Department: Education and Training
Editor: Andrew L. Kun, University of New Hampshire

Reader and Teacher: Fourteen Books That can Inspire Teaching in Pervasive Computing (and Beyond)

Andrew L. Kun
University of New Hampshire

As my colleagues and I argued in a recent IEEE Pervasive Computing article, teaching pervasive computing is hard.[1] It is hard, because advances in this field require organizing multidisciplinary teams to solve complex socio-technical problems. As it turns out, it is not easy to teach students to contribute to, as well as lead, such teams. In our paper, we proposed that it is time to rethink pervasive computing (or simply ubicomp) education by focusing on three central questions:

1. ***Why*** *is training in ubicomp needed?* Do we need ubicomp-specific training? Or should we focus on training for domain expertise (e.g., in psychology or circuit design)? We propose that the answer lies in assessing which training can help our students become ubicomp professionals who can meet the grand challenges to be tackled by ubicomp.
2. ***What*** *should constitute training in ubicomp?* If ubicomp-specific training is needed (and we expect that it is), what are the goals of this education? What are the values, knowledge, and skills that our students will need?
3. ***How*** *should we teach and engage a diverse body of students?* Once we identify ubicomp educational goals, it is time to turn to pedagogy and identify the approaches that will best help us achieve the goals.

In this paper, I introduce fourteen books that can help us frame the three questions above within the broad understanding of history, society, human psychology, and the tools for

Digital Object Identifier 10.1109/MPRV.2019.2912257
Date of current version 25 July 2019.

Published by the IEEE Computer Society

generating new knowledge. These books can also support us as we embark on teaching ubicomp.

WHY IS TRAINING IN UBICOMP NEEDED?

As my colleagues and I argued, in order to decide on the need for ubicomp training, we should start with identifying the grand challenges that ubicomp research and practice will try to solve in the coming years. There are a number of diverse books that can help us formulate our vision of these grand challenges.

One such book is Yuval Noah Harari's "21 Lessons for the 21st Century".[2] As the title indicates, Harari takes on 21 big questions that our society faces. A key lesson for ubicomp from this book is that, in the long run, pervasive advanced technology could create never-before-seen divisions between humans: some could have cartoon-like superpowers, while others are given a basic income and forgotten. A book that takes on a much more immediate threat is "The Circle" by Dave Eggers[3] This book describes a dystopian (near) future, in which ubicomp technologies allow the creation of a world with no privacy. The book also provides a stark warning: tech company executives who control ubicomp technologies can have immense political power.

The two books above both sound an alarm that technology development can lead us into trouble. But there are many books that point out the hope that lies in tech. For example, Neal Stephenson's "Seveneves"[4] is a science-fiction book that reminds us that technology can literally be the difference between the life and death of our species. In this book, a broad coalition of tech experts and politicians has to create technologies and procedures to save humanity. One key message in this book is that today's actions and decisions can have consequences for thousands of years.

Another book that has an important, yet often neglected, a message is Steven Pinker's "Enlightenment Now".[5] The key message of the book is that, on average, life has been getting better for humanity for a long time. Much of these advances are related to the technologies we are developing. While we should continue to fight the threats posed by, or enabled by, technology, let us not forget that ubicomp, and more broadly science and technology, has a great deal of positive impact on society.

WHAT SHOULD CONSTITUTE UBICOMP TRAINING?

Our students need exceptional technical training because ubicomp is a field that is almost entirely about future technological challenges. There are a number of technical books that focus on different aspects of pervasive computing[6] to help train our students.

