

book in earnest, I thought, “This is going to be nice and compact and manageable. It’s only five months. I don’t have to scan whole great sweeps of history. I don’t have to understand all that was happening in Europe.” It was basically one summer, one country. As you can tell by the thickness of the book, it turned out to be a lot more sprawling than what I expected.

But it was a fun exercise. I do think you get a different perspective by looking at a particular period. There are certain times when looking at a freeze-frame of a moment in history has real benefits. I don’t know offhand of any other period that I would particularly want to do. The only one that would leap to my mind would be 1903, because that was the year of the first World Series, and it was also the year when Henry Ford made the first Model T. And the Wright Brothers’ flight was then. So that was an exciting year, too. You get them every once in a while, where just out of coincidence a number of momentous events happen at the same time. I think that’s quite interesting.

### **Biographical Sketch**

Michael Ray Taylor is a frequent reviewer and literary writer for Chapter16.org, the website of Humanities Tennessee, a nonprofit agency sponsoring literary events and providing free reviews to Tennessee newspapers. He is currently collaborating with Randy Duncan and David Stoddard on *Creating Comics as Journalism, Memoir and Nonfiction*, a textbook to be published by Routledge Press in 2015.

## **When “Language for Specific Purposes” classes aren’t specific enough: Abbreviated Second Language Occupational Training (ASLOT)**

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### **Abstract**

Increasing worldwide immigration is leading to extreme cases of localized globalization, creating sizable secondary language (L2) communities within larger primary language (L1) populations. Although interest has risen in teaching Language for Specific Purposes (LSP) courses, these programs cannot wholly meet the societal needs engendered by the highly concentrated numbers of L2 speakers in some areas. A new discipline within LSP, Abbreviated Second Language Occupational Training (ASLOT), can and does meet a wide range of specific language and occupational needs, at many different societal and economic levels, and is accessible to most working adults. ASLOT is an important first step in allowing persons in the L1 community to reach out to L2 speakers within the primary environment. This training process, when based on correct and appropriate curriculum, produces a linguistic bridge that may, at a minimum, lessen tensions, reduce fear, and promote understanding by L1 speakers of local L2 speakers, and improve work productivity for L1 speakers, in as few as 20 hours of instruction. In more extreme cases or situations, such as law enforcement and medical emergencies, ASLOT can mean the difference between life and death. ASLOT has been used over the last 25 years by hundreds of trainers for thousands of students. It is time to recognize ASLOT as a distinct discipline in the field of LSP.

**When “Language for Specific Purposes” classes aren’t specific enough:  
Abbreviated Second Language Occupational Training (ASLOT)**

An ER nurse in Minneapolis needs to calm a Hmong-speaking man who may be having a heart attack. A firefighter in Miami is trying to determine if a Haitian-creole speaking child is trapped in a home. A lineman in rural Idaho needs to warn a Spanish-speaking family about a downed power line. A police officer in Omaha needs to question a Nuer-speaking Sudanese youth. Increased worldwide immigration is leading to extreme cases of localized globalization, creating sizable second language communities within the larger primary language population. Although there is an expectation that immigrants will learn the primary language of their new country, there is a steep learning curve and a long period of limited communicative ability while that language learning takes place. In the meantime, how do members of the dominant language community both provide services (public safety, medical, educational, but also installation of cable TV, water, or utilities) and reap the economic benefits (sales of food, clothing, furniture, cars, etc.) of these new society members? One of the answers is the increased use of a new method of second language instruction: Abbreviated Second Language Occupational Training (ASLOT).

**Development of Language for Specific Purposes (LSP)**

Historically, virtually all North American university and college language departments have been responsible for teaching “foreign” languages, that is, languages spoken outside the borders of the primary linguistic community or national borders. Although various language teaching methodologies evolved, there was still a strong adherence to teaching all four skills of communication (reading, writing, speaking, and listening), as well as to the assumption that the foreign language being taught was for use in travels to the foreign country where it was spoken. During the 1960s, research in the field of teaching Language for Specific Purposes (LSP) began to emerge, based largely on the theories and original studies by British scholars in the field of English for Specific Purposes or ESP (Anthony, “Defining” 1997, Hutchinson & Waters, 1987). It was during the 1990s, however, when a new academic interest in teaching Language(s) for Specific Purposes<sup>1</sup> came to the forefront, most notably in the U.S., fueled largely by the overwhelming number of Spanish-speaking immigrants who were arriving.

