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The *Language Muse™ Activity Palette*: NLP-guided Curriculum Support for English Language Learners

Jill Burstein
Educational Testing Service

Joint workshop on NLP for Computer-Assisted Language Learning & NLP for Language Acquisition
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- ETS Research Team: S. Andreyev, Kietha Biggers, Kelsey Drier, Nitin Madnani, Dan McCaffrey & John Sabatini

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Today's Discussion

- Motivation for language technology to support classroom teachers
- *Language Muse™ Activity Palette ("the Palette")*
  - Pedagogical alignment
  - Demo
- Small-Sale Pilot Instructional Intervention Study
- Future Work: Large-Scale Instructional Intervention Pilot Study
- Take-away: Contributions and Potential of NLP for Educational Technology = Impactful NLP

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Motivation: U.S. K12 Literacy Issues

- English language learner (ELL) population
  - 4.5M ELLs enrolled in K12
  - 9.3% participating in ELL programs
- Common Core State Standards
  - Students required to understand increasingly more complex text with difficult English constructions
    - *Figurative language, complex sentences, discourse relations*
- Content-area teachers support reading, writing & language skills

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Similar Literacy Issues in Europe

- **European Literacy Policy Network (ELINET)**
  - Collaboration between researchers, practitioners, professionals and volunteers in 28 countries
  - "*In Europe one in five 15-year-olds … lack basic literacy skills*."
  - **"**Framework of Good Practice"
    - Children, Adolescents, and Adults
    - Focus on reading and writing
  - The Netherlands' "Reading and Writing Foundation"
    - "*Healthier Through Literacy*"
- **Common European Framework for Language Learning, Teaching, and Assessment**
  - 6 levels of proficiency and related assessments
    - Learning a foreign language for residents / promote multilingualism
  - Refugee foreign language learning

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NLP Technology Solution

- Provide classroom activities centered around linguistic elements in content-area texts
- *The Palette*, a web-based tool
  - Various NLP algorithms used to automatically generate customizable language activities
  - Activities generated are grounded in language learning research

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The *Language Muse Activity Palette* "*The Palette*": Reading & Language Skills Development

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"The *Palette*" Motivation & Pedagogy

- Motivation
  - U.S. K12 classrooms can high % of English learners (ELs)
  - Content-area teachers are responsible for EL learning, but not sufficiently trained in reading or language learning
- Pedagogy-informed
  - Leverages empirical findings from 2nd language learning literature
  - Collects practitioner/educator knowledge to inform language activity types/design

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The *Palette*: How it works

- Relies on **NLP backend** to identify different linguistic features (lexical entities, syntactic structures, rhetorical & discourse relations.)
- Upload classroom texts → Generate activities for various aspects of content comprehension: vocabulary, grammatical structures, and discourse & text organization
- Administers activities to students
- Provides automated scoring and analytics for teachers based on student work

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ELL Difficulties Informed Palette Activities

- Vocabulary: lack of familarity with academic vocabulary, morphology, unfamilar words
- Sentence-Based: complex sentences
- Phrase-Based: complex phrasal structures (NPs, VPs, PPs)
- Discourse-Based: discourse term meaning/function in text

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NLP, Lexical Resources & Activity Types

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Lexical Activity	NLP/ Lexical Resources
Academic Words	Coxhead (2000) Academic Word List + WordNik API to **generate definitions** (https://www.wordnik.com/)
Key Concepts	Heuristic to **identify frequent "key" words** across paragraphs
Multiword Expressions	Rank-ratio-based **collocation detection algorithm** trained on Google Web1T n-gram corpus (Futagi et al, 2008)
Contractions	**Regular expressions** defined on constituency parses
Morphologically -complex Words	**Rule-based morphological parser** (discussed in Leacock & Chodorow, 2003)
Morphological Variants	ETS proprietary resource that identifies inflectional & derivational variants
Synonyms	**WordNet** (Fellbaum, 1998) + a **Lin thesaurus** (Lin, 1998) + **SMT-based paraphrases** (Bannard and Callison-Burch, 2005)

Lexical Activity	Lexical Resources
Cognates	Manually-created dictionary of Spanish-English word pairs e.g., *retired/retirar, person/persona*
Antonyms	**Wordnet** (Fellbaum, 1998)
Homonyms	Manually-created list (Burstein et al., 2004) e.g., *their, there, they're*