However, the truly exciting technology challenges will not be solved by only teaching students to solve homework assignments with known answers. Rather, these future challenges will require generating new knowledge. For this reason, ubicomp education must help students acquire the general tools for generating new knowledge. These are the tools that are generally among disciplines and are indispensable for those who wish to lead efforts to invent the future. The general tools are described by Karl Popper's model of conjecture and refutation, in which scientific theories are built through proposing hypotheses which are subsequently empirically tested and either supported or refuted.[7] Steven Pinker describes these general tools in terms of Bayesian reasoning: certain hypotheses are given a baseline probability based on prior knowledge, and this probability is adjusted based on empirical tests.[5] Importantly, these skills are not only useful in scientific research in academia. As the recent work of Eric Ries demonstrates, these general tools are also critically important for productive research and development in industry.[8]

Training students to generate new knowledge is also the focus of "Becoming Brilliant: What Science Tells Us About Raising Successful Children," by Roberta Michnik Golinkoff and Kathy Hirsch-Pasek.[9] They propose that we should help children acquire skills to be successful at what they call the '6 Cs': collaboration, communication, content, critical thinking, creative innovation, and confidence. Golinkoff and Hirsch-Pasek are learning scientists, and they developed this list of six skills in response to the question: how should we prepare our children for 21st century jobs? One of their central arguments is that an exclusive focus on only one of

the Cs, content, might have been appropriate in the past, when there was less content, and content changed slowly. However, in today's world, content is vast, and it changes rapidly. This means that we need to prepare our students for work that requires both creating new knowledge and quickly adapting to a professional change. I want to add that, just as the need to teach the 6 Cs applies to schoolchildren who are the focus of the work of Golinkoff and Hirsch-Pasek, it also applies to college students.

The reader will recognize that some aspects of these 6 Cs overlap with the specific tools and general tools above. Namely, "content" primarily refers to the specific skills, while "critical thinking" and "creative innovation" are related to the general tools of generating new knowledge. Of course, specific skills (being able to solve differential equations, test electrical circuits, and write computer code) receive the lion's share of time in any undergraduate and graduate technical program of study, and rightfully so. Without these specific skills, our students cannot turn into productive professionals. However, they can benefit greatly by being exposed to the general tools as well.

HOW SHOULD WE TEACH AND ENGAGE A DIVERSE BODY OF STUDENTS?

The pedagogy of teaching ubicomp is a complex topic, and in this article I will only focus on three of its aspects. The first one is developing grit. In her recent book on this topic, Angela Duckworth describes grit as the ability to put sustained effort into an undertaking over long periods of time, even in the face of difficulties and setbacks.[10] Grit has been shown to be critically important for students in achieving their academic and professional goals. Many of our students have grit—that is how they made it into college in the first place. But, the newer generations of students might have less of it, at least partly due to overparenting. As Julie Lythcott-Haims, former Dean of Freshmen at Stanford, argues in her book on the harms of overparenting, if your parents smooth the way for you at every turn, it is difficult to develop grit.[11] Furthermore, disadvantaged students might not have had the opportunity to learn important lessons about grit in their pre-college years.[12] Finally, as Duckworth argues, grit improves with practice. I would argue that the focus on project-based learning in ubicomp provides an excellent opportunity to help students become grittier: good projects are small laboratories for learning how to generate new knowledge, and this activity inevitably comes with the need to overcome frequent setbacks.

The second topic I want to focus on is online education. When I attended the Microsoft Research Faculty Summit in 2016, I had the opportunity to listen to an interview with Microsoft cofounder Bill Gates. This was a discussion about a wide range of topics, but I vividly remember his response to a question about the future of online learning. Gates said that he believes that online education will expand and that the number of experts who provide the online material will likely shrink over time. Gates pointed out that today there is a relatively large number of educators who create online material—e.g., many universities might have their own version of the same course, taught by their own professors. Gates believes we are headed to a future in which a relatively small number of educators will rule the market. These educators will be supported by large teams of people to provide the slides, videos, simulations, etc., to make the online lectures effective. A key observation by Gates is that this does not leave all the other professors, those who do not generate the majority of online content, out of a job. Instead, they can devote more time to the interactions that cannot be taught in an online video, such as teach students how to generate new knowledge, help them advance in all 6 Cs and not just content, and help them become ever grittier.

