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Automated Writing Evaluation & the Literacy Challenge:

Tools for Supporting & Understanding Postsecondary Writers

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Discussion

Social Challenge: Improve Literacy!

- Low literacy affects critical practical and social aspects of social participation
  - Employability
  - Social factors: Self-esteem & self-confidence
  - Health
- Global issue

Body of Knowledge: NLP & Literacy Support

- History
- State-of-the-art

Motivation: How Can Innovative NLP Contribute to Improving Literacy?

- Writing Mentor™ application, Google Docs Add-on
- NLP, Writing Analytics, and Success Indicators

Evidence of Global Literacy Challenge

U.S. K12

- *NCES Nation's Report Card (2011)*
  - **73%**% -- *Below Basic* (21%) or *Basic* (52%) Proficiency in 12th Grade (2011)

U.S. 4-year post-secondary institutions (Complete College America, 2012)

- More than 20% placed in developmental courses
- 1/3 or fewer of students in remediation graduate in 6 years

***European Union**: (EU Commission "High Level Group Report ", 2012)*

- "One in five 15-year-olds in the EU still has insufficient reading skills." (PISA 2012 findings)
- "In 2011, across Europe ~73M low-educated adults …many of whom …have literacy problems .."

Literacy Challenge Factors & Education Policy in U.S.

In K-12

- ELL populations
  - In 2013-14
    - ~4.5M ELLs enrolled in K12
    - 9.3% participating in ELL programs
- Under Common Core State Standards, **content-area teachers** support reading, writing & language skills

In 2- & 4-year postsecondary institutions

- Roughly *18 million students enrolled* in postsecondary education
- About *1.7M lack prerequisite skills* to complete college
- Projected enrollment increases over the next 10 years

NLP & Social Challenges

Biomedical Informatics

Author profiling in health forum analysis

Mental Health/Clinical Psych

Violence risk, suicide assessment from text

Negative Societal Issues

Analysis of web ads soliciting sex

"Bad Policing"

Education

Automated writing evaluation for instruction & assessment

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How can NLP support the literacy challenge? History, Status Quo, and What's New

Project Essay Grade (PEG) (Page, 1966) for essay scoring for classroom writing assignments

- Transformation of essay length
- Some syntactic analysis

Writer's Workbench (Cherry et al, 1982) for editing support

- Editing tool for students
- Diction, style, spelling
- Detection of topic sentences (discourse)

Intelligent Essay Assessor™ (Landauer, et al 1998) for large-scale high-stakes exams

- Vocabulary usage (Latent Semantic Analy
- Style, mechanics measures

E-rater® (Burstein et al, 1998; Attali & Burstein, 2006) for large-scale high-stakes exams

- Vocabulary usage
- English conventions
- Discourse, argument structure & coherence
- Sentence complexity

A lot has happened since the 90's

Reading

- **Readability measures**: 1) Flesch-Kincaid to compute document readability in MS Office's MS Word, 2) Lexile® is used to assign textbook readability by large publishers (such as, McGraw-Hill Education)
- **Language and reading skills development** with automated item generation: *Language Muse*™ Activity Palette, (ETS)

Writing

- **Automated Writing Evaluation (AWE) feedback:** *Criterion*® (ETS), *Writing Mentor* (ETS), Write-to-Learn™(Pearson), Turnitin® Revision Assistant, Grammarly®
- **Peer Review:** SWoRD: MyReviewers, Turnitin Feedback Studio

Speaking

- Automated scoring of spontaneous speech: ETS' SpeechRater™
- Automated evaluation of multimodal input (e.g., video for interviews)
- Automated evaluation of speech for reading apps

AWE & the Literacy Challenge

Automated writing evaluation

- Writing Mentor app, *free* Google Docs Add-on
- Writing analytics to examine college success

Some ETS history

E-RATER

E-rater®

NLP methods used to detect 50+ linguistic features

Features aggregated into 10-12 high-level features aligned with the human *holistic* scoring criteria (typically 4 – 6 point scale)

Each feature is represented by a module

- Rule-based: collection of manual rules and/or regular expressions
- Statistical: Statistical models compute feature values

Feature modeling with multiple regression

Linear equation with feature weights yields final score

E-rater Facts & Use Cases

Evaluates *expository, argumentative, & source-based essay writing*

Used for high-stakes assessment since 1999

Scores about 16M submissions yearly

High-stakes assessment

- Test-takers: Supports multiple writing measure types
- Adminstrators: Acceptance decisions

Classroom Instruction: *Criterion*®

- Students: support for writing quality
- Educators: supplemental grading support with scores & feedback
- Available with institutional subscription only

Next-Generation Writing Feedback

U.S. Literacy Challenge in Postsecondary Contexts

- 1.7 of 18 million college students lacking prerequisite skills
- Disjuncture in writing requirements from K12 to postsecondary (Bridgeman & Carlson, 1984; Melzer, 2014; Burstein et al, 2016)

Growing Body of Evidence that AWE feedback helps

- Attali (2004), Shermis et al (2004) showed increased production with *Criterion* use
- Chapelle et al (2015): relationship between correct *Criterion* error feedback & improved revisions
- Cassidy et al (2016) :positive teacher perceptions of feedback utility

Wider accessibility & construct coverage needed

- *Criterion* accessible only through institutional subscriptions
- Grammarly version is "free" and accessible, but limited to English Conventions

Motivation

27% of U.S. 12th graders scored at or above "proficient" on the NAEP writing assessment (U.S. DoE, IES, & NCES, 2012)

Burstein et al (2016): Two college faculty surveys

- Collect perceptions of student writing competencies
- Inform AWE development
- Findings: Perceive a general lack of writing preparedness

How can an NLP solution provide convenient & relevant support?