Sentence Activity	NLP: Regular expression on constituency parser
Relative Clauses	*Fish are rich in* ***protein and nutrients*** *that contribute to good health.*
Multi-Clause Sentences	*The half of the moon* ***that faces the sun is always illuminated****, but we see both the light and dark sides in different proportions as it orbits the Earth.*
Complex Noun Phrases	*It is during* ***the rapid eye movement stage*** *that most dreams occur.*
Complex Verb Phrases	*During this time, women* ***were never supposed to travel*** *alone.*

Discourse Activities	NLP/Lexical Resources
Compare-Contrast	**Discourse term lexicon** indicating a comparison or contrast between text segments, e.g., "*He was a wise and patient leader; **however**, his son . .*
Cause-Effect	**Discourse term lexicon** indicating a cause-effect relation between text segments, e.g., "*The discovery of fossils of tropical plants in Antarctica **led to** the hypothesis that . . .*"
Pronoun Reference	*Pronoun identification with maximum entropy tagger (MXPOST) **part-of-speech tagger***

Palette Screenshots

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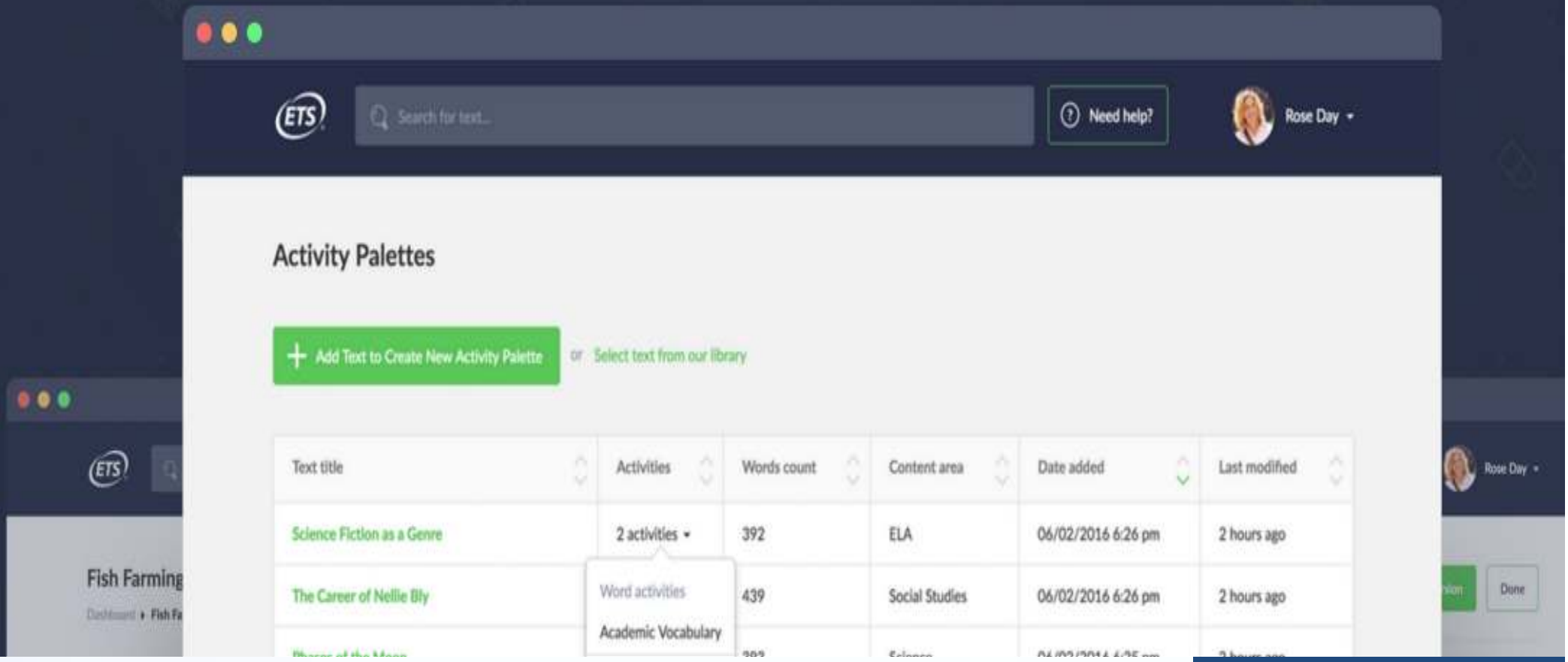
Language support in content-area classrooms

The *Language Muse*™ engine generates activities intended to help English learners build the skills they need for deeper reading comprehension in Science, Social Studies and English Language Arts.