Of course, if we do embrace online education, we will have to confront broad societal concerns about the use of electronic devices by all of us, and young people in particular. I have to admit that I look at much of the concern about digital device use as a modern-day moral panic. In this attitude, I am supported by the recent work of Jordan Shapiro entitled "The New Childhood: Raising Kids to Thrive in a Connected World".[13] Shapiro's opening argument is that writing was a technology rejected by Socrates, but embraced by his student Plato. Lucky for us that Plato embraced writing, otherwise the work of Socrates would have been lost. We should look at the technologies

that our students embrace, and not panic that they will make them incapable of rising to the challenges of inventing the future. On the topic of devices, and online activity in general, I also agree with the argument of danah boyd in "It is Complicated: The Social Lives of Networked Teens"[14] that "by and large, the kids are all right." Do young people spend a great deal of time online? Yes. Are they addicted to the Internet? No. They just want to be with their friends, and the Internet is where many of those friends are. Overall, when it comes to devices and the Internet, we would do well to observe that, as Steven Pinker points out in "The Sense of Style," older generations have complained about the younger generations for a long time, even if the particular concern varies from one age to another.[15] Pinker tells us of ancient Sumerian tablets with "complaints about the deteriorating writing skills of the young." The reader will recall that ancient Sumerians invented writing, so clearly, this line of complaining has a long tradition. But, obviously, plenty of students became accomplished writers in the last 5000 years since the invention of writing; consequently, we should expect that most of our students will also do well professionally.

Finally, the third topic I would like to address is diversity—how do we engage a diverse student population? As I read Lisa Damour's "Under Pressure: Confronting the Epidemic of Stress and Anxiety in Girls",[16] I was struck by how little I know about the challenges that teenage girls confront as they move from childhood to adulthood. I had a similar realization reading Paul Tough's "How children succeed: Grit, curiosity, and the hidden power of character"[12]—I know very little about the challenges that students from lower-income and/or minority families face. All of this made me realize that teachers must carefully plan for their efforts to engage a diverse student population. Simply having good intentions is not enough. The reason is that we all have limited personal experiences, and these will not have prepared us to systematically help a diverse student population tackle a diverse set of challenges.

CONCLUSION

As ubicomp teachers and researchers, we can learn a great deal from reading both fiction and non-fiction books. The 14 books that inspire my teaching (in ubicomp and beyond) are a good example of this—take a look at Table 1 to see my one-sentence summary for how each of them can inspire teaching ubicomp (as well as other subjects).

Of course, our students can also learn a great deal from reading broadly. I would argue that reading fiction and non-fiction books that reach beyond students' narrow technical interests should have a prominent place in ubicomp education. This can help students relate their ubicomp efforts to the needs of society and individuals, it can provide technical ideas, it can help them become better writers, and it can motivate them to dream big. At the University of New Hampshire, I teach a graduate course entitled "Research and Development from Concept to Communication." This course introduces the general tools of generating new knowledge and trains students to communicate their ideas. As part of the course, students read one fiction book and one science-related book. While not every student enjoys these assignments (younger generations also complain about older generations!), they all benefit from being exposed to reading books and drawing ideas from them that are relevant to their own work. For example, for the report on the science-related book, I ask students to list writing practices they observed in the book that they plan to use in their own writing.

As teachers, we should read broadly, and we should strive to make connections between the ideas in the books that we read, and our teaching and research interests. Just as importantly, we should encourage our students to do the same.

Send me your book suggestions!
Which books have inspired your teaching in ubicomp and beyond? And which books would you like your students to read? Please send me your suggestion via email to andrew.kun@unh.edu. I plan to report on your responses in an upcoming issue of IEEE Pervasive Computing.

Table 1. The 14 books discussed in the article, and a one-sentence summary of how each of them can inspire teaching Ubicomp, as well as other subjects.