Since 2010, a proliferation of Language for Specific Purposes certification programs have been established at universities throughout the United States, promoted by two Modern Language Association studies (2007, 2009). The two certification programs most commonly created are Spanish for Business and Spanish for Medical Personnel. A quick internet search reveals fewer than a dozen U.S. or Canadian universities which offer French for Business, and even fewer that offer any other language (German, Arabic, Chinese, Japanese, etc.) for any specific purposes program or certification.

Language for Specific Purposes courses differ from traditional four-skill language classes in a variety of ways. Kristen Gatehouse (2001) explains that most are based at least in

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<sup>1</sup> The term “specific” is often interchanged with the term “special” in LSP research. In this paper LSP is always understood to be Language(s) for Specific Purposes, as there is nothing inherently “special” about the language taught in ASLOT courses; it is, however, highly specific to whatever occupational area is being addressed.

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part on Hutchinson and Waters' (1987) proposed definition of English for Specific Purposes courses:

- class and material are designed to meet the specific needs of the learner
- instruction is restricted to the language skill needed
- instruction is centered on a style of language appropriate to the activities
- instruction contrasts with general language teaching (or TENOR: Teaching of English for No Obvious Reason)

Gatehouse shows how Hutchinson and Water's definition of English for Specific Purposes was refined and expanded by Dudley-Evans (1998), to include a greater emphasis on instructional differences from General English courses:

- instruction is designed to meet the specific needs of the learner
- instruction uses an underlying methodology which is different than that of General English
- instruction is related to or designed for specific disciplines
- instruction is generally for adult learners at a tertiary level
- course is designed for intermediate or advanced students
- instruction assumes some basic knowledge of L2, but may be used with beginners

Both of these definitions (Evans, and Hutchinson and Waters) still consider ESP (or, by extrapolation, LSP) instruction to fall within the educational realm, rather than a training framework.

### Language for Specific Purposes' Societal Value

While important, the type of Language for Specific Purposes instruction described and defined by the aforementioned scholars is of limited value to the population as a whole, and cannot make a dent in the community needs of persons of the official, dominant, or primary language population (L1) who may encounter and work on a limited or intermittent, but regular basis with speakers of other "minority" languages (L2)<sup>2</sup>. Historically, courses in specific purpose English (or any other language) have presupposed one of two situations about where and with whom the student will ultimately speak the "specific purpose" language. One assumption is that the ESP/LSP student is, or will soon be, living in the fully supported new language environment (for example, Chinese students studying business English in preparation for arrival in the U.S. to work). These students have a stake in learning to speak the second language and know that they will be called upon to use English daily at many different tasks and in many different situations, regardless of the "specific purpose" (in this case business) for which they are studying the language. The other possibility is that the ESP/LSP student will be someone, like an Italian tour guide, who desires to learn English knowing that he or she will

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<sup>2</sup> Nelde (1987) offers five reasons to avoid the term "minority" with reference to smaller ethnic groups, three of which apply to this paper: 1) "Minority" has a negative connotation; 2) "Minority" languages have less prestige; and, 3) "Minority" has no universal definition. (39-40) Throughout the rest of this paper, "L1" will refer to the official, or dominant language of a city, state, region, or nation, and "L2" will refer to the primary or first language of the smaller ethnic immigrant community within the larger community.

use English in an extended situation every day, and will, in addition to the “specific purpose” of giving tours, need to answer a wide range of questions from the visiting tourists. English may be the *lingua franca* of his or her job.<sup>3</sup>

Neither of these situations is true for a primary language speaker who, within his or her home (i.e. primary language) environment, may encounter a resident L2 speaker only occasionally for brief, largely anticipated, communicative interactions—for example, a cashier with a customer, an ER nurse with a patient, or a police officer with a motorist. Generally, these momentary and intermittent language encounters are much more prevalent, and cover a wider range of subject matter, while at the same time are even more occupation-specific than what existing Language for Specific Purposes courses cover at the tertiary or college level.

In spite of an upsurge in teaching Language for Specific Purposes (LSP) classes in many post-secondary schools, these programs cannot wholly meet the societal needs engendered by the highly concentrated numbers of second language (L2) speakers who have settled within the borders of a primary language population.

