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The Gap Between Human Factors Engineering Education and Industry Needs

Bella Zhang and Mark Chignell

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Bella (Yigong) Zhang[1]and Mark Chignell[1]

[1]University of Toronto, Toronto, Canada
yigong.zhang@mail.utoronto.ca,chignell@mie.utoronto.ca

Abstract. Traditional Human Factors Engineering (HFE) education focuses on bridging the gap between human and system design. Given the rapid, and accelerating technological advancement, particularly in areas such as machine learning and data science, how should HFE education adapt to better equip students for working in industry? This project sought to identify and understand the gap between HFE education and industry needs by surveying human factors engineering students and practitioners concerning their impressions of the gap and how it can be addressed.

Keywords: Human Factors Engineering, Education, User Experience, Practitioner Survey, Industry needs

1 Introduction

In recent years the field of human factors and ergonomics has expanded and changed to meet the challenges of new internet and communication, and healthcare, technologies. In today's digital economy, big data is everywhere – our society is being transformed by the ubiquity of data. With the assistance of ever more pervasive software and hardware technologies, an increasing amount of data is created, stored, and distributed on a daily basis. The surfeit of ("big") data affects the practice of human factors engineering (HFE) by providing vast amounts of data about human behaviour that can guide design. In the meantime, it is also an opportunity for the HFE discipline to assist in human-centerd system design with automated data analysis and machine learning systems [1]. In areas such as cybersecurity, there is often a great deal of tacit knowledge that is available to domain experts but not to machine learning systems, for instance in the case of data exfiltration [2]. In such cases, collaborations between human experts and machine learning algorithms may provide better results than either party alone, using an interactive machine learning approach. From an HFE perspective, emerging topics such as interactive machine learning and explainable AI represent a new example of human-machine collaboration, which is core to the discipline of human factors and ergonomics.

Human factors engineers play an important role in designing effective and safe automation solutions and avoiding catastrophe or undesired outcomes. In the face of accelerating change, HFE needs to adapt further in order to meet the challenges and

opportunities created by the recent explosion in areas such as data science and machine learning. To better integrate human factors into intelligent systems and organizations, there is an increasing number of emerging research areas, such as explainable artificial intelligence, human-centered data science, human-centered design of artificial intelligence, interactive machine learning, and human-automation interaction. However, research results need to be translated into industry practice, and thus it is important that HFE education keeps up to date with the latest results, and industry needs, so that future generations of human factors engineers will be prepared to contribute and benefit emerging fields.

There has been relatively little research on how human factors engineers can better work with data scientists, nor has there been much research on how we can impart data science skills in HFE education programs, though there has been recent discussion among HFE educators [3], [4]. Thus the following questions need to be addressed if we are to have the information needed to design up to date HFE curricula.

- How do we provide future human factors engineers with the skills to play their role in the emerging era of automation and data?
- How can human factors engineers better serve the systems and organizations that are increasingly dependent on data analytics and artificial intelligence?

The research reported in this paper is intended to provide an important first step towards answering these questions.

2 Objective

In this research, we aim to understand the unmet training needs for future human factors engineers by surveying HFE students and practitioners and interpreting their responses. The results of this research identify the perceived gap between that education and industry needs. The research should provide insights that will inform the design of future HFE education curricula.

3 Methodology

We conducted two surveys, one with HFE students and the other with HFE practitioners. The surveys comprised 11-12 questions in a combination of multiple-choice, Likert scale, and open-ended questions. All responses to the survey were anonymous and voluntary. We promoted the surveys on the Human Factors and Ergonomics Society member forum, LinkedIn HFE/UX Technical groups, and through researchers' alumni network. If interested audience self-identified as HFE/UX practitioners/students, they could participate in the survey research voluntarily after agreeing to the consent at the beginning of the survey.

The student survey sought to understand the perceived needs of undergraduate and graduate students who specialize in HFE at major universities. This survey had two sections: 1) education experience; 2) evaluation of the respondent's education experience. The HFE practitioner survey focused on identifying skillsets that were desired, but currently missing, based on the work experience of the respondents and on the recommendations of the respondents for changes in the HFE curriculum. The survey questions covered the practitioners' education and work experience, as well as their reflections on their work demands relative to the education they received.

