



MATH ACADEMIC VOCABULARY FOR ELLS

An Exploration of Best Teaching Practices

This teacher handbook is a culmination of detailed analysis and research based on journal articles, books, and other publications focused on the English Language Learners language acquisition process, math academic language, and best teaching practices to facilitate their learning.

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Overview

The fastest-growing student population in U.S. schools today are children of recent immigrants, half of whom do not speak English fluently and are thus labeled English Language Learners (ELLs) (Calderon, Slavin, & Sanchez, 2011). Although the federal government requires schools and school districts to provide services to ELLs, it states no consistent policies that must be followed in identifying, assessing, placing, or instructing them (Calderon, Slavin, & Sanchez, 2011). English language learners are a very diverse group of students but they all face the same academic challenge; they must learn the English language at the same time they are learning the academic content in all the different subject areas in an unfamiliar language.

In my school district, ELLs represent 8.9% of the student population. This number represents 1,380 ELL students district-wide. These ELLs are a diverse group of students coming from 57 different countries and speaking 47 different languages from around the world. About 126 ELL students are enrolled at my high school (Facts at a Glance, 2017). When they start high school, they are placed in classes based on their English knowledge and the OELPA assessment results (English Proficiency Test). They receive sheltered English, History, Science, Algebra and Geometry classes based on their academic achievement in content, previous background knowledge, years of schooling, past grades, and state tests results.

This teacher handbook presents and shares important definitions, instructional tips, and best teaching practices that will help first time teachers or teachers who are having their first experience working with ELLs to be better informed and prepared. The creation of this teacher handbook is the results of researching and summarizing what research states are the best teaching practices to facilitate the learning of math academic language while learning English.

English Language Learners

The Ohio Department of Education establishes and implements statewide guidelines and procedures for the identification of ELLs. The first step in this process consists of administering a Home Language Survey at enrollment time. This survey identifies language backgrounds other than English spoken at home for all students enrolling in grades Pre-K-12. It is important to mention that place of birth is only a secondary factor in this identification process. English Language Learners may either be born outside the US or within it. The student is then assessed for English Language Proficiency in reading, writing, listening and speaking skills by qualified screener (ODE website, 2017).

Stages of Language Acquisition

The Ohio Department of Education classified the stages of language acquisition by ELLs as well as the different types of languages used for these ELLs and the type of learners we can have in our classrooms. These are the classifications of ELLs by the stages of language acquisition:

Pre-functional - Pre-production or “the silent period”

New students just listen. Some may not speak for weeks or months. Don't force them. Some will start using simple learned phrases and simple sentences.

Beginner

Students will develop a vocabulary of about 1,000 words; speak in one or two-word phrases, memorized chunks and simple sentences. This may last about 6 months.

High Beginner

Students will develop a vocabulary of about 3,000 words, use simple sentences, ask simple questions, read easy stories, and write simple sentences.

Intermediate

Now students have a 6,000-word vocabulary, use more complex sentences, and ask questions. They will still have grammar errors.

Advanced

It can take 4 – 10 years to achieve this. Students are able to cope in the classroom but will still need help with vocabulary, idioms, writing and content such as mathematics and social studies.

Types of languages

The ODE (ODE Website, 2017) suggests that classroom teachers need to consider not only the stages of language acquisition when working with English learners but also the difference between social and academic language. Based on research conducted by ELL experts such as Jim Cummins, it is important to differentiate between social and academic language when working with ELLs. These two types of languages are:

BICS - Basic Interpersonal Communicative Skills

This is social language and develops in 1 to 3 years. This is the day-to-day language needed to interact with other people. This language is context based and ELLs use BICS on the playground, in the cafeteria, on the bus and in other social settings.

CALP - Cognitive Academic Language Proficiency

This is academic language and takes 5- 7 years to develop. These are general academic words and content specific words. Academic language is decontextualized and often involves large and uncommon words.

Important definitions

Accommodations

Changes of language or written language to make comprehensible for ELLs.

Adaptations

Modifications in materials and instruction made for ELLs.

Background Knowledge

Also called prior knowledge, this term refers to the background experience and knowledge that students bring to the classroom.