### Localized globalization

The world has entered an era of extreme *localized globalization*: the rapid and large-scale influx or immigration of populations who create an L2 language island within an L1 language area. The “it’s a small world” attitude of globalization takes on a more personal meaning as “others” move into neighborhoods and communities. Many of these new groups are highly isolated from the mainstream society because of language differences. An influx of L2 speakers may occur rapidly and with little warning, placing a strain on all types of services, most notably on education, medical, criminal justice, and social services but only within a highly localized area (a neighborhood or a city, for example), while in other nearby communities there may be either no appreciable L2 community settled within it, or its L2 community may speak a different L2 language. In these cases, the “specific” of Language for Specific Purposes is relevant not only to the purpose of speaking a second language (for medical, business, judicial, etc. purposes), but for the actual language needed (Spanish, French, Hmong...) for the linguistic transactions.

Although a person may have prepared, by secondary school or university education, to speak another language (either for a specific purpose, or for general education), that language may not match the language of the newly-arrived language group who has settled into the local community. Take, for example, a person who studied two years of college Spanish, but who now works in Lexington, Nebraska (population 10,230) where there has been a recent influx of approximately 2,200 Somali immigrants, who, in 2010, made up over 20% of the town’s population.<sup>4</sup> Clearly, in these situations, some rudimentary communication skills need to

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<sup>3</sup> For example, in 2003 when I and my husband were in Mexico City we took a tour with three other couples—each of whom were conversant in at least two languages: 1) Hebrew/English, 2) French/Spanish/English, 3) German/English, and 4) Spanish/English were our language options. The tour guide spoke English, Spanish, and Italian, so English was the only language in common for the eight persons in the tour group.

<sup>4</sup>[http://lexch.com/news/local/article\\_f94d084d-bd98-587c-9c30-a3b497500d39.html](http://lexch.com/news/local/article_f94d084d-bd98-587c-9c30-a3b497500d39.html) (Original post, Sept. 24, 2010, “A Community Call for Spiritual Assistance”, Lexch.com). This situation also holds true beyond the U.S.

develop among many, if not most members of the primary language community, in order for basic contact to begin and positive relationships to develop between these local linguistic islands and the surrounding L1 community at large. (It goes without saying that the L2 community also has a responsibility to begin learning the primary language of the community in order to more fully integrate into it.) Jane Jacobs in her groundbreaking work about urban planning, *Death and Life of Great American Cities*, says: “The sum of such casual public contact at a local level—most of it fortuitous, most of it associated with errands, all of it is metered by the person concerned and not thrust upon him by anyone—is a feeling for the public identity of people, a web of public respect and trust, and a resource in time of personal or neighborhood need. The absence of this trust is a disaster to a city street.” (73) Although Jacobs is talking about the importance of sidewalks in cities, her remarks could as easily be understood to be about verbal interchanges—casual and intermittent—but crucial to the promotion of trust and understanding among persons of different languages and cultures.

### **Finding a Communication Solution**

In the U.S. today, there are hundreds of thousands of English-only adults who encounter and provide vital services to second language speakers, on either an occasional or a regular basis, but who are no longer studying in a formal educational environment. Most of these English-speaking persons do not have the luxury of studying in a general communication, multi-semester, four-skill (reading, writing, speaking, listening) second language class in order to promote meaningful communication between themselves and persons in the secondary language group(s). Even current college students do not have the time (in terms of both physical time and credit hours) to study a second language that may or may not be applicable in their career field after graduation. How can cross-language communication be promoted cost-effectively among the adult population?

### **Abbreviated Second Language Occupational Training**

One effective solution is the use of Abbreviated Second Language Occupational Training (ASLOT), a new type of language training that is accessible to any adult in virtually any occupation. ASLOT is a non-grammar-based, highly focused, job-specific method of training primary language (L1) adults in enough L2 to be able to speak using correct, but limited, language in order to communicate efficiently and appropriately with L2 speakers with whom they have momentary or intermittent interaction within the community. ASLOT relies on psychomotor skills (as opposed to cognitive skills) and memory burns to achieve this level of limited language. Reading and writing in the second language are eliminated as real-world goals, and receptive skills are practiced only to allow the recognition of short answers based on diagnostic and screen questions. The amount of material to be mastered in any ASLOT course is limited, and the amount of time required for instruction is of short duration (usually 12-24 hours).

The new methodology prescribed by ASLOT provides for a wide range of identifiable language needs for very specific occupations, at many different societal and economic levels, in

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borders. Parisian police struggled to control the 2005 riots, which broke out in various L2 (Arabic) neighborhoods; it is unlikely that French police were bilingual in French and Arabic.

