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Exploring the Future of Human Factors Education; Online Learning, MOOCs, Next Generation Standards, and the Technological Skills We Need to Impart

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Abstract- The objective of this panel was to examine how the future of human factors education is changing given the influx of technology, a push for online learning, and adapting to the changing market. The panel will begin by *Heather Lum* briefly giving an overview and the precipice for this discussion panel. The panelists then provided their views and experiences regarding this topic. *Kelly Steelman* will discuss the potential for MOOCs and other online formats to create faster and more flexible postgraduate programs. *Christina Frederick* will discuss her perspectives on the technological skills we should be equipping our human factors graduates with to be successful. *Nathan Sonnenfeld* will give his unique take on this as an undergraduate student currently obtaining a human factors education. *Susan Amato-Henderson* will discuss the Next Generation Science Standards and the ramifications for educators. Lastly, *Thomas Smith* will focus on the advantages and disadvantages of online learning at the K-12 level. Dr. Lum will foster discussion among the panelists and questions from the general audience. Discussion time: 90 minutes.

INTRODUCTION FROM THE PANEL ORGANIZER

Heather C. Lum*, Assistant Professor of Psychology, Penn State Erie, The Behrend College*

What is the future of human factors education? This is a question that we as educators are constantly grappling with. Those of us in thick of it, teaching at the K-12, undergraduate, and graduate levels, tend to get bogged down in the day-to-day responsibilities of our profession. But it behooves us to take a step back from time to time and think about where we are going as a field and how human factors education is changing, growing, and expanding. At the 2010 HFES conference, a discussion panel was organized on the subject of the future of human factors education (Brill, Andre, Beith, Boehm-Davis, Gawron, & Mayhorn, 2010). The focus was meeting marker demands for human factors professionals, developing flexible curricula, encouraging domain specific knowledge, while also supporting the more traditional scientist-practitioner model of learning. We have decided to expand this discussion from six years ago with an emphasis on how the future of human factors education is changing given the influx of technology, a push for online learning, and adapting to the changing market. One glance at the HFES Educational Resources page under "Academia" and it says that the "the two main skills necessary for success in academia are focus and creativity." (HFES.org, 2016). That is easier said than done when we as educators are being pulled in so many directions and have ever increasing deadlines and demands on us. Where are we now and where are we headed as educators and importantly how is it affecting the future of human factors? This panel will address these questions from the administration, educator side, and student perspectives.

DISCUSSANT PERSPECTIVES

Kelly S. Steelman, Ph.D., Assistant Professor
Michigan Technological University
Toward Faster and More Flexible Postgraduate Training in Human Factors.
Rising costs of college tuition coupled with growing industry demands for specialized training means that students are seeking ways to hone their skills and add to their credentials without amassing large amounts of debt or delaying their entry into the workforce. Accordingly, graduate certificate programs and accelerated masters programs are becoming extremely attractive options for our students. At Michigan Tech, for example, our accelerated programs allow students to complete their bachelor's and master's degrees in five years. We currently offer accelerated programs in 18 areas, and we are exploring this option for human factors.

The question here, though, is what role MOOCs and other online platforms will play in the future of human factors education. Will these new platforms supplant traditional in-person, university-based programs? Probably not. But, I do think these platforms can help us make our current programs more flexible and will allow students to complete postgraduate certificates and degree programs faster, and in some cases, while simultaneously gaining industry experience and insight.

For example, many current accelerated degree programs require students to remain on campus for five years. Integrating some online components into the program would allow students the flexibility to take courses while participating in internships or co-ops. In some cases, students may be able to go on the job market immediately following the completion of their bachelor's degree and complete their remaining master's requirements while working.

Flexible online programs may also be attractive to companies seeking professional development or continuing education opportunities for their employees. Although MOOCs may meet this need to some degree, the massive and open components of MOOCs disallow tailoring these classes to meet the needs of specific employers. Many MOOCs, due to the number of students, also have very little instructor-student or student-student interaction. Smaller, closed online courses may better serve the interests of companies by providing tailored curricula and the opportunity for employees to freely address and discuss company- or industry-specific human factors issues.

