

# Tools and Resources to Meet the Needs of English Language Learners in the Science Classroom

## *Best Practices for Emergent Bilinguals Complement and Enhance Best Practices in the Science Classroom*

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### Abstract

The world today is in the midst of an unprecedented level of human migration, with about 66 million refugees currently displaced from their homes (comparable to the entire population of France or the UK). Of these, about 25 million are seeking asylum in other countries (about the entire population of Australia). If we add to this all other forms of migration, it is not hard to see why second language acquisition is becoming a pressing issue in schools across the globe. For these and other reasons, content teachers in many countries are already seeing growing numbers of students in their classrooms who are also beginning to learn the language of instruction. Fortunately, research in the field of second language acquisition is also burgeoning, and there are many valuable lessons that can be used to leverage content instruction and language acquisition in a symbiotic way. This contribution to the May 2018 PALM Conference at the Pädagogische Hochschule NÖ, while based on the experience of new English Language Learners in an American science classroom, has wide applicability across content areas and in other multilingual contexts.

## Pädagogische Instrumente und Ressourcen für die Bedürfnisse von Englischlernenden im Naturwissenschaftsunterricht

### *Beste pädagogische Praxis für beginnende zweisprachige Schülerinnen und Schüler ergänzt und verbessert die beste Praxis im Naturwissenschaftsunterricht*

### Zusammenfassung

Die Welt befindet sich heute in einem unerhörten Maß in Migration, wobei etwa 66 Millionen Flüchtlinge aus ihren Heimat vertrieben wurden (vergleichbar mit der gesamten Bevölkerung Frankreichs oder des Vereinigten Königreichs). Von diesen suchen etwa 25 Millionen Asyl in anderen Ländern (vergleichbar mit der gesamten Bevölkerung Australiens). Wenn wir dazu alle anderen Formen der Migration hinzufügen, ist es nicht schwer zu verstehen, warum der Zweitspracherwerb in Schulen auf der ganzen Welt ein drängendes Problem wird. Aus diesen und anderen Gründen sehen Lehrkräfte in vielen Ländern bereits eine wachsende Zahl von Schülern in ihren Klassenzimmern, die erst anfangen die Unterrichtssprache zu lernen. Glücklicherweise wächst auch die Forschung im Bereich des Zweitspracherwerbs und es gibt viele wertvolle Erkenntnisse zur Symbiose des Unterrichts von Inhalten und des Spracherwerbs. Dieser Beitrag zur PALM-Konferenz an der Pädagogischen Hochschule NÖ basiert auf der Erfahrung beginnender Englisch-Lerner an amerikanischen Schulen, aber er findet breite Anwendung in verschiedenen inhaltlichen Bereichen und anderen mehrsprachigen Kontexten.

### Keywords:

Bilingual education  
Second Language Acquisition  
English as a New Language (ENL)  
English Language Learner (ELL)  
First/Second Language (L1 and L2)

Emergent Bilingual students  
Transitional/Maintenance Bilingual Education  
Dual Language Program  
Long Term English Language Learner (LTELL)  
Normal Curve Equivalents (NCE)  
Tier 1/Tier 2/Tier 3 Words

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## 1 Introduction/A Complex Issue

The acquisition of a second language is a complex puzzle. It combines a plethora of different factors: the age of the learner; whether both the home language or the target language are phonetic or not; whether the two languages in question share the same alphabet or not, or whether one of the languages is pictographic; whether the learner has already learned to read, or even become an expert reader, in the home language or not; whether the learner's parents are highly educated or not; whether the learner has experienced schooling in the home language or not, and to what extent; whether the learner has had significant interruptions to their formal education or not; whether the learner comes from a multilingual family or not; and in particular among many other factors not yet listed, whether the schooling received by the learner in the target language is *subtractive* (makes no use and undervalues the home/native language and culture) or *additive* (leverages, reinforces, and honours the value of the home/native language).

To underscore just how different the experience of two different immigrant students can be in the United States, let's consider the lives of two Spanish speaking six-year-olds:

Ana arrives in Vermont from Argentina. Because she is of Italian descent, and Vermont is so homogeneous, she looks just like the other kids in her first-grade class. Because she is the only Spanish speaker in the class, she is surrounded with kids her age who speak English at an appropriate developmental level, and soon has a handful of friends. Her mother, Ana, is an engineer. Ana's father is a journalist and does not speak English, so he works from home but has time to teach Ana to read and write in Spanish, and they all speak only Spanish at home. Ana's home is filled with books in Spanish, and she soon begins to correspond with her grandma and her cousins in Argentina, whom she visits every summer. By sixth grade, Ana will be equally fluent and literate in English and Spanish and is likely to continue reading in her native language the rest of her life. She will always think that learning English was no big deal and will likely outperform her monolingual peers by the time she graduates from high school.

