's discussions. A potential barrier comes in the form of policies and standardized practices governing educational technologies (Harris and Walling 2014).

Group B report (Joseph south)

Group B was led by Joseph South who also reported to the full plenary session on behalf of the group. Group B focused on three issues, each of which is summarized below: (a) challenges, (b) impact, and (c) inequality.

The group identified eight challenges in their two-hour discussion:

1. Maintaining the value of formal education is a challenge, consistent with Group A's discussion of increasing emphasis on digital certificates;
2. Maintaining a balance between diversity and convergence of new technologies is also a challenge; focusing advanced technologies on learning and impact while not disenfranchising large groups is a challenge (see, for example, UNESCO 2017);
3. Schools and higher education have traditionally been organized around specific subjects and skills but new technologies make it possible, for example, to integrate computer coding and computational thinking into a great number of subject areas;

one challenge, then, is to balance the use of new technologies in both domain-specific and domain-general ways;

4. Information available to nearly everyone on the Internet has led to new kind of knowledge explosion while many humans still have limited intellectual skills; the challenge is to balance artificial intelligence 2.0 (AI 2.0) (Pan 2016) with human intelligence 0.2 (HI 0.2) [Spector introduced HI 0.2 to emphasis that it seems that more emphasis is being placed on making machines smarter than on developing the intelligence of the world's population];
5. There are many inequalities of resource allocations, as also mentioned by Group A, that need to be addressed; the digitally developed world should not abandon or leave behind less developed parts of the world;
6. Challenges in the area of privacy and security were also discussed in Group B as they were in Group A; this group linked the challenges to the rapidly increasing amount of data available or use by data mining algorithms;
7. Emerging and powerful technologies leads to the challenge of changing teacher preparation training and providing ongoing professional development for educators, neither of which is simple or inexpensive;
8. There is an ongoing challenge of assessment; while it is easy to find advocates for using a new technology to support learning, there is little empirical evidence that a particular technology has made a significant and positive impact on learning; there are many confounding variables that are difficult to control in conducting research on how the use of a technology influences learning.

In addition to the above eight challenges, the group also discussed nine issues pertaining to impact which was the focus of the last item listed above:

1. To attain significant impact, the critical factors of real-time mentoring and feedback are of primary importance; integrating formative feedback with the use of new technologies is likely to have a positive impact;
2. New forms of assessment are becoming possible associated with new technologies; examples include extracting data in near real-time from live-stream sources as well as using indicators from multiple sources (e.g., annotated concept maps compared with reference maps, biometric data, etc.);
3. Tools to support educators in preparing learning activities and instructional events is likely to have a positive impact and improve the quality of instruction using new technologies;
4. Tools to accelerate learning that make active and real-time use of cloud-based resources can impact learning while also making traditional content sources (i.e., textbooks) obsolete;
5. Disruption on school system due to effective integration of technology to transform learning can then quickly spread to other school systems;
6. One impact of emerging technologies is that traditional learning environments may become isolated, fragmented and perhaps obsolete;
7. Pressure to develop specific skills may result in less emphasis on higher-order thinking;
8. There is growing tension between group-work, collaboration and interdisciplinary learning and traditional learning focused on individuals;

9. It is possible to use new technologies to have a group accomplish a task aimed at having everyone living better and developing common interests and goals.

The last area addressed by Group B involved values, which is an emphasis that showed itself in all four groups. In this area, the group identified two issues pertaining to inequality:

1. While access to resources is necessary, it is not sufficient to ensure effective learning; there is a persistent discrepancy between the bottom 25% of students and the top 25% of students in many countries and regions; a focus on low-performing students would reflect an understanding of this discrepancy and reflect the value of helping all students attain their potential;
2. In addition to resources and priorities, policy issues contribute to persistent inequalities; these policy barriers vary from one place to another and include such things as high costs of higher education, highly competitive entry requirements, lack of ongoing support for educators, poorly maintained educational institutions and more.