The potential, though, to teach online courses simultaneously to current undergraduate students and to industry employees may be one of the most enticing reasons for integrating online courses into postgraduate human factors training. Traditional college students would greatly benefit from discussing real-world human factors issues with engineers, scientists, and psychologists actively working in their fields. This opportunity would provide them with a perspective that students may not otherwise receive through interactions with their academic instructors or university peers. Industry employees, likewise, may benefit from the fresh perspective, energy, enthusiasm, and skill sets of undergraduate students.

Christina M. Frederick, Ph.D., Graduate Program Coordinator and Professor, *Embry-Riddle Aeronautical University*

High Tech, Hands on and in Perspective: The Future of Human Factors Education.

As the Program Coordinator for a Master's and Ph.D. program in Human Factors, the future of our curriculum confronts me on a daily basis. Just twenty-five years ago, graduate students roamed the stacks in libraries and made photocopies of articles they needed, while the computers used to do statistical analysis were primarily mainframes. Today, information can be obtained online, statistics are done on laptops in labs and technologies that humans can use have grown enormously. Our mission, however, is still the same: To educate human factors' students with a depth of knowledge in the field both past and present, and to prepare them for excellence in their chosen workplaces. How do we do this?

There is no doubt we need to equip our graduates with technology-rich skills and the ability to communicate and customize technologies for human users. What this means is first, we should require some level of programming skill in our graduates. Programming skills allow for a deeper understanding of technology, as well as the development of logic and reasoning skills. Our students don't need to be expert programmers, but in order to understand and communicate human needs on a team with engineers and programmers, they need to have some knowledge of how technologies work. Second, we need to provide them with the technologies themselves to use and practice with before they enter the workplace. At my institution, we recently equipped a lab with virtual reality devices, a 3d printer and a drawing tablet. Students have the ability to create new designs and products, bring them to life, and test them within the latest virtual environments. We've assigned students to master technologies that are of interest to them and then transfer that expertise to their peers. We've also promoted interdisciplinary collaboration in our labs with engineering students who need to develop skills in the same areas, but who interact with technologies and on projects using a slightly different prospective. Third, required classes in usability, ergonomics and user experience should be in place, with hands-on components, in every HF graduate program, Master's or PhD level.

Last, it is important to make sure students not only can use technology as it evolves, they still need to place that knowledge in a more global perspective. We created a seminar class that looked at emerging technologies and the human, social and organizational challenges faced when these technologies are introduced. Students read about the history of technology, where we are at present, and where we are likely to go. The focus on class was on in depth discussion and understanding of trends. The class was lively and engaging. Students commented on how important ti was, not only to use the technologies available, but to be able to see how and where they fit in the world today and follow the myriad of possibilities, good and bad, technologies present for the future. This type of understanding provides the foundation for a technologically rich learning environment and in many ways is the glue that holds skill sets together, providing coherence and support for those applied experiences.

Nathan A. Sonnenfeld, *Undergraduate Student & President of the ERAU Human Factors Student Chapter, Embry-Riddle Aeronautical University*
A Voice Beckons: Defense and the Future of Education. Foremost, I believe that it is overdue to recognize education alone as the true foundation of global sustainability, supporting the pillars of social, environmental, and economic resilience in addition to their macro-ergonomic interactions. Moreover, if we are to improve public education for future generations - not watch it degenerate as in Chicago and Detroit – we must regard our students with rigor equal our soldiers. Both are the gatekeepers to our nations' future prosperity.

The goals of public education are not the same as those of military training, as stated by a nationally-recognized author and expert on education at a recent Q&A session at our university – we cannot afford to clench on to this unfounded conviction. It is the responsibility of the individual to explore their own interests and passions – to be curious, to discover oneself and their place in the world. It is the responsibility of educational institutions to empower those individuals to attain mastery over those passions, to guide them to become experts in whatever professions, trades, or skills they desire along the way. To bequeath expertise – such is the goal of any given military training regimen - and such is the goal of educators and their institutions.

The Department of Defense understands these similarities. In spite of this, public education's adoption of innovation from within the defense community – which, through training research and technological development, has directed innovation in education for longer than most care to realize – moves at a snail's slither.