Pedro, on the other hand, arrives in Spanish Harlem from a small rural town in the state of Puebla, in Mexico. His parents have a sixth-grade education and read only when they must, and they both work second jobs to make ends meet. Pedro goes to a school where 22 out of 26 students in his first-grade class speak Spanish, but they are from different countries and their accents and vocabulary are not what Pedro is used to. He is surrounded with Spanish speakers in class, and his exposure to English is mostly from the teacher, an adult who speaks at a much higher developmental level. He goes home to a small apartment without books in any language, and because his parents arrive home much later, is not exposed to his native language at home for more than a couple of hours a day. His parents find it hard to navigate the school system and do not effectively advocate for their son's needs, so it is likely that Pedro might be held back a year or two and may even be erroneously assigned to a Special Education class.

It is very likely that Pedro will retain a modest command of his native Spanish orally, but will not learn to read and write it properly. In addition to losing a significant aspect of his rich culture, he will not be able to leverage his home language to learn English, and because he had to "start over" in with a new language at age 6 with a vocabulary of zero, the resulting academic language gap will follow him throughout his schooling. He will most likely never experience higher level science, math, or social studies classes before graduation, and is much more likely to drop out of school before graduating. The schooling received by most immigrant students in the United States most closely resembles Pedro's experience, and this has given rise to a new classification: that of Long-Term English Language Learners, or "LTELLs", students who never close the academic language gap and are relegated to a second-rate education. Moreover, the vast majority LTELLs in the United States are actually American citizens by birth but live in households where English is not the primary language spoken.

These two parallel lives illustrate a pernicious reality: Ana and Pedro may both receive 12 years of public education in American schools, but this "equal treatment" is very far from *equitable*, because Pedro faces systemic obstacles that can only be addressed with additive bilingual programs that help students maintain, leverage, and ultimately master their first language, and that honour their cultural heritage.

## 2 Key Elements of an Additive Bilingual Education Program

The key elements of an effective second language acquisition program are: intensive instruction in the target language; challenging first language instruction for mastery and biliteracy; and at least some content-area instruction in the first language.

“Bilingual Education” is an umbrella term that includes a wide range of different types of programs, and one reason people disagree about its virtues is that the term is so broad that any two people discussing the topic cannot be sure that they are actually talking about the same thing. The term “Bilingual Education” includes additive bilingual education programs that are research-based, effective, and currently used in many countries with very different financial resources, but it also includes subtractive bilingual education programs that focus only on the target language, are used broadly in public schools across the United States, and have been shown by recent research to be not only ineffective, but to actually harm the academic progress of the students they claim to serve.

## 2.1 Not All Bilingual Programs Are the Same

Let’s dissect the term. Not all bilingual programs are the same: some programs do not value the first language or the culture of the Language Learner, while others leverage the first language of the student to help him or her learn the target language faster. Studies have shown that students who take part in additive bilingual education programs often outperform monolingual students academically by the time they graduate from high school.

Around the world, a number of languages are being revived through bilingual education: Gaelic is now offered in many Scottish middle schools, where a Website called Gaelic4Parents is designed for parents whose children are learning the language that their grandparents spoke and loved; in Spain, Basque society and government agencies have made a huge effort over the past twenty-five years to revive Euskara (the Basque language in Euskadi), and now a third of the population speaks the language, with the biggest gains among school age children; and even in Mexico and Guatemala, efforts are being made to preserve the language of the Maya (still spoken by two million people), with the help of bilingual education programs in the schools and a new university in Valladolid that is offering courses in the language of the ancient civilization that first invented the concept of zero and produced an extremely accurate calendar without the use of telescopes. It is worth remembering that 65 percent of the world population speaks more than one language, and that people often learn new languages without the benefit of formal bilingual education programs, a testament to the value of multilingualism.

