



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?



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

Ed Tech Trends

The logo for EdTech, featuring the word "Ed" in white and "Tech" in red on a red background.The logo for eLearning Industry, featuring a stylized tree icon and the text "eLearning INDUSTRY" in blue and orange.The logo for EdSurge, featuring a lightning bolt icon and the text "EdSurge" in white on a green background.The logo for Teach HUB.com, featuring the word "Teach" in black and "HUB.com" in red.

- 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



Recommended Lesson
Pronoun Agreement
Category: Sentence Structure

Time: 6 minutes Level: Intermediate

Pronouns and nouns must "agree"—and that doesn't mean be nice to each other. Pronouns must represent the gender and number of the nouns they replace. This lesson provides examples and exercises to help you avoid the confusion that results when pronouns and nouns don't get along.

More recommended lessons 1/14



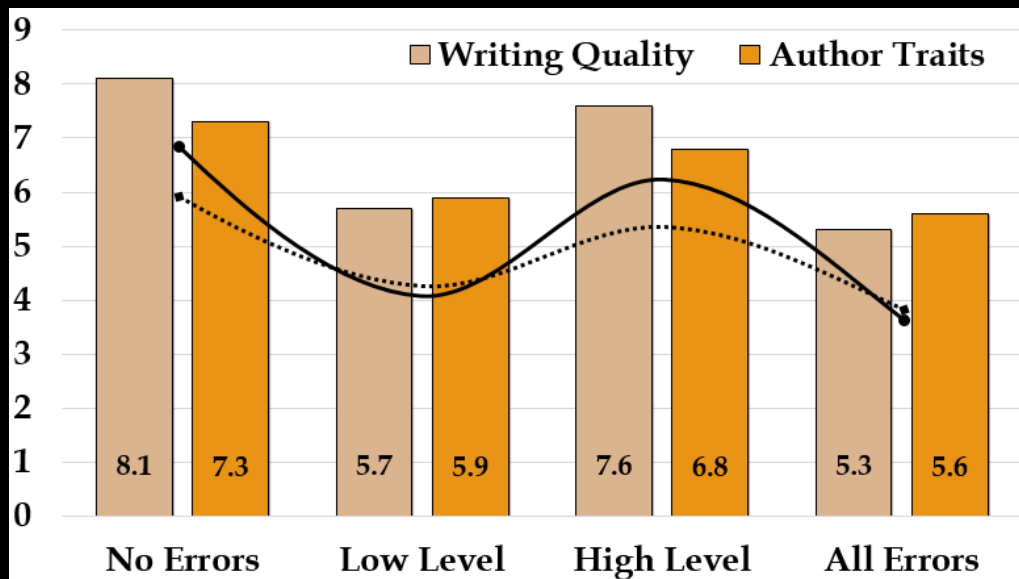


Interdisciplinary AWE Research

- **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

The figure displays three screenshots of a multimedia learning interface, each showing a character in a green suit standing next to a white box containing text about connectives. The interface includes a window background and a chain with a padlock icon.

50% Overlap: The left and right slides share the first two bullet points: "- connectives are special words and phrases that show your reader how your ideas are connected, they show links..." and "- between ideas within a sentence".

26% Overlap: The left and right slides share the first three bullet points: "- connectives are special words and phrases that show your reader how your ideas are connected, they show links...", "- between ideas within a sentence", and "- between different sentences".

10% Overlap: The left and right slides share only the first bullet point: "- connectives are special words and phrases that show your reader how your ideas are connected, they show links...".