In conclusion, the collection of these challenges, impact issues, and equality problems represents a challenge of the public will to support learning and instruction for all at all levels from early childhood learning to lifelong and life-wide learning.

Group C report (Chee-kit Looi)

Group C was led by Chee-Kit Looi who also reported to the full plenary session on behalf of the group. Group C focused on four issues, each of which is summarized below: (a) opportunities to ride on the wave of technology to transform learning, (b) issues of sustainability and scale of educational innovations, (c) challenges to AI development, and (c) inequality, as was also highlighted in Groups A and B.

Higher education needs to adopt and adapt data strategies similar to the mobile market space, which harvests and fuses a broad range of consumer data together to facilitate action (Looi et al. 2010). The goal would be to create a seamless integration and blending of data from economic, social, characteristic, and behavioral categories segmented within a geospatial map and draw inferences to learning performance outcomes. This approach would require support to develop strategies for change. The different change antidotes can be included in the model to determine the impact in relation to the situation. Approaches for machine learning need be developed that will automatically recommend specific interventions based on real-time student data. As data continues to enter into the system, the automated or semi-automated systems will learn from and transition actions to meet the demand of the future students.

Progress is occurring in the area of artificial intelligence as indicated by the term 'AI 2.0' (Pan 2016). However, artificial intelligence (AI) will need to adopt best case scenario planning and model adaptation which is associated with best possible outcomes. This will require a set of best-case scenarios to be developed with characteristics for the machine to detect and associate situations with. Therefore, this will allow machines to make better suggestions and provide solutions to decision makers and students.

Learning environments should be created on personal learning development models that utilize social and neuro-psychological analysis (and big data sets mentioned earlier) to provide personalized educational roadmaps and instructional delivery methods that adapt to learning styles of the students. This would also account for the time frame of learning and the assessment of learning.

In the development of learning content, institutions should integrate cross-media information collection through machines that crawl the Internet and literature, gather, and then synthesize the topical findings into summaries to help engage students in real-time content.

Professional learning and innovation will be predicated on the opportunities for open collaboration in open environments which consist of individuals with diverse backgrounds and perspective to facilitate the development, implementation, and evaluation of new ideas. The focus should also include the sustainability and scale of adoption, and the ability to implement at scale. In this group, researchers and academics from various institutions around the world share challenges of motivating and engaging student in social collaboration via different online platforms (including MOOCs) and different participation incentive structures. There are complex challenges and there is no one-size-fits-all when it comes to addressing organizational issues and social infrastructures around learning that seek to bring out optimal efficacies out of the learning experiences, AI-enabled or otherwise.

In the advancement of AI technology, there are still technical challenges that loom and provide obstacles to the application of AI to education. In China, there is a big research project involving 20 universities that seek to build an automated AI system that can take the national university entrance examinations (known as Gaokao) and perform a kind of Turing test (see Spector et al. 1996) – that is to say, a knowledgeable AI system that can perform as well as or even outperform the best students. While the system performs well in mathematics with a score of 130 out of 150, it still does not yet fare well in subjects like history, geography and the Chinese language with scores of about 70. So, even in a more traditional and somewhat well-scoped application of AI, there are technical challenges which need to be resolved or addressed.

Caveats are also raised that while advanced technology developments will be happening, there are countries and regions in the world that are still battling with very basic infrastructure issues for education, such as provision of computers and network connectivity. The future intelligent society will have to address issues of equity and opportunities for all in the field of education (see Visser 2016). In addition, learning with new technologies creates a requirement for new measurement scales and attention to non-cognitive aspects of learning (Chang et al. 2014).

Group D report (Maiga Chang)

Group D was led by Maiga Chang who also reported to the full plenary session on behalf of the group. Group D imagined a scenario happening in a future classroom to discuss possible promising technologies not only help learners but also make teachers aware of individual student's needs and situation and teach more efficient, from both hardware and software perspectives, that could be seen as feasible, adopted, and likely to have a positive impact on teaching. The group also raised some concerns and challenges based on the proposed scenario.

