Interdisciplinary Research Opportunities in Educational Technology

The Case of Automated Writing Evaluation

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SLATE Lab

- **S** ustainable
- **L** earning and
- **A** daptive
- **T** echnologies for
- **E** ducation

Why should we care about education and learning?

Why should we care about educational technology?

http://slatelab.engineering.asu.edu/

Why Care about Education?

- development of knowledge, strategies, skills, critical thinking, creativity, and more

- expertise doesn't grow on trees

- education empowers…
  - personal growth
  - innovation and discovery
  - employment opportunities

Why Care about Technology?

- technology is ubiquitous and persistent, reaching into every facet of our lives

- including education

- many claims about...
  - societal transformation
  - challenges and barriers
  - industry and jobs

The "Ed Tech" Industry

- SIIA Report from 2014
  - U.S. institutional pre K-12 market for education software and digital content: **$8.38B**
  - increase of 5.1% from previous year
  - increase of 11.7% over four-year analysis period
  - "testing and assessment" are big

- schools are investing in hardware, software, infrastructure, and digital curricula

Richards, J. & Stebbins, L. (2014). 2014 U.S. Education Technology Industry Market: PreK-12. Washington, D.C.: Software & Information Industry Association.

Ed Tech Trends

- augmented/virtual reality
- clouds, connectivity
- digital textbooks, OERs
- intelligent/interactive systems
- internet of things
- learning analytics, "big data"
- maker spaces, 3D printing
- mobile learning/devices
- next-gen learning management
- personalized, adaptive systems
- serious games, simulations
- social media, social networking
- wearables

A Few Articles and Links

Brown, M. (2015, July/August). Six trajectories for digital technology in higher education. *EDUCAUSE Review*, *50*(4), 16-28.

Kelly, R. (2016, January). Virtual roundtable: 9 ed tech trends to watch in 2016. *Campus Technology*.

Pappas, C. (2016, January). Top eLearning trends for 2016 you need to know. *elearningindustry.com*.

Smith, D. F. (2015, December). 5 tech trends that could supercharge education in 2016. *EdTech Magazine: Focus on Higher Education*.

Taylor, E. (2016). Top 10 eLearning trends in K-12 education. *TeachHUB.com*.

Note: the examples provided here are *not* meant to be comprehensive or rigorous. They simply highlight diverse popular opinions available to online information seekers.

Ed Tech Research

- educational technology **innovation** is driven by (educational) technology **research**
  - academic research; industry R&D
  - may be directly or indirectly education-related

- relevant work in **human systems engineering**
  - augmented and virtual reality
  - digital textbooks
  - human-automation interaction and teaming
  - intelligent and adaptive systems
  - learning analytics, (educational) data mining

Interdisciplinary Research

- many different fields contribute to effective educational technology development

- **learning science (LS)**: learning theories, learning processes, pedagogical principles

- **computer science (CS)**: software engineering, artificial intelligence, natural language, learner modeling, automation

- **user science (US)**: human-centered design, usability, technology adoption and integration

Automated Writing Evaluation

- **AWE**: the design and use of computer-based tools to assess writing and features of writing
  - grading, placement, feedback, and instruction

Interdisciplinary AWE Research

- **learning science (LS)**: writing processes, teaching of writing, writing feedback

- **computer science (CS)**: natural language processing (NLP), learning analytics, automated scoring and feedback

- **user science (US)**: perceptions of automation and automated feedback; interface design

Perceptions of Errors (LS)