Relevance to ubicomp teaching?	Book author and title	Key inspiration for teaching ubicomp (and beyond)
Why training for ubicomp?	Harari, "21 questions for the 21st century"	Tech can have terrible effects.
	Eggers, "The Circle"	Ubicomp can lead to (a) loss of privacy & (b) immense political power for tech execs.
	Stephenson, "Seveneves"	Tech can save humanity.
	Pinker, "Enlightenment now"	Our lives have been improving, in part due to tech advances.
What should constitute ubicomp teaching?	Popper, "The logic of scientific discovery"	Hypothesis testing drives the generation of new knowledge in science and in industry.
	Pinker, "Enlightenment now"	
	Ries, "The lean startup"	
	Michnik Golinkoff and Hirsch-Pasek, "Becoming brilliant"	Education must go beyond content only, to the 6 Cs.
How should we teach and engage students?	Angela Duckworth, "Grit"	Students must learn to persevere – this is grit.
	Lythcott-Haims, "How to raise an adult"	Overparenting reduces grit.
	Tough, "How children succeed"	Students from disadvantaged backgrounds might have less grit.
	Shapiro, "The new childhood"	When it comes to the Internet, don't give in to the moral panic about electronic device overuse. Instead . . .
	boyd, "It's complicated"	. . . remember that "the kids are all right". . .
	Pinker, "Sense of style"	. . . and remember that moral panics are nothing new.
	Damour, "Under pressure"	It takes more than good intentions to understand the needs and challenges of a diverse student population.
	Tough, "How children succeed"	

REFERENCES

1. A. Girouard, A. L. Kun, A. Roudaut, and O. Shaer, "Pervasive computing education," *IEEE Pervasive Comput.*, vol. 17, no. 4, pp. 9–12, Oct.–Dec. 2018.
2. Y. N. Harari, *21 Lessons for the 21st Century*. New York, NY, USA: Random House, 2018.
3. D. Eggers, *The Circle*. Baltimore, MD, USA: Penguin, 2015.
4. N. Stephenson, *Seveneves*. New York, NY, USA: Harper Collins, 2015.
5. S. Pinker, *Enlightenment Now: The Case for Reason, Science, Humanism, and Progress*. Baltimore, MD, USA: Penguin, 2019.
6. A. L. Kun, "Textbooks for pervasive computing training and education," *IEEE Pervasive Comput.*, vol. 16, no. 3, pp. 59–61, 2017.
7. K. Popper, *The logic of Scientific Discovery*. Evanston, IL, USA: Routledge, 2005.
8. E. Ries, *The Lean Startup: How Today's Entrepreneurs use Continuous Innovation to Create Radically Successful Businesses*, New York, NY, USA: Crown, 2011.
9. R. M. Golinkoff and K. Hirsh-Pasek, *Becoming Brilliant: What Science Tells Us About Raising Successful Children*. Washington DC, USA: Amer. Psychol. Assoc., 2016.

10. A. Duckworth and A. Duckworth, *Grit: The Power of Passion and Perseverance*. New York, NY, USA: Scribner, 2016.
11. J. Lythcott-Haims, *How to Raise An Adult: Break Free of the Overparenting Trap and Prepare Your Kid for Success*. New York, NY, USA: Henry Holt and Company, 2015.
12. P. Tough, *How Children Succeed: Grit, Curiosity, and the Hidden Power of Character*. Boston, MA, USA: Houghton Mifflin Harcourt, 2012.
13. J. Shapiro, *The New Childhood: Raising Kids to Thrive in a Connected World*. New York, NY, USA: Little, Brown Spark, 2018.
14. D. Boyd, *It's Complicated: The Social Lives of Networked teens*. New Haven, CT, USA: Yale Univ. Press, 2014.
15. S. Pinker, *The Sense Of Style: The Thinking Person's Guide to Writing in the 21st Century*. Baltimore, MD, USA: Penguin, 2015.
16. L. Damour, *Under Pressure: Confronting the Epidemic of Stress and Anxiety in Girls*. New York, NY, USA: Ballantine Books, 2019.

Andrew L. Kun is with the University of New Hampshire, Durham, NH, USA. Contact the author at: andrew.kun@unh.edu.