The fundamentals of serious gaming and gamification have existed within military training since Kriegsspiel. Distributed virtual simulations have been in use for military training since SIMNET. The defense community would shock contemporary opponents of Pressey's "teaching machine" with the extensiveness and effectiveness of today's adaptive intelligent tutoring and training systems. Systems like those used in DARPA's Education Dominance program, which created IT experts in months not years, effectively demonstrated that students with adequate training – adequate education – can outperform those with even ten years of experience in the field. Systems which may take decades to effectively implement in K-12 education, let alone contemporary academia.

For the sake of future generations, we can only hope that efforts such as DARPA's recent ENGAGE program, federal funding of an ARPA-ED, or a paradigm-shift from the reactionary position of the powers that be can increase the speed of adoption for these innovations. This paradigm-shift begins with the educators and administrators. Especially those in the human factors domain, where we are fully aware of the breadth and depth of human-computer interaction and training research, and of our lack of effort in its application.

In all of my years of education, I have yet to experience the flipped classroom, engaging online courses, effective mixed courses, or real options to test-out of subjects I already knew. AP and IB program courses were only variably challenging until the final examinations. Never was I required to learn a programming language in K-12 or made aware of its value. MOOCs are hardly a worthwhile option for a student like me because there are very few accredited degrees built upon them, and few if any MOOCs are integrated with the simulations needed to make them any more engaging than a traditional lecture. There is no reason why we, when we deeply care about education, refuse to act by immediately changing the way that we educate and create experts. I am just one of an excess of students that feels this way, jaded by our shared experience. In spite of this, the future of education remains bright:

A few favored avatars of a digital tutor will be guiding students through personalized interactive lectures and vivid simulations in the comfort of their own homes; aided by real-time emotional and cognitive state recognition systems that assist the intelligent tutor in adapting the content and its difficulty to elicit the appropriate levels of engagement and cognitive load for the students' needs. Automatic speech recognition and multimodal interfaces allow for dialog and almost human interactions with the digital tutor. Through ubiquitous mobile access and social networks, peer mentors and classmates with similar interests are available to help or discuss tangent topics in a moment's notice. Educational analytics allow for the optimization of instructional design and training strategies, while content is updated regularly toward preparing students for success in a society twenty years in the future. Student are encouraged to take their time with difficult material, as performance is assessed in real-time rather than by intermittent examination. Students move on to subsequent material as they demonstrate mastery of the prerequisite; those which acquired KSAs from independent study will quickly accelerate through any module of learning. Attending an almost platonic academy to work in teams on applied projects, students work individually with a teacher if needing extra assistance. Projects are related to current global goals and local community issues, each eligible to compete internationally for prize seed money to fund future start-ups. Students graduate, excited for the future, understanding the value of STEM and how it may apply to their future passions, whatever they may be.

A voice ahead beckons us, the faint call of the defense community. For now, we stumble in the darkness, trying to find any path that takes us to that bright future – guided only by the dim candlelight of the human factors perspective.

Susan Amato-Henderson, Ph.D. ***Chair of the Department of Cognitive and Learning Sciences, Michigan Technological University***

Next Generation Science Standards: Implications for Human Factors Education and Careers.

The Next Generation Science Standards (NGSS), released in April 2013, are based upon the National Research Council's (NRC) Framework for K–12 Science Education and were designed to provide internationally benchmarked science standards that seamlessly apply across K-12 grade levels and core science areas. The development of the NGSS were, in part, prompted by the leaky STEM pipeline. According to the NRC:

> *We anticipate that the insights gained and interests provoked from studying and engaging in the practices of science and engineering during their K-12 schooling should help students see how science and engineering are instrumental in addressing major challenges that confront society today, such as generating sufficient energy, preventing and treating diseases, maintaining supplies of clean water and food, and solving the problems of global environmental change. (NRC 2012, p. 9).*

One of the novel aspects of these new standards is the role of teaching "engineering" at K-12 levels. Specifically, one of the noted advances of the new standards is that "Science and engineering are integrated into science education by raising engineering design to the same level as scientific inquiry in science classroom instruction at all levels, and by emphasizing the core ideas of engineering design and technology applications." (The Next Generation Science Standards, Executive Summary, p. 1). The standards also emphasize the importance of integrating content learning with practice, which enhances learning through contextualizing science. For each disciplinary core, multiple science and engineering practices are offered, emphasizing the real-world nature of science. The definitions of "engineering" and "technology" are broad, implying the necessary knowledge than any literate citizen would need. As such, engineering is defined as a "systematic practice for solving problems", and technology as "the result of that practice".