In a future classroom there will be sensors and the Internet of Things (IoT) to collect data for an *affective computing and data analytics* systems to assess students' styles, preferences, needs, affect states, and levels of attention. An affective computing system can determine if a student is not paying attention to learning activities; such a system can also identify whether or not a student is nervous when taking a quiz or responding to a teacher's question; an affective system can note and notify the student or teacher that a student is attracted, engaged, frustrated or bored with the content or learning activity. Similarly, a data analytics system with educational data mining and artificial intelligence not only can keep track of a student's preferred learning style, affective state, and meta-cognitive skill level, but also can identify a student's misconceptions and even predict his or her academic achievement for the lesson or course. These capabilities are made possible by the combination of affective computing and data analytics.

The group discussed potential feasible technologies for the sensors and IoTs that can be applied to the proposed future classroom. There are obtrusive/invasive and unobtrusive solutions. The obtrusive/invasive one includes a vest or uniform that has built-in sensors, a head-mounted device for electroencephalogram (EEG) monitoring, and sensors attached to various parts of the learner's body. On the other hand, the unobtrusive solution includes a wearable wristband to track heart rate, blood pressure, and sweating as well as a touch sensitive surface, a real or virtual keyboard, and a camera that can capture a student's actions or points of interest. The obtrusive/invasive solutions are more expensive and in some situations are inapplicable or prohibited for various reasons.

When the affective computing finds a situation that might inhibit learning, it can notify or bring the fact up for the teacher's attention. The group believes that to provide the teacher the feedback through a wall mount whiteboard projection screen or surface would be a better choice as the feedback will be unobtrusive to the students and the lecturing process.

In order to help teachers teach better and make the class get motivated in learning, the group also thinks augmented reality can help a lot in terms of giving students immersive experience for learning and understanding concepts and phenomena in simulations, games, and holodeck – a science fiction immersive technology proposed in the television series Star Trek. Moreover, an advanced system could provide teachers the ability to design and conduct learning activities in the classroom that involve interaction, collaboration, competition, as well as group or crowd-based participation.

Although the proposed future classroom can be realized with these promising technologies and the teaching can be improved, a major concern did exist – namely, the privacy issue. The group discussed and proposed three basic guidelines for building such a future classroom: (1) using a closed-circuit environment; (2) using computer-based solutions; and (3) ensuring that the free will of students. It is worth noting that these three guidelines are not consistent with how other envision future learning environments (see, for example, P21 nd). The group believes that all the data should be collected and analyzed in a closed platform that no outsider can access; generated results and resources should be protected from outside influence or monitoring. Besides the closed environment, all of the data should be automatically fed into a local computerized resource and the results should be generated automatically without human interference. The group felt that it was important to emphasize that no inappropriate person would be able to see or access the collected data on a student or the group.

Last but not the least is the issue of a student's free will. Students should be given permission to decide, at any time, that they allow or disallow their data being collected. For instance, if a student feels sad or uncomfortable at any time, he or she can choose to say no to the system monitoring and the environment and the system should never to collect his or her data when or while a student has opted out. The group believes in such way, a personalized and adaptive system can be provided for educational and learning purpose without sacrificing individual rights and while protecting the privacy of individuals.

Conclusion

Given these four group reports, it is possible to note some similarities and some divergence of ideas. Perhaps the strongest similarity among the group reports was the emphasis placed on values. While the values emphasized varied somewhat, the prominence of values rather than technology was evident in all four groups. The values the groups emphasize ranged from things involving individual rights and privacy, to the value of helping all learners, to valuing education as a general social good. In an important sense, one theme emerging from the four groups is that the right to learn is a fundamental right of all persons. This could be expressed by changing Locke's (Locke 1689) three basic or natural rights in a free society from *life, liberty and property* to *life, liberty and learning.*

A second common theme was the structure of education is changing. Changes include such things as integrating new technologies, new pedagogical approaches and new learning spaces and places. Given what advanced technologies make possible, it makes little sense to keep doing what has been happening in classrooms for the last several hundred years. Engaging and empowering learners using highly interactive and powerful technologies (e.g., 3D printers, interactive virtual realities, and adaptive systems) is possible becoming ever more affordable, although there is some tension with concern with issues involving the digital divide. There was also emphasis in all four groups about developing specific skills and competencies, although the skills and competencies varied somewhat in the different groups, from critical thinking to vocational skills to the pursuit of individually selected knowledge and skills.

