Supporting Science Learning and Teaching in Middle School Classrooms through Automated Analysis of Students’ Writing

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Goals and Objectives

- Develop NLP technology (PyrEval) to provide students and teachers with real-time feedback about students’ written explanations to:
- Help students reflect on quality of their scientific explanations and foster ability to use evidence; and
- Provide teachers with aggregated and individual information about students’ explanation writing so they can better scaffold students’ science learning

Research Questions

1. How does feedback from PyrEval affect the quality of students’ written scientific explanations?
2. How do teachers use the automated assessments and summaries of students’ explanations during instruction?
3. In what ways does scaffolding from the auto-coder and teacher feedback support students’ explanations writing and learning?

Digital Science Notebook

1. Support for Student Writing
   - Scaffolding for design and scientific writing
   - Automated integration of experiment data from the roller coaster simulation
   - NLP feedback on student writing
2. Support for Teacher Scaffolding
   - Monitor students’ progress through design and writing
   - Track iterative design history of student experiments
   - Use NLP summaries to show a map of common and/or persistent (mis)understandings and explanations
3. Support for Management
   - Deliver notifications to class, groups, or individual students
   - Export data needed to answer research questions
   - Provide support for classroom management

Automated Analysis of Student Writing

1. Short Answers - SFRN: Semantic Feature-wise Relation Network
   - BERT encodes Q(uestion)-R(efERENCE)-A(nswer) into 3 vectors
   - RNs learn vector abstractions over tuples of vectors, e.g. QRA triples
   - Up to 11% performance gain over SOTA on benchmarks
2. Essays - PyrEval: Wise crowd content evaluation
   - WTMF: phrase vectors for reference essays and student essays
   - EDUa: set partition algorithm finds optimal sets of vectors in reference essays, producing weighted content units
   - WMIN: independent set algorithm matches student text to weighted content units

Plans for Year 2

- Revise digital notebook and wise-crowd model based on feedback from advisory board and middle school science teachers
- Test iteration 1 with two science teachers (200 students) to examine (a) how the automated assessment and feedback (b) how teachers use the automated aggregate summaries

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