

Modeling Language Extinction:  
The Need to Encourage Diversity within Language Curriculum

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The disappearance of languages has been traced by many researchers, yet it is unknown how rapidly this process is occurring and to what extent these changes will cause damage to existing cultures (Bishai, 1962; Kleiner, 1995; Abrams & Strogatz, 2003; & Marks, 2008). The threat of language extinction is crucial since language is not only a key component of communication, but it is also a part of one's identity and cultural heritage (Tse, 2001). Through assimilation and pressures from other hegemonies within English speaking countries, younger generations have often strayed away from their original traditions and native language (Tse, 2001). Thus, as an increasing number of languages are becoming endangered and extinct, so too are cultural identities and educational links to the history of specific ethnicities. Kleiner (1995) has researched that "linguists estimate that between 20 per cent and 50 per cent of the 6000 languages now spoken are no longer being taught to children, and will become extinct in the next century" (p. 15).

Studies by the U.S. News and World Report have found that there are approximately 6,000 living languages currently in the world (Hayden, 2003). Nevertheless, many of these languages are in danger of becoming extinct if they are not reinforced and revived at least through the culture of oral tradition. At this time, only six hundred of the world's languages are considered "safe" from extinction as they continue to be learned by new generations of children (Lowry, 2001). The world's most popular languages, which would fall under the category of being a language "safe" from extinction, include: English, Mandarin Chinese, Spanish, Arabic, Bengali, Hindi, Portuguese, Russian, Japanese and German (Lowry, 2001). According to Lowry (2001), as the international language of both business and technology, English is spoken by 250

million people as a second language, which significantly outnumbers the quantity of people who speak English as a native tongue, a figure close to 322 million.

In essence for a language to go extinct it means that it no longer has any native speakers, which could impact research abilities related to the study of smaller cultures and global communities. Although the regions most closely faced with the threat of language death or extinction are typically those of a smaller scale, these cultures may assist in providing insight into fields of herbal medicines, mathematics, and educational systems among other fields (Marks, 2008). Generally, a language undergoes the occurrence of language death as it becomes subjugated and replaced by a more prevalent language, which supports the hypothesis that, due to acculturation and globalization, less popular languages are being abandoned as they are not being viewed as useful to the future (Belikov, 1994). On the other hand, there are theorists who would also argue for the null hypothesis in that globalization and acculturation are not playing a role in the disappearance of many less popular languages (Johnson, 2002).

While there are many different views on the nature and causes for language extinction, the more pertinent issues are how one will predict the rate at which language extinction occurs and how the school curriculum can encourage language diversity education to assist in reversing this phenomenon. Most students in the United States begin taking foreign language courses during middle school and high school (Ramage, 2006). Thus, secondary schools should prepare students for both the business world of the future and personal development and growth through skill sets such as foreign languages. Effective mastery of language is important for an individual to not only succeed in a global business market, but also to provide personal connections with ones ancestral roots (Ramage, 2006).

As many secondary schools require foreign language coursework within the curriculum to graduate, an important concept for research and study is the question of which languages should be taught and why. Currently, most secondary schools currently teach languages that are popular to the parents of secondary students. However, this may not allow for diversity in foreign language education and may no longer be the best to offer in the curriculum for the students of today. Thirty years ago, languages such as French, Spanish, and German may have been more useful to international communication, yet over the last 30 years language curriculum has not changed with transitioning global dynamics. For example, due to political pressures, one of the current languages which is of highest demand to the United States is Arabic, which is not taught in the secondary school classroom (Gordon, 2010). The purpose of this paper will be to assess potential theories through which language extinction may be predicted utilizing mathematical modeling and to discuss the need for change within the current U.S. educational foreign language curriculum.

### **Determining the Rate of Language Extinction**

Abrams and Strogatz (2003) have conducted research to support the ideology of globalization as a factor in language death and have found a way to observe this parallel relationship through mathematical modeling. Furthermore, this research has shown that there is a positive correlation by which prestige languages are overpowering endangered languages (Abrams & Strogatz, 2003). In essence, this dynamical systems model states that more people will switch to speaking the prestige language as a function of time due to the dominant language's rise in social status (Abrams & Strogatz, 2003). Additionally, this model demonstrates the key point that languages which are seen to have some material value are

retained, and otherwise they are lost to the dominant prestige language (Abrams & Strogatz, 2003).