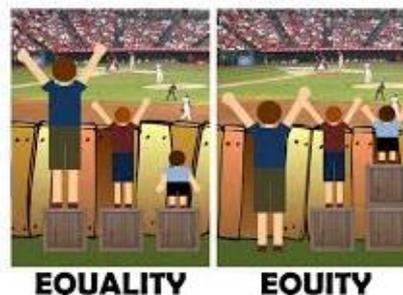


Fig. 1: Equality vs. Equity

In the U.S., the term “bilingual education” includes a wide range of methodologies. At one end of the spectrum we find the Immersion (or Submersion) Program, where the student receives no help whatsoever in his or her native language and all the classes are in English. This “method” requires nothing from the school district beyond intensive English classes, and students must navigate all content classes in what is, for them, a new language, with no additional support. The message is: “your language and your culture have no currency here, so just do the best you can.” Since it takes an average of five years to acquire the academic language needed for success in school, this method condemns most students to failure.

While not ideal, a slightly better method is the English as a Second Language (ESL) or English as a New Language (ENL) method. This method also relies on intensive English lessons while all content classes are still in English, but the student receives some extra help from specific ENL learning methods, either from the content teacher or from another person in the classroom who is there to help the students who are learning English. While preferable to the immersion method, the results of the ENL method are not substantially better. It is the method most commonly used by American school districts for their English language learners who start school in the secondary grades.

Better yet are the Transitional Bilingual Education methods where, in addition to intensive English lessons, students can sign up for a few content classes in their native language. The goal of this method is to transition as quickly as possible to all-English classes, typically in one or two years.

## 2.2 Additive Bilingual Education Programs

Let us now consider the additive methods based on the latest research. These methods produce the best results and are truly worthy of being called “bilingual education programs.” An interesting key aspect of these programs is that, in addition to intensive English classes and some content classes in the students’ native language, they rely on perfecting the language skills of these students in their first language. For Spanish speakers, for example, this means learning Spanish literature and poetry, and the continuing practice and growing mastery of reading

and writing in Spanish—a “Cervantes instead of Shakespeare” approach. These instructional methods are based on the discovery that many of the skills and abilities one has in their first language can transfer to the new language being learned. A person learning a second language does not learn it the way a baby learns to speak their first language. Our first language gives us useful competencies and abilities that can transfer to the second, target language. The takeaway is that those students who continue to improve their Spanish in school learn English better and faster than students who do not receive these classes. These classes are often called Native Language Arts or Heritage Language Arts.

The teaching methods that include the study of the student’s first language, and that are much more effective for bilingual students than those mentioned earlier, are called Maintenance Bilingual Education, and can be adapted for primary or secondary schools. The goal of these methods is to develop academic competency in both languages, and so they eventually include content classes in English and also in the native language. For Spanish speakers, if history and social studies are taught in English, for example, then mathematics and science can be taught in Spanish, or vice versa. The important thing is for students to continue to improve their academic Spanish as they continue to learn more and more English.

Lastly, a method similar to this last one is called the Dual Language Program. This method also seeks the development of academic competency in two languages simultaneously but is usually set up for students who begin the program in kindergarten, because it may be set up with classes where half of the students speak one language and half of them speak the other. In this way, students who only speak English, for example, can also become perfectly bilingual by the time they finish sixth grade. In these programs both languages and both cultures are accorded the same value, and both are appreciated because they contribute to the linguistic competence of all students, no matter which language they speak at home. Students in these programs often do better academically than their monolingual peers, and graduate high School with better grades across the board in addition to their valuable linguistic and cultural competencies.

For a comparison of the outcomes of these various programs, please reference [Thomas and Collier<sup>1</sup>](#). In the graphic, the heavy dotted line in the NCE axis represents the average performance of a monolingual student. The other lines in the graph are compared against that baseline.

Variations of these methods have long been used with excellent results in multilingual countries such as Canada (English, French, and several native languages), Switzerland (French and German), Finland (Finnish and Swedish), and Belgium and the Netherlands (it’s complicated...). In addition, many of these research-proven methods are now being introduced in multilingual countries like India—which has 23 official languages and hundreds of dialects—and in other countries intent on reversing the loss of languages that are an integral part of their cultural heritage.

### 3 The Complex Needs of Emergent Bilinguals in our Schools

When setting up bilingual programs, it is important to know the many things that work that are research-based, because there is no silver bullet. Programs that promote second language acquisition successfully must incorporate a number of features simultaneously. It is important to recognize, in addition, that language learning (with its traditional emphasis on mastering grammatical rules and the practice of speaking and writing) is not the same thing as language acquisition (acquiring the ability to function in the target language, which relies mostly on reading and on listening carefully to native speakers in meaningful contexts). Language acquisition is more natural, more robust, more long-lasting, and can best leverage the person’s first language (L1).