The Writing Mentor™ app – a Google Docs Add-on

See video:

https://mentormywriting.org

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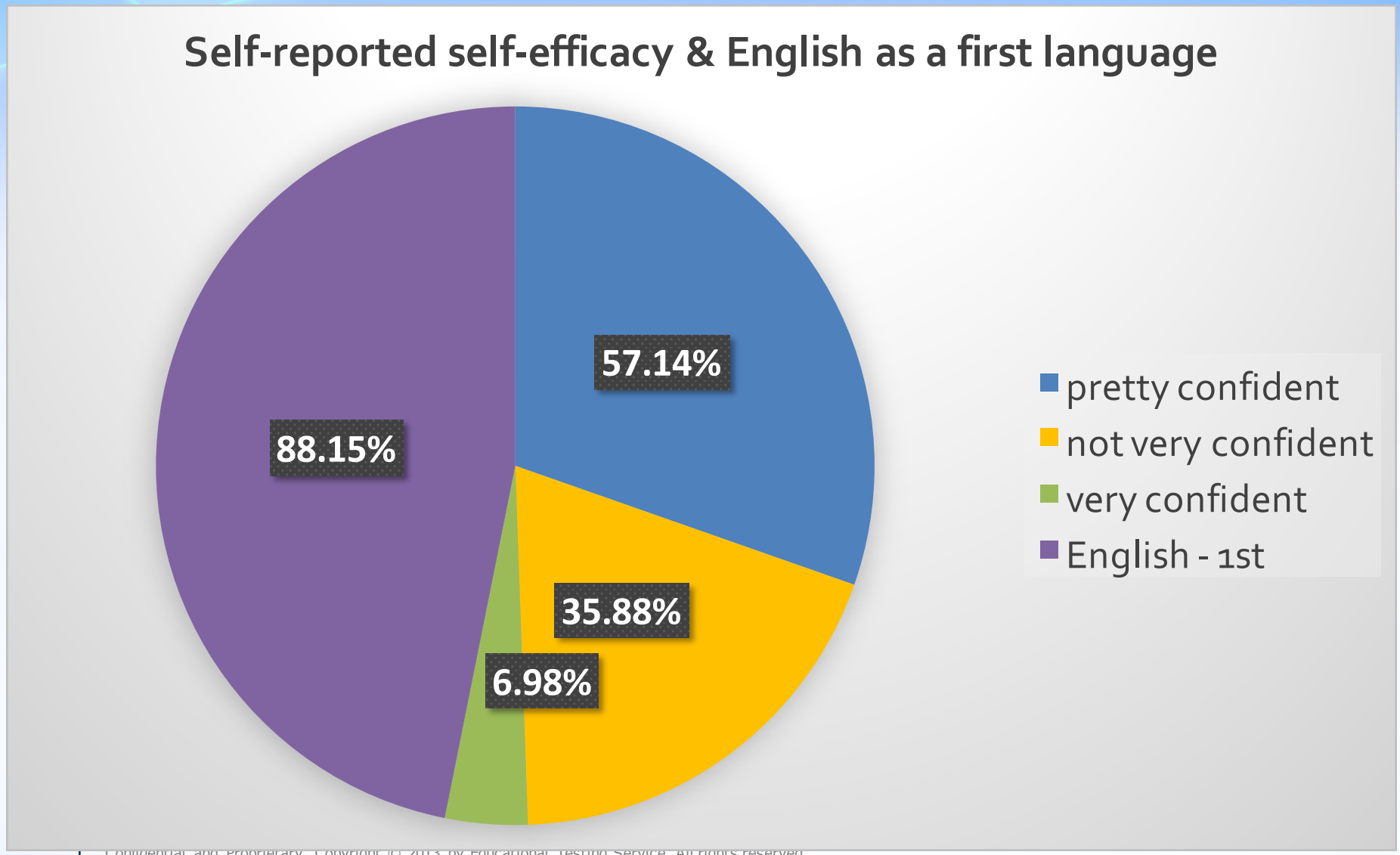
The Writing Mentor ™ app 'Early Use' Data

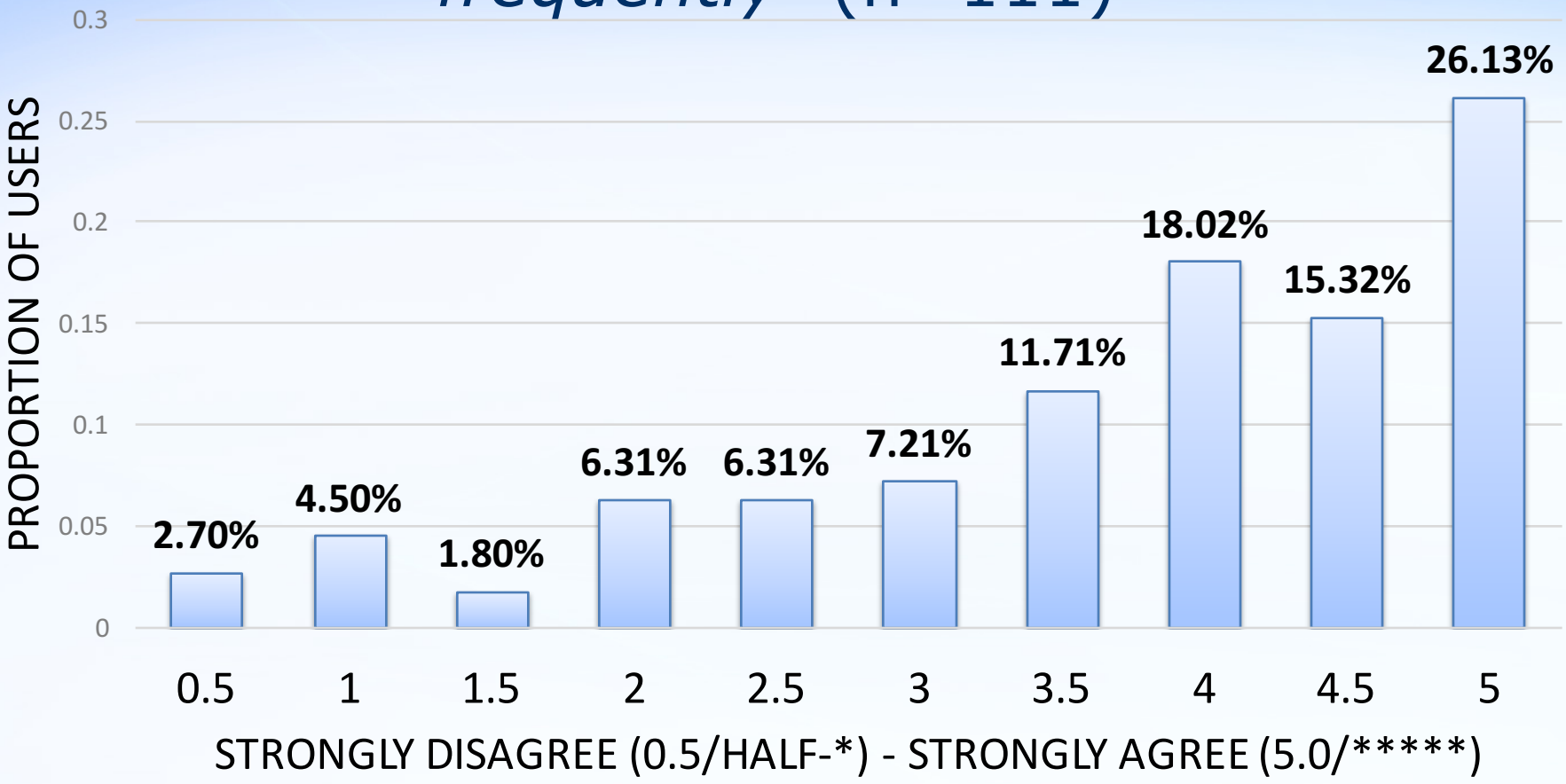
WHO ARE WRITING MENTOR USERS?