- student perceptions of low- (e.g., spelling) and high-level (e.g., argument) **writing errors**
  - effects on essay ratings and author ratings?
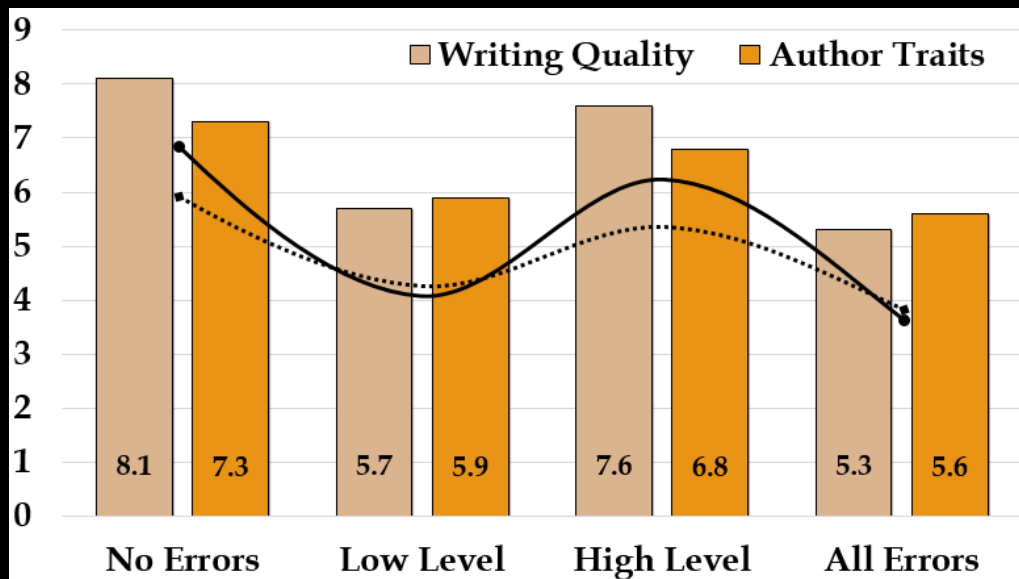
Findings:

- low level errors had stronger impact on ratings (1 to 10)

- affected judgments of text *and* author

- error detection bias

Multimedia Learning (LS)

- variations in **partial redundancy** of text and narration in multimedia materials
  - does overlap interact with reading skill?

Findings:

- students learned

- reading skill influenced learning overall

- no interaction with degree of overlap

- offers design flexibility

50% Overlap

26% Overlap

10% Overlap

Modeling Skilled Writing (CS)

- natural language processing (NLP) **modeling of successful writing styles**
  - can computers detect different "good" styles?

Findings: four distinct clusters or profiles based on patterns of automatically-detected linguistic features

Action/Depiction   Academic   Accessible   Lexical

Detecting Revisions (CS)

- many AWE systems assess the current draft but do not consider **draft-to-draft changes**
  - can we automatically detect revisions to guide improved feedback?

Findings:

- we can detect changes at a linguistic level

- frequent revisions not always aligned to productive revisions

Original Draft

Revised Draft
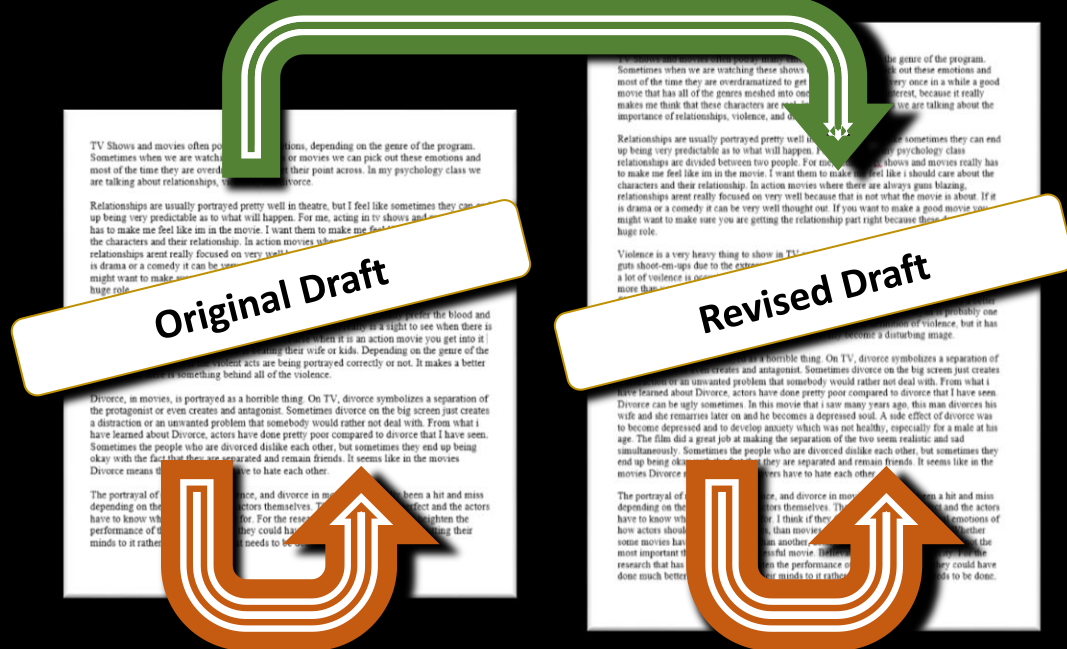
Classroom Feasibility (US)

- the Writing Pal tutoring system "version 1" was evaluated in **high school classrooms**
  - user perceptions guided W-Pal (re)design

Perceptions of Feedback (US)

- **skepticism** about capabilities of "automated" writing evaluation might lead to rejection
  - do perceptions of automated feedback influence revising within an AWE? (two studies)

Findings:

- mainly positive perceptions

- immediate perceptions did not affect revising

- perceptions over time did influence revising

- affected future intentions

Take-Home Message

- AWE development offers a wealth of research opportunities

- **AWE benefits from (and requires) inputs from multiple fields and backgrounds**
  - interdisciplinary, collaborative
  - not every contributor has to be an expert (or interested) in all facets of the problem
  - we may be solving slightly different but overlapping problems

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Take-Home Message

- in ed tech research and design, **boundaries between learning science, computer science, and user science can be very thin**
  - converging goals, multiple bottom lines
  - makes ed tech an exciting and flexible field

- many "**points of entry**" and opportunities to **develop and demonstrate powerful skills**
  - skills and innovations from educational technology work may transfer broadly

e.g., NLP and Chatbots

- the future of business, and connecting with customers and clients… via NLP chatbots

- Beaver, L. (2016, Sept.). Chatbots explained: Why businesses should be paying attention to the chatbot revolution. *Business Insider*.

- Peccolo, G. (2016, April). 5 reasons why your customer service should include chatbots. *CustomerThink.com*.

- Miller-Out, E. (2016, Sept.). How chatbots will help education. *VentureBeat.com*.