It is also important to recognize that oral proficiency in social situations is not the same as the mastery of academic language. **BICS**, or **Basic Interpersonal Communicative Skills**, refers to the development of conversational fluency in the target language, while **CALP**, or **Cognitive Academic Language Proficiency**, refers to the use of language in decontextualized academic situations. Academic language tasks often require students to respond to written prompts without meaningful context (tests). Research shows that it takes emergent bilinguals in the higher grades five years or more to acquire the language proficiency required to succeed academically, which is

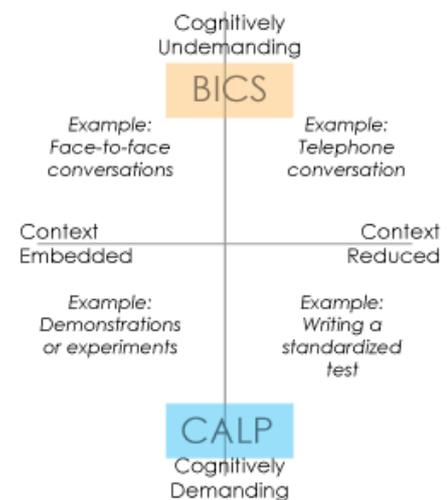


Fig. 2: BICS & CALP

why providing at least some content in the students' native language is so important. Without any instruction in their native language, emergent bilinguals face a virtual "language desert". A recent study found that during their first year in a typical American school, English Language Learners use language for academic purposes an average of only 4 minutes a day.

Moreover, it is all too easy for content teachers to hear a student speak with near fluency in the target language and to forget that their academic language, the depth of their vocabulary, and their ability to comprehend academic texts and written materials in low context situations may still lag far behind the comparable skills of their monolingual peers. Providing at least some content materials in the student's own language gives that student more context to make sense of the information, allows for the use and further mastery of native language skills, prevents students from falling too far behind in regular content classes, and ultimately accelerates the acquisition of the target language as general language skills transfer from the native to the target language.

### 3.1 The Importance of Tier 2 Words/Dictionaries/Glossaries

Another important consideration involves the type of words that most hinder emergent bilinguals academically. If we consider all vocabulary as being made up of three different types of words, from the most common everyday words to the specialized words of a specific discipline, we could divide words into three tiers.

**Tier 1** words are the simple words used at a high frequency in normal conversation and are learned readily; their instructional impact is low. **Tier 3** words are specialized words that we rarely encounter outside of a specific content area, their meaning and etymology is complex, and they are often cognates between the native and the target language (like photosynthesis); because of this their instructional impact is also fairly low. **Tier 2** words, however, are sophisticated words that are encountered regularly in a variety of texts across content areas, their frequency is moderate to high, they often have nuanced meanings, and their instructional impact is high (words like extrapolate, adjacent, or criterion). Both instructors and emergent bilinguals benefit from consciously focusing on Tier 2 words during instruction, and from making sure that students learn to flag these words when they do not understand their meaning fully so that they can continuously and efficiently enrich their academic vocabulary.

Together with this awareness, students need to be taught and encouraged to use the many general, subject-specific, and etymological dictionaries available online in their native language, and rewarded for doing so regularly. There are also many general and subject-specific glossaries available online from national universities, state education departments, museums, historical societies, and other institutions that can be used online or copied and printed for student use, especially during examinations. They are only a couple of clicks away. In many cases, some of these glossaries have links to other valuable instructional materials.

## 4 Tools and Resources for Language Acquisition that Can be Used in the Science or Content Area Classroom

The content classroom—as opposed to the language classroom—is obviously focused on the curriculum of the particular content area, but conscious attention to language acquisition strategies can yield benefits both in language acquisition and in the mastery of content area skills and knowledge. The benefits in terms of language acquisition were discussed already, but the benefits in terms of content area instruction are just as important.

It is said that if you give someone a fish, they can eat for a day, but if you teach them to fish, they can eat for a lifetime. Without stretching the metaphor too far, the argument can be made that learning to learn is a more valuable skill than anything else we might learn in a classroom. Students who are trying to learn content in a new language face much more daunting obstacles than native speakers of the language of instruction, so motivation is a key to success. And just as motivation is crucially important in language acquisition, motivation is also a powerful tool in the content areas. It follows, then, that setting up a classroom where students have more agency, and where they feel more in charge of their own education, will result in a powerful symbiosis between language acquisition and more effective learning in the content areas.