The ramifications of the NGSS on institutions of higher education is that both administrators and faculty have to be familiar with the performance expectations and learning progressions that underlie the standards so that college instruction can build on the knowledge and skills that students gain through NGSS. Students entering post-secondary institutions will have experienced science education in a whole new way – deeply, integrated across disciplines and with engineering, and from an active, problem solving and hypothesis testing approach. What can we do to build on this new level of preparation at the post-secondary level? More specifically for this presentation, though, are what ramifications exist for the educational pathways and careers in HF?

Through discussion, we will examine implications of NGSS students' previous educational experiences, such as their experiences with: integrated cross-disciplinary STEM learning experiences, technological innovations aimed at solving societal problems, research-based learning experiences in which problem solving skills are enhanced, systems level thinking, and the integration of engineering across learning experiences. Possible implications include the need for more 5th year M.S. programs as students entering post-secondary education will have been exposed to the concepts and ideas of "mixed" or interdisciplinary fields and will look for these types of programs in their college selection criteria, enhanced problem solving abilities as post-B.S. level students pursue higher educational opportunities, how online learning opportunities may have to change to meet the needs of learners, and how our accreditation of HFES programs may need to change.

Thomas J. Smith, Ph.D., ***CHFP, School of Kinesiology, University of Minnesota***

Online Education in K-12 Classrooms - the Good, the Bad and the Ugly.

Over the past two decades, provision of online courses has become a regular and widely accepted mode of instruction in the world of higher education – for example, online enrollments have continued to grow at rates far in excess of the total higher education student population, such that an estimated one in four higher education students now take at least one course online (Allen & Seaman, 2010).

In contrast, implementation of online learning environments in K-12 schools has remained comparatively modest, despite calls for much wider application of this technology, plus strong endorsement from the Gates Foundation (Mangu-Ward, 2010). Based on a 2007 Sloan Consortium report (Picciano & Seaman, 2007), out of an entire population of 48,000,000 U.S. public school students, an estimated 600,000 (1.3 percent) to 700,000 (1.5 percent) K-12 public school students were enrolled in online learning for 2005–2006.

Reports of the impact of interaction with online learning environments on K-12 student performance are equivocal and non-systematic. The Sloan report (Picciano & Seaman, 2007, pp. 14–17] presents a balanced mix of both positive comments, and expressions of concern, about the benefits of this technology. Student enrollees in the Florida Virtual School are reported to score higher on advanced placement tests than regular public school students (Mangu-Ward, 2010); in contrast, the superintendent of a Pennsylvania school district reports that its regular school students outperform cyber school enrollees in almost every regard based on achievement data (Jubera et al., 2010)

Survey data indicate that online learning has been growing in K-12 schools, and that this growth will continue for the foreseeable future (Picciano and Seaman, 2007). This suggests that if K-12 trends follow the more established patterns observed in institutions of higher education, it is possible that online learning will emerge as a substantial contributor to the education of K-12 students, especially at the secondary level. Blended learning environments, combining student enrollment in both fully online and blended (combination of online and regular classroom instruction) courses, represent one particularly likely manifestation of this trend (the Good?).

Nevertheless, the learning impact of this technology on K-12 students has yet to be systematically explored, and unless or until this shortcoming is addressed, the putative benefits of online learning remain uncertain (the Bad?). More fundamentally, the following findings (Smith, 2007, 2012) raise the critical question of whether the application of online courses in K-12 classrooms will ultimately prove more detrimental than supportive for student learning: (1) the almost universally accepted mantra that 'Teachers Matter Most' for K-12 classrooms; (2) educational ergonomic findings that student-teacher face-to-face interaction represents the social cybernetic basis of this mantra; and (3) interaction with computer and mobile technology displays can have adverse effects on social IQ and brain function, especially among immature students (the Ugly?). Panel commentary will critically examine this question and explore its implications for online learning in K-12 classrooms.

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