4 Results

In the HFE student survey, 58 students from 26 universities participated. Over half of the respondents were pursuing their graduate degrees (Fig. 1). Fig. 2 shows the students' rating on the HFE education they received from their home university. There are three main takeaways from the student survey results (Fig.2). First, over half of the students did not feel confident in working with data scientists on data-driven products (Statement 1-4, in Fig.2); secondly, the students were generally satisfied with the HFE education they have received (Statement 5&7 in Fig. 2); lastly, the students thought that HFE education should incorporate more data science skills in the curriculum (Statement 6 in Fig. 2)

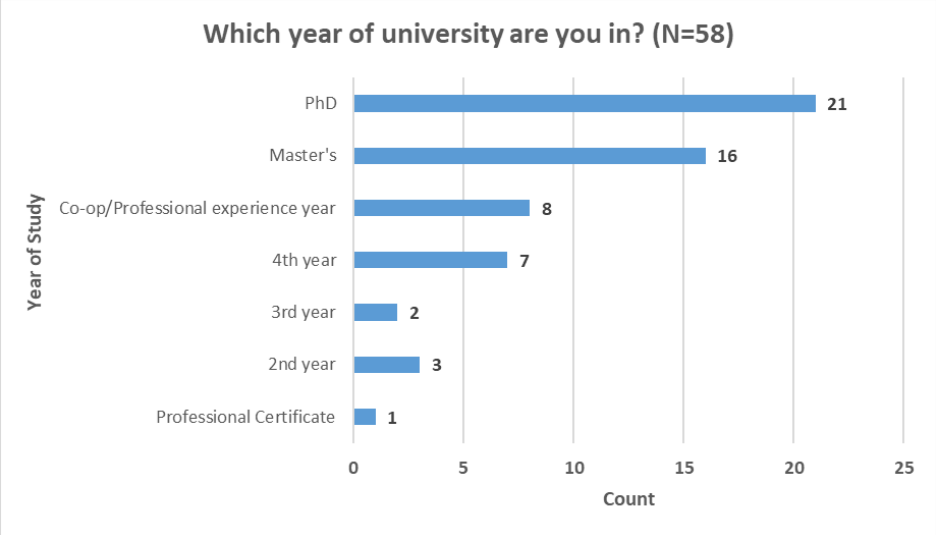

Fig. 1. HFE student respondents' year of study in their education program (N=58)

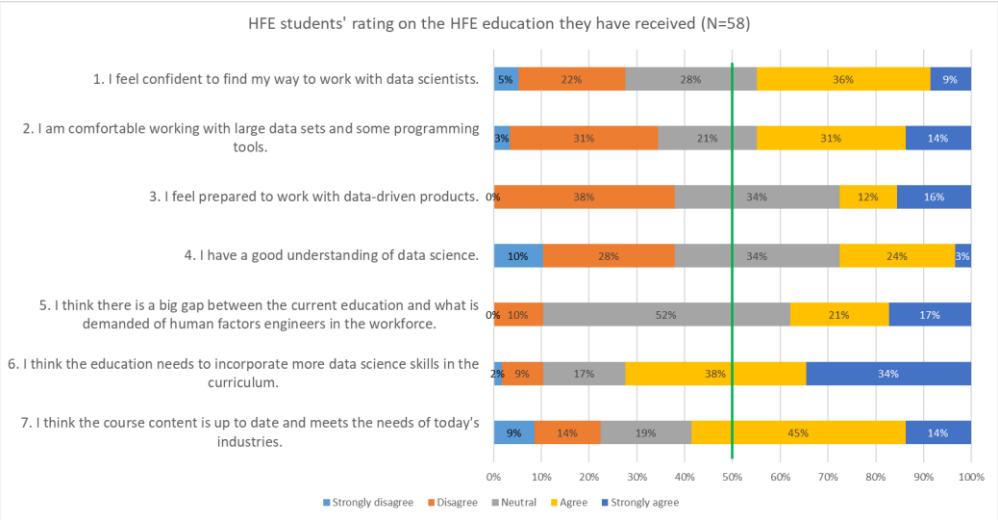

Fig. 2. HFE students' rating on the HFE education they have received (N=58)

We received 99 responses for the HFE practitioner survey. Most of the respondents had worked in industry for over 5 years (Fig. 3). Over 60 percent of the respondents had graduate degrees in HFE, and a further 37% had bachelor's degrees. The top three gaps areas in their education that were identified by the practitioners were 1) Understanding basic principles of artificial intelligence, advanced data analytics, big data, data visualization, 2) Real-life projects with clients and internship opportunities, 3) Practical User Experience (UX) research and design skills. The top three areas of change practitioners would like to see in the future human factor engineering education were 1) incorporate more materials in HCI, UX, UI, and visual design, 2) teach advanced data analytics tools and statistics to equip students to work with big data sets, and 3) apply theories in hands-on projects or case studies.