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a manner that is accessible to most working adults. ASLOT courses build an important, potentially life-saving connection that allows persons in the L1 community to reach out to L2 speakers living within the L1 environment. This model will work, not only in the U.S., but also in any community, of any nation where there is a significant second language population. The persons affected may work in many varied professions and occupations; they may be of various ages (though admittedly they are more likely to be adults than teens). These are persons who speak the native or dominant language of their city, state, or region, who also, on an intermittent but regular basis need to communicate and interact in a limited situation, with persons who speak a different language—Spanish, yes, but also Hmong, Russian, Somali, or Burmese. Imagine, for instance, an English-speaking police officer who patrols a Hmong neighborhood in Minneapolis, a firefighter in a Russian neighborhood in New York City, or a bilingual Spanish- and English-speaking ER nurse who works in a hospital in a Haitian neighborhood in West Palm Beach, Florida.

### The Purpose of ASLOT Training

While the underlying principles and pedagogy of ASLOT remain essentially the same between various occupations, the purpose of training using ASLOT will vary according to the relationship of the L1 speaker to the L2 speaker. There is a conceptual difference behind the language required by different occupations that goes beyond a simple descriptive differentiation of vocabulary lists. As one moves from one occupation to another, the purpose for learning the second language changes, as well as the relationship between the primary and secondary language speakers. A police officer's purpose may be to *command and control* a crime scene; a social services clerk may need to *question and gather information*; a pharmacist may need to *make statements and relate appropriate information* about administering medications. In all of these cases, the choice of language and vocabulary is always based on the maxim of "More is less and less is more". Offering multiple (i.e. more) grammatical or vocabulary choices actually impedes communication as the learner must filter through more words to arrive at the appropriate output. For example, a police officer needs only to know one way of saying, "Turn around"; to know more requires precious seconds of determining which might be more appropriate phrase, increases the possibility of mispronunciation, and can so frustrate the officer that he or she says nothing at all.

Since relatively few phrases are taught in any ASLOT course (approximately 50 beyond basic greetings and social niceties) each one must be judiciously chosen based on strict criteria:

- 1) Criticality to job task or function in L1
- 2) High use in job tasks or functions in L1
- 3) Applicability in multiple job tasks

Once these L1 phrase choices are made, the L2 translation must be one that is commonly *understood* by all major L2 dialects (although the translation may not be the more commonly *used* phrase in one or more of those dialects). Taking the "Turn around" example from above, and applying it to Spanish: police officers are taught to use "Voltéese" ("Turn around") because it is understood by all Spanish dialects, although some Spanish-speaking countries "Dé vuelta", or "Gire" are more commonly said.

The purpose of ASLOT and its intense contextualized training allows for variation in the types of output required by different occupations, as well as acknowledging their separate

goals and objectives. For many occupations, such as police, emergency medical services, safety supervisors, etc., the need to communicate is so crucial and so immediate that they do not have the time to negotiate meaning. Clerical occupations may be able to take a more relaxed approach and read pre-formed questions from a script. Still other occupations, such as retail sales must speak without the support of written language materials, but will have more time and less stress to negotiate meaning, using gestures and even pantomime. The classroom methods required for learning language lines that must be ready for use at all times, or “in your head” materials, are significantly different from those questions and statements which may be looked up, or exist as “in your book” content.<sup>5</sup>

### **ASLOT Pedagogical and Learning Theory**

ASLOT is based on intense, contextualized learning (sometimes called purposeful learning), in which every word or phrase is learned within the specific context in which it will be used. Moreover, this contextual approach is largely responsible for the high level of motivation for students studying in ASLOT programs. Precisely because police (or nurses, or teachers, or real estate agents, or . . .) are continuously engaged in learning language lines that are directly associated with their real-world occupation, they remain intensely interested throughout the training sessions.

In all ASLOT-based classes, oral production of language is stressed almost exclusively, and is learned through memory burn and kinesthetic (rather than cognitive) exercises in the classroom. Unlike a traditional beginning language class, because of the importance of oral production (speaking), ASLOT courses begin with intensive L2 pronunciation instruction, based on both print/sound (i.e. correspondence between the written L2 and its oral pronunciation) and phonetic encoding. Phonetic encoding is a system that uses both real and made-up one-syllable words from the L1 to approximate the syllabic sounds of the L2—for example, the English phrase “Turn around” is taught as the French “Tournez-vous” with the phonetic encoding support of “tour-nay/ voo”. Pronunciation modeling by the instructor and intensive repetition by the students begin every ASLOT course.