Entry Survey (n=617)



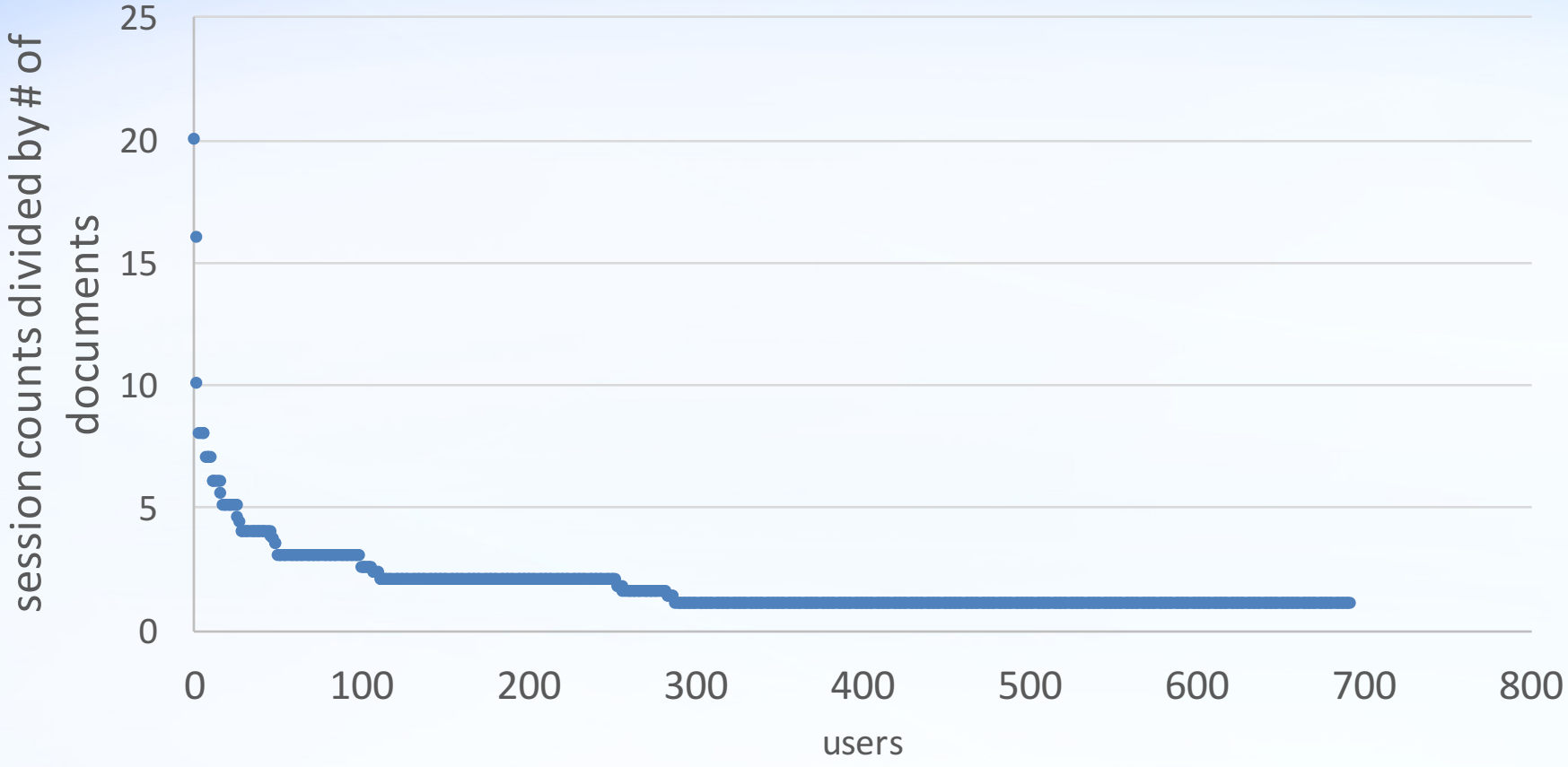
WHAT ARE USER PERCEPTIONS?

Exit Survey: "*I would use Writing Mentor frequently*" (n=111)