Bilingual Paraprofessional

ESL staff who collaborate with licensed staff, support and assist ELLs with second language and second culture families as needed.

Comprehensible Input

It is language input that can be understood by listeners despite them not understanding all the words and structures in it. Students being able to understand the essence of what is being said or presented to them.

Co-teaching

A teaching approach whereby an ESL and general classroom teacher share responsibility for co-planning and co-delivering instruction in a general education classroom.

ELL

English Language Learners refer to those students whose native or home language is other than English, and whose current limitations in the ability to understand, speak, read or write in English limits their effective participation in a school's educational

programs. This term is often preferred over Limited English Proficiency (LEP) as it highlights accomplishments rather than deficits.

ESL Teacher

Develops students' social and academic English language skills (reading, writing, listening, and speaking) using State Standards. Requires a TESOL (Teachers of English to Students of Other Languages) endorsement to existing license.

Interpreter

"Interpreter" and "translator" are often used interchangeably, but they have different meanings. An interpreter conveys information from one language to another orally. A translator conveys information in the written form.

Mainstream

The placement of ELLs in regular education classes in which the language of instruction is the dominant language.

OELPA

Ohio English Language Proficiency Assessment (OELPA). Administered to all identified ELLs in Ohio. This test determines each student's level of English proficiency and is the basis for exit from an ESL program.

Parent Refusal

Parents decline ESL services for which children qualify. Students are placed in mainstream programs without ESL support. In Ohio, students remain eligible for accommodations on statewide tests and must take the OELPA test until exit from the ESL program.

Push-out

A teaching arrangement whereby a teacher or specialist takes small groups of students from the mainstream classroom for part of the school day to provide specialized support.

Push-in

A teaching arrangement whereby a teacher or specialist join the mainstream classroom to give specialized support to a small number of students or to help the general education/content teacher improve content instruction for ELLs.

Realia

Real life objects that are used as visuals in language instruction.

Scaffolding

The use of temporary supports that help ELLs comprehend information as they develop English language.

SIOP

Sheltered Instruction Observation Protocol. A program model for teaching grade-level content in a way that is understandable for ELL students while at the same time promoting their English language development.

TPR

Total Physical Response. Instruction that provides opportunities for students to develop language and conceptual understanding by physically doing an activity or engaging in the concept being taught.

Standards at a Glance

ELP Standards

The English Language (ELP) Standards ¹ developed for k-12 by the Ohio Department of Education highlights the necessary language skills and knowledge that ELLS need to be successful in schools and meet the college and career ready standards.

ELP consists of 10 standards that describe a set of language functions (what students do with language to accomplish content-specific tasks) and language forms (vocabulary, grammar, and discourse specific to a particular content area or discipline) that are needed by English language learners as they develop competence in English language arts and literacy, mathematics, and science.

1. Construct meaning from oral presentations and literary and informational text through grade-appropriate listening, reading, and viewing
2. Participate in grade-appropriate oral and written exchanges of information, ideas, and analyses, responding to peer, audience, or reader comments and questions
3. Speak and write about grade-appropriate complex literary and informational texts and topics
4. Construct grade-appropriate oral and written claims and support them with reasoning and evidence

¹ Source Ohio Department of Education: <http://education.ohio.gov/getattachment/Topics/Other-Resources/Limited-English-Proficiency/ELL-Guidelines/Ohio-English-Language-Proficiency-ELP-Standards/ELP-Content-Standards-20150824.pdf.aspx>

5. Conduct research and evaluate and communicate findings to answer questions or solve problems
6. Analyze and critique the arguments of others orally and in writing
7. Adapt language choices to purpose, task, and audience when speaking and writing
8. Determine the meaning of words and phrases in oral presentations and literary and informational text
9. Create clear and coherent grade-appropriate speech and text
10. Make accurate use of standard English to communicate in grade-appropriate speech and writing

The ELP Standards can also be framed in relation to narrower domains of listening, speaking, reading, and writing and also in relation to broader receptive, productive, and interactive modalities. (See mapping table)

Mathematics Standards

Mathematics content standards² define what students should understand and be able to do in their study of mathematics. The content standards are grade-specific but do not define the intervention methods or materials necessary to support students who are well below or well above grade-level expectations. It is also beyond the scope of the Standards to define the full range of supports appropriate for English language learners and for students with special needs.

² Source Ohio Department of Education: <http://education.ohio.gov/getattachment/Topics/Learning-in-Ohio/Mathematics/Ohio-s-Learning-Standards-in-Mathematics/Math-Standards.pdf.aspx>

The Standards for Mathematical practice describe varieties of expertise that mathematics educators at all levels should seek to develop in their students. There are eight standards for mathematical practice.

Mathematical Practices

1. Make sense of problems and persevere in solving them.
2. Reason abstractly and quantitatively.
3. Construct viable arguments and critique the reasoning of others.
4. Model with mathematics.
5. Use appropriate tools strategically.
6. Attend to precision.
7. Look for and make use of structure.
8. Look for and express regularity in repeated reasoning.

Mapping ELP Standards and Math Practices

Modalities	Domains	ELP Standards	Math Practices
Receptive Modalities	Listening and Reading	1. Construct meaning from oral presentations and literary and informational text through grade-appropriate listening, reading, and viewing	MP1 Make sense of problems and persevere in solving them.
		8. Determine the meaning of words and phrases in oral presentations and literary and informational text	MP1 Make sense of problems and persevere in solving them.
Productive Modalities	Speaking and Writing	3. Speak and write about grade-appropriate complex literacy and informational texts and topics	MP1 Make sense of problems and persevere in solving them. MP6 Attend to precision
		4. Construct grade-appropriate oral and written claims and support them with reasoning evidence	MP3 Construct viable arguments and critique reasoning of others MP6 Attend to precision
		7. Adapt language choices to purpose, task, and audience when speaking and writing	MP6 Attend to precision
Interactive Modalities	Listening, Speaking, Reading and Writing	2. Participate in grade-appropriate oral and written exchanges of information, ideas, and analysis, responding to peer, audience, or reader comments and questions	MP1 Make sense of problems and persevere in solving them MP6 Attend to precision
		5. Conduct research and evaluate and communicate findings to answer questions or solve problems	MP1 Make sense of problems and persevere in solving them
		6. Analyze and critique the arguments of others orally and in writing	MP1 Make sense of problems and persevere in solving them MP3 Construct viable arguments and critique reasoning of others

Vocabulary List

Creating an instructional program that promotes vocabulary instruction as a strategy to teach academic language to ELL students is crucial to the success of their math content and academic language learning. Learning academic vocabulary requires more than just learning conversational language because this academic language is more specific and sometimes abstract, making it difficult to grasp by ELLs. Here is a list of some of the vocabulary words that I believe should be included in any vocabulary instructional program in the math classroom, especially before and during Algebra instruction. This list is organized in 4 levels and they are based on the book *Building Academic Vocabulary Teacher's manual* by Marzano and Pickering (2005).

Level 1	Level 2	Level 3	Level 4
Above	2-dimensional shape	3-dimensional shape	Absolute value
Addition	Acute angle	Addition of fractions	Acceleration
Area	Addend	Algebraic expression	Add radical expressions
Behind	Addition algorithm	Alternate interior angle	Addition
Below	Angle	Angle bisector	Algebraic function
Between	Angle unit	Area model	Angle depression
Cardinal number	Area	Array	Arc
Chance	Associative property	Axis of symmetry	Area
Circle	Bar graph	Circle formula	Asymptote of function
Coin	Basic number combinations	Circumference formula	Binary system
Decrease	Capacity	Combining like terms	Cartesian coordinates

Level 1	Level 2	Level 3	Level 4
Difference	Centimeter	Complementary angle	Central angle
Direction	Circumference	Composite number	Chord
Estimate	Classes of triangle	Congruence	Circle
Foot (measurement)	Cluster	Conjecture	Circular
Graph	Common denominator	Constant difference	Classes of functions
Greater than	Common fractions	Constant rate of change	Combination
Grouping	Commutative property	Constant ratio	Compound interest
Guess and check	Constant	Convert	Conditional
Height	Corresponding angles	Coordinate	Continuous
Hour	Corresponding sides	Counter example	Control group
In front	Cube	Counting	Correlation
Inch	Cylinder	Cube number	Cosine
Increase	Data	Cube root	Curve
Inside	Data collection	Cubic unit	Dependent
Left	Decimal	Data	Dilation
Length	Diagram	Deductive	Discrete
Less than	Different	Defining	Divide
Location	Distributive property	Dilation	Divide radical expressions
Measuring cup	Dividend	Distance	Domain function
Minute	Divisibility	Enlarging transformation	Equivalent
Model	Division	Equal ratios	Expected value
Money	Equation	Equation	Exponent
Near	Equilateral triangle	Experiment	Exponential function

Level 1	Level 2	Level 3	Level 4
Number	Equivalent fractions	Exponent	Factorial
Number line	Estimation	Exponential notation	Finite graph
Numeral	Even numbers	Fair chance	Fraction
Numeric pattern	Event likelihood	Frequency	Function notation
Ordinal number	Expanded notation	Graphic representation of	Geometric function
Orientation	Extreme value	function	Imaginary number
Outcome	Factors	Growth rate	Isometry
Outside	Fraction	Input/output table	Law of probability
Pattern	Function	Integer	Limit
Pound	Geometric pattern	Intercept	Line equation
Prediction	Greatest common factor	Intercepting lines	Line segment
Rectangle	Growing pattern	Irregular polygon	Line segment congruence
Right	Histogram	Large sample	Line segment similarity
Ruler	Horizontal axis	Line symmetry	Linear
Second (time)	Identity pattern	Linear arithmetic sequence	Minimum/maximum of function
Set	Improper fraction	Linear equation	Monomial
Shape	Inequality	Mathematical expression	Multiply radical expressions
Similarity	Intersection	Maximum	Natural number
Size	Irrelevant	Minimum	Negative exponent
Square	Isosceles triangle	Multiple	Parallel
Subtraction	Less common multiple	Number property	Pi
Sum	Line graph	Odds	Polynomial
Table	Linear pattern	Ordered pairs	Postulate

Level 1	Level 2	Level 3	Level 4
Temperature	Mass	Parallel figures	Powers
Time	Mean	Percent	Probability
Triangle	Measurement	Perimeter	Proof
Under	Median	Perpendicular	Protractor
Volume	Meter	Plane	Pythagorean theorem
Week	Metric system	Polygon	Radical expression
Whole number	Midpoint	Prime factor	Radius
Width	Mixed numbers	Problem	Range of function
Year	Mode	Projection	Rational function
Zero	Multiple	Proportional	Real numbers
Some words needed to understand math problems:	Multiplication	Quadratic equation	Reciprocal
	Negative number	Quadrilateral	Recursive
	Number of faces	Random	Reflection
	Number pairs	Range	Regression
Analyze	Number sentence	Rate	Relative
	Obtuse angle	Rational number	Right triangle
Answer	Odd numbers	Rectangle	Roots and real numbers
Complete	Order of operations	Rectangular	Rotation
Describe	Parallel lines	Recursive sequence	Sample
Evaluate	Parallelogram	Reflection	Series
Examine	Part to whole	Root	Similar
Explain	Pattern	Rotation symmetry	Similar figures
Find	Percent	Sample	Speed

Level 1	Level 2	Level 3	Level 4
Graph	Perimeter	Scale	Standard
Investigate	Perpendicular lines	Scatter plot	Statistic
Mark	Pie chart	Scientific notation	Strategy
Observe	Positive number	Sequence	Subtract
Resolve	Prime factorization	Similar	Summary
Ruler	Prime number	Similarity vs. congruence	Surface area
Solve	Prism	Simplification	Systems of equations
Study	Probability	Slope	Systems of inequalities
Survey	Process of elimination	Slope intercept formula	Tangent
	Product	Solid figure	Term
	Proof	Solution	Theorem
	Pyramid	Square number	Transversal
	Quotient	Square root	Trigonometric
	Rectangle	Square units	Two-way tables
	Rectangle prism	Substitution	Unit
	Reduced form	Supplementary angle	Vector
	Relative distance	Table representation	Velocity
	Relevant information	Thermometer	Vertex
	Remainder	Trapezoid formula	
	Repeating pattern	Tree diagram model	
	Restate a problem	Triangle sides	
	Rhombus	Underestimation	
	Right angle	Unit size	