Get an invite



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Activity Palettes

+ Add Text to Create New Activity Palette or Select text from our library

Text title	Activities	Words count	Content area	Date added
Penny Debate	5 activities	1097	Other	09/07/2016 2:05 pm
Penny			Other	09/06/2016 2:04 pm
The Triangle Shirtwaist Factory Fire			Social Studies	06/30/2016 2:16 pm
Phases of the Moon			Science	04/09/2016 2:47 pm
The Career of Nellie Bly			Social Studies	04/01/2016 12:53 pm
Fish Farming			Science	03/29/2016 12:27 pm
Cave Paintings			Social Studies	12/14/2015 3:34 pm
Good Sleep for Good Health			Science	10/29/2015 2:12 pm
this is a test	0 activities	14	Other	09/25/2015 9:34 am

Sentence activities

Multiple Clause Sentences

Finding Referential Terms in Relative Clauses

Discourse Marker Vocabulary

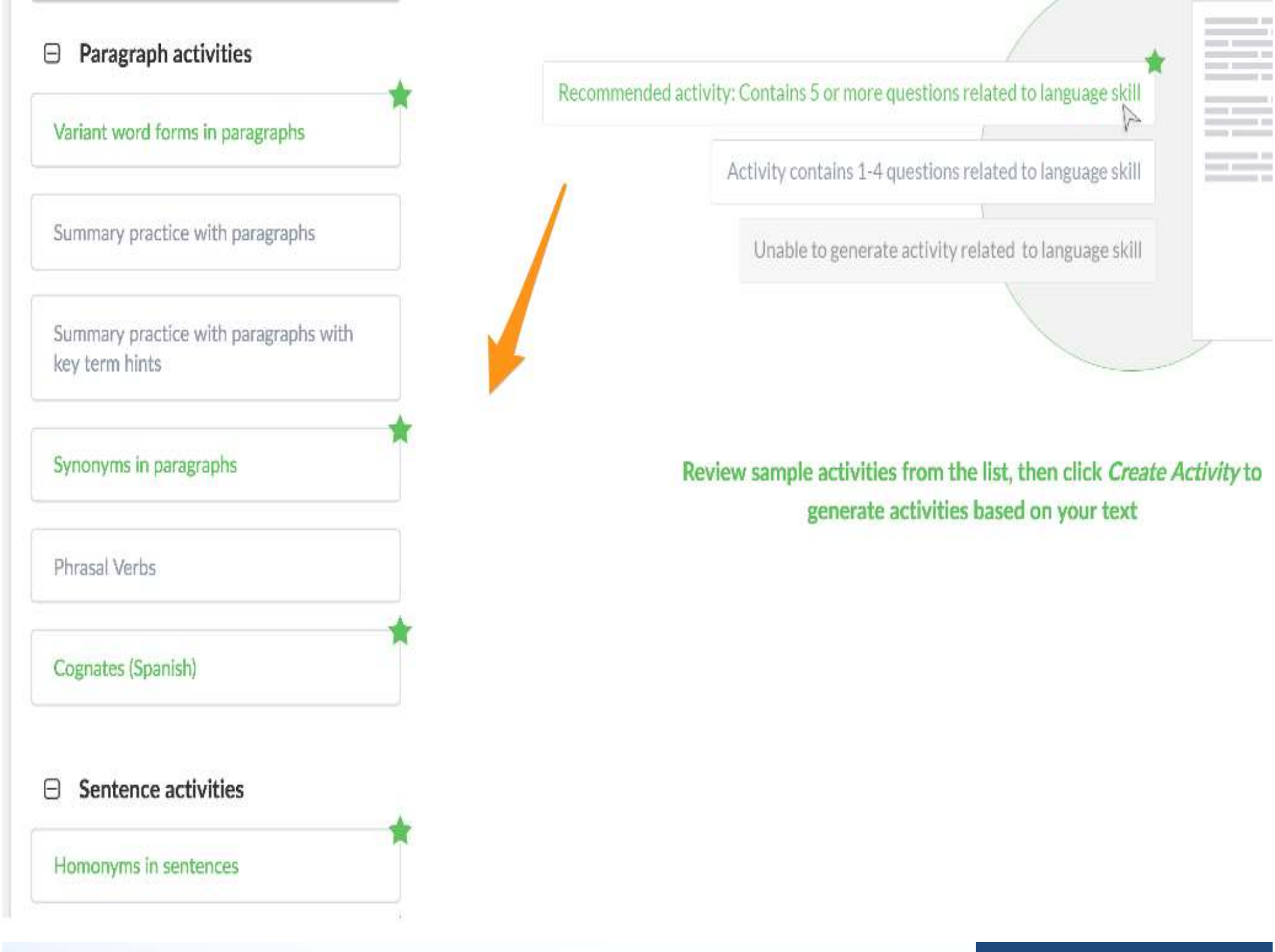
Paragraph activities

Summary practice with paragraphs

Word activities

Academic Vocabulary

+ Add new activity


Paragraph activities
Variant word forms in paragraphs
Summary practice with paragraphs
Summary practice with paragraphs with key term hints
Synonyms in paragraphs
Phrasal Verbs
Cognates (Spanish)
Sentence activities
Homonyms in sentences
Recommended activity: Contains 5 or more questions related to language skill
Activity contains 1-4 questions related to language skill
Unable to generate activity related to language skill
Review sample activities from the list, then click *Create Activity* to generate activities based on your text

Activity

Hide all sentences

Sentence 1

Hide

In the early 1900s, a time known as America's Progressive Era, 146 people were killed in the Triangle Shirtwaist Factory Fire in New York City.

Correct answer

- Now Hide
- Past Hide
- Future Hide

Add new answer

+ Create another variant of sentence

Sentence 2

Hide

All but six bodies were identified in the days that followed the fire of March 25, 1911.

Directions

In each sentence below, decide whether the event is happening now, happened in the past, will happen in the future, or may happen in t

Activity

Sentence 1

In the early 1900s, a time known as America's Progressive Era, 146 people were killed in the Triangle Shirtwaist Factory Fire in New York City.

- ○ Now
- ○ Past
- ○ Future

Sentence 2

All but six bodies were identified in the days that followed the fire of March 25, 1911.

- ○ Now
- ○ Past

1 In the early 1900s, a time known as America's Progressive Era, 146 people were killed in the Triangle Shirtwaist Factory Fire in New York City.

Put the correct answer in the box

peoples peopling peopled



2 Jewish and Italian immigrant girls and women made up the majority of those _____, with just 23 boys and men making up the rest.

Put the correct answer in the box

killing killed kills kill

3 Approximately half _____ teenagers, and some were as young as ten years of age.