### Language Extinction Model 1

Specifically, this model works with a population of speakers who are limited to choosing between two languages, the endangered language and the prestige language (Abrams & Strogatz, 2003). Furthermore, Abrams and Strogatz (2003) assessed that the factors which play a critical role within this dynamical systems model are the proportion of speakers and their social status. Essentially, Abrams and Strogatz (2003) hypothesized that a language will become more attractive as the number of speakers increase directly impacting the speakers relative social status. In order to determine the effects on the endangered language, Abrams and Strongatz (2003), created the following equation to find the fraction of endangered language speakers,  $x$ :

$$\frac{dx}{dt} = (1 - x) P_{yx}(x, s) - x P_{yx}(1 - x, 1 - s) \quad (1)$$

Within the above equation,  $s$  is representative of the social status of the endangered language, while the  $P_{yx}(x, s)$  represents how attractive the endangered language is to speakers of the prestige language (Abrams & Strogatz, 2003). In order to simplify this equation, Abrams and Strogatz (2003) then modified this model and transformed it by assuming that  $P_{yx}(x, s)$  could also have the following form:

$$P_{yx}(x, s) = c x^a s \quad (2)$$

The above simplification makes use of  $c$  as a constant and  $a$  as a parameter which plays a role in determining the effect of the number of speakers on the attractiveness of a language (Abrams & Strogatz, 2003). Once finalized, this model was applied to the languages including Scottish Gaelic, Quechua and Welsh (Abrams & Strogatz, 2003). The results of a multitude of studies, by Abrams and Strogatz (2003), have postulated that for each of these endangered languages, they will all rapidly become extinct unless there is a movement to increase the social status of these less prestigious languages.

### **Analysis**

This trend of moving toward a prestige language is occurring today with the English language, which continues to dominate and become the world's official international language for business and commerce (Erard, 2008). Due to its large population size, Mandarin Chinese is currently the most spoken language, but through globalization English is quickly rising toward becoming the most widespread of the world's languages with predictions that in the near future there will be over 2 billion people on the planet speaking English (Erard, 2008).

Currently, half of all business deals are conducted in English, two-thirds of all scientific papers are written in English, and seventy percent of all mail is written and addressed in English (Firth, 1996). Additionally, most international tourism, diplomacy, and aviation are conducted in the English language (International Civil Aviation Organization, 2008). Though English is a highly necessary language for the future it has become a dominant language overpowering smaller tribal languages (Mechura, 2007). A loss of these less popular languages implies that there is also a loss of diversity and background for a large number of people who identify with these endangered and extinct languages (Mechura, 2007).

Examples of this global issue can be seen through languages such as Coptic, which was replaced by Arabic, and the multitude of Native American languages which have become dominated and replaced by English, French, Spanish, or Portuguese (Bishai, 1962). Another similar term to language extinction is dead language, which is applied in reference to an older language which has significantly altered itself and evolved into a new language group (Kleiner, 1995). Exemplifying this occurrence is Latin, which is a dead language in that it has no speakers, yet it forms the basis of the modern Romance languages (Adams, 2003). Additionally, studies by Wales (2008) has tracked the transition through which modern English has come to replace old English, which does not have the same inflections and spellings though it uses analogous vocabulary. In a similar fashion, Sanskrit has almost become lost to the modern Indo-Aryan languages, as there are children using Sanskrit as a revived language within Mathoor, a small Indian village (Hastings, 2008).

Personally, as a child, language was reinforced through both my customs and traditions. My mother taught me Gujarati, the state language of Gujarat (a north-western state in India), alongside English the dominant language of the United States. As a maturing adult I also attempted to pick up the national language of Hindi, which is based directly off of the historical Sanskrit language. Thus, I have become proficient in reading, writing, and conversing orally in both Gujarati and Hindi. Additionally, since Sanskrit is the root of Hindi I am also able to read and write in Sanskrit, yet being an ancient language it is difficult to comprehend the intended meanings of much of the vocabulary. Sanskrit is an example of a dead language which has been revived as a few individuals such as the Indian saints are proficient, but it is still on a trend toward deterioration, as it is not being taught and is hence slowly becoming forgotten.

In some cases, extinct languages, such as Sanskrit, still remain intact as they serve a function whether it is scientific, legal, or ecclesiastical (Hastings, 2008). Examples of these languages include Latin, Coptic, Avestan, Old Church Slavonic, Old Tibetan, and Ge-ez which are among the numerous extinct languages which are continued as sacred languages (Bishai, 1962; Adams, 2003; Hastings, 2008). These languages have essentially been conserved based on their spiritual and religious significance; however others may have been preserved due to their colonial background (Pinar, Reynolds, Slattery, & Taubman, 1995). Moreover, some languages are preserved in that they have been recorded in some form of communication, although they may not be currently spoken or used on a continuous basis.

These forms of preservation could include audio or video recordings or in script through text books. Nevertheless, if these languages are not spoken or used in oral communication they will eventually evolve and move toward extinction as the population of speakers will decrease. Additionally, this implies that the proper terminology and stylistic ways of speaking will also deteriorate as the oral communication form of the language is forgotten. This gradual process of language death through change, can be attributed to a plethora of factors, which have been studied and modeled by numerous researchers (Abrams & Strogatz, 2003; Wang, Ke, & Minett, 2004).

### **Language Extinction Model 2**

One such model is the lexical diffusion model which correlates with the hypotheses by Abrams and Strogatz (2003) in that globalization could be causing less popular languages to be overcome by the majority language. The Lexical Diffusion mathematical model has been widely studied as it is closest to determining the rate at which a language moves toward extinction, based on the rate at which the unchanged form of a word is lost to the new changed form (Wang

et al., 2004). This model of language extinction was created by Wang, Ke and Minett (2004), and postulated that rather than undergoing complete death, a language is transformed and becomes changed into a new form of the current language or replaced by a more predominant one.

The Lexical Diffusion model emerges through the use of the dynamical system which models a sound change in only a single word (Wang et al., 2004). Using the same principles, the lexical diffusion model is applicable to a group of homogeneous language users who can each choose to either retain the unchanged form of the word,  $U$ , or learn the new changed form,  $C$  (Wang et al., 2004). Thus, the model uses a factor of time ( $t$ ), and in this way it can be seen what frequency of individuals used the unchanged form,  $u(t)$ , as opposed to the changed form,  $c(t)$  (Wang et al., 2004). Hence, each individual must make a decision based on two choices to either adopt the new word choice or retain the original word choice meaning that  $c(t) + u(t) = 1$  for all  $t$  (Wang et al., 2004). Basically, this shows that there is no accountability for the free variation variable,  $V$ , as there is merely a bi-conditional system of equations and there are only certain factors which will be considered in determining the rate of language extinction (Wang et al., 2004).

Also, it was determined, by Wang et al. (2004), that the increase in the frequency of changed forms of the language is proportional to the product of  $c(t) \times u(t)$ . This increase in the frequency is also proportional to the rate of effective contact represented by,  $\alpha$ , and the length of time in which the sound change is viewed,  $\delta t$  (Wang et al., 2004). Based on the assimilation of the prior factors, the frequency at the time  $t$ , for the frequencies of the changed and unchanged forms of  $t + \delta t$ , can be rewritten as the equations:

$$c(t + \delta t) = c(t) + \alpha c(t) u(t) \delta t, \quad (3)$$

$$u(t + \delta t) = u(t) - \alpha c(t) u(t) \delta t. \quad (4)$$

The term  $\alpha$  plays a significant role within these above equations, as it acts not only as a measure of effective contact, but also as a measure of social pressures inclining one to adopt the changed form of the word or in a larger scale the language. In order to specifically determine the rate of change of the frequency of changed forms, the difference in the values of  $c$  at time  $t$  and time  $t + \delta t$  are taken and divided by the duration  $\delta t$ , as follows (Wang et al., 2004):

$$\frac{c(t + \delta t) - c(t)}{\delta t} = \alpha c(t) u(t). \quad (5)$$

Basically, the original equation is employed and the  $c(t)$  is subtracted and moved to the left portion of the equation, and the factor  $\delta t$  is then divided on both sides. In essence, the equation is rearranged in a way to solve primarily for the change of frequency as dependent on the changed form of the word (Wang et al., 2002). Following this step, using mathematics in terms of differential equations, Wang et al. (2002) found that the limit as  $\delta t$  moves toward zero can be studied showing that:

$$\frac{dc}{dt} = \alpha c(t) u(t) \quad (6)$$

Thus, knowing that  $u + c = 1$ , the equation can be rearranged in that  $u(t) = 1 - c(t)$  (Wang et al., 2004). Hence the equation which is arrived at is as follows:

$$\frac{dc}{dt} = \alpha c(t) [1 - c(t)]. \quad (7)$$

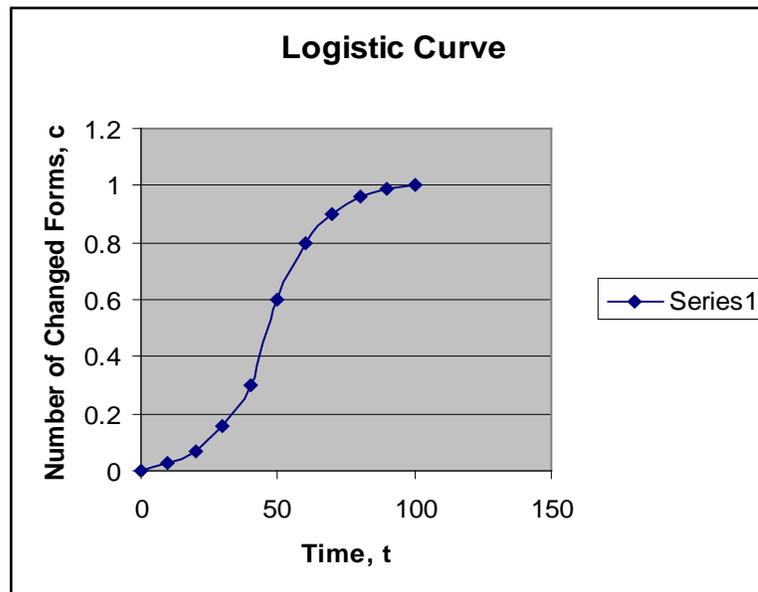
Finally, Wang et al. (2004) solved these equations for the changed variable with respect to time. This is also in the form of a Logistic equation and is the general solution to the mathematical model and can be written as follows, where  $\varepsilon$  is the initial frequency of the changed forms at the time when  $t = 0$  (Wang et al., 2004):

$$c(t) = \varepsilon \frac{\exp(\alpha t)}{1 + \varepsilon [\exp(\alpha t) - 1]}. \quad (8)$$

### **Explanation**

When studying these equations and their results many conclusions can be drawn. If this information is plotted, graphically, the results emulate the same characteristics present within an S-shaped logistic curve. This would include a slow increase initially, which would be followed by a period of further rapid increase in adoption of the new language in a near linear fashion, and lastly the graph would plateau as it reaches its peak, drops off, and stabilizes. This graph below displays that essentially as the frequency approaches the whole, or 100%, there is a gradual diffusion of the changed language form throughout the complete population. The following graph is a representation of the one presented in the study by Wang, Ke, and Minett (2004):

Fig. 1: Logistic Curve, with  $\varepsilon = 1\%$  and  $\alpha = 0.1$ .



*Note:* Wang, Ke, & Minett (2004). Computational studies of language extinction. In C. R. Huang, & W. Jenders (Eds.), *Computational Linguistics and Beyond* (pp. 65-106). London, UK: Academia Sinica, Institute of Linguistics.

In addition to studying language extinction on the basis of population size or prestige languages, there are also some studies which focus primarily on the change of vernaculars and patois (Nuessel, 1990). Subtle changes in dialects or lingo may not drastically alter a language, however, they are warning signs that the language is changing and transforming. Additionally, cultural markers and noticeable changes within the environment of the culture serve as early warning signs of change (Johnson, 2002).

### **Application**

Through globalization many cultures are trying to emulate the first world nations and rapidly adopt the English language (Johnson, 2002). One example, with India is that it is trying

to depict the American lifestyle in its movies, award shows, and music. Thus, there is a great push toward assimilation which has led many smaller tribal languages to become endangered, and many of these tribal family languages are lost as children feel that they have limited value (Hastings, 2008). Instead, these children move towards learning English since it has become understood that this is a necessary international language for both the present and the future (Hastings, 2008).

Each of the languages which become extinct, undergo a similar process although there may be multiple factors attributed to the language loss (Mechura, 2007). This includes a decrease in the number of people teaching the language to younger generations, and eventually when the language has too few speakers it will reach the breaking point. This is the point at which the language basically dies out and is then overpowered by the new global and prestigious language (Abrams & Strogatz, 2003). Another term for a language which follows this similar pattern of language death is a frozen language (Gross, 1986). It is primarily frozen since it has no chance of revival, meaning there is little hope that the language will continue in the future. Though certain aspects of the language may remain, the main components to classify the language will have deteriorated and diminished (Gross, 1986).

### **Foreign Language Curriculum**

The prior language extinction models have provided analysis and explanation which have implications for both secondary school and university curriculum design. As we have learned throughout the course, curriculum should be assessed and revised to reflect the needs of the students being served within educational standards. Despite limited financial resources, which restrict a broad offering of several languages; efforts should be made to have the proper number

of language choices as consistent with data regarding top language usage and the demographics of the student community.