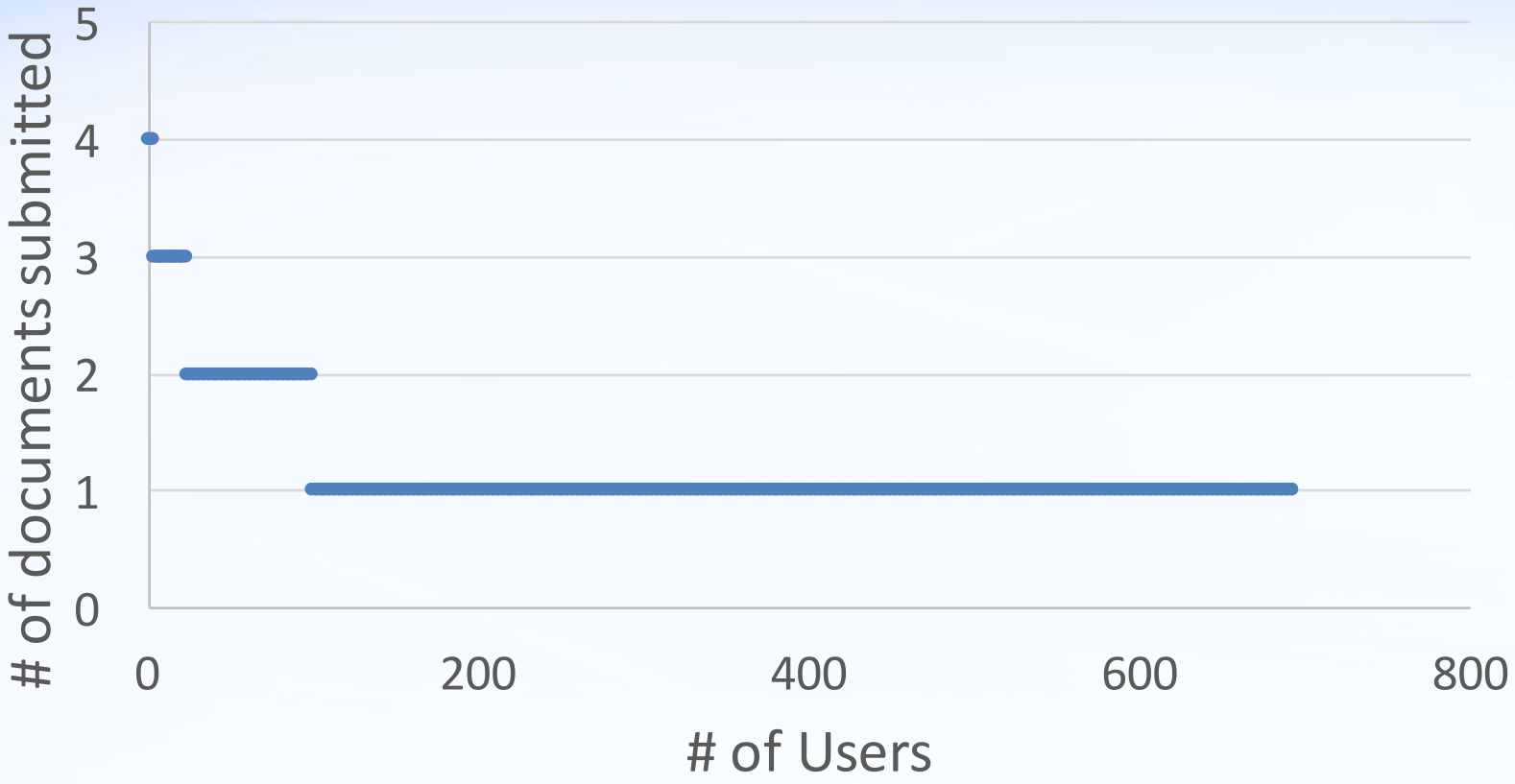


HOW ARE USERS ENGAGING WITH THE WRITING MENTOR APP?

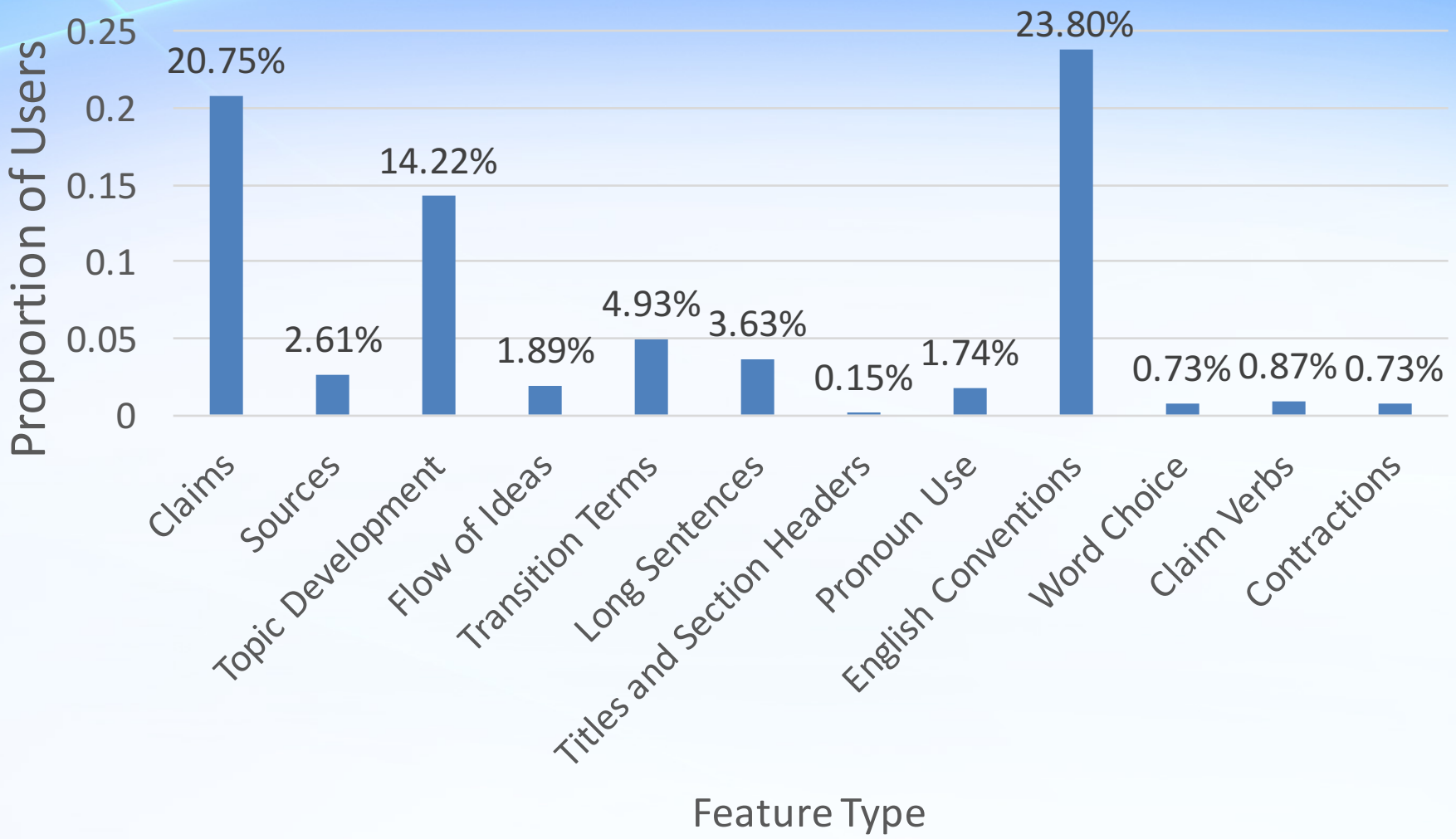
Session counts: Rate that users return to work on a documents (n=693)



No. of different documents submitted by a single user (n=693)

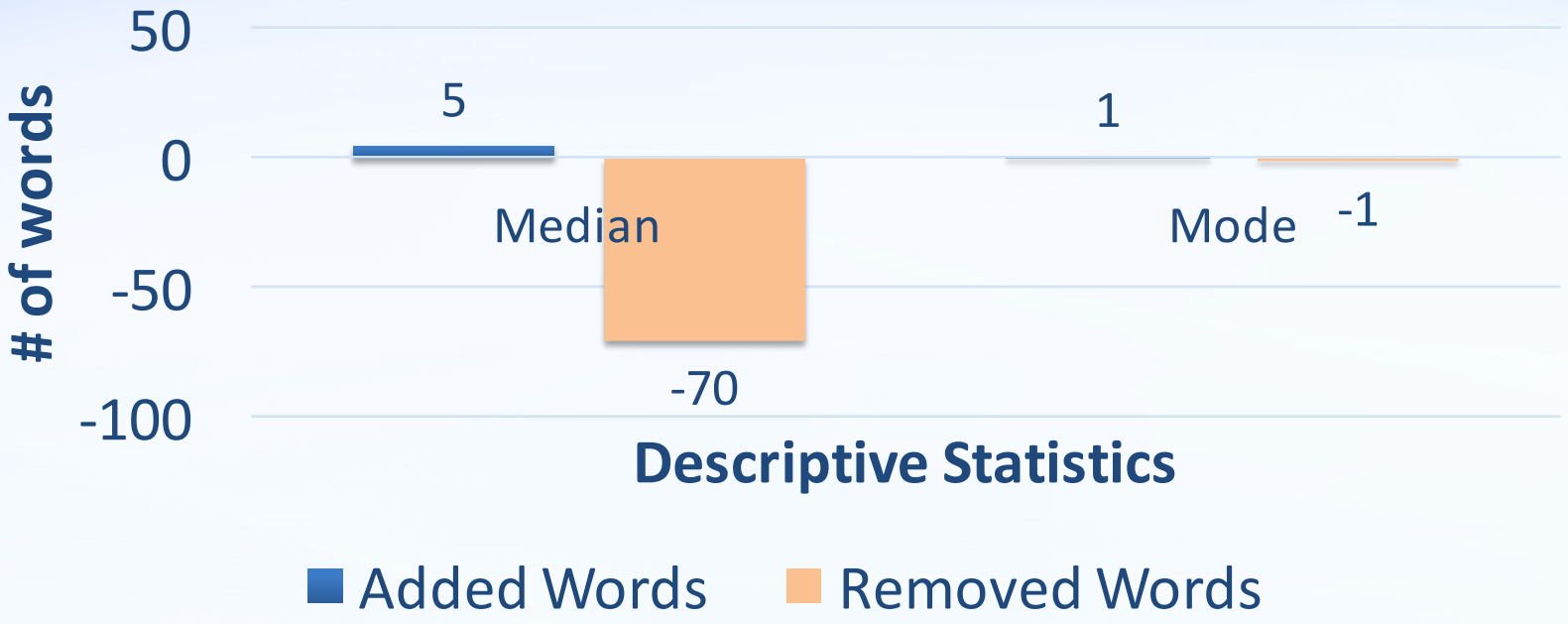


Most frequent feature event (n=693)



WHAT'S CHANGED?

Median and Mode: Added or Removed Words from first to final document across all 914 documents



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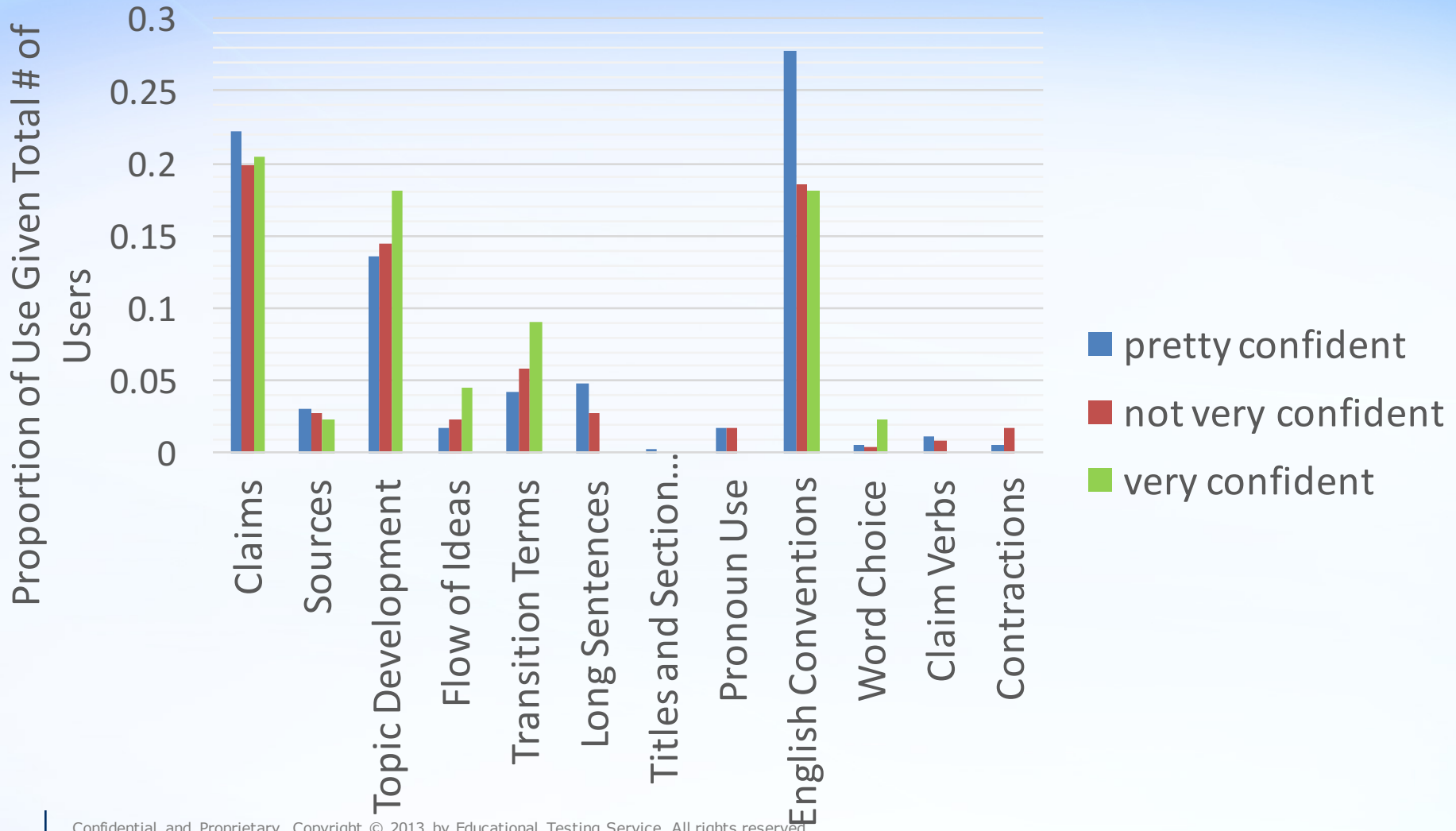
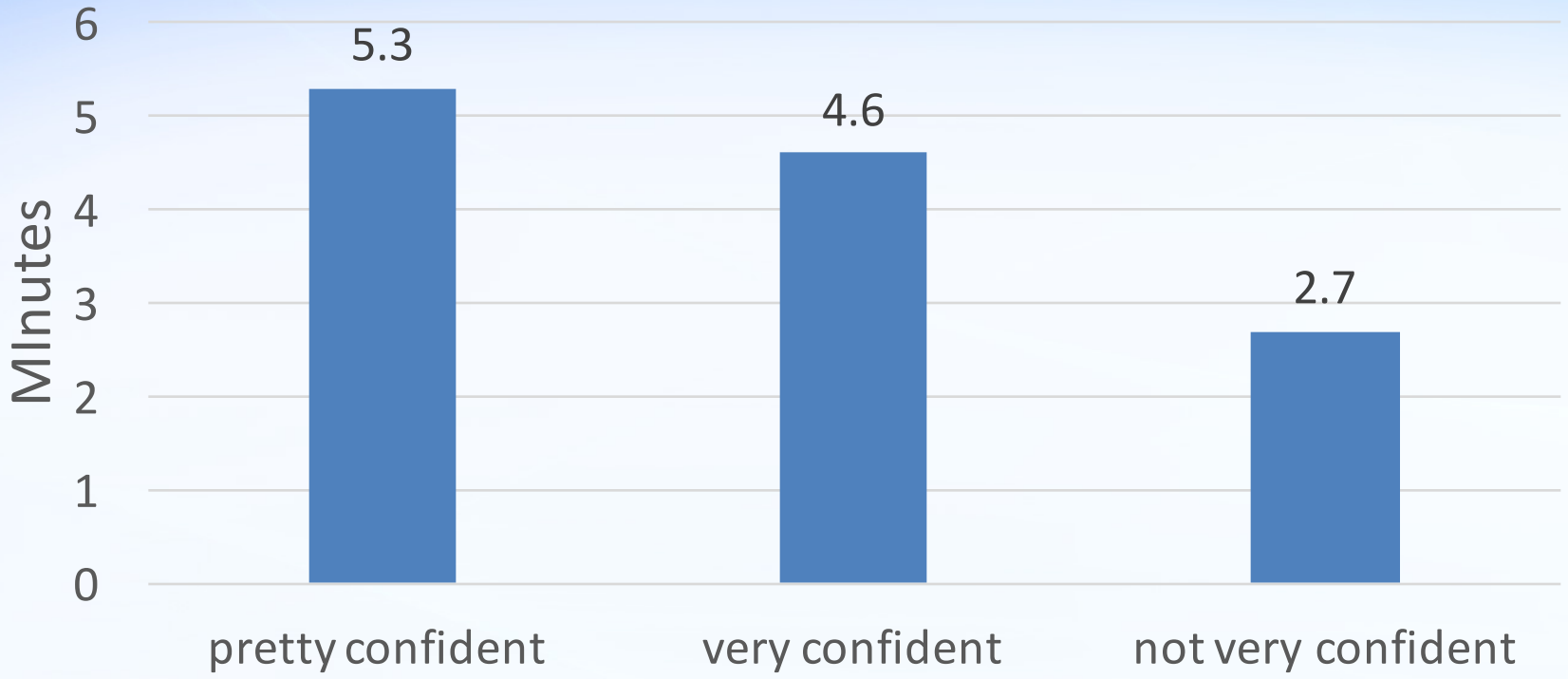
SELF-EFFICACY AND TOOL ENGAGEMENT

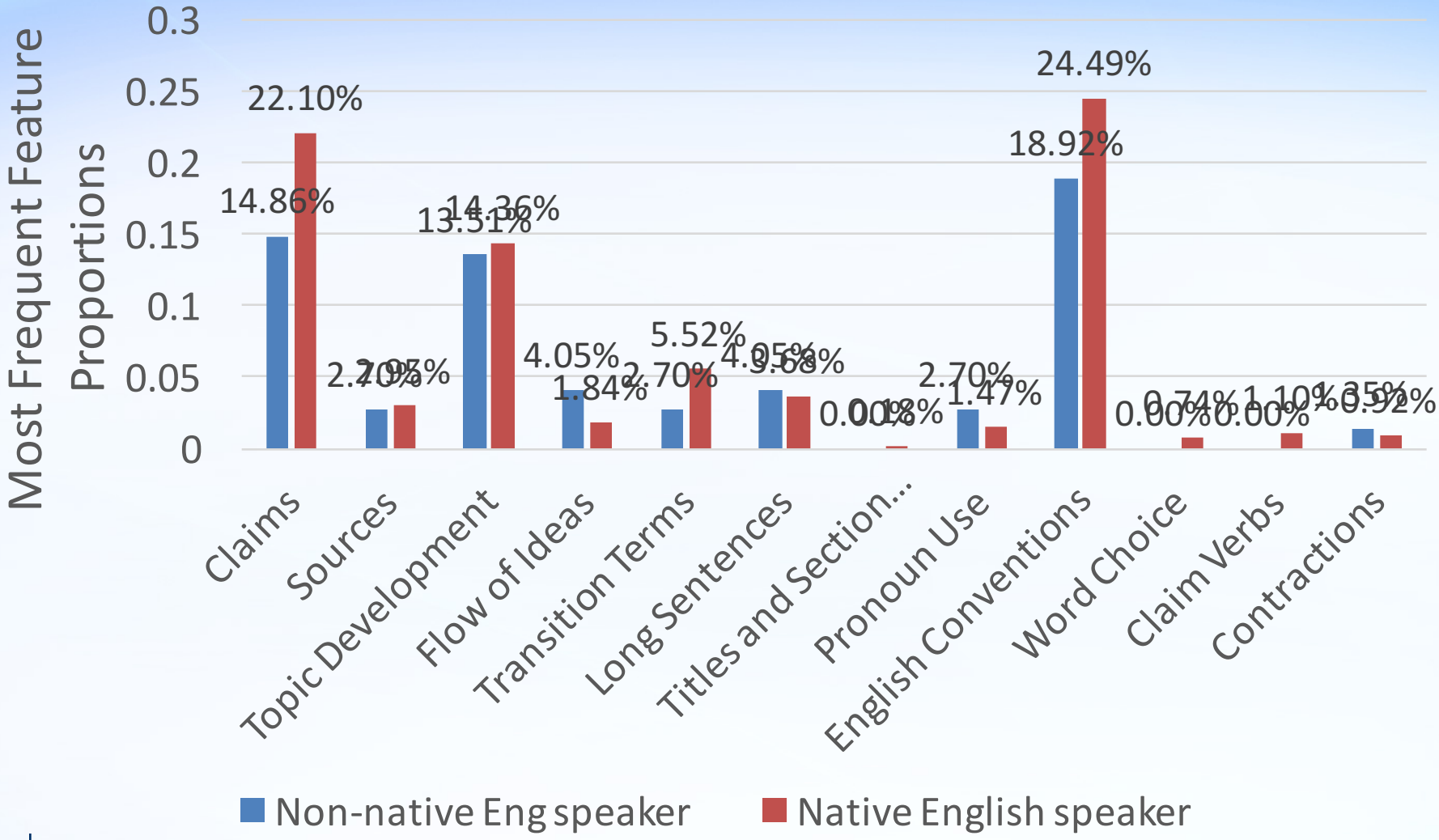
Preferred feature events by self-efficacy (n=617)



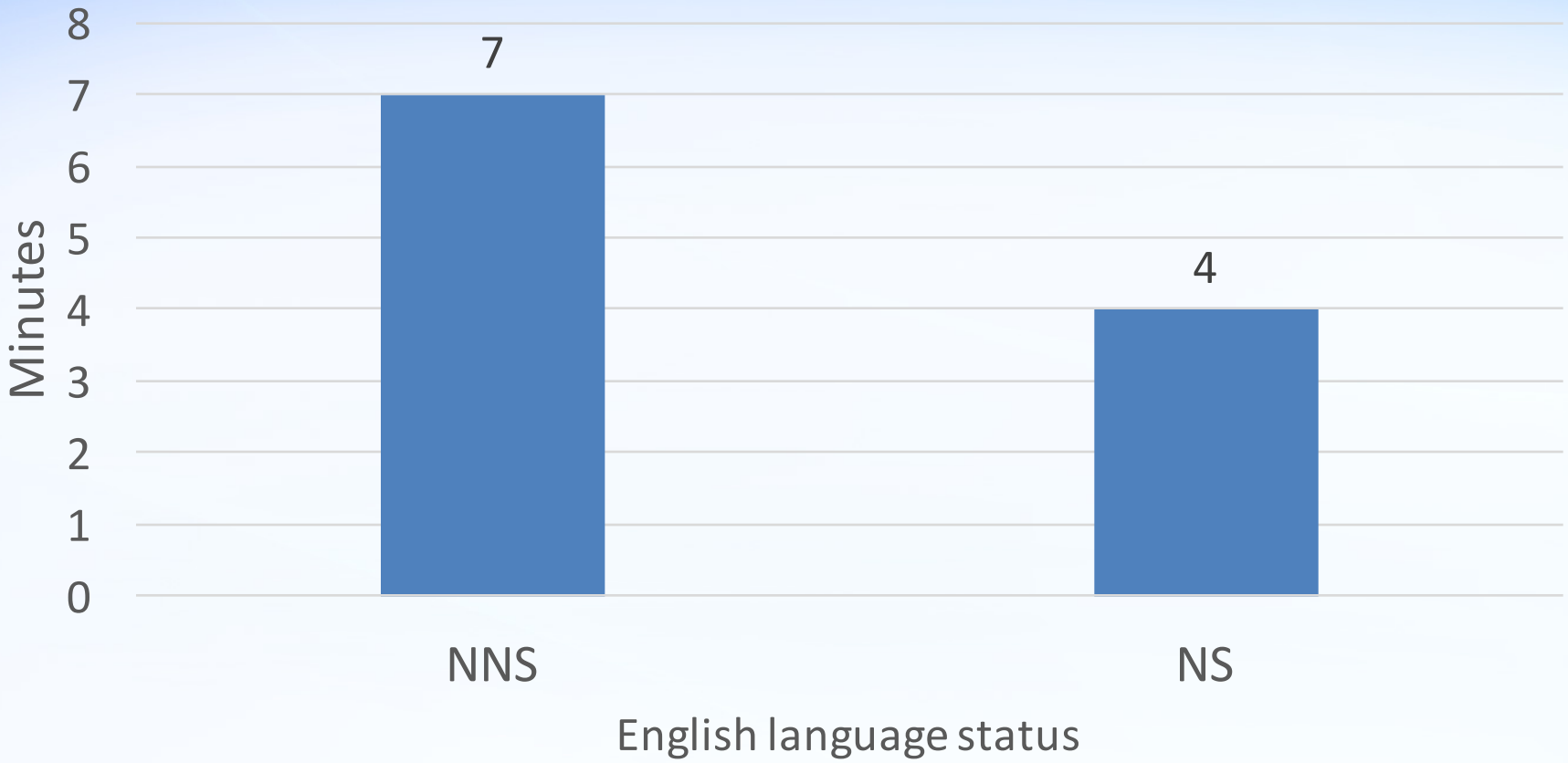
Average time spent (mins) on preferred feature event by self-efficacy (n=617)