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Synonyms in Isolation

Match the words with similar meanings.

Hide instructions



1

America
US

Progressive
liberal

killed
dead

Shirtwaist
blouse

Match synonyms from the box

2

Factory

women

made

majority

Match synonyms from the box

people
mainly
plant
get

Text

In the early 1900s, a time known as America's Progressive Era, 146 people were killed in the Triangle Shirtwaist Factory Fire in New York City. Jewish and Italian immigrant girls and women made up the majority of those killed, with just 23 boys and men making up the rest. Approximately half were teenagers, and some were as young as ten years of age. All but six bodies were identified in the days that followed the fire of March 25, 1911. One hundred years later, a researcher named Michael Hirsch identified those six individuals. Every year since the fire, those who died have been remembered with the reading of their names to the tolling of a bell.

The Triangle Factory workers were sewing machine operators and cloth cutters at a time when labor unions were...

Show more...

Print text

Last update: 06/30/2016 2:16 p

Description: Add description

Tags: +

Edit text

Library texts cannot be edited



Activities

+ Add ne

Paragraph activities

Summary practice with paragraphs with key term hints
Created: 8 days ago

Cognates (Spanish)
Created: 11 days ago

Variant word forms in paragraphs
Created: 12 days ago

Synonyms in paragraphs
Created: 2 months ago

Variant word forms in paragraphs
Created: 2 months ago



Classes

New class

Filters Show All accounts

Mrs. B's Science Class

Name	Student ID	Grade	Status
J. Cassway	22345	6	Active account
A. Burstein-Stern	12345	6	Active account
A. O'Neill	12348	6	Active account
A. Somasundaran	12349	6	Active account
M. Burstein-Stern	12346	6	Active account
M. Beigman	12356	6	Active account

Add student Import file Print login credentials

Assignments

New assignment

Filters Status Draft Active Archived

Assignment Name	Activities	Students	Due date	Created	Status	Type
Verb Practice #1: Working with Tenses 2		6 students assigned 2 turned in, 4 not turned in	11 days left (11/22/2016)	11/09/2016	active	online

Show all

Assignment Verb Practice #1: Working with Tenses

Interactive preview | Actions | Archive

Assignment Summary

Details

Status	active
Type	online
Description	Helps student to work with tenses.
Due Date	11/22/2016
Sent	

Activities

Verb Tense Practice

Turned in	Not turned in
2	4

6 students assigned

Name	Student ID	Grade	Submission
J. Cassway	22345	6	11/09/2016
A. Burstein-Stern	12345	6	Feedback received
A. O'Neill	12348	6	-
A. Somasundaran	12349	6	-
M. Burstein-Stern	12346	6	-
M. Beigman	12356	6	-

1 **Verb Tense Practice**
the-northern-lights-77

4 / 6

Overwrite score

In each sentence below, decide whether the event is happening now, happened in the past, will happen in the future, or may happen in the future.