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



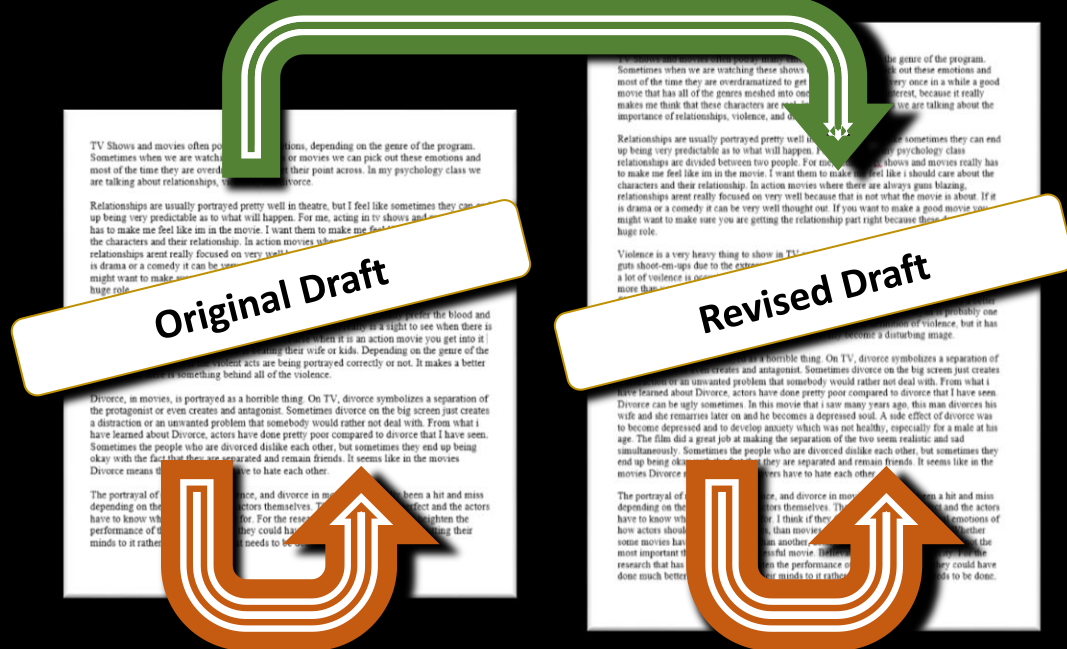
Lexical

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



Classroom Feasibility (US)

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

Introduction Building
Three requirements for every introduction:
T A G
T = Thesis statement
A = Arguments
G = Grab the reader's attention

You want your introduction to be interesting, so that the reader will want to keep reading.

Make a C.A.S.E. for it!
- begin each paragraph with a **CONCISE ARGUMENT**... also called a "topic sentence"
- convince your reader by providing as much **SUPPORTING EVIDENCE** as possible

Evaluation and Comparison Claims
- arguments about relative value or worth
"Reading a book is often **more educational** than watching television."

Types of Persuasive Evidence
- examples
- data (numbers, dates)
- explanations
- all of your evidence must be **factual**
- try to combine several types of evidence

Caution: Not Enough Evidence!
- even a good argument must be backed up with ample supporting evidence
- one example or piece of information may not be enough to get your point across
Elaborate the Paragraph
- add more details
- add more explanation
- add more examples
- stay on topic

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

ESSAY WRITING FEEDBACK REPORT: 90a56c93-5167-40a8-9119-ccc23a015193

POOR WEAK **FAIR** OKAY GOOD GREAT

LENGTH: Acceptable
RELEVANCE: Acceptable
STRUCTURE: Acceptable

BODY BUILDING

Strong body paragraphs begin with topic sentences that state the argument to be discussed in the rest of the paragraph. One way to ensure that your arguments are clearly presented is through the use of topic sentences.

- Write clear, straightforward topic sentences that directly related to the prompt
- Write topic sentences that can be supported by facts and evidence
- Avoid using personal opinions and speculations (e.g., "I think," "I believe") in the topic sentence, because they cannot be refuted

For further help, watch the Body Building Lesson: Topic Sentences.

BODY BUILDING

Persuasive essays consist of multiple body paragraphs that make individual claims. One way to ensure each paragraph has a strong argument might be to add clear and concise topic sentences.

- Do your paragraphs begin with independent argument sentences that can be debated?
- Are your arguments based on facts and evidence?
- Make sure your topic sentences are clear and concise to avoid confusion!

For more information on topic sentences watch the Body Building Lesson: Topic Sentences!

CONCLUSION BUILDING

An effective conclusion ties together all of the ideas presented in the body paragraphs of the essay. One way to improve your essay is to make sure that your conclusion does not contain any new information.