One way to accomplish this is to give emergent bilingual students tools that they can use in their own language to access materials in the content area. In some cases, students may be able to access educational materials that are made available on the Internet by Ministries of Education or universities in their own countries,

or by other countries where their language is spoken. These include free online textbooks, study guides, curricula, and short reading passages that can be easily incorporated into content instruction and that promote acquisition and mastery of reading skills in the native language. It is also possible to find a variety of materials posted online by professors, teachers, university students, or others with an interest in the particular subject being studied—a little digging usually pays off. In addition, Wikipedia, Google, Google Images, Prezi, and many other websites are resources that teachers and students alike can learn to use judiciously and mine for content, labelled diagrams, and as a springboard to other online resources. Even YouTube has entire lessons on particular subjects in various languages taught by university professors, experts in the field, and graduate students. There are also various free online learning platforms, such as the Khan Academy, that provide lessons in a variety of subjects both in English and in Spanish, and some lessons are beginning to appear in other languages as well. The trick is to conduct the search in the target language. For example, a search in Spanish for “Biodiversidad en \_\_\_\_\_”, with any country in the blank where Spanish is spoken, will turn up a number of wonderful resources and materials for the country in question, with obvious applicability in the science classroom.

Other resources, such as Phet Labs, appear to be English-only resources, but if you dig patiently you will find that teachers around the world are using these online science resources for their classes, and posting their own lessons and materials in a number of languages.

In the United States many institutions that have excellent educational resources online are now providing a portion of those resources in Spanish and, in some cases, they are mirroring their entire websites, making very professional Spanish translations of every one of their Web pages, videos, blogs, and other materials. Among these are the Howard Hughes Medical Institute (HHMI), National Geographic, The Smithsonian, The Nature Conservancy (Nature Works Series), and many others. Institutions in certain countries, such as the Canadian Museum of Nature, have materials in two languages as a matter of course, as do a number of other sites such as Zoo Portraits.

#### 4.1 Leverage Available Resources

How best to leverage these online resources? Motivation to learn springs from a felt need in the student, and that felt need can be fostered in a number of ways. In the science classroom, one obvious way is by using Problem Based Learning, where students learn to collaborate in order to tackle real-world problems, as this collaboration requires a more intensive use of language and promotes soft skills like teamwork, perseverance, and other leadership skills. Another excellent way to promote internal motivation and a growth mindset is through the authorship of learning materials for the use of peers. This can be accomplished by having emergent bilinguals produce concise, foldable, one-page mini-pamphlets in their native language for use by their same-language peers to study or to prepare for tests. Each folded sheet can be accompanied by a set of practice questions, also in the native language.

With the help of a clear rubric and a little practice, groups of two to four students can produce very useful foldables with a modest amount of effort that can be shared with their peers. When studying organ systems, for example, one group can cover the nervous system, and another the respiratory system, etc. At first, depending on the number of students who speak a specific language, not all systems may be covered unless each group does more than one system, but the effort is cumulative, and over time students will have access to more and more materials. Then, students can focus on improving the materials, editing the content, and otherwise making the foldables more useful, colourful, or expanding them to cover, for example, common diseases of each system and/or medical treatments for them. In mixed classes, students who are fluent in the language of instruction can also author materials for their peers, and students can then collaborate across languages, comparing their learning materials and helping each other improve their products.

By grappling with content in this way, students use their native language more intensively, which helps them acquire the target language faster as the skills they learn transfer. While pedagogically sound in its own right, authoring learning materials for peers is especially beneficial in the content areas for students who are still learning the language of instruction: they use language more intensively and at a higher cognitive level; it gives them more context in the content area, improving retention; it encourages them to seek out learning materials on their own; and it gives them more confidence that they are capable of learning whatever they need to learn to succeed academically, both in their own native language *and* in the target language.