1 Northern Lights can be seen in the northern or southern hemisphere, in an irregularly shaped oval centred over each magnetic pole.

- (•) Now
- ( ) Past
- ( ) Future

2 The lights are known as 'Aurora borealis' in the north and 'Aurora australis' in the south.

- (•) Now
- ( ) Past
- ( ) Future

3 Scientists have learned that in most instances northern and southern auroras are mirror-like images that occur at the same time, with similar shapes and colors.

- ( ) Now
- (•) Past
- ( ) Future

4 Because the phenomena occurs near the magnetic poles, northern lights have been seen as far south as New Orleans in the western hemisphere, while similar locations in the east never experience the mysterious lights.

- ( ) Now
- ( ) Past
- (•) Future

Spring 2016 Small-Scale Pilot Study

- 6-week instructional Intervention
  - Teachers integrated tool into curriculum
- 3 middle schools (2 in TX; 1 in NJ)
- 17 teachers
  - ELA
  - Social Studies
  - Science
- Teacher Perception Survey
- Pre-post test student reading and language assessment show overall gains
- Pre-, During, Post-Intervention Observations

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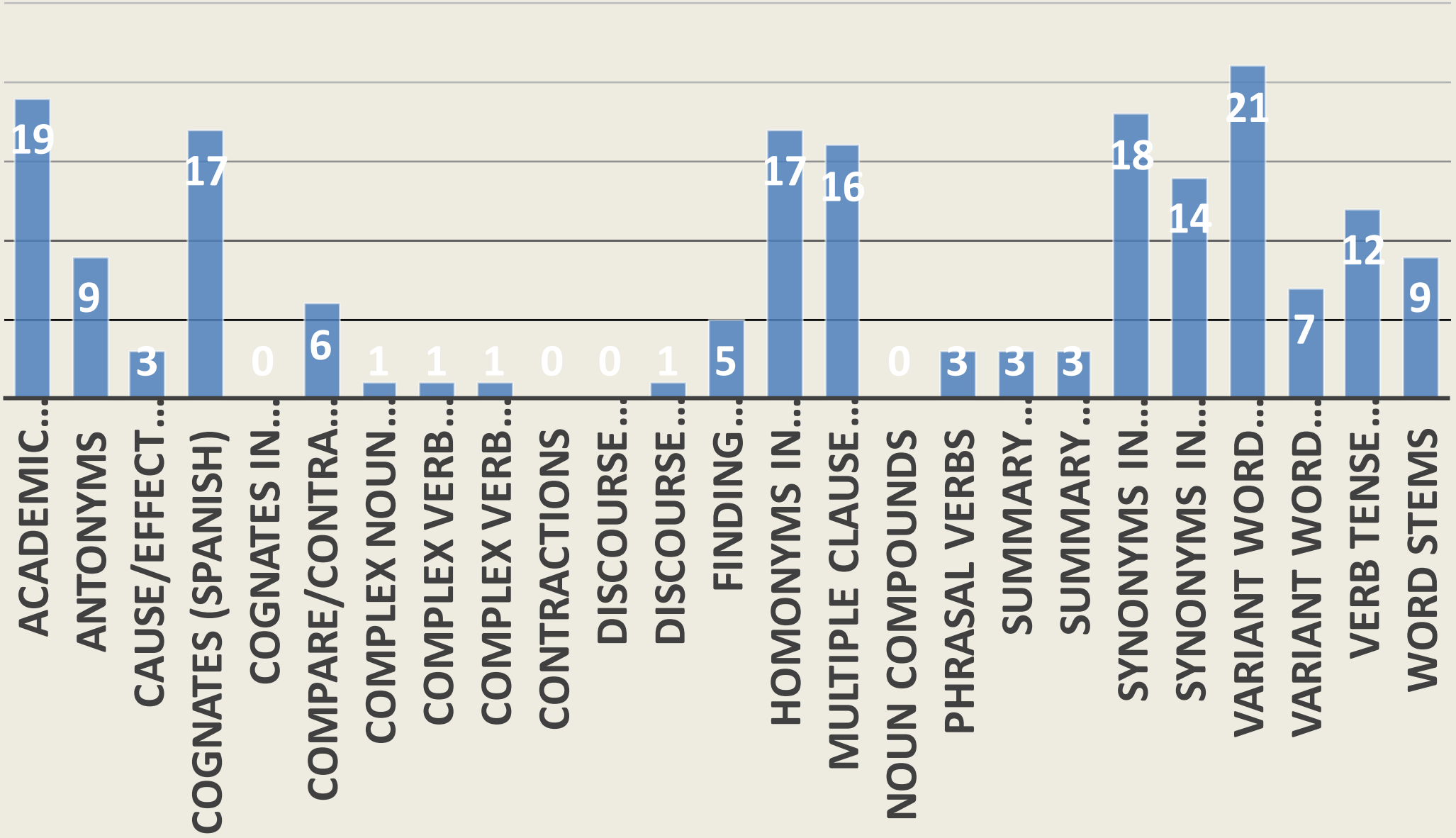
Activity Type Counts:
Reported Use During Instructional Intervention