Preferred feature events by English language status (n=617; 74 NNS + 543 NS)



Average time (mins) spent on preferred feature event by English language status (n=617)



Some User Wishes …

Interface	Usability	Feature Enhancements	New Feature Suggestions
a better proportioined interface. The add-on scales a bit oddly on my monitor. I had to use sliders to position the interface properly.	I loved the writing mentor I though it worked well I just wish I had more experience in writing to actually use the advice better.	a better understanding of run ons. There were lines in my writing that I dont believe to be run ons.	more active walkthroughs to help make changes instead of just highlighting problems.
A clear word count and easy high contrast text.	Easier navigation - full screen instead of a smaller window/frame, and funtion/menu tabs across the top, as in a word processing program rather than on the right side.	recommended words to use for the sentences as a correction	more interactive comments.
A little larger screen area		More suggestions for pronouns	could write my paper for me
A slightly easier-to-follow flow. The "Done" button generally brings you back to the next session, except under "Review Topic Development."		correction of citations	Shown me examples
		spelling helping	I wish it had personalized comments and feedback.
		more humor	A way to check for a conclusion

Future Work: Spring 2018 Usability Study

- Post-secondary & Adult literacy settings
  - Integrate tool use into instruction
  - Collect student-user data
  - Evaluate usability: what do users use?
  - Examine utility: how does writing change?

Writing Mentor Team

- **ETS Research Team**: Jill Burstein, Nitin Madnani & Beata Beigman Klebanov
- **Research Consultant:** Norbert Elliot (USF)
- **ETS Engineers**: Diane Napolitano & Maxwell Schwartz
- **Front-End Development**: 10clouds.com

Exploring Writing Achievement and Its Role in Success at 4-Year Postsecondary Institutions Funded by U.S. Department of Education, IES (Co-PI, Dan McCaffrey, ETS) "WAVES Study"

What can we learn about student success from writing features?

Significance

- Writing is a challenge, esp. for at-risk students w/o prerequisite writing skills required to persist in U.S. 4-year postsecondary institutions.
- Educators could benefit from a clearer understanding of writing achievement and its role in postsecondary success

Solution

- AWE allows processing and generation of linguistic features for large-scale data sets
- Writing-based linguistic & skill relationships can inform actionable analytics for students, educators, parents and policy-makers

Impact

- AWE features may provide meaningful information about student success predictors
- AWE has potential for educational analytics beyond assessment and instruction

4-year Exploratory Study

- **Year 1: Secondary data analysis with writing assessment data collected from college students to examine writing features & success predictors**
- Year 2: Collect *authentic* student writing data, writing assessment data, & writing attitudes survey data from students enrolled in 4-year institutions to examine writing features, writing attitudes, & success predictors
- Years 3-4: Examine relationships between student writing data and longitudinal success factors (e.g., continued enrollment)

Study Overview

Exploratory, secondary data analysis to examine relationships between responses to an on-demand essay writing task & broader success predictors.

Data

Writing: Essay assessment responses from 929 students from 22 4-year institutions.

Success predictors: Critical thinking assessment scores, SAT/ACT college admissions composite & subject scores & GPA.

Methods

26/200+ AWE features (English conventions, Coherence, Organization, Vocabulary Usage) selected using statistical evaluations, e.g., eliminate highly correlated features.

Regression analyses conducted to predict 6 success indicators. Independent variables:feature+length+human score.

Results

AWE features emerged across sub-constructs as predictors for all 6 indicators: (1) critical thinking assessment score, (2) writing assessment selected response, (3,4) SAT/ACT composite scores, (5,6) SAT/ACT subject area scores, (7) college GPA.

Example: SAT Verbal Score

Variable Construct	Coefficient	Std. Error	R^2	Inc. R^2
grammar	0.11	0.04	0.18	0.01
word usage	0.14	0.04	0.18	0.02
mechanics	0.15	0.04	0.18	0.02
sentence variety	0.29	0.06	0.21	0.04
vocabulary sophistication	0.15	0.04	0.19	0.02
vocabulary complexity	***0.29***	***0.04***	***0.24***	***0.07***
word usage	0.12	0.05	0.18	0.01
argumentation	0.13	0.05	0.18	0.01
personal reflection essays	-0.15	0.04	0.19	0.02
phrasal variety	0.11	0.05	0.17	0.01
derivational morphology	0.13	0.05	0.18	0.01
infllectional morphology	0.22	0.05	0.20	0.04
vocabulary richness	***0.33***	***0.05***	***0.23***	***0.07***
coherence	0.28	0.13	0.17	0.01
sentiment	0.12	0.04	0.18	0.01

Current Study Underway

- *Amidst* Year 2: Collect *authentic* student writing data, writing assessment data, & writing attitudes survey data from students enrolled in 6 4-year institutions to examine writing features, writing attitudes, & success predictors
- Conduct similar analyses, but will have *authentic* student writing data and self-efficacy and beliefs responses!!

IES WAVES Team

Research Team: D. McCaffrey (Co-PI), Beata Beigman Klebanov, Nitin Madnani, & Guangming Ling

Engineers: Diane Napolitano & Binod Gyawali

NLP & the Literacy Challenge

Accessible NLP solutions to bump up low literacy in reading and writing

- Writing instruction: The *Writing Mentor*
- Potential educational analytics beyond assessment and instruction

More NLP-Literacy solutions in more domains

- Language Muse® automated activity generation for reading
- Peer review systems
- Automated evaluation of speech (e.g., reading apps)
- Multimodal (spoken dialog & video): workforce interviewing tools

BEA 13 Workshop

- Innovative Use of NLP for Building Educational Applications @ NAACL 2018 in New Orleans in June 2018

- https://www.cs.rochester.edu/~tetreaul/naacl-bea13.html

Thanks! & Questions?