## 4.2 Concept Maps

One of the learning tools that best exemplifies and promotes the symbioses between content and language acquisition goals is the use of concept maps. The Institute of Human and Machine Cognition ([IHMC](#)) offers one of the best and most intuitive concept-mapping software packages for free, along with instructional and support materials on the use of concept maps and a library of completed concept maps in various languages organized by theme. Teachers can copy or create concept maps for their students, who can then use them to revise and evaluate their notes, learn content, study for assessments, and review before major exams. Many excellent concept maps in many languages are available for download and use, some created by experts in their field and some by students. If time allows, advanced or highly motivated students can download the software and use the IHMC Concept Mapping tools to create their own concept maps.

A single concept map can display amounts of information that would be equal to many pages of text, but because the *relationships* between each concept are clearly labelled, concept maps facilitate higher order thinking and a focused use of Tier 2 words. In addition, they are information dense without requiring a lot of reading, making it easier for language learners to use in both their native *and* the target languages. Using the same concept map in both the native language and the language of instruction also allows emergent bilinguals to see how many true cognates exist within the discipline, and to see important Tier 2 words used appropriately in both languages, facilitating the transfer of already mastered language skills to the target language.

Creating concept maps is a prime example of a higher-order thinking skill, because each concept has to be linked to other concepts by a clearly defined relationship. While not all students might be up to the task of creating concept maps, the use of concept maps should be part of the curricula of any 21<sup>st</sup> Century school, especially if it caters to multilingual students who are in the process of acquiring the language of instruction. Like good expository writing and a broad, multicultural perspective enhanced by multilingual skills, creating concept maps is the kind of skill all educators should seek to master, use, and impart to their students.

## 5 Key Points to Remember

Because second language acquisition is such a broad and complex issue, and because the implementation of bilingual programs in schools suffers from a number of severe constraints such as high-stakes state tests, it bears highlighting the most important aspects of recent research on those strategies that have proven to be most effective in order to help practitioners “keep our eyes on the prize”.

- Students who are learning science or any other content while they are also learning a new language will do far better at both if they continue to develop literacy skills in their own language, so encourage your emergent bilingual students to use their own language as much as possible
- Context is very important: giving students at least some materials in their own language provides more context, increases confidence, and promotes language use
- “Code switching” between languages develops executive skills in the prefrontal cortex of the brain, and executive skills go hand in hand with self-directed, intrinsically motivated learning: this is what we call *agency*
- Learning to learn is a lifelong endeavour—as students learn *how to learn*, they free themselves of the need for formal instruction and begin to act as the key agents of their own learning
- In the early stages (especially the first year), listening and reading are the keys to language acquisition (Krashen, 2003; Krashen, 2008)
- Comprehensible input is key (both in L1 and L2), so maximize high context, meaningful communication between learners at an appropriate level of development
- Learning is a meaningful social exchange mediated by language, so maximize the use of language, *any language*, by your emerging bilingual students in *all* content areas
- Ultimately, using language for meaningful communication is much more important than which language is used
- Tier 3 words are often cognates and are subject specific, so the focus should be on Tier 2 words
- Having students participate actively in *constructing meaning* is KEY
- Creating something useful for others is a powerful motivator and helps students acquire the skills and mindsets needed in an increasingly innovative world, so give students the opportunity to author learning material for themselves and others

- There are many more free, online resources than we imagine—in a variety of disciplines—in most of the native languages spoken by our emergent bilingual students
- A welcoming school culture and an inclusive atmosphere go a long way to lowering affective barriers to language acquisition, so pay attention to bilingual or multilingual signage and important announcements

In the last two decades we have been trying very hard to wring marginal improvements from the industrial mode of schooling, an outmoded paradigm that was extremely successful a few decades ago, but that is based primarily on obedience and on learning to do tedious, repetitive tasks well without complaining. This is why multiple-choice tests are such a prevalent form of assessment today, even though they tend to only measure skills and abilities that are, at best, marginally useful in today's world. In the 21<sup>st</sup> Century, the industrial model of education does not lead to better outcomes in the content areas OR in the area of second language acquisition, so we need to stop trying to *do things better*, and should instead start *doing better things*.

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<sup>1</sup> [http://www.dlenm.org/uploads/files/La\\_Siembra\\_TM\\_El\\_Enriquecer\\_TM\\_Program\\_Planning\\_Retreats/Communication\\_Samples/5\\_2-Collier\\_Thomas\\_Graph\\_Els\\_Long-Term\\_K-12.pdf](http://www.dlenm.org/uploads/files/La_Siembra_TM_El_Enriquecer_TM_Program_Planning_Retreats/Communication_Samples/5_2-Collier_Thomas_Graph_Els_Long-Term_K-12.pdf)