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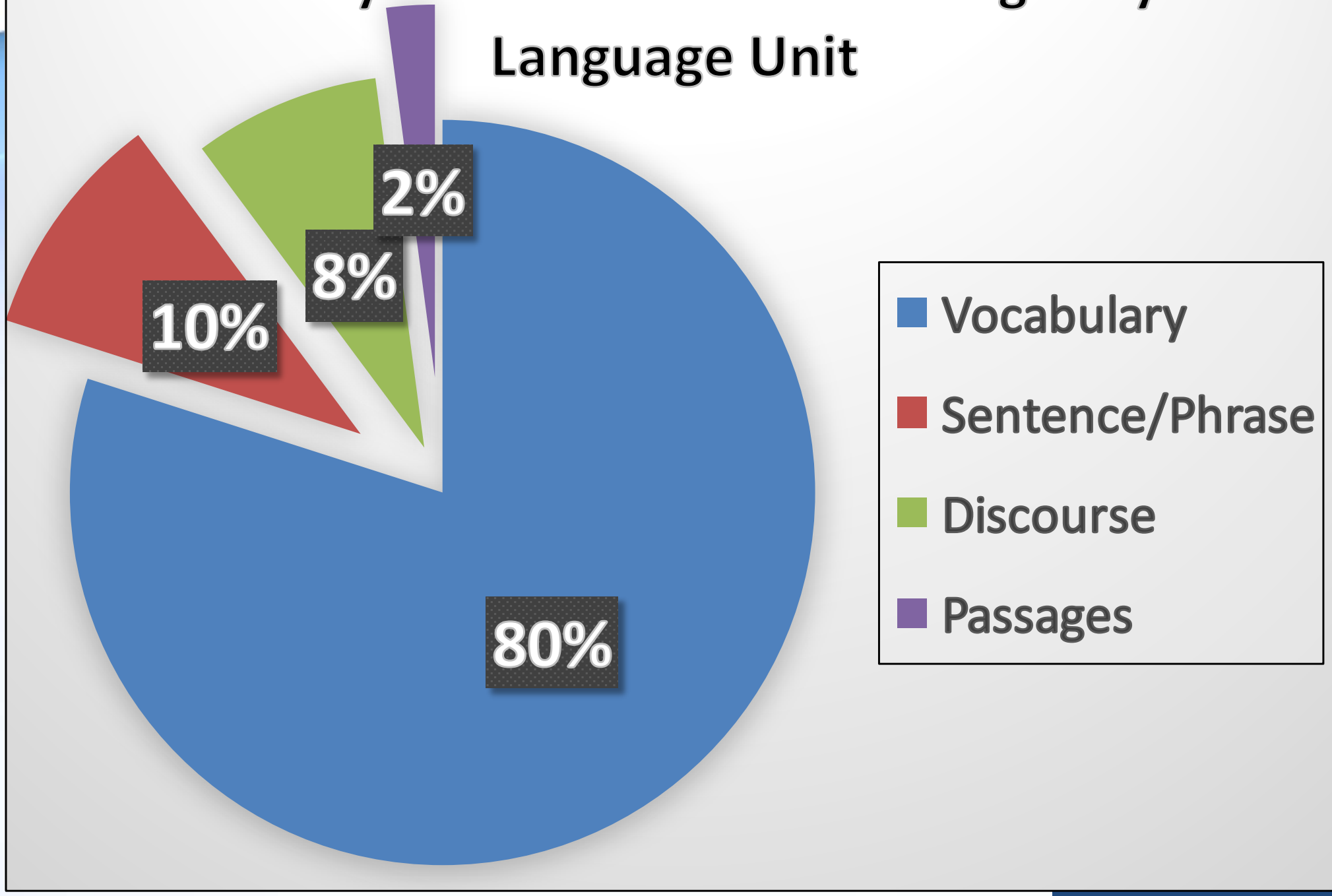
Activity Selection Use Percentages by Language Unit