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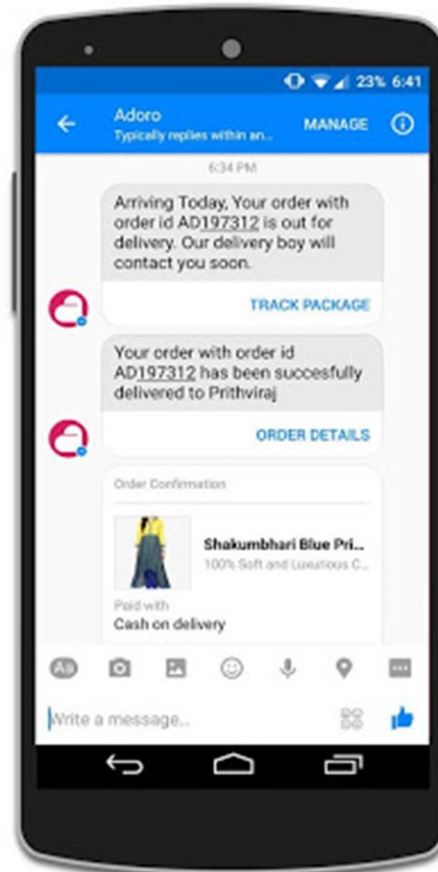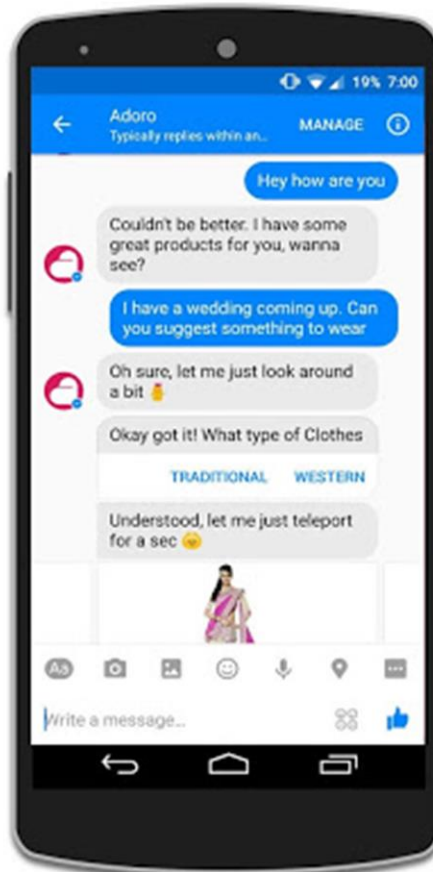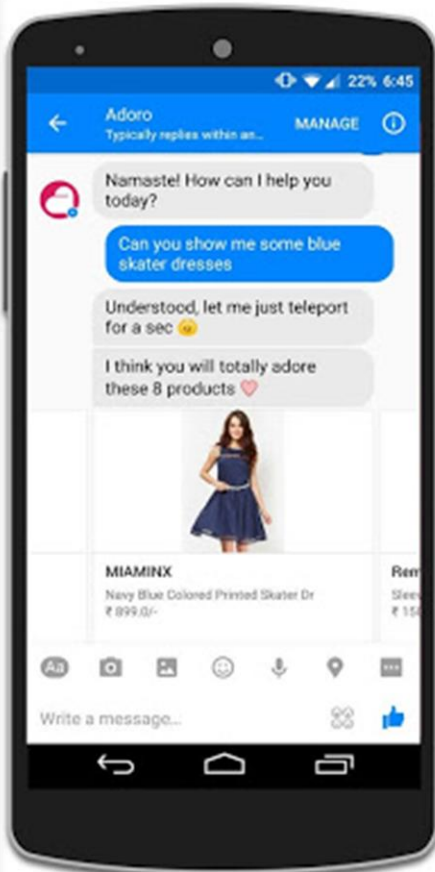
e.g., Data Analytics

- humans are generating *massive* amounts of commercial, personal, and institutional data
  - exploring new ways to analyze those data to improve/personalize experience is huge

- Olavsrud, T. (2016, Jan.). 21 data and analytics trends that will dominate 2016. *CIO.com*.

AIED/EDM Conferences

International Educational Data Mining Society

International Artificial Intelligence in Educational Society

Thank you!

Questions?

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Visit the new SLATE Lab website

References and Links

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Roscoe, R. D., Allen, L. K., Johnson, A. C., Mayra, C. R., Snow, E. L., & McNamara, D. S. (**under review**). High school student perceptions of automated writing evaluation. Submitted to *Educational Technology Research & Development*.

Roscoe, R. D., Jacovina, M. E., Harry, D., Russell, D., & McNamara, D. S. (**2015**). Partial verbal redundancy in multimedia presentations for writing strategy instruction. *Applied Cognitive Psychology*, *29*, 669-679.

Roscoe, R. D., Snow, E., Allen, L., & McNamara, D. S. (**2015**). Automated detection of essay revising patterns: applications for intelligent feedback in a writing tutor. *Technology, Instruction, Cognition, and Learning*, *10*, 59-79.

Roscoe, R. D., Varner, L., Weston, J., Crossley, S., & McNamara, D.S. (**2014**). The Writing Pal Intelligent Tutoring System: usability testing and development. *Computers and Composition, 34*, 39-59.

Roscoe, R. D., Wilson, J., Johnson, A. C., & Mayra, C. R. (**under review**). Presentation, expectations, and experience: Sources of student perceptions of automated writing evaluation. Submitted to *Computers in Human Behavior*.