The most significant difference had to do with the technologies that were mentioned. One group mentioned MOOCs, another emphasized affective computing, another focused on cloud-based resources, and one focused on data analytics and second generation artificial intelligence. One way to summarize the meeting is to provide preliminary answers to the four motivating questions.

(a). *What are the 5 most promising technologies likely to transform education in the next 10 years?* We are not sure, but likely possibilities include wearable devices, conversational interfaces made possible by AI 2.0, learning analytics, virtual reality, and whole person approaches made possible by affective computing and advances in neuroscience.

(b). *How do/will advanced learning technologies impact the future of education?* Learning places and spaces are likely to change, however slowly, with more emphasis on flexible learning spaces, informal learning opportunities and personalized learning pathways.

(c). *What challenges do advanced learning technologies bring to education?* Providing equal opportunities for all learners, protecting the privacy of individuals, and supporting the development of higher order reasoning skills are among the major challenges to consider.

(d). *What are the new demands for education in the future of society?* A major demand that was implicit and much discussed in side conversations is getting policy makers and the general public to value and support education for all. Avoiding increasingly fragmented and disadvantaged groups is a serious challenge as well as a social demand that is not fully satisfied or understood.

By no means can this report be considered a comprehensive account of the future of learning. It is our hope that it can serve as a point of departure for thinking about the future of learning and how technologies can be effectively and fairly integrated for the benefit of all. The basic unifying theme of this session of learning technology scholars is that the primary consideration should be the kind of society we want to create for our children and future generations. Technology can help or hinder in that endeavor, but what matters are the values which we seek to promote and support.

Appendix

Table 1 Summit Meeting Groups

Panel discussion			
Group A	Group A	Group A	Group A
Phillip Harris[a] USA	Joseph South[a] USA	Chee-Kit Looi[a] Singapore	Maiga Chang[a] Canada
Thomas D. Parsons USA	Pia Wood USA	Kinshuk USA	Elvira Popescu Romania
Patrick Perry USA	Nian-Shing Chen Australia	Aeron Zentner USA	Zhang Xiong China
Ronghuai Huang China	Yang Yang China	Bin Xu China	Marco Temperini Italy
Yonghe Zheng China	Yanyan Li China	Abdelmoiz Ramadan Sudan	Erik Isaksson Sweden
Vivekanandan Kumar Canada	Sylvia Chew Taiwan	Benazir Quadir Bangladesh	Kaushal Kumar Bhagat India/China
Ebenezer Aggrey Canada			Anmadaliev Doniyorbek Uzbekistan

[a]Group Reporter

Abbreviations
3D: Three dimension; AI 2.0: Second generation artificial intelligence; AI: Artificial intelligence; EEG: Electroencephalogram; HI 0.2: Second generation human intelligence; HI: Human intelligence; IoT: Internet of things; MOOC: Massive open online course; P21: Twenty-first century learning; SLFG: Smart Learning Futures Group; UNESCO: United Nations Educational, Scientific and Cultural Organization; USA: United States of America

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Availability data and materials
Not relevant as this is not a data-driven study.

Authors' contributions
All authors contributed equally as noted in the footnote. All authors read and approved the final manuscript.

Ethics approval and consent to participate
Not required as no subject were involved in any intervention.

Consent for publication
All participants at the meeting are co-authors of this paper and consented at the subject meeting to this publication and the review process established for creating this paper.

Competing interests
The authors declare that they have no competing interests.

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