On the job there is a strict dichotomy between what an L1 speaker *needs* to know in a given situation and what would be *nice* to know, not to mention those things they have *no need* to know. For example, a dentist does not need to know how to ask a patient about bowel movements, and a medical doctor does not need to tell someone they need a root canal, although both the dentist and the doctor might have taken an LSP “medical Spanish” course in the university. Because of the extreme specificity of the language purpose, ASLOT does not need to allow time for “creation” or any whole language capacity. In addition, L2 writing and reading skills are jettisoned, because they are not needed by the L1 speaker to do his or her job properly: nurses and social workers write their charts in the primary language, not in the L2; waiters and retail clerks do not need to read the L2, and have to write very little even in the L1.

Because ASLOT focuses almost exclusively on oral (productive) skills, the concepts of “one-way communication” and “diagnostic discourse” are used to a greater or lesser degree, depending again on the needs of the language learner. When a safety supervisor issues a directive, such as “Pick that up”, no verbal response is required, and yet when the recipient

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<sup>5</sup> For an introduction to these training techniques, see Dunn, *Instructional Guide*.

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complies, the communication loop is complete: one-way verbal with an observable (but not verbal) response. In other occupations, when more language is necessary than simple directives, ASLOT methods teach negotiation of meaning through the use of diagnostic and screen questioning, reducing the need to learn receptive (auditory) skills. Diagnostic discourse techniques rely on simple, directed questions, most often of a yes/no format or questions that allow a physical response such as pointing. Screen questions are those questions that have a limited set of possible answers, for example, when asked, “What do you want to drink?”, the L2 speaker will respond with a beverage (a limited answer), and not with a discourse about where milk comes from.

### **Cross-cultural information**

In all ASLOT courses, important day-to-day cross-cultural information is presented directly through the language lines taught. Some occupations, such as law enforcement, medical care, and social services, function in a higher cultural context where observational (rather than linguistic) misunderstandings are more likely to occur. These groups may need some cross-cultural lessons in addition to simple language training. Other occupations (retail sales, receptionists, bank tellers, etc.) function in a transactional context where cultural misunderstandings are less likely to occur or to cause difficulties. Regardless of the specific purpose of the instruction, all second language learners need to be familiar with common methods of greeting, leave-taking, and social niceties (please, thank-you, excuse me, etc.)—tasks taught in virtually all beginning, traditional L2 classes. In addition, ASLOT ensures that learners understand the L2 naming system, and the relational status implied by greetings (addressing women or men first? elders before others? by first name or by title? etc.). Proxemic and chronemic variations between the L2 and L1 groups should also be addressed briefly in every ASLOT course.

### **ASLOT as a Post-secondary Teaching Tool.**

Although a class based on ASLOT materials and methodology does not need to be tied to a college or university setting, an ASLOT-based course may be offered as a short, one- or two-credit “[*Language*] for \_\_\_\_” course that is highly specific and relevant to a college student’s specialization, such as “[*Language*] for Restaurant Management” (for a restaurant and hotel management major) or “[*Language*] for Landscapers” for horticulture majors, or “[*Language*] for Childcare” for human development majors. Classes based on ASLOT methodology and curricula may be offered within the language department for language credit, or through other university programs and departments for credits awarded in those departments.

For example, a university offering a B.S. in Health Science with a Radiology Concentration could offer an elective, one-credit course, “Spanish for Radiology”, with credit awarded either for language or for radiology depending on program requirements. In some cases, this will give students who have not been required to study any “foreign” language in their college career both an introduction to second language learning as well as specific, productive, useable second language phrases, commands, and questions that will allow them to do their job more professionally and courteously. At least two schools (Washburn University and Worcester State University) have offered Spanish for Educators, based on ASLOT curricula, as three-credit courses through their M.Ed. programs. In both of these cases, the students learned between 50 - 75 language lines that focused on both classroom management



and teacher-parent interactions, and were also required to do extensive cross-cultural reading and investigation about various topics, such as the role of education in the Spanish-speaking migrant population, educational systems in Latin America, literacy among L2 Spanish-speakers, etc.

Taking a short, occupation-specific, restricted competence ASLOT class introduces learners to real, useful, productive skills in a second language. It often either leads them to additional study, in general language courses, or in a more detailed Language for Specific Purposes course. An ASLOT course bolsters students' confidence that they will be successful in learning and using a second language in the real world, giving them an added incentive to continue their language studies. For those students who are unable to continue in general second/foreign language courses, they will, at a minimum, have the language tools to initiate friendly and occupation-related contact with persons in the L2 community.