- Be sure to reread your conclusion to make sure that you have not included any new information

More feedback on this issue Feedback on a Different Issue Save Feedback and Exit



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



Take-Home Message

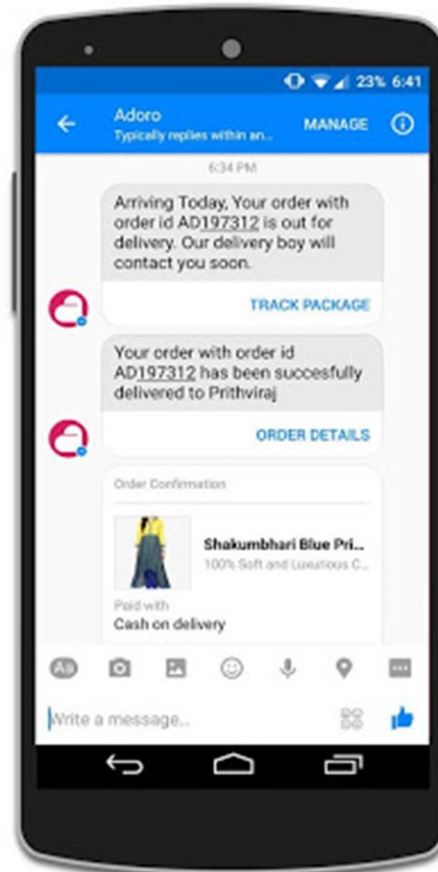
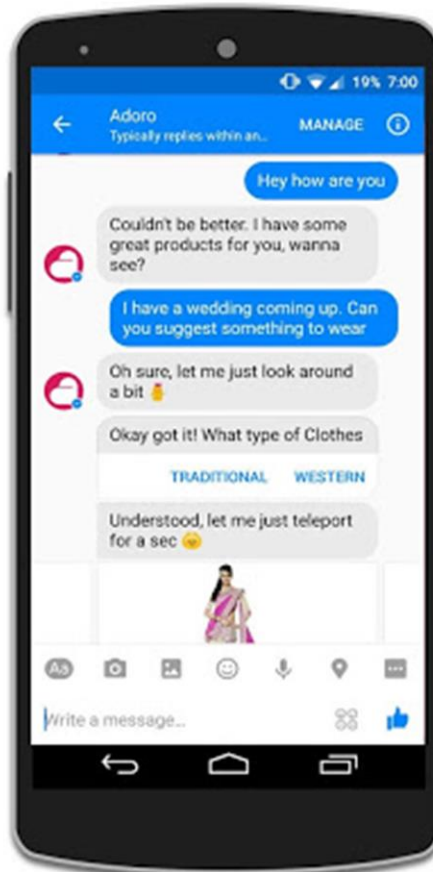
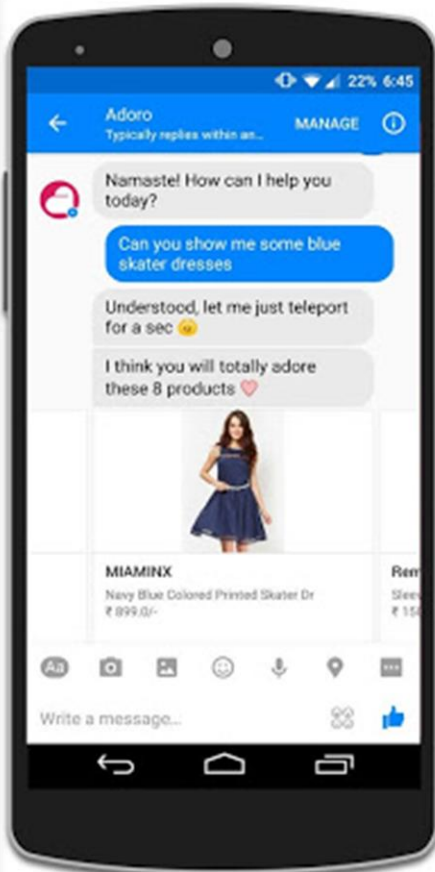
- in ed tech research and design, **boundaries between learning science, computer science, and user science can be very thin**
 - converging goals, multiple bottom lines
 - makes ed tech an exciting and flexible field
- many “**points of entry**” and opportunities to **develop and demonstrate powerful 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*.

e.g., NLP and Chatbots





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*.



Thank you!

Questions?

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Visit the new [SLATE Lab](#) website



References and Links

- Crossley, S. A., Roscoe, R. D., & McNamara, D. S. ([2014](#)). What is successful writing? An investigation into the multiple ways writers can write successful essays. *Written Communication*, 31, 184-215. (2014 John R. Hayes Award)
- 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*.