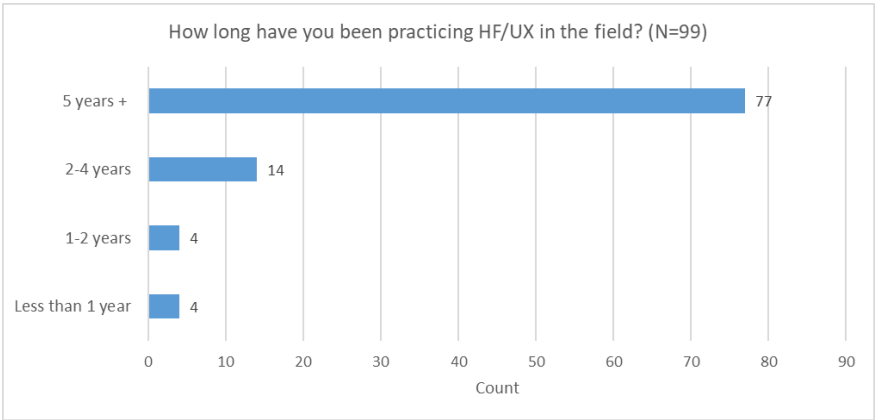

Fig. 3. HFE practitioners' years of work experience in HF/UX (N=99)

5 Discussion

Based on the survey results, we learned that there is an urgent need to integrate a data science perspective into the existing HFE curriculum. As most HFE educators are not sufficiently trained in data science and automation, the implementation of the revised curriculum will require educators to proactively get training in data science and seek more interdisciplinary teaching collaboration between faculties. Due to the practical nature of the HFE discipline, educators should promote more hands-on learning in both undergraduate and graduate HFE education. This echoes earlier calls for more problem-based learning in engineering education (e.g., [5]). Problem-driven learning from examples should also assist in learning how to collaborate in teams and learning from reflection on experience, which is increasingly recognized as important components of engineering education (e.g., [6]).

Besides the obvious need to create more internship opportunities, we recommend collaborating with HFE practitioners in the field and establishing a database of up-to-date case studies in the HF/UX field to make it easier for educators to integrate relevant, practical, and trending materials into the HFE courses. Lastly, it will be useful to create more collaborative opportunities for HFE educators around the world to learn best practices from one another and establish an up-to-date, recognized, standardized but customizable HFE curriculum.

There are three major limitations of the surveys. First, due to overlaps between HF and UX, we did not make a differentiation between respondents who are more specialized in HF or UX. Second, the respondents self-identified themselves as students or practitioners in HF/UX and participated in the research without the researchers scrutinizing whether they qualified for participation. Lastly, more respondents to the student survey would help improve the accuracy and validity of the results. We will continue to promote the survey to gather more responses.

6 Conclusions

HFE has been traditionally more academic and has focused on safety-critical industries. With the increasing prevalence of emerging mobile technologies and big data, the HFE profession is faced with opportunities and challenges to expand and adapt to the changing work context. To better serve quickly evolving systems and organizations, it is important that we, educators and practitioners, welcome the opportunity to collaborate with new industries, expand the practical knowledge of students and emerging practitioners, and keep the HFE curriculum relevant to industry needs.

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References

[1] C. G. Drury, "Human factors/ergonomics implications of big data analytics: Chartered Institute of Ergonomics and Human Factors annual lecture," *Ergonomics*, vol. 58, no. 5, pp. 659–673, May 2015.

[2] M. H. Chung, M. Chignell, L. Wang, A. Jovicic, and A. Raman, "Interactive Machine Learning for Data Exfiltration Detection: Active Learning with Human Expertise," in *IEEE Transactions on Systems, Man, and Cybernetics: Systems*, 2020, vol. 2020-October, pp. 280–287.

[3] D. Hannon *et al.*, "A Human Factors Engineering Education Perspective on Data Science, Machine Learning and Automation," *Proc. Hum. Factors Ergon. Soc. Annu. Meet.*, vol. 63, no. 1, pp. 488–492, 2019.

[4] D. Hannon *et al.*, "The Education of the Human Factors Engineer in the Age of Data Science," 2020.

[5] D. R. Brodeur, P. W. Young, and K. B. Blair, "Problem-based learning in aerospace engineering education," in *ASEE Annual Conference Proceedings*, 2002.

[6] J. A. Turns, B. Sattler, K. Yasuhara, J. L. Borgford-Parnell, and C. J. Atman, "Integrating reflection into engineering education," in *ASEE Annual Conference and Exposition, Conference Proceedings*, 2014.