While Chinese, Hindi, and Spanish are the top languages spoken worldwide, it is interesting that some of these language choices are not offered as options for students in the United States (Lowry, 2001). Furthermore, many educational institutions do not allow students to petition to take language courses outside of the middle school or high school setting unless these courses are available at a community college or university level. This option of taking coursework outside of the university would be effective if a diverse range of foreign language courses were offered at the higher education level. Unfortunately, most universities also provide standard foreign language choices, promoting those which are more dominant (Brecht & Ingold, 2002).

Personally, as a Gujarati language instructor for the past eight years working with students between the ages of 3 to 18, I see the value of being proactive in encouraging students to save a dying language. If individuals did not volunteer to take initiative to teach foreign languages, it may be too late in ten years to try to resurrect the language. Gujarati is not the only language in such a circumstance, and thus there is a need for assessment and redesign of the educational curriculum to offer diverse course selections. When applying to colleges, I found it fascinating that I was able to waive out of the University of California foreign language requirement by merely passing an exam of proficiency in the Gujarati language, yet students such as myself were not allowed to take language courses outside of the university for credit.

It may be a difficult undertaking to completely transform the language curriculum within the educational setting, as there may be opposition, limited resources, and a lack of qualified individuals to teach certain languages. However, students study world cultures and history and

this would be a complementary component to offer additional language options to those students who are motivated to pursue diverse language opportunities. The Heritage Language Initiative was created in 1999, to specifically address these growing concerns regarding language extinction and proposed that it was necessary to initiate, support and encourage collaborative dialogue and strengthen existing community based educational systems (Brecht & Ingold, 2002). Additionally, the foundation aims to specifically “design and implement heritage language programs in pre-K-12, community colleges, and college and university settings” (Brecht & Ingold, 2002).

### **Future Research**

Although researchers have designed various mathematical models to determine the rate of language extinction, in the future, I would like to attempt a study to develop a mathematical model which can emulate the disappearance of languages as based on a specific number of generations. The basis of my research would be the concept of determining the current population which speaks a given language and taking into account external economic, societal, and political factors to evaluate the number of generations before a language is lost. For instance, the following would present the loss of language over generations on the basic principle that those who are elders typically have a stronger linguistic knowledge:

Generation 1: Hi, how are you? My name is Monica.

Kem cho? Maru nam Monica che.

Generation 2: My name is Monica.

Maru nam Monica che.

Generation 3: Monica

Monica

Generation 4: {}

Additionally, I would like to conduct research observing the correlation of extinct languages and the size of the vocabulary for each of these languages, which is a study which has not been conducted to this point. In researching global language transition for this paper, I came across the website for the Foundation for Endangered Languages, which is collecting grant proposals through January 31, 2011 to promote diverse minority languages within the educational environment. I have already completed the student registration and plan to apply for these types of educational grant opportunities which will assist in enhancing foreign language development.

### **Conclusion**

Overall, it is necessary to test out a variety of hypotheses to determine what the causes are for language extinction. By determining these variables which affect language disappearance, there can be movement toward revival of extinct languages and saving those which are merely threatened or endangered. If enough individuals work to preserve a language the process of language death can be reversed. Through initiatives by the Foundation for Endangered Languages, the Heritage Language Initiative, and other language organizations there is progress being made to revive languages in danger of becoming extinct.

These organizations are taking on a large scale initiative and it may be difficult because it requires time, patience, and perseverance toward foreign language knowledge and acquisition by younger generations. Also, it is only through the joint efforts of students, parents, educators, and policymakers that collaborative progress can be made on a large scale to transform language curriculum. While secondary schools and higher education institutes are not at the resource capacity to promote and preserve all language studies, it is currently the responsibility of both

students and parents. However, in the future, there may be shifts in which additional organizations, individuals and policymakers may see the need to assist in the preservation of dying languages by enhancing language curriculum offerings.

Essentially, the disappearance of languages is of immense global significance. Statistics have tragically shown that ninety percent of existing languages today are likely to die out within the next century (Crawford, 2000). Currently, with more research, study, and work, I plan to create a mathematical model which will test another hypothesis as to why language disappearance is prevalent today and design a display of the negative global impact of language loss. Just like global warming, economic recessions, and environmental tragedies, language extinction is a universal issue and it is one in which we all share the responsibility to take action and provide support. As the popular quote by Henry Ford once stated “Coming together is a beginning. Keeping together is progress. Working together is success.”

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