Level 1	Level 2	Level 3	Level 4
	Rotation	Variable	
	Rounding	Vertex	
	Same size units	Volume formula	
	Sample	Volume of cylinder, prism, and pyramid	
	Scale	Work backward	
	Shape	Written representation	
	Sphere		
	Standard		
	Studies		
	Subtraction		
	Surface area		
	Survey		
	Symbolic representations		
	Tallies		
	Time zone		
	Triangle formula		
	Unit		
	Unlike terms		
	Venn diagram		
	Verification		
	Vertical axis		
	Volume		

Instructional Strategies

The following tables include a series of teaching strategies and suggestions that represent the culmination of comprehensive research on how to integrate instructional strategies used during English instruction into the math content class in order to facilitate the teaching of mathematics academic and vocabulary content to ELLs. These recommended best practices and strategies have been summarized in the below charts based on the following categories:

1. **Teacher Knowledge and Understanding**, including second language acquisition, math academic language and vocabulary knowledge.
2. **Teacher Planning and Organization**, including planning techniques, classroom management and room organization.
3. **Teacher Attitudes and Dispositions**, including beliefs, attitudes, and awareness of student background knowledge.

Knowledge and Understanding	<ul style="list-style-type: none"> • Face your class when you are speaking to them • Use simple sentence structure and vocabulary • Minimize the use of idiomatic expressions • Model or demonstrate directions • Always speak in a normal tone (not louder) • Avoid overstressing correct pronunciation and grammar • Teach groups of words that are related together • Remember it can take two to seven years for a non-English speaker to acquire academic language
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Planning and Organization

- Simplify your language but not the concept when you are planning your lessons
- Announce and write objectives on the board
- State objective orally at the beginning of each lesson
- Review objectives at the end of each lesson
- Give students plenty of time to copy your notes
- Allow sufficient wait time or think time
- Write legibly, many ELLs cannot read cursive. Write in print
- Use the chalkboard or overhead projector to write important words and ideas
- Incorporate pictures and objects to teach new words and concepts
- Incorporate hands-on activities into each lesson
- Use objects like visuals displays, photos, and authentic materials such as newspapers and magazines
- Use manipulatives to promote hands-on activities and understanding of difficult concepts
- Use real objects (realia) to help students understand
- Use graphic organizers to simplify the language (timelines, diagrams and webs
- Label objects in the classroom in English
- Provide a list of directional words (write, read, underline, circle, match, add/subtract, trace, draw, cut)
- Summarize at the end of the day what was taught
- Use group assignments
- Reduce the number of test questions, simplify
- Design appropriate rubrics for assignments
- Allow students to demonstrate knowledge in drawings, posters, visual representations

Attitudes and Dispositions

- Learn the student's given name
- Never discourage parents from speaking with their student in their native language
- Never discourage student to speak their native language in the classroom. Establish common rules during instructional time
- Help student to feel part of the classroom
- Remember that some students have low levels of literacy and may not know the English alphabet
- Emphasize key words and phrases using intonation, repetition, and gestures
- Add elements of student's culture in your writings (problems)
- Make information comprehensible (comprehensible input)
- Encourage student to indicate when he/she does not understand you
- Employ daily routines in classroom activities
- Post a schedule in the classroom or provide a picture schedule
- Check frequently for comprehension (ask questions, think pair-share, etc.)
- Instead of asking students "do you understand?" ask students to reword or explain
- Avoid oral correction of language errors, instead model correct usage
- Consider giving ELL students a second chance to correct errors before grading

Helpful Resources and Websites

Colorin Colorado

<http://www.colorincolorado.org>

CPM Math Homework

<https://homework.cpm.org/cpm-homework/>

FluentU Educator Blog

<https://www.fluentu.com/blog/educator-english/esl-math/>

Free Rice

<http://freerice.com/category>

Kahoot

<https://kahoot.com>

Khan Academy

<https://www.khanacademy.org>

Ohio Department of Education

<https://education.ohio.gov>

Prodigy Math

<https://www.prodigygame.com>

SAT Free Practice

<http://www.satfreepractice.com>

Ten Marks

<https://www.tenmarks.com>