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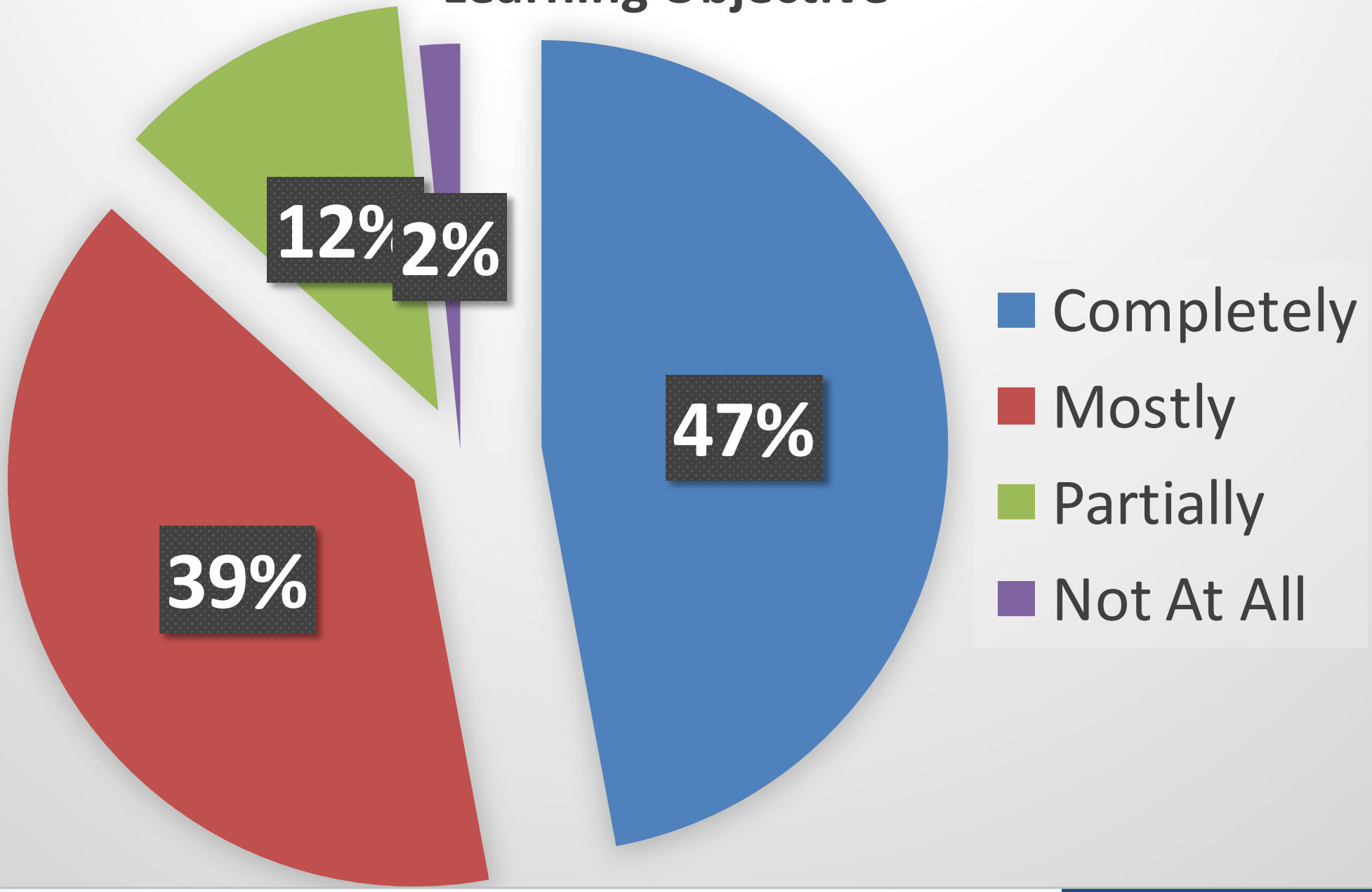
Perception of Activity Fulfillment of Learning Objective



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Pre-Post Test

- RISE Assessment
  - *Word Decoding*
  - *Vocabulary*
  - *Morphology*
  - *Sentence*
  - *Efficiency (*reading speed)*
  - *Reading Comprehension*
- Pre-test prior to classroom intervention
- *The Palette* classroom intervention
- Post-test after the intervention

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Two Schools

- **School A**
  - Small private school in Texas
  - Primary first language of ELLs: Arabic
- **School B**
  - Large pubic middle school in New Jersey
  - Primary first language of ELLs: Spanish

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RISE Scale Scores

- 250:Middle of scale.
- 270 or above: Proficient
- 230 or below: Warning level

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Pre-Post Outcomes: Both Schools

Test	N	Mean, Pre	Mean, Post
DecWrd	169	255.21	253.47
Vocab	169	254.49	255.89
Morph	167	253.71	253.52
Sentences	63	251.21	247.6
Efficiency	59	250.31	252.8
RComp	41	246.5	247.11

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School A vs School B

Test	Group	N	Mean, Pre	Mean, Post
DecWrd	SchoolA, Grade 6	23	253.35	257.3
DecWrd	SchoolA, Grade 7	13	260	253.85
DecWrd	SchoolA, Grade 8	28	268.5	254.36
DecWrd	SchoolB, Grade 6	52	251.94	252.92
DecWrd	SchoolB, Grade 7	27	249.22	250.44
DecWrd	SchoolB, Grade 8	26	252.88	253.15

Test	Group	N	Mean, Pre	Mean, Post
Sen	SchoolA, Grade 6	23	252.78	244.26
Sen	SchoolA, Grade 7	13	255.54	235.85
Sen	SchoolA, Grade 8	28	253.93	238.04
Sen	SchoolB, Grade 6	50	251.02	254.2
Sen	SchoolB, Grade 7	25	246.4	248.12
Sen	SchoolB, Grade 8	24	249.58	254

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Motivation

Sample size across the tests

	DecWrd	Vocab	Morph	Sents	Effic	Rcomp
SchoolA, 6	23	23	23	23	23	23
SchoolA, 7	13	13	13	13	13	13
SchoolA, 8	28	28	28	28	28	28
SchoolB, 6	52	52	51	50	49	37
SchoolB, 7	27	27	26	25	24	23
SchoolB, 8	26	26	26	24	22	17

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Observations: Palette in the Classroom

- **Content-area teachers**
  - Used *paragraph-level* activities
  - Focused on the entirety of the text by reading before doing the actual activity
  - Almost always used Palette activity as a *warm-up* in content area
- **English (ELA or ESL) teachers**
  - Used the activity as the *basis of the entire lesson*
  - Focused less on the text chosen
  - More likely to introduce the language feature and give detailed instructions about how to complete the activity
- **Activity Delivery: Most teachers used an interactive whiteboard**
  - Students responded on paper
  - Teachers would read aloud the question from white board
  - Students would respond at their desk, or walk up to the white board

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Summary

- The Palette is a web-based, NLP-driven learning application that supports teachers and their ELLs
- A small-scale pilot suggests promise for classroom use
  - Positive gains at 6th grade in School A, but negative gains at 7th * 8th, strongly suggested that these are motivation based.
  - Significant, positive gains in School B across all three grades and across all six tests

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Next Steps: Spring 2017 Randomized Control Large-Scale Instructional Intervention

- **Participants**. Schools. Approximately 20 middle school sites in districts in Connecticut, Georgia & New Jersey with higher ELL populations.
- Teachers. Expected 35 ESOL & content-area teachers across the districts/states.
- **Methods**. Teachers (1) receive 2-day professional development in ELL language & reading support, and ***the Palette version 2***, (2) administer a 6-week instructional intervention with the *Palette version 2* (3) are observed observed prior to, and during the intervention, & (4) participate in PLCs. Students will take a reading components proficiency (RISE) pre-posttest.

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"Impactful NLP" Serving Language Learners

- US: Language learning resource need in U.S. K12
  - *http://www.dekalbschoolsga.org/english-learners-studies-program/*
  - *22K int'l students, 156 countries, 162 languages*
- MOOCs for Refugees (K12 – postsecondary)
  - edX (U.S.) + Kiron University (Germany)
  - Coursera + U.S. Department of State
  - Erasmus+ *(European Commission)*
  - http://www.paper-airplanes.org/
- "Palette" for languages other than English

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