### **Practical Application of ASLOT**

There is, in fact, a concrete example of ASLOT that has been extremely successful for over 30 years. Dr. Sam L. Slick began developing a new pedagogical model that when he was asked to teach Spanish for law enforcement officers, while serving as a Spanish professor at Sam Houston State University in Texas in the mid-1980s. Later, after moving to the University of Southern Mississippi, he continued privately to offer Spanish training for law enforcement officers, as well as correctional officers, and nurses, creating and publishing language manuals under the "Command Spanish®, Inc." name.

The author of this paper began working with Dr. Slick in 1992 after having independently created a similar (Spanish) training program for the Omaha, Nebraska fire department after a near disaster in which firefighters had been unable to evacuate a building because of language barriers. They worked together for some ten years, to develop, test, and refine the axioms that are today the basis for Abbreviated Second Language Occupational Training<sup>6</sup>. The beginnings of ASLOT methodology were specified and explained in a handbook, *Instructional Guide for Command Spanish® Language Programs*, first published by Command Spanish®, Inc. in 2001. While these "ten commandments for training Command Spanish®, Inc. programs" (ii) were originally written to explain the methodology and pedagogy upon which Command Spanish® training is based, they also serve as the bedrock principles of ASLOT. Between 1995 and 2011, Drs. Slick and Dunn trained nearly 1,000 Spanish speakers and Spanish teachers in two-day "Train the trainer" seminars in how to deliver this new method of quick, effective, achievable, and useful Spanish to adults across the U.S.

Today, Command Spanish®, Inc. is the largest provider of occupational Spanish training and occupational Spanish training materials in the United States, and currently publishes over 70 distinct manuals for workers and professionals in the fields of public safety, medicine, teaching, construction, industry, real estate, hospitality, and service. The company also produces some of these manuals for a French/English market and has licensed its instructional model for Haitian Creole and Armenian ASLOT materials.

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<sup>6</sup> For an overview of the history of Command Spanish®, Inc. and its role in the development of occupational Spanish, see Slick and Dunn (2005).

### Conclusion

In our shrinking world, as globalization opens new markets and opportunities around the world, as travel increases, as migration and immigration of large-scale populations occur, and as technology allows communication around the globe instantaneously, it is easy to believe that we live in a small world with few barriers to communication. This is not the case. As primary language and secondary language speakers interact, either regularly or intermittently, misunderstandings arise and the immigrant secondary language groups become more isolated while members of the primary language population become resentful of their presence in the community. There will always be a need for fluency for some, but in the here and now, it is time to help people work and live together in spite of their language differences.

Applied Second Language Occupational Training, when based on correct and appropriate curriculum, can build a linguistic bridge that may lessen tensions, reduce fear, and promote compassion and understanding by primary language speakers of the secondary language speakers who are living in their communities. ASLOT can serve as a vital answer to language learning needs found throughout the world.

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### Biographical Sketch

Dr. Maryjane Dunn is an Assistant Professor of Spanish in the Department of English, Foreign Languages, and Philosophy at Henderson State University. Although primarily a scholar of the Pilgrimage to Santiago, Spain, and 15<sup>th</sup> century allegorical literature, mid-career her path turned to the linguistic field of teaching language for special purposes while teaching Spanish to law enforcement officers, teachers, health professionals, and public safety workers across the United States.

## 2-Sample t-Distribution Approximation

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### Abstract

The  $t$ -distribution used for the 2-sample procedures introduced in elementary statistics is actually an approximation introduced by Welch and Satterthwaite in the late 1940s. We will explore how the error of this approximation depends on the sample sizes and the variances of the independent populations.

### Motivation

We will examine the following example, which was extracted from a PowerPoint slide that accompanies a popular elementary statistics book:

Does smoking damage the lungs of children exposed to parental smoking? Forced Vital Capacity (FVC) is the volume (in millimeters) of air that an individual can exhale in 6 seconds. FVC was obtained for two samples of children, one group exposed to parental smoking, and another group of children not exposed to parental smoking.

Parental smoking	$\bar{x}$ FVC	$s$ FVC	$n$
Yes	75.5	9.3	30
No	88.2	15.1	30

We want to know if parental smoking decreases children's lung capacity as measured by the FVC test.

The following must be checked, or assumed, for the test statistic to have approximately a  $t$ -distribution: