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Feasibility of Digitizing LEI Evaluations with an Internationalized ASSISTments

Bryce Christian Kaw-uh
Worcester Polytechnic Institute

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Feasibility of Digitizing LEI Evaluations with an Internationalized ASSISTments

A Major Qualifying Project

Submitted to the Faculty of

Worcester Polytechnic Institute

In partial fulfillment of the requirements for the

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in

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by

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Bryce Kaw-uh

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The Latino Education Institute of Worcester State University

Project Advisors:

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Professor Aarti S. Madan, Advisor

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Professor Neil T. Heffernan, Advisor

Abstract

The Latino Education Institute (LEI), a Worcester-based nonprofit dedicated to improving the social and academic wellbeing of Latino youth and families, sought to streamline its student evaluations by moving from pen-and-paper to an online platform. ASSISTments, an online educational platform run by WPI, looked to expand its global presence beyond the United States. This MQP addressed both issues at once by internationalizing ASSISTments and determining whether it was the optimal service for digitizing LEI's evaluations. I achieved my goal by identifying software requirements, modifying source code, analyzing competitors, and conducting student pilot programs. In the end, I provided ASSISTments with translation capabilities and helped LEI transition to an appropriate means of digitization.

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1 Introduction

When I began looking for a Major Qualifying Project (MQP) about a year ago, I wanted to find a cause that combined both the technical skill of Computer Science and the social purpose of International & Global Studies. In this project, I found that cause. For my MQP, I internationalized a web service called ASSISTments and explored the feasibility of using that web service to digitize student evaluations for the Latino Education Institute (LEI).

Created in 2000, LEI is a nonprofit organization affiliated with Worcester State University that aims to "improve the academic achievement and well-being of Latino students (grades K-16) and their families" ("About LEI"). This work is crucial for addressing something called the Latino achievement gap. The Latino achievement gap is the longstanding difference in academic performance between Latino students and their non-Latino peers. The Latino achievement gap is symptomatic of underlying issues that disproportionately impact Latinos and can collectively be called an education debt society owes to the Latino community (Ladson-Billings 5-6).

The education debt contradicts the principle that every child has the right to an equal education—a right the United States has supposedly embraced ever since the 1954 Brown v. Board of Education Supreme Court decision. By letting Latino students down, society is letting itself down, too. Latinos are a rapidly growing part of our nation's future. In 2015, 24.3% of children attending elementary and high school in the United States self-identified as Latino ("FFF: Hispanic Heritage Month" 5), and that number is likely to go up in the future.

Yet despite sharing a common *latinidad*, U.S. Latinos are not a homogenous group. Latinos are a highly diverse subset of the U.S. population, differing in terms of geographic residence, country of heritage, and much more. Topics such as immigration and emigration, transnational identities, and citizenship à la carte come into play when you talk about the Latino community more comprehensively (Fitzgerald 2008; Sánchez and Machado-Casas 2009; Soehl and Waldinger 2010; Torres 2012). This makes the education debt complex in more ways than one, in addition

to it being increasingly important as we turn our attention more and more to the matter of social justice.

Latino students in Worcester currently comprise more than 41% of Worcester Public Schools enrollments (Commonwealth of Massachusetts), and they face many of the same challenges. In an effort to reduce the barriers facing Latino students in Worcester, LEI runs a number of important programs in the city. These programs correlate to demonstrable gains for students and their families. In fact, measuring these gains with pre- and post-evaluations is essential to ensure continued funding for LEI. But LEI's important work is hindered by their current—and cumbersome—mode of evaluation, which is paper-based. LEI staff and students currently spend a lot of time printing out these evaluations, filling them out with pen and paper, entering these responses into a computer, and analyzing the results.

LEI is caught in a catch-22. LEI must perform these evaluations to get the funding to run its programs, yet it must take time away from its programs to do these evaluations. LEI needs a way to do its evaluations digitally to save time and make it more engaging for the students and, simultaneously, easier for the staff. This is the challenge faced by LEI, and this is where ASSISTments comes in.

ASSISTments is a free public service run by WPI that provides a platform for teachers to create homework assignments and quizzes for their students to complete online. A digital platform like this is very much in the vein of what LEI was looking for. Additionally, ASSISTments has been eager to expand its global presence. But language is a critical roadblock—for some time now, ASSISTments has only been available only in English. This lack of global competence on a technological level is a challenge for any aspiring service, and for this type of challenge, the technique of internationalization holds a lot of a promise.

Between the two separate challenges faced by LEI and ASSISTments, I saw the potential for a shared solution. What if I could internationalize ASSISTments and then use it to digitize the student evaluation process of LEI? This proposition functioned as the bedrock of my project.

2 Foundations

2.1 Salad Bowl Society

The United States of America is a nation of immigrants. This common refrain likely gained prominence because it is demonstrably true. From the very founding of the country to the present day, immigrants and their descendants have contributed much to the formation and evolution of the United States. The vast majority of residents of the United States owe their presence in this country to past immigration—whether it be their own, their parents' or their ancestors'. As of April 2010, only 0.9% of United States residents claimed solely Native American heritage (Norris et al. 3).

My own family heritage can be traced abroad as early as one generation ago on my father's side, and four generations ago on my mother's side. My father is a first-generation immigrant who left Thailand with his mother and older brother when he was only five years old. My mother was born in the United States, but her great grandfather was not; he was born in the Netherlands. The prevalence of personal histories such as these is why United States has been rightly described as a "salad bowl." The extended and dynamic mixing of peoples and cultures that occurs within the nation-state's borders has produced its contemporary society.

When people immigrate to the United States from abroad, they do not leave everything behind. Although people who have recently arrived in a new country will assimilate to a certain degree, the reality experienced by many immigrants and their new communities is more complicated than wholesale assimilation (Rodolfo and Pachon 2000; Shukla 2003; Villenas 2009). For example, immigrants may maintain personal and familial contacts with individuals in their countries of origins (Soehl and Waldinger 1490-1491). They may also maintain their own unique cultural practices and perspectives over time, either in part or in whole (Villenas 60). In this way, the culture of their new home is not adopted wholesale, but instead reworked, recombined, and created anew.

The above process occurs across geographies and generations as more people immigrate and integrate into a society. For this reason, any holistic discussion of a population within the United

States also implies a discussion with global context. Such an implication is especially true of populations whose international connections may be stronger due to factors such as recent immigration and enduring transnational ties.

In this project, I focus on a diverse population that has existed in the United States since before its inception, contributes much to the nation's culture and development, maintains significant international ties, and is today the most populous minority group in the country: the Latino community.

2.2 What's in a Name?

A variety of terms are currently used throughout academic and lay discourse in the United States when referring to members of the Latino community. Alternatives to Latino such as Latino/a, Latin@, and Latinx offer the benefit of greater inclusivity and gender neutrality. However, the sponsor of this Major Qualifying Project, the Latino Education Institute, currently uses Latino for the bulk of their internal and external publications. In the interest of making this report more accessible to LEI, I will follow the current practices of the organization in using "Latino" when referring to gender-nonspecific members of the Latino community.

I will also use "Latino" in lieu of "Hispanic" throughout this report. Controversy surrounds the usage of these two terms (Arreola 14; Ramírez 42). The latter, for example, more strongly communicates a heritage that traces its roots to Spain and the Spanish history of imperialism (Del Rio 3). Conversely, the term "Latino" embraces a more regionally-focused heritage that embraces the fusion of cultures and peoples that has occurred in Latin America over the last half millennia (Del Rio 3). As a result of this disparity in connotation, as well as the aforementioned current practices of LEI, my writings will refer to persons of Latin American heritage as members of the Latino community.

2.3 The Latino Diaspora: A Tale of Old and New

Latinos have lived in the United States since prior to the country's founding. Today, the Latino community is one of the fastest growing segments of the national population. According to

census records, the U.S. Latino population expanded from approximately 35 million to more than 50 million between 2000 and 2010 (Albert et al. 3)—an increase of more than 40% in only ten years. This population growth has been fueled both by immigration from Latin American nations and a high birth rate among Latinos already living in the United States (Stepler et al.).

Of course, despite their shared *latinidad*, U.S. Latinos are not a monolithic group. As recently as 2015, Latinos claimed Mexican, Puerto Rican, Salvadoran, Cuban, Dominican, and Guatemalan heritages at rates of 63.4%, 9.5%, 3.8%, 3.7%, 3.3%, and 2.4% respectively ("FFF: Hispanic Heritage Month" 2). These figures represent only 86.1% of all Latino respondents at most, even if one assumes that each heritage is completely discrete and that no person claims more than one heritage. Putting aside the riskiness of that assumption, this tabulation still leaves nearly 3 in 20 respondents as claiming other Latino heritages. Additionally, these responses only demonstrate one of the many threads of diversity that exist within the Latino community.

While many Latino residents of the United States can trace their heritage back through generations of United States citizens, other Latinos were born to immigrant parents or immigrated to the United States themselves. As of 2015, approximately 34.5% of the country's Latino population was born outside the United States ("FFF: Hispanic Heritage Month" 5). Foreign-born Latinos currently living in the United States may be naturalized citizens, permanent legal residents, or undocumented immigrants. The latter category is especially noteworthy because of the ongoing and increasingly acrimonious public debate over immigration (Brader et al. 961), which has reached its apex with the Trump administration. Approximately 9 million undocumented immigrants from Latin America were living in the United States as of 2008 (Passel and Cohn), and the contemporary sociopolitical climate undoubtedly shapes their experiences and identities. The impact of these social currents on the children of undocumented immigrants is significant as well, even though 73% are U.S. citizens by birth (Passel and Cohn). In fact, the children of undocumented immigrants "are more exposed to a number of risk factors than children of immigrants generally and all U.S. children, including lower preschool enrollment, reduced socioeconomic progress, and higher rates of linguistic isolation, limited English proficiency, and poverty" (Capps et al.).

The variety of backgrounds described above still does not encompass all the differences that exist within the U.S. Latino community. In terms of geographic residence, Latinos live in every state and major city. The states of Arizona, California, Colorado, Florida, Illinois, New Jersey, New Mexico, New York, and Texas are considered part of the traditional Latino diaspora (Hamann and Harklau 157) and have historically been home to the highest numbers of Latino residents. However, the concept of a new Latino diaspora (Murillo and Villenas 1997; Villenas 2009; Hamann and Harklau 2010; Figueroa 2013) has focused on increased patterns of domestic migration and international immigration, particularly with respect to states outside the traditional Latino diaspora. For example, Massachusetts is now home to approximately 729,000 Latinos— 11% of the total population for the state (López and Stepler). Although the traditional Latino diaspora was described as including nine states in particular, the geographic distribution of Latinos in the U.S. is neither limited to those states nor static.

Numerous other threads of diversity exist within the U.S. Latino community outside of heritage, immigration status, and geographic residence. Additional characteristics such as skin color and age can also diversify the experiences of individuals and communities (Villenas 60). Yet despite the varied existences of different Latino groups in the United States, a broader identity and community has formed. This is particularly true in the communities of the new Latino diaspora, where "people with ancestries tracing from Mexico, Central America, Puerto Rico, Ecuador, and the Dominican Republic, view themselves and/or are being viewed as belonging to a singular, inclusive pan-ethnic identity: i.e., Latino" (Hamann and Harklau 161). The formation of this shared identity is encouraged in part by the ongoing new Latino diaspora (Hamann and Harklau 158), a phenomenon with both domestic and international components.

2.4 Both Here and There, *Ni de aquí ni de allá*

As described in the paragraphs above, U.S. Latinos have managed to develop a common identity despite possessing a widely diverse array of personal histories. This may appear paradoxical until one considers that Latinos understand first-hand the profound personal impacts that "membership in a diaspora, formed through migration," can cause (Shukla 10). Membership in the Latino diaspora places one within a community that possesses significant global ties through the inseparable and bidirectional natures of emigration and immigration. Just as discussing the

United States implies a discussion of the international, so too does discussing the U.S. Latino community. In many ways, the U.S. Latino community can be considered a transnational entity.

As a result of increasing globalization, one's exact physical location is no longer wholly determinative of one's societal identifications. This is the concept of "deterritorialization," which can be more formally defined as "the uncoupling of residence in a territory with membership in a community and the displacement of culture from geography" (Fitzgerald 2). Deterritorialization is a key component of transnationalism. Without it, the transnational identities of many global communities—such as the Jewish, Indian, and Latino diasporas—would not be possible.

Transnationalism itself can be defined as "the processes by which immigrants forge and sustain multistranded social relations that link together their societies of origin and settlement" (Shukla). This multidirectional model is far more appropriate for describing contemporary migration than the older unidirectional notions that envisioned migrants as individuals who have been "uprooted" or "transplanted" (Waldinger et al. 713). The pertinence of transnationalism as a conceptualization for migration becomes especially clear when one considers that "most migrants maintain some degree of home-country connectedness, with a minority severing ties" (Soehl and Waldinger 1489). One prime example of transnationalism is how Latin Americans who have immigrated to the United States now participate in U.S. society on a daily basis, yet still claim—either formally or informally—a sort of "citizenship à la carte" (Fitzgerald 1) with their country of origin.

For instance, more than half of respondents to Pew's 2006 National Survey of Latinos indicated that they spoke with relatives and friends still living in their country of origin on a weekly basis (Soehl and Waldinger 1496-1497). An additional quarter of respondents said that they did so monthly (Soehl and Waldinger 1497). Furthermore, over 50% of respondents sent remittances in the past year, and approximately one in three had visited their country of origin within the past two years (Soehl and Waldinger 1497). Other expressions of transnational life include purchasing consumer goods from one's country of ancestry and participating in cultural celebrations (Torres 80). Even if a Latino individual does not directly participate in many

expressions of transnationalism, they are prone to associating with Latinos who do and who thus facilitate less direct notions of connectedness (Soehl and Waldinger 1490).

Transnationalism is also of relevance to the children of Latino immigrants. Although "first-generation immigrants are more likely to pursue transnational lifestyles" (Sánchez and Machado-Casas 6), it is important to note the impact and value of transnational ties inherited by their children (Torres 80). After all, nearly 65% of Latino students in U.S. public schools are either children of first-generation immigrants, or first-generation immigrants themselves (Sánchez and Machado-Casas 8). One example of inherited transnationalism is the fact that approximately 70% of these students "speak a language other than English at home" (Sánchez and Machado-Casas 9).

Another example of inherited transnationalism is the tendency of Latino students in California and New York to make visits to their country of ancestry. In fact, some school districts in California that are home to high proportions of Mexican immigrant families "have adjusted their school calendars to accommodate the large exodus of transnational students each winter holiday break" (Sánchez and Machado-Casas 7). Similarly, the frequent "transnational movement of Dominican children" in some New York school districts has led officials to "streamline school documents such as immunization records and grade reports for better interface among schools in the U.S. and the Dominican Republic" (Sánchez 495).

A failure to adapt educational institutions to the needs of Latino students in these circumstances would have yielded significant systematic disadvantages for the affected students. As the above paragraphs demonstrate, understanding transnationalism is key to understanding the U.S. Latino community. Doing so is also crucial for discerning how to best address the many challenges the Latino community currently faces, including the serious disadvantages experienced by Latino students in the realm of education. It is essential that the Latino community be understood in both a domestic and transnational context if those educational disadvantages are to be resolved.

2.5 An Unpaid Debt

Latino students have long experienced a disparity in educational outcomes when compared to their non-Latino white peers. This discrepancy was brought onto the national stage in 1966 with the release of the Coleman Report, which showed that a student's socioeconomic background played a disproportionate role in determining their educational success (Lee 3). Since then, much research has been performed to examine what has been described as the "achievement gap" (Ladson-Billings 2006; Gandara and Contreras 2009; León 2011; Madrid 2011; Milner 2013).

Although Latino students have made gains over the years in educational attainment, and although the gap between them and their non-Latino white peers has narrowed at times, the achievement gap persists to the present day (Lee 3; Vanneman et al. 1). According to the 2015 census, only 66.7% of Latinos aged 25 and older graduated from high school compared to 93.3% of their non-Latino white peers (Ryan and Bauman 2). This discrepancy is also present in higher education, with only 15.5% of Latinos acquiring a Bachelor's degree or more compared to to 36.2% of non-Latino whites (Ryan and Bauman 2). Additionally, middle and high school Latino students continue to score lower than their non-Latino white counterparts on standardized NAEP reading and mathematics tests (Lee 5; Ryan and Bauman 2). As illustrated by **Figure 1** below, the achievement gap between Latino students and their non-Latino counterparts has not yet sufficiently diminished despite decades of awareness (Ryan and Baumann 5).

Figure 3.
Percentage of the Population 25 Years and Older With a Bachelor's Degree or Higher by Race and Hispanic Origin: 1988 to 2015

Source: U.S. Census Bureau, 1988–2015 Current Population Survey.
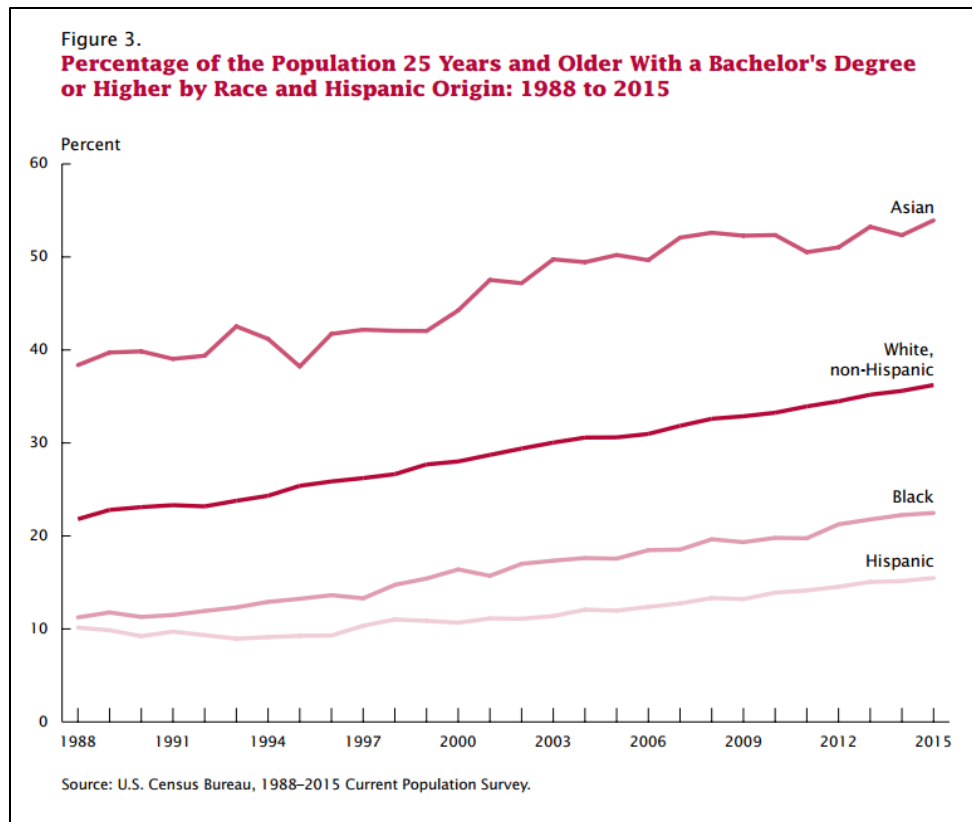
Figure 1: The persistence of the Latino education gap over time

Unequal educational attainment is problematic for any student or group that lags behind. However, the achievement gap of the Latino community is especially concerning since their school-age population is growing at a rapid rate (Gandara and Contreras 1). From 1987 to 2007, the proportion of public school students who were Latino increased from 11% to 21% (Gandara and Contreras 1), and by 2015 approximately 24.3% of children attending elementary and high school were Latino ("FFF: Hispanic Heritage Month" 5). The population pyramids provided by **Figure 2** illustrate the difference in age distribution among Latinos and whites in the United States and show that the recent increases in Latino student population will not likely diminish in the near future (Saenz). If the achievement gap between Latino students and their non-Latino white counterparts is not reduced, the disadvantages conferred by an unequal education will negatively impact millions of Latino students and the United States as a whole.
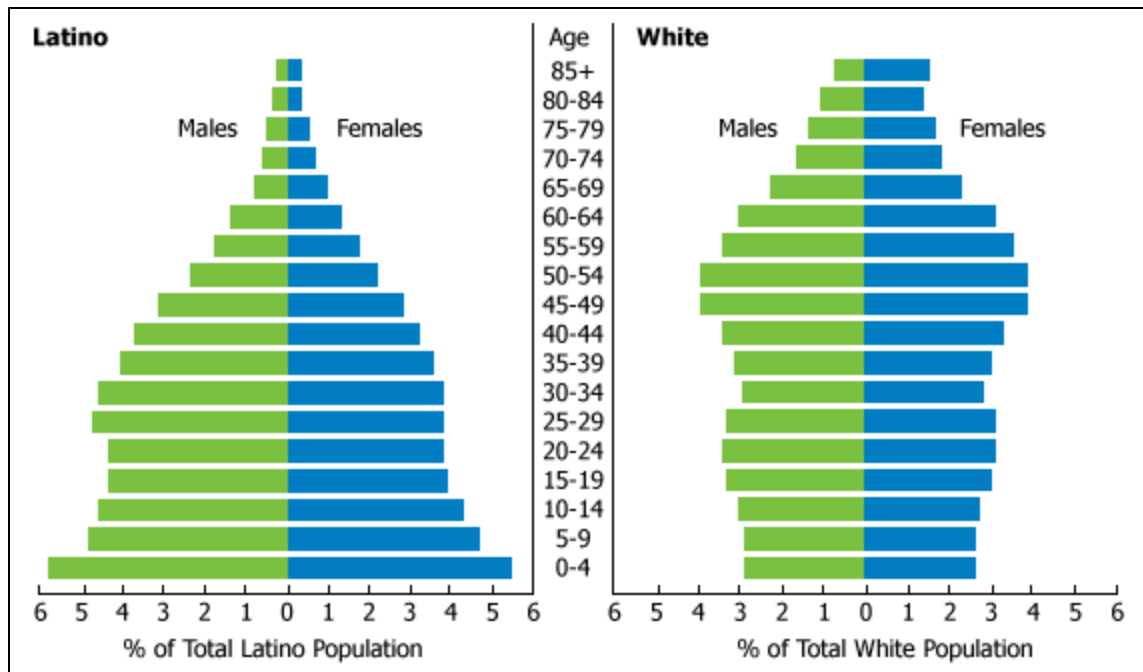
Figure 2: Age distributions of Latinos and whites living in the United States

The achievement gap experienced by Latino students does not exist without context—rather, the comparatively lower academic performance of Latino students in the United States is the result of a variety of influences, many of which are systemic in nature. In her 2006 Presidential Address for the American Educational Research Association, Gloria Ladson-Billings defined a term for this predicament by arguing that "the historical, economic, sociopolitical, and moral decisions and policies that characterize our society have created an education debt" (5). Others have echoed her argument and asserted that using the phrase "education debt" provides a greater focus on the systemic issues that have contributed to disparities in academic performance, rather than on the individual students themselves (Irvine 2010; Milner 2013). In this sense, one can describe the achievement gap as a symptom of the education debt. And although the achievement gap can involve clearly identifiable and immediate challenges such as shortages in the academic resources possessed by local school districts (Madrid 8), it also derives from causes that are deeper, more longstanding, and sometimes indirect in nature, such as systemic poverty, racism, subpar teaching, or inadequate government funding.

For example, the financial status of one's family determines whether one is able to afford to attend high school or university without needing to supplement the family income through full-time or part-time employment. Latino students are more likely than their peers to live in poverty (León et al. 2011; Krogstad 2014). As a result, they more frequently experience the difficulties of achieving an education while struggling economically. Latino students can also face economic barriers with regards to school funding. As late as 2006, public schools in Chicago and New York that served heavily black and Latino neighborhoods tended to receive less funding than those that served heavily white neighborhoods (Ladson-Billings 6). The education debt is comprised of numerous interrelated elements, and the two aforementioned challenges of poverty and school funding contribute to the economic portion of that debt.

A lack of cultural awareness and the presence of outright discrimination also negatively impacts the educational development of Latino students (Ladson-Billings 2006; León et al. 2011; Madrid 2011). These factors contribute to the sociopolitical aspect of the education debt. For example, the capabilities of parents are sometimes underestimated or ignored by school staff, to the detriment of Latino students (Tinkler 2002; Madrid 2011).

Another sociopolitical influence on Latino academic performance is the language barrier that can exist between students, parents, and school staff when students and parents do not speak English proficiently and when school staff do not speak Spanish proficiently. Latino students are more likely to have parents who are not proficient in English (Tinkler 2002; León et al. 2011; Madrid 2011). Parental engagement in education is important because parents can positively influence their children's academic success when they are involved (McKool 2007; Gordon and Louis 2009; Madrid 2011).

The influences described above function as systematic barriers to Latino students acquiring an education equivalent in quality to that their non-Latino white peers. These influences are not new, having long inhibited the academic achievement of the Latino community in the United States. The sum of these influences, both historical and contemporary, comprise what has been termed the education debt.

2.6 Education in the Heart of the Commonwealth: Worcester, MA

Latino education is a national concern that extends to all corners of the country, including Worcester, Massachusetts, which has seen its Latino population grow by at least 44.6% since 2000 ("Hispanic or Latino by Type: 2000"; "Hispanic or Latino by Type: 2010"). In 2011, the Worcester city government published a report drafted by the Commission for Latino Educational Excellence that discussed the significant challenges faced by its Latino students. The report offered clear recommendations for what efforts the city could undertake in order to reduce the achievement gap of Latino students in Worcester, such as hiring more culturally knowledgeable teachers, supporting community-based education programs, facilitating greater parental involvement, and so forth (The Commission 14-22).

The academic success of Latino students is of especially great importance to the city because, as of 2010 and 2016 respectively, Latinos comprised nearly 21% of Worcester's population at large and more than 41% of Worcester Public Schools enrollments ("Hispanic or Latino by Type: 2010"; Commonwealth of Massachusetts). The city is also motivated by the knowledge that educational outcomes for Latino students lag behind those of all other racial or ethnic subgroups in the city (The Commission 4).

For example, Latino students in Worcester are approximately 15%, 11%, and 9% less likely to graduate from high school in four years than their Asian-American, white, and African-American counterparts, respectively, as shown in **Figure 3** (The Commission 5). Latino students also tend to score lower than the overall Worcester average on the standardized Adequate Yearly Progress exams run by the Massachusetts state government (The Commission 5).
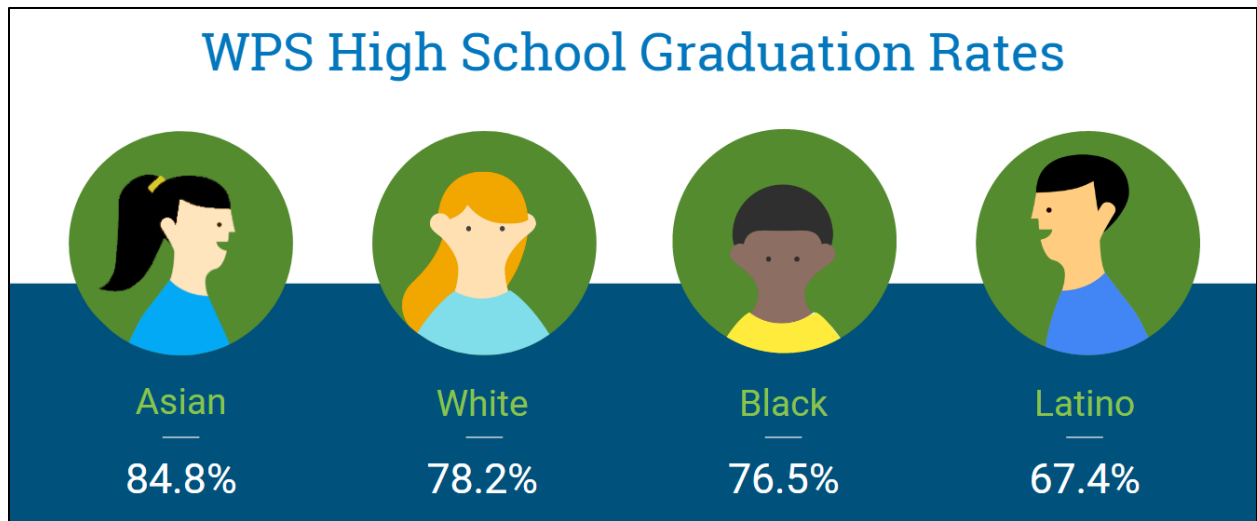
Figure 3: Four-year high school graduation rates of WPS students in 2010

As the proportion of Latinos living in Worcester continues to rise, reducing the achievement gap of Latino students is becoming increasingly integral to the wellbeing of the city as a whole. In the ten years between 2000 and 2010, the Latino population of Worcester increased from 26,155 to 37,818 ("Hispanic or Latino by Type: 2000"; "Hispanic or Latino by Type: 2010"). Latinos comprised 20.9% of the city population at the time of the last census ("Hispanic or Latino by Type: 2010") and may constitute more than a quarter of residents when the next census is conducted in 2020.

Clearly, closing the achievement gap is an increasingly important responsibility for the city of Worcester. However, before a problem can be solved, its causes must first be identified. As with the achievement gap at the national level, Worcester's achievement gap derives from an education debt that has accumulated over time from disparate factors that include poverty, improperly navigated cultural differences, language barriers, and other systemic issues.

According to the Commission for Latino Educational Excellence (2011), nearly 87% of Latino students attending Worcester Public Schools receive free or reduced price lunch (4). This is the highest rate among any racial or ethnic subgroup (4) and implies that Latino residents experience a higher level of poverty than their non-Latino counterparts. Census estimates from 2014 support this notion, showing that almost 41% of Latino residents of Worcester live in poverty ("People at

Specified Levels"). Furthermore, census data from 2015 indicated that 38.9% of Latino households in Worcester earned less than $20,000 that year ("Household Income"). No other major racial or ethnic group experiences the same level of poverty, and the challenges associated with a scarcity of financial resources undoubtedly place another educational barrier in front of the city's Latino students.

A lack of cultural awareness also posed a concern to the Commission for Latino Educational Excellence, which remarked that "insufficient cultural competence throughout the education system" was negatively impacting educational outcomes (13). Cultural competence is an important quality for any school system that interfaces with a heterogeneous student body. However, this is more difficult to accomplish when teachers and administrators hail from very different backgrounds than the students they serve. And in the Worcester Public Schools system, only 1.7% of teachers and 5.7% of administrators are Latino—far below the proportion of Latino students in attendance (The Commission 13).

The above statistics do not delve into intra-community differences, but such differences are highly relevant to cultural competence as well. In Worcester, almost two-thirds of Latinos claim Puerto Rican heritage while the remaining third traces their heritages to more than a dozen other Latin American nations ("Hispanic or Latino by Type: 2010"). Additionally, roughly 10% of the Worcester Latino community was born outside of the United States ("Native and Foreign-Born"). Furthermore, approximately 11% of Latino students in the city were English language learners as of 2010 (The Commission 3). This diversity of backgrounds matters because each group within the Latino community brings its own cultural nuances into the education equation. As a result, increased cultural awareness is crucial to navigating difference in a way that does not limit Latino student achievement, and thus serves as a crucial component to formulating an adequate response to the education debt.

A number of other systemic issues contribute to the education debt experienced by Worcester's Latino community alongside the socioeconomic factors described above. Given the wide array of causes, a comprehensive and socially competent approach is needed to reduce the education debt and thereby close the achievement gap. Fortunately, a number of organizations within Worcester

are already working towards this purpose. One such organization is the Latino Education Institute.

2.7 The Latino Education Institute

The Latino Education Institute (LEI) is a nonprofit organization that was founded in 2000 and is currently affiliated with Worcester State University ("About LEI"). For nearly two decades, the organization has sought to improve the academic achievement and general wellbeing of Latino students in the Worcester area ("About LEI"). While LEI is motivated by a desire to close the academic achievement gap, the organization does not focus solely on academic disparities. Instead, LEI dedicates much of its efforts to resolving various components of the education debt that have collectively contributed to the formation of the achievement gap in the first place.

In particular, LEI addresses these issues through programs that encourage parental engagement, promote self esteem, develop leadership skills, teach about the college admission process, facilitate the learning of English, and more (A Year in Review 2-3). For example, Latina Achievers in Search of Success (LASOS) brings 6th grade girls and their mothers together to encourage personal and educational development with the help of local Latina professionals ("LEI Programs"). Programs like LASOS can be highly impactful. In central Texas, a program called Con Mi Madre also seeks to involve mothers in the socioeducational development of their daughters (Field). And the successes of Con Mi Madre are clear: for every 100 girls who complete Con Mi Madre, "100 will graduate high school, 77 will go on to college, and 54 will earn a college degree" (Field).

Another LEI program, Padres Comprometidos (Active Parents), helps Latino families prepare for the challenges and opportunities of kindergarten ("LEI Programs"). A third program, Innovative Services for Latino Adolescents, provides third through sixth grade students with "time for homework help, academic classes in literacy and mathematics, and mentorship" ("LEI Programs"). These examples are just three of the many programs that LEI offers to the Latino community of Worcester.

Altogether, LEI used its programs to impact more than 2,500 families during the 2015-2016 academic year (The Latino Education Institute 1). In doing so, LEI helped almost 90% of its students develop "life skills, resiliency, and self confidence" (The Latino Education Institute 1). The organization also helped 94% of its students gain a greater understanding of college and their future educational and career plans, with 90% of high school seniors in its college preparatory program being accepted into university (The Latino Education Institute 1). By focusing on improving family engagement and offering both social and academic support for students, LEI takes a holistic approach to closing the achievement gap.

LEI has spent nearly two decades supporting the Latino community in Worcester through its advocacy and programs. Thousands of students and their families have been positively impacted as a result. However, in order to acquire the necessary funds to run the organization and manage their programs, LEI must convince funders that it is worth funding. This task is made easier when the organization can use data to demonstrate why its programs are effective and beneficial to the Latino students of Worcester.

Since LEI currently collects various evaluation data from the students participating in each of its 19 programs, the organization is already very data-rich. Unfortunately, collecting the necessary data, processing that data, writing reports, and writing grant applications from those reports consumes a significant amount of time for the staff and volunteers of LEI (Ramirez 19 Feb. 2016). In essence, LEI faces a catch-22 situation: LEI needs financial support in order to run its programs. But, in order to acquire funding, the organization's staff and volunteers must take time away from running those very programs in order to produce the necessary reports and grant applications.

Notably, much of LEI's data acquisition and processing is performed manually. Students participating in the organization's programs begin by filling out paper-based evaluations with a pen or a pencil. Staff and volunteers must then parse through these handwritten responses in order to compile a workable data set. Lastly, the staff and volunteers use the resultant data set to tabulate and calculate various statistics that they will later incorporate into their written reports.

This approach requires significant amounts of time and effort. It also requires expertise, which the staff and volunteers do not always have because of yearly turnover.

LEI has recognized that a digital system could help the organization quickly and efficiently collect, process, store, and analyze their data. As the sponsor of this MQP, LEI has commissioned software to facilitate and expedite its evaluation process (Ramirez 19 Feb. 2016). This deliverable would allow LEI to dedicate more of its efforts to expanding and running its programs rather than collecting and processing data. In this way, the introduction of sufficiently relevant software would help resolve the catch-22 LEI faces with its limited financial and human resources.

2.8 ASSISTments: The Software Solution?

A large number of education-oriented software platforms such as Blackboard, Canvas, and Moodle already exist. However, another platform—ASSISTments—was brought to my attention during the formation of this project. In fact, ASSISTments co-founder Professor Neil Heffernan eventually became an advisor to this project.

ASSISTments is an online service for schools and teachers that allows the creation of custom content, provides all its functionality for free, and offers a limited amount of data pre-processing with its downloadable Item Reports. Although ASSISTments is primarily used to assign homework, LEI could still use the service to represent its evaluations by creating assignments with ungraded multiple choice and open response questions. Furthermore, ASSISTments is locally run: the service is operated by a team of researchers at Worcester Polytechnic Institute, only two miles from LEI. As a result, not only does ASSISTments have the potential to fulfill LEI's requirements—it also provides an opportunity for intra-community development and collaboration between two of the premier educational institutions in Worcester.

However, ASSISTments was not necessarily a fully satisfactory match for LEI at the inception of this project. The platform operated only in English, and a variety of other software services could have potentially met the needs of LEI more effectively. The remainder of this chapter is

dedicated to describing a potential solution to the monolingualism of ASSISTments; the following chapter further explores the latter issue.

Fortunately, the ASSISTments team at WPI was interested in improving the service through an internationalization initiative. This initiative would introduce support for multiple languages and potentially implement additional changes that would be necessary to expand the ASSISTments user base.

At its core, internationalization is "the process of designing an application so that it can be adapted to various languages and regions without engineering changes" ("Lesson: Introduction"). These adaptations involve transforming the culturally variable components of a software service, such as modifying the underlying source code so that a user can choose to display English text in Spanish instead. This method of implementing a specific adaptation for a particular language or region is called localization.

The principle of localization is especially crucial in expanding the potential user base of a product because "people expect the computer to blend into their individual culture" (Chroust 2), and the world is filled with billions of individuals from thousands of different cultures. Furthermore, one of the great advantages to internationalization is that adding localizations for new locales is comparatively trivial once the software infrastructure of a product is sufficiently internationalized.

The failure to adequately localize an internationalized product can lead to issues with inoperability, miscommunication, and general reductions in user satisfaction (Chroust 10). And although automated text translation has made great strides towards fluency in recent years, human beings remain better equipped for traversing linguistic boundaries. This is why software companies tend to outsource the nuances of localization to translators and other cultural specialists (Hogan et al. 2; Ressin et al. 50). When developers and cultural specialists successfully work together, internationalization can lead to a much larger, more diverse, and highly satisfied user base than would have otherwise been possible.

The internationalization of ASSISTments had the potential to resolve two issues simultaneously. Through the addition of language translation, ASSISTments would finally be able to more easily extend its impact outside of the Anglosphere and across the globe. And through both the new and pre-existing features of ASSISTments, LEI would have a multilingual electronic solution to improving its evaluation process. In the following chapter, I describe how my project attempted to address the needs of both LEI and ASSISTments through the addition of Spanish language capabilities to ASSISTments and the novel application of the web service in a nonprofit extracurricular context.

3 Research Aims and Methodology

The goal of my project was to simultaneously meet the needs of both ASSISTments and LEI by adding Spanish-language capabilities to the Tutor component of the ASSISTments web service. In doing so, the potential user base for ASSISTments would be expanded outside of the Anglosphere, and the staff and students of LEI would acquire a more efficient and less burdensome evaluation process. I satisfied five objectives in order to achieve this goal:

1. Elicit a set of software requirements from LEI and use the information to measure the appropriateness of ASSISTments for LEI against other online platforms;

2. Internationalize the Tutor component of ASSISTments and add localizations for both English and Spanish speakers;

3. Evaluate whether an internationalized and localized ASSISTments sufficiently meets the requirements of LEI;

4. Identify ways in which the internationalization of ASSISTments could be further improved in the future; and

5. Provide LEI with a collection of evaluations pre-programmed into the recommended software platform and create a document with training resources for LEI staff members.

This chapter describes how I used the above objectives to guide my research. Through the use of software development strategies, interviews with ASSISTments and LEI staff, and focus group with LEI students, I was able to successfully meet the needs of both ASSISTments and LEI.

3.1 Objective 1
Elicit a set of software requirements from LEI and use the information to measure the appropriateness of ASSISTments for LEI against other online platforms.

In the Foundations chapter, I briefly described how ASSISTments seemed to be a promising solution for LEI. If a different software service would better satisfy the organization's needs, however, it would be optimal for LEI to utilize that service instead. As such, although I intended to internationalize the ASSISTments Tutor anyways, a more in-depth analysis was warranted to determine whether any viable alternatives would exist for LEI.

I constructed a software requirements matrix for the purpose of evaluating ASSISTments against both an objective set of conditions and a more subjective set of similar software platforms. This approach allowed for a clear and coherent appraisal of all the platforms considered.

To create the software requirements matrix, I gathered information about LEI's needs through a series of in-person unstructured interviews with the current Assistant Director of the organization, Hilda Ramirez. Even though interviews can require large amounts of time (Opdenakker 4), conversing with Ramirez was worth the commitment because of her vast personal experience with the organization. Over the course of our conversations, I asked Ramirez a variety of questions such as how useful it would be to have Spanish language translations for the web service, whether the service needed to be free, and whether LEI would like to share surveys across its programs.

In order to identify alternative web services that might be of use to LEI and thus should be evaluated in my software requirements matrix, I browsed the Internet for relevant products and spoke with several ASSISTments staff members. I communicated both in person and via email with ASSISTments co-founder Cristina Heffernan. Heffernan's direct involvement with ASSISTments since its inception provided her with a highly detailed understanding of how ASSISTments operates and how it fits into the digital market. Her knowledge regarding the potential competitors of ASSISTments was highly valuable. I also reached out to ASSISTments software developers David Magid and Christopher Donnelly for their perspectives on the matter. Speaking with Magid and Donnelly allowed me to gather expert opinions from individuals who may view ASSISTments from a different angle.

I established the structure of the software requirements matrix once I understood the extent of LEI's requirements and the existing alternate services. I then browsed the website of each service to determine its fulfillment of each requirement category. When recording my discoveries in the software requirements matrix, I assigned the values of 0, 1, and 2 to signify no fulfillment, partial fulfillment, and complete fulfillment, respectively. Lastly, I computed a numerical utility value for each web service by calculating the sum of its fulfillment values. The service with the highest

utility was presumed to be the service that best met the needs of LEI at the time of analysis. This matrix is displayed along with other results in the following chapter.

3.2 Objective 2

Internationalize the Tutor component of ASSISTments and include localizations for both the English and Spanish languages.

A crucial step towards helping ASSISTments meet LEI's requirements was the internationalization of the online service. The previous chapter described how internationalization is the process of making a software product capable of supporting usage by people of different linguistic or cultural backgrounds. This process involves multiple steps, such as identifying the specific words and phrases—known as 'strings'—that need translation, creating files for each language that contain the proper translations for each string, writing the necessary code to implement the translations, and testing the final product for quality assurance purposes. In the following paragraphs, I will describe how I achieved each of these steps for a component of ASSISTments called the Tutor.

3.2.1 The Tutor

The Tutor is a part of the ASSISTments website that students encounter when they are completing an assignment. It displays all the content a student needs to see when they are opening their homework, typing their response to a question, checking their answer, or submitting their work. The Tutor is an especially important part of the ASSISTments web service because it is the component that requires the most interaction from students and any parental observers.

3.2.2 String Identification and Location

My first step in the internationalization process was to determine which strings required translation. Executing the *findstr* command on the Windows Command Prompt is an efficient way to identify the locations of any strings that match the given specifications ("Findstr"). However, using *findstr* to search for all strings contained in the Tutor source code directories did not prove effective. Although the command executed appropriately, the resulting list of strings

was multiple thousands of elements in length. Examining every element on the list would have consumed far too much time, and taking small samples of the list made it clear that the bulk of the strings would never be seen by users of the ASSISTments website.

Instead of continuing to examine the aforementioned list, I instead decided to manually navigate the ASSISTments website and record any string I encountered while using the Tutor to complete some generic assignments. The resulting list contained fewer than one hundred strings.

After identifying this more manageable quantity of strings, my next step was to find their locations in the Tutor source code. I accomplished this task by using the File Search feature of Eclipse to search for one string at a time, as seen in **Figure 4**. The results of that search are displayed in **Figure 5**.
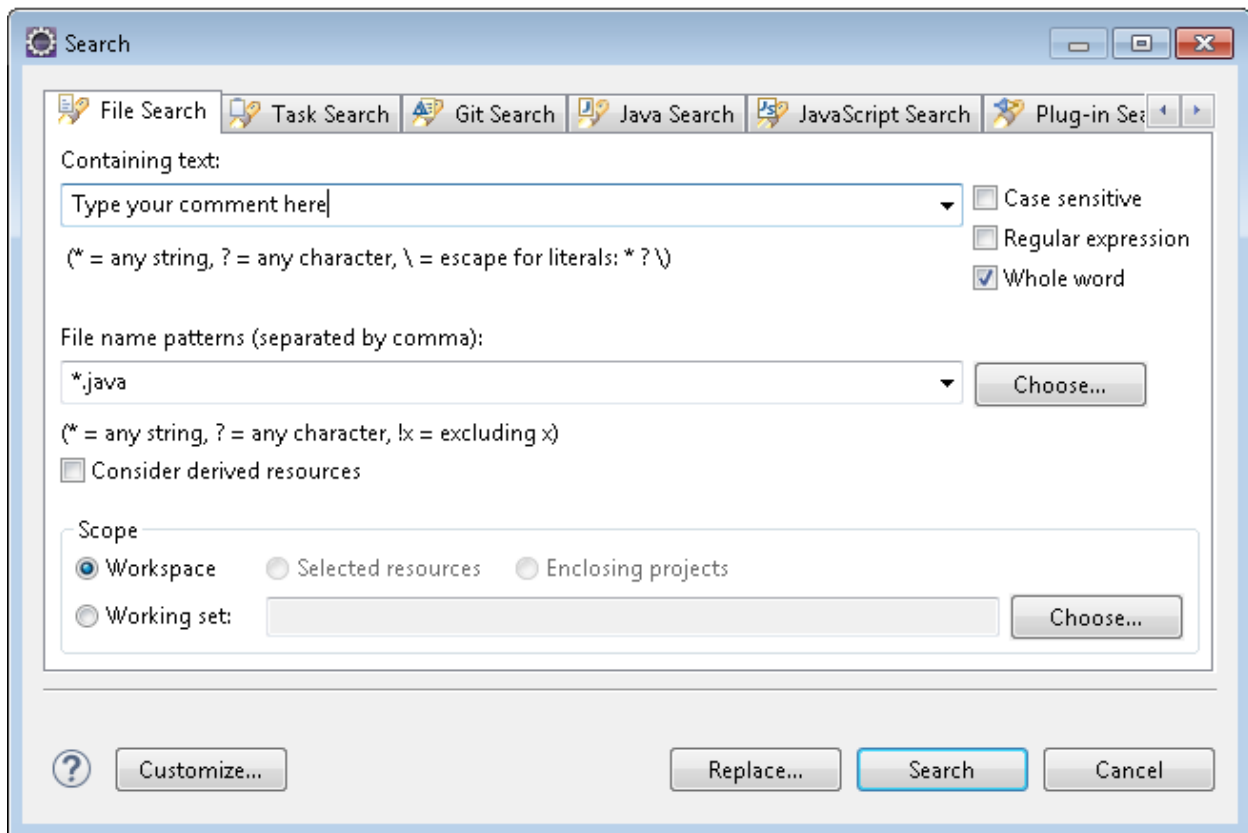
Figure 4: The search criteria that were used to determine the exact locations of a given string
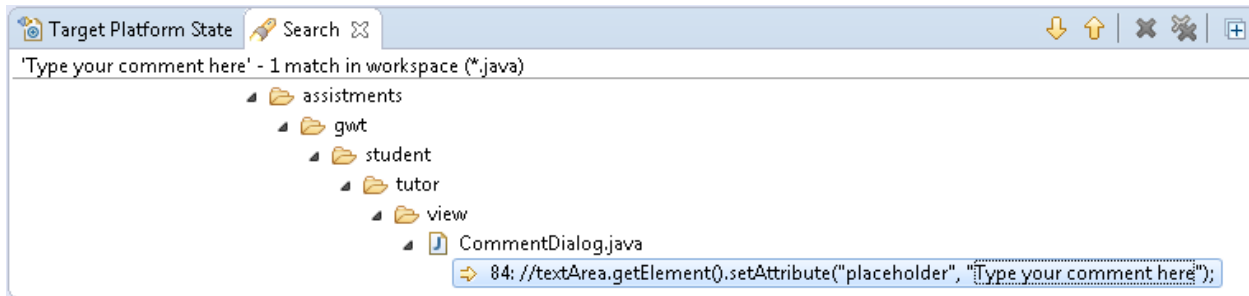
Figure 5: The result of the file search specified by the criteria in Figure 4.

It was highly probable that I would not discover a number of relevant strings when manually navigating the ASSISTments website. However, following this approach was still the most optimal course of action available to me, given the untenable time requirement I would have faced if I were to have manually searched thousands of files for the relevant strings. Furthermore, if non-internationalized text is discovered after the conclusion of this project, the translation of those new strings will be a straightforward process since this project will have already established most of the necessary internationalization infrastructure.

3.2.3 String Translation

The primary purpose of internationalization is to allow the representation of strings in multiple languages. Consequently, after compiling the list of strings that I described in the preceding section, I translated the strings in a two-part process. First, I sent each string through Google Translate in an attempt to quickly achieve most of the necessary conversion from English to Spanish. Then, I worked with one of WPI's Spanish tutors, fellow undergraduate Andrea Bayas, to manually correct any grammatical and usage mistakes. Collaborating with Bayas allowed me to receive timely assistance from a locally based and technologically savvy member of the Latino community.

The next step was to create properties files. When internationalizing a Java project, one must create at least one properties file per language. These files essentially act as dictionaries by matching each translated string to a key as seen below in **Figure 6**.

```
📄 StudentTutorMessages_es.properties        📄 StudentTutorMessages.properties  ⊠

  1# This is the default StudentTutorConstants properties file. It contains English translations.
  2
  3# INTERNATIONALIZATION FOR WebApp/gwt/student
  4
  5# CommentDialog.java
  6 view_sendComment = Send Comment
  7 view_typeComment = Type your comment here
  8 view_cancel = Cancel
  9
 10# ProgressPanelView.java
 11 view_problemID = Problem ID:
 12 view_moreToCome = More to come...
 13 view_loadingProblem = Loading problem...
 14
 15# StudentResponsesView.java
 16 view_myResponses = My responses:
 17
 18# VerticalMultiContentView.java
 19 view_assignment = Assignment:
 20
 21# TutorContentFeedbackCategoryStrings.java
 22 domain_questionGeneral = General Comment
 23 domain_questionDifficult = I am having difficulty with this problem
 24 domain_questionLiked = I liked this question
 25 domain_questionLearned = I learned something from this question
 26 domain_questionMath = Math error in this question
```

```
📄 StudentTutorMessages_es.properties  ⊠   📄 StudentTutorMessages.properties

  1# This is the Spanish StudentTutorConstants properties file. It contains Spanish translations.
  2
  3# INTERNATIONALIZATION FOR WebApp/gwt/student
  4
  5# CommentDialog.java
  6 view_sendComment = Enviar comentario
  7 view_typeComment = Escribe tu comentario aquí
  8 view_cancel = Cancelar
  9
 10# ProgressPanelView.java
 11 view_problemID = ID del problema:
 12 view_moreToCome = Más por venir...
 13 view_loadingProblem = Cargando el problema...
 14
 15# StudentResponsesView.java
 16 view_myResponses = Mis respuestas:
 17
 18# VerticalMultiContentView.java
 19 view_assignment = Tarea:
 20
 21# TutorContentFeedbackCategoryStrings.java
 22 domain_questionGeneral = Comentario general
 23 domain_questionDifficult = Tengo dificultades con este problema
 24 domain_questionLiked = Me gustó esta pregunta
 25 domain_questionLearned = Aprendí algo de esta pregunta
 26 domain_questionMath = Error matemático en esta pregunta
```

Figure 6: Above: StudentTutorStrings.properties; Below: StudentTutorStrings_es.properties

Internationalization was required for two Google Web Toolkit (GWT) directories in the ASSISTments WebApp Java project. Thus, I created an English properties file and a Spanish properties file for each directory. The files were placed in the appropriate resource folders for later access. I also created properties files for Arabic and French. The translations for those two languages were acquired from the team of Ilyas Azzioui, a Moroccan entrepreneur who was introduced to me by the ASSISTments staff and is fluent in both the aforementioned languages.

3.2.4 Finalizing the Internationalization

3.2.4.1 Internationalization of Java Files within GWT Packages

Once the above building blocks had been put in place, I added two interfaces called StudentTutorMessages and CoreTutorMessages to the Student and Core GWT directories, respectively. Both interfaces extended the GWT Messages interface for internationalization and served as a crucial link between the properties files and the Java files that needed internationalization.

Next, I added internationalization infrastructure to the Java files of each string that I had identified in the String Identification and Location stage. The new code invokes the existing public instance of the appropriate Messages interface—Student or Core—and calls a specialized method to retrieve each correctly translated string that is necessary. **Appendix A** provides a couple examples of internationalized code.

3.2.4.2 Internationalization of ui.xml Files within GWT Packages

Although most translatable strings could be found in Java files, a number of the strings also existed in ui.xml files. The internationalization of these strings required a different approach. For example, in each ui.xml file I added a ui:baseMessagesInterface attribute to the ui:UIBinder tag as seen in **Figure 7**. This attribute helped create a reference to the appropriate Messages interface.

```
 6  <ui:UiBinder xmlns:ui="urn:ui:com.google.gwt.uibinder"
 7    xmlns:g="urn:import:com.google.gwt.user.client.ui"
 8    xmlns:my="urn:import:org.assistments.gwt.student.tutor.view.devconsole"
 9    xmlns:coreview="urn:import:org.assistments.gwt.core.view"
10    ui:baseMessagesInterface="org.assistments.gwt.student.StudentTutorMessages">
```

Additionally, I surrounded each translatable strings belonging to the ui.xml files with a ui:msg tag that referenced the appropriate translation method as provided by the previously mentioned Messages interface. **Figure 8** shows the result of this encapsulation.

```
188    <g:Anchor ui:field="assignmentsLink" visible="false" addStyleNames="{style.subHeade
189    <g:HTMLPanel tag="span" ui:field="indicatorField"></g:HTMLPanel>
190    <g:Anchor ui:field="settingsLink" addStyleNames="{style.subHeaderLink}" href="#sett
191        <ui:msg key="view_settings">Settings</ui:msg>
192    </g:Anchor>
193    <g:Anchor ui:field="aboutLink" addStyleNames="{style.subHeaderLink}" href="#about">
194        <ui:msg key="view_about">About</ui:msg>
195    </g:Anchor>
196    <g:HTML addStyleNames="{style.beta}" ui:field="betaNotice">
197        You are using the Beta Tutor
198    </g:HTML>
199    </div>
```

Figure 8: The internationalization of a translatable phrase with a ui:msg tag

In the above example, "About" is considered the default value for the string. Alternative translations come from the "view_about" key, which points to the view_about() method that belongs to the StudentTutorMessages interface. That method returns "About" in whichever language is set as the current locale. Although the exact internationalization mechanisms differ slightly between ui.xml and Java files located within GWT packages, they achieve the common purpose of translating string values from a given set of keys.

3.2.4.3 Internationalization of Java Files outside of GWT Packages
A different approach was needed in order to internationalize the small number of strings that existed in the WebApp/core and WebApp/util packages. Christopher Donnelly configured most of the initial infrastructure for these translations and I finished the implementation.

More specifically, Donnelly created a ResourceBundle class, a Messages interface, and a set of properties files for each package. He also created two classes in the GWT packages that are used to access the WebApp/core and WebApp/util translations at build time. My primary contributions to this segment of the code involved identifying of a small number of new strings

to internationalize, finding appropriate translations for the Spanish properties files, and creating new properties files for Arabic and French.

3.2.4.4 Language Preference Creation

The next task was to establish a mechanism that students and teachers could use to indicate their language preference. Christopher Donnelly accomplished this task through URL parameterization, an example of which is displayed in **Figure 9** below. The text enclosed by the red rectangle indicates that the web service should render its content in the Spanish language.

Figure 9: An example of URL parameterization for ASSISTments

A student user can change their language setting by navigating to the Preferences webpage. A link to this webpage is found in the top-right of the ASSISTments Tutor, as shown in **Figure 10**. Once on the Preferences webpage, the user can then select whether they wish to view the Tutor in Arabic, French, Spanish, or English, as demonstrated in **Figure 11**. Only Spanish and English were available at the time **Figure 11** was created. Implementing a language setting provided ASSISTments the ability to load pages according to whether the user preferred Arabic, French, Spanish, English, or any other language that will be localized in the future.
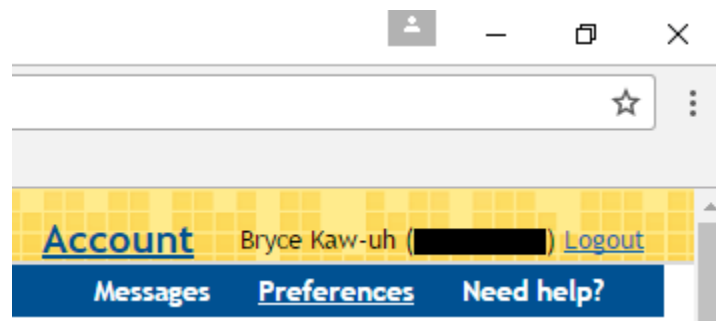
Figure 10: The Preferences webpage is accessed through a link in the top-right of the Tutor
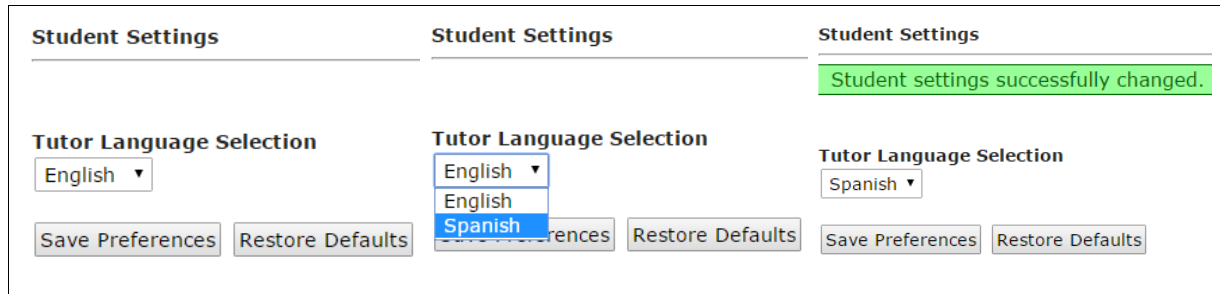
Figure 11: Changing the student user's language preference on the Preferences webpage

3.2.4.5 Quality Assurance

When the above steps were complete, I submitted my code so that it could undergo the necessary quality assurance testing processes. As part of this effort, Christopher Donnelly pushed my code to the ASSISTments Test 1 server, where it underwent a rigorous testing regimen. After the successful termination of these this stage, my modifications to the Tutor were then merged into the main ASSISTments code repository. The internationalized Tutor is now available for public use.

3.3 Objective 3

Evaluate whether an internationalized ASSISTments sufficiently meets the requirements of LEI.

3.3.1 Internationalization and Walkthrough

I wanted to determine whether ASSISTments sufficiently met LEI's needs once the internationalization of the Tutor was complete. In order to do so, I evaluated ASSISTments in three ways. First, I revisited the software requirements matrix that I designed to satisfy Objective 1. Although internationalizing the ASSISTments Tutor represented a significant step forward, it was important to maintain a comprehensive view of the appropriateness of ASSISTments for LEI. Revisiting the software requirements matrix allowed me to review more holistically whether ASSISTments could meet the needs of LEI.

Next, I performed a walkthrough of the newly modified website with LEI Assistant Director Hilda Ramirez to gauge her perceptions of the altered product. This walkthrough occurred on March 27, 2017 and took the form of a semi-structured interview so that I would have the

"freedom to digress" (Berg 81), ask open-ended questions, and give Hilda Ramirez the opportunity to provide detailed responses.

On April 21, 2017 I performed another walkthrough with Ramirez that focused on Google Forms, although we also reviewed ASSISTments once more. This second walkthrough was crucial for obtaining qualitative feedback that guided my decision on whether to recommend that LEI use ASSISTments or Google Forms to digitize its student evaluation process.

3.3.2 First Pilot Program with LEI Students

I then ran a pilot program with eight female high school LEI participants on March 28, 2017 in order to gather feedback about the web service that they would be using if LEI were to adopt ASSISTments. I intended to follow a focus group structure for this pilot program because "focus groups are an excellent means for collecting information from informants who might otherwise tend to go off on their own topics, such as young children and teens" (Berg and Lune 166). Personal interviews would have required much more time in each instance (Opdenakker 4), and I wanted to receive feedback from more than just a handful of students at LEI.

Ramirez brought the participating students to a Worcester State University computer lab. Once everyone had arrived, I gave a brief introduction of how the pilot program would run. I asked the students to complete an ASSISTments assignment that was styled after an LEI evaluation provided to me by Ramirez. I had only one account at my disposal, so the students began completing the evaluation one at a time. However, in order to ensure there would be enough time for the discussion stage of my pilot program, I decided to ask the last six students to work in pairs. The model LEI evaluation for my first student pilot program is included in **Appendix B**.

Asking the pilot program participants to complete this assignment allowed me to simulate the experience of completing LEI an evaluation electronically, rather than on paper. Once all students had completed the assignment, I asked for their opinions regarding the quality of the experience and any potential improvements that could be made to ASSISTments in the future. **Appendix C** contains the main questions that I intended to ask this first group of pilot program participants.

The pilot program lasted approximately an hour. Conducting this program allowed me to gain meaningful feedback from students who would potentially be using ASSISTments in the future, including suggestions about what could make the web service more useful and appropriate for them. This kind of information is especially useful for localizing a software product and understanding the needs of the Worcester Latino community.

3.3.3 Second Pilot Program with LEI Students

In order to build upon the discoveries that I made in the first student pilot program, I coordinated another session for April 25, 2017. This was the earliest date amenable to LEI's schedule. The participants of my second pilot program were six female high school students and one male high school student.

Improving upon the previous student pilot program required that I make a few changes to the structure of this second session. First, I created a separate ASSISTments student account for each participant so that they could all log into the web service and complete the evaluation at the same time. This sped up the evaluation stage of the pilot group and allowed more time for discussion.

Second, I used www.assistments.org instead of www.test1.assistments.org to administer the model LEI evaluation. This shift was important because it meant that the students were accessing the faster, production-level version of ASSISTments instead of the slower, testing-level of ASSISTments. Using the production version of ASSISTments was not possible with the first pilot group because not enough internationalization code had yet passed the final quality assurance stage and moved to the production version of the website.

Third, I asked students to complete a survey on Google Forms that contained the same exact questions that I had placed in ASSISTments. This allowed me to simulate the experience of filling out an LEI evaluation on Google Forms as an alternative to ASSISTments. The questions used in the model LEI evaluation for this second pilot program are located in **Appendix D**. I also handed each student a small piece of paper to fill out that asked whether they preferred to do evaluations on paper, on ASSISTments, or on Google Forms. At this stage, I was in the process

of determining which of the two services I would eventually recommend that LEI use. Acquiring feedback on this matter directly from the students who would complete the evaluations provided important information that I used to make this final determination.

After all participants had completed the LEI evaluation on both ASSISTments and Google Forms, I invited the students to discuss the experience as a group. I asked the five main questions that I had asked the first pilot group in addition to a few other new main questions regarding Google Forms. These questions are listed in **Appendix E**.

Unlike the first pilot program, this second pilot program lasted only half an hour due to the more efficient approach. Conducting a second session allowed me to gain additional feedback from a different set of students who would be using LEI's digitized evaluation process in the future. Gathering information from these stakeholders was crucial for determining which online platform I would eventually recommend to LEI.

3.4 Objective 4

Identify ways in which the internationalization of ASSISTments could be further improved in the future.

Even with the Tutor capable of displaying Arabic, French, Spanish or English according to the user's language preference, the Tutor and ASSISTments as a whole were still not yet fully internationalized. This situation inhibited ASSISTments from more fully meeting LEI's needs. Although there was not enough time to internationalize every aspect of the web service over the course of this project, I was able to determine where the internationalization of ASSISTments could be further improved.

I achieved this objective with two separate measures. First, I created a video tutorial that will provide ASSISTments developers the technical expertise needed in order to continue my language internationalization efforts. And second, I formulated recommendations for new internationalization efforts that the ASSISTments team could undertake in order to make the web service more globally accessible.

3.4.1 Accessible Documentation to Support Future Tutor Internationalization

Providing ASSISTments developers with sufficient documentation was critical for ensuring that the work I began in this project will continue in the future. Although I internationalized a significant portion of the ASSISTments Tutor, it is nearly certain that some relevant Tutor strings remain un-internationalized. Those strings will need to be internationalized when they are discovered. Additionally, ASSISTments developers will need to know how to implement localizations if they ever want the existing internationalization infrastructure to cover more languages. Lastly, other segments of the ASSISTments code base have not yet been internationalized, and understanding how internationalization works in the Tutor will help developers determine how to set up internationalization in those other areas of the web service.

Professor Neil Heffernan and Cristina Heffernan felt that the most effective manner for sharing the necessary knowledge would be a video tutorial (Heffernan and Heffernan, 13 Mar. 2017). As a result, I created a comprehensive video tutorial that teaches how ASSISTments developers can—and should—use internationalization to maintain and improve the web service. The video was reviewed by Christopher Donnelly before its submission to Professor Heffernan. By making this comprehensive video tutorial available to current and future ASSISTments developers, I have ensured that they will have the tools necessary to maintain and expand upon my internationalization efforts.

3.4.2 Recommendations for Additional Internationalization Efforts

In order to determine what new internationalization efforts might be effective, I relied on the feedback I received from my walkthrough with Hilda Ramirez, the opinions that were shared by the LEI students in my pilot programs, and the information I gathered from a further review of relevant scientific literature. The first two data sources were described in further detail in the section for **Objective 3**.

This wide range of sources allowed me to acquire a variety of ideas from both professional and nonprofessional stakeholders as well as internationalization experts. The following chapter includes the results of my research and my recommendations for where the ASSISTments team could improve upon the web service's current state of internationalization.

3.5 Objective 5

Provide LEI with a collection of evaluations pre-programmed into the recommended software platform and create a document with training resources for LEI staff members.

Acquiring the means to digitally perform evaluations was LEI's primary interest in this project. By analyzing my software requirements matrix, conducting walkthroughs with LEI Assistant Director Hilda Ramirez, and hosting two student pilot programs, I came to the conclusion that one platform in particular would be the optimal evaluation platform for LEI.

While recommending a particular online platform to LEI was a crucial step towards achieving this fifth objective, I needed to do more in order to better satisfy the needs of LEI. This supplementary activity included adding two LEI evaluations to the recommended platform and creating a document that contained training resources for LEI staff and volunteers. The results of my efforts on this objective and the four others described above are presented and discussed in the following chapter.

4 Results and Discussion

4.1 Requirements Gathering and Analysis

My first objective was to elicit a set of software requirements from LEI and use the information to measure the appropriateness of ASSISTments for LEI against other online platforms. I accomplished these tasks by communicating with LEI Assistant Director Hilda Ramirez and creating a software requirements matrix to evaluate ASSISTments against other services.

4.1.1 Shifting Expectations

Ramirez was initially interested in improving the LEI evaluation process through gamification (Ramirez 19 Feb. 2016; Ramirez 15 Jul. 2016). However, after further investigation and personal communication with Professor Aarti S. Madan, it was determined that gamifying pre-existing evaluation materials went against the general consensus of educational game developers. In a discussion with Ramirez, it was agreed upon that foregoing gamification would be satisfactory and that the key was improving the ease of survey completion and processing (Ramirez 27 Sep. 2016). As a result, I focused primarily on improving the efficiency and usability of LEI evaluations, rather than making them more game-like.

4.1.2 Requirement Identification

As mentioned in the Foundations chapter, any potential software solution needed to fulfill the needs of LEI. One such need was low-cost or even free institutional usage of the service since LEI has limited financial resources (Ramirez 27 Sep. 2016). The same principle also applied to the cost of technical support. Additionally, the optimal solution for LEI would support both Spanish and English functionality so that LEI could use the service with any of its potential program participants, regardless of their proficiency with the English language (Ramirez 19 Feb. 2016).

Of course, LEI needed effective electronic representation of the evaluations it currently performs with its program participants (Ramirez 19 Feb. 2016). This requirement implies that the ability to create custom content was a necessary feature of any potential solution. The custom content that LEI creates also needed to be shareable between the numerous staff and volunteers who may

need to assign the same content to different students at different times. Furthermore, it was reasonable to require that a software solution be capable of storing the LEI's electronic content in a long-term fashion so that it can easily review outcomes of past programs.

Another important feature for LEI was the ability of a potential software solution to pre-process and export the collected data, as one objective of LEI was to reduce the burden placed on its staff when interpreting the gathered information (Ramirez 15 Jul. 2016). And lastly, the inconsistent availability of technical resources for LEI made it crucial that the selected service be operable on both desktop and mobile devices (Ramirez 27 Sep. 2016). In summary, an optimal software solution for LEI needed to possess the qualities listed in **Figure 12**.

System Requirements
✔ Free Institutional Usage
✔ Free Technical Support
✔ Multilingual Capabilities
✔ Custom Content Creation
✔ Shareable Content
✔ Long-Term Storage
✔ Pre-Processed Data
✔ Exportable Data
✔ Multiplatform Support

Figure 12: The required features of a potential software solution for LEI

4.1.3 Software Requirements Matrix

Since a number of potentially useful education-oriented software platforms already existed, it was important to evaluate the suitability of some of those platforms for LEI. I chose to evaluate five software services: ASSISTments, Blackboard, Canvas, Moodle, and Qualtrics. These software platforms each offer a unique set of capabilities that seemed to at least partially meet the needs of LEI. The resulting requirements matrix is shown below as **Figure 13**. As mentioned in the previous chapter, the values of 0, 1, and 2 were respectively used to signify no fulfillment,

partial fulfillment, and complete fulfillment of a particular requirement. The bottom row of the requirements matrix displays a numerical utility value for each web service that I calculated by computing the sum of its fulfillment values. I determined the software requirements matrix ratings by referring to the sources described in **Appendix F**.

Requirement	ASSISTments	Blackboard	Canvas	Google Forms	Moodle	Qualtrics
Free Institutional Usage	2	0	0	2	2	0
Free Technical Support	2	2	2	2	2	2
Multilingual Capabilities	0	2	2	1	2	2
Custom Content Creation	2	2	2	2	2	2
Shareable Content	2	2	2	2	1	2
Long-Term Storage	2	2	2	2	2	2
Pre-Processed Data	1	2	1	2	1	2
Exportable Data	2	2	2	2	2	2
Multiplatform Support	2	2	2	2	2	2
Total	15	16	15	17	16	16

Figure 13: The software requirements matrix

4.1.4 Matrix Analysis

At first glance, the software requirements matrix seemed to place each platform on fairly equal footing. Google Forms scored the highest at 17 points, with ASSISTments and Canvas scoring the lowest at 15 points. However, these sum totals did not tell the whole story. Additional context and interpretation was necessary in order to more holistically determine which platform would best suit LEI. That rationale is described in the following paragraphs.

Blackboard, Canvas, and Qualtrics scored 16, 15, and 16 points respectively. These scores were not far behind the 17 points attained by Google Forms. However, none of these three platforms allowed institutions to utilize their services for free except during product trials. Given the

limited financial resources of LEI, it would not necessarily be worth the cost for LEI to acquire an institutional account with Blackboard, Canvas, or Qualtrics.

The other three platforms in the software requirements matrix were offered completely for free to institutions. ASSISTments, Google Forms, and Moodle achieved scores of 15, 17, and 16 points respectively. Although these platforms offered free usage, none of them received full marks for every category. It should be noted that ASSISTments initially scored 0 points for multilingual capabilities. However, that number would change once my internationalization and localization efforts were taken into account; later in this chapter I consider a version of the software requirements matrix that recognizes the translation abilities of the modified ASSISTments Tutor.

In the end, none of the platforms considered in the software requirements matrix received full marks for every category—yet most came close. This made the qualitative differences between them all the more important to consider. From this preliminary matrix analysis, it appeared that ASSISTments, Google Forms, and Moodle were most likely to meet the needs of LEI.

4.2 Tutor Internationalization and Localization

My second objective was to internationalize the ASSISTments Tutor and add English and Spanish localizations. To do this, I modified the ASSISTments code base as described in the previous chapter. This section briefly showcases the impact of these changes on the web service. **Figure 14** provides a glimpse of how the ASSISTments Tutor appears when the student language preference is set to Spanish; **Figure 15** emphasizes the extent of internationalization on the same webpage displayed in **Figure 14**; and **Figure 16** displays the result of clicking the "Comente acerca de este problema" link in **Figure 14**.
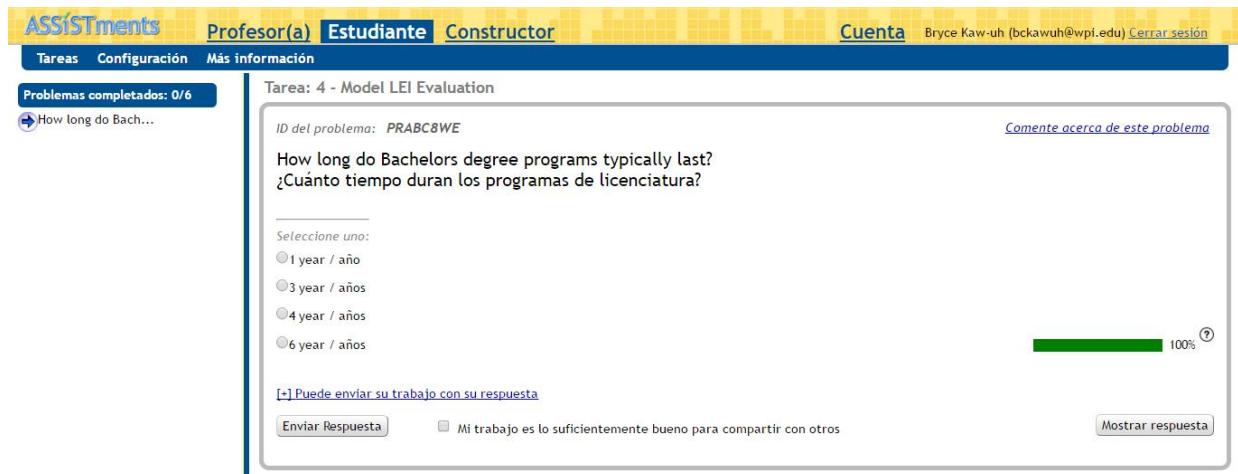
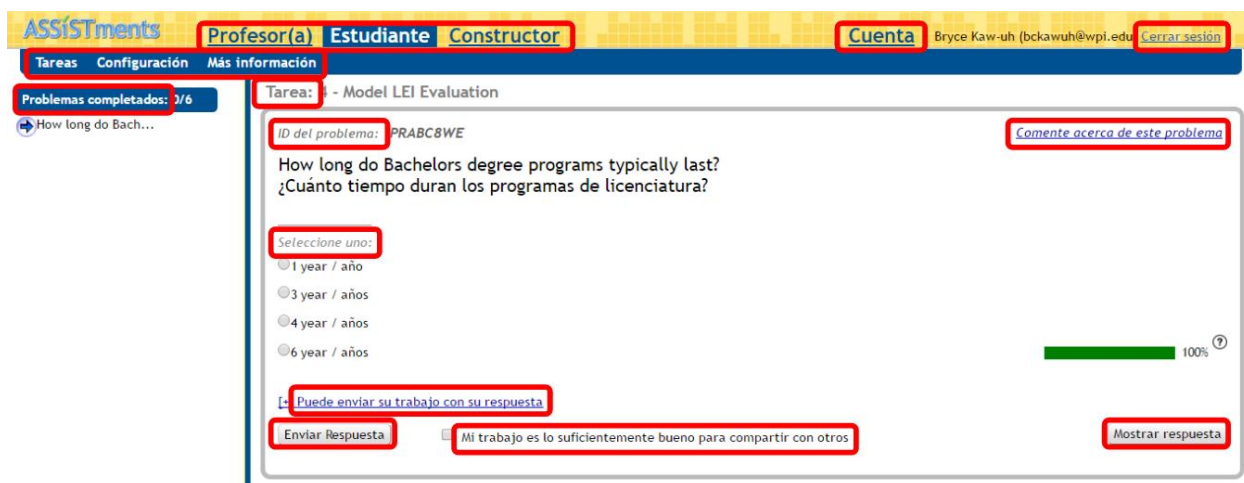**Figure 14:** The ASSISTments Tutor when viewed with a Spanish language preference

Figure 15: The Spanish ASSISTments Tutor with internationalized strings enclosed with red
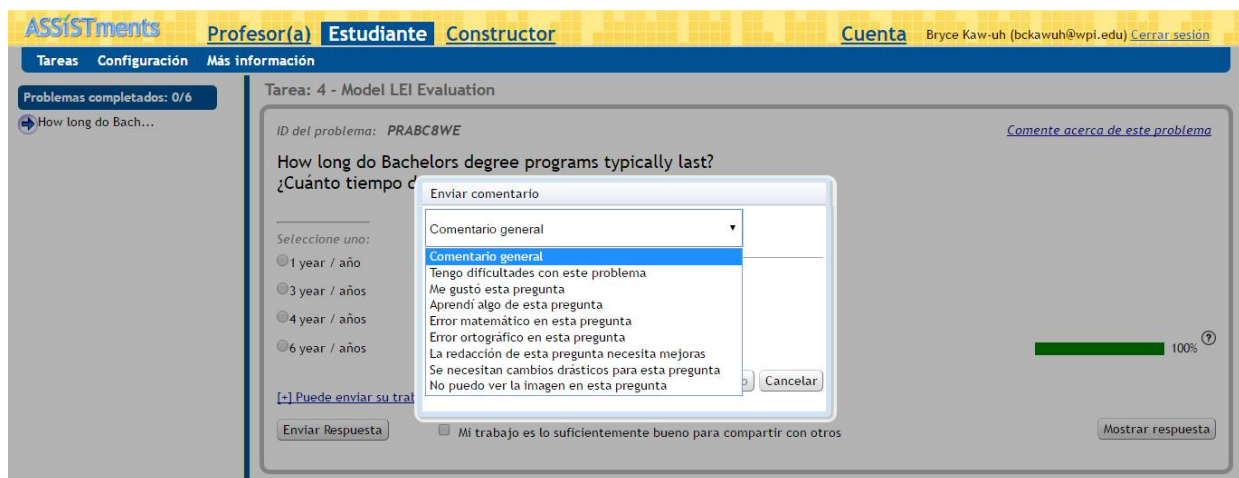

Figure 16: The pop-up dialogue produced by clicking "Comente acerca de este problema"

4.3 Reevaluation of ASSISTments

In order to satisfy my third objective, I needed to evaluate whether an internationalized and localized ASSISTments sufficiently met the requirements of LEI. This was accomplished by reviewing an updated version of the software requirements matrix, providing Hilda Ramirez with a walkthrough of the updated service, and running two pilot programs with LEI students.

4.3.1 Revisiting the Software Requirements Matrix

I wanted to review the software requirements matrix with the improved translation capabilities of ASSISTments taken into account. This helped determine whether the Tutor internationalization and localization effort made ASSISTments the optimal platform for LEI. The updated matrix is shown below in **Figure 17**.

Requirement	Web Service					
	ASSISTments	Blackboard	Canvas	Google Forms	Moodle	Qualtrics
Free Institutional Usage	2	0	0	2	2	0
Free Technical Support	2	2	2	2	2	2
Multilingual Capabilities	1	2	2	1	2	2
Custom Content Creation	2	2	2	2	2	2
Shareable Content	2	2	2	2	1	2
Long-Term Storage	2	2	2	2	2	2
Pre-Processed Data	1	2	1	2	1	2
Exportable Data	2	2	2	2	2	2
Multiplatform Support	2	2	2	2	2	2
Total	16	16	15	17	16	16

Figure 17: The updated software requirements matrix

In this updated software requirements matrix, Google Forms comes in first at 17 points. ASSISTments and Moodle follow closely at 16 points each. Reviewing the updated scores made it clear that my internationalization and localization efforts placed ASSISTments on roughly

equal footing with Moodle and on nearly equal footing with Google Forms. With ASSISTments scoring 1 point instead of 0 points for its multilingual capabilities, it could be considered more seriously as a potential evaluation platform for LEI.

Additionally, although Moodle is free, the platform requires more effort and upkeep than LEI has the time for, especially since LEI is trying to save time through digitization. Because Moodle is hosted on individual machines, LEI would retain responsibility for setting up the Moodle Learning Management System, ensuring proper functionality, and debugging any technical issues that arise.

Updating and revisiting the software requirements matrix helped me narrow the field of potential platforms down to ASSISTments and Google Forms. However, deciding between the two finalists was a more qualitative task that required feedback from LEI staff and students.

4.3.2 ASSISTments Walkthrough Result

On March 27, 2017, I met LEI Assistant Director Hilda Ramirez at the LEI office to review the current state of ASSISTments. I demonstrated the completion of a sample LEI evaluation and showcased the ability of teachers to view assignment response data from their students. Ramirez was satisfied with the quality of ASSISTments as seen from the student side, and appreciated the ability of ASSISTments to go into Spanish mode (Ramirez 27 Mar. 2016).

However, Ramirez was less satisfied with the quality of the assignment Item Reports that teachers can download (Ramirez 27 Mar. 2016). A partial screenshot of a downloaded Item Report can be seen in **Figure 18**. In the downloaded Item Report, free response answers were surrounded by the <p></p> HTML tag. Characters with accent marks were also not displayed correctly. For example, the word "Sí" was displayed as "SÃ-" instead. This erroneous behavior is likely the result of inadequate text encoding. Following my walkthrough with Ramirez, I reached out to the ASSISTments team about improving the downloadable Item Reports in terms of utility and user friendliness. As of the publication of this report, ASSISTments team member Forrest Cinelli has been assigned to work on improving the HTML tag and text encoding issues of the downloadable Item Report.

Figure 18: A partial screenshot of a downloaded Item Report

4.3.3 Google Forms Walkthrough Result

I met with Ramirez again on April 21, 2017 to conduct a walkthrough of Google Forms. We examined the functionality of Google Forms from the perspective of both a student and a staff member. We also revisited ASSISTments during our conversation.

Overall, Ramirez formed a highly positive view of Google Forms. She described the graphing features of Google Forms as "a seller" and strongly appreciated the ability to send evaluation results to a Google Spreadsheet (Ramirez 21 Apr. 2017). Ramirez wanted to learn how LEI could take greater advantage of these graphing capabilities (Ramirez 21 Apr. 2017), so I made sure to address this topic in the training resources document I provided to LEI. Ramirez also felt that Google Forms would be easier to use than ASSISTments for LEI staff members (Ramirez 21 Apr. 2017).

The perceived simplicity of Google Forms is an important finding because it means that Google Forms is more likely to help LEI achieve its goal of reducing the time and effort needed to complete its student evaluations. Furthermore, LEI already uses other Google products such as Gmail, Google Docs, and Google Drive (Ramirez 21 Apr. 2017). Introducing Google Forms instead of ASSISTments would consequently require much less training for LEI staff. Google Forms would also be a natural fit in LEI's current file management system.

My walkthrough with Ramirez seemed to solidify Google Forms as the optimal platform for digitizing LEI's student evaluation process. However, I did have one more student pilot program to run, and Ramirez also expressed an interest in using ASSISTments for other purposes. In

particular, Ramirez considered using ASSISTments as a supplementary tutoring resource (Ramirez 21 Apr. 2017). The tutoring and skill building capabilities of ASSISTments could provide additional help to LEI students who are struggling academically (Ramirez 21 Apr. 2017). LEI could also use the custom content creation capability of ASSISTments to design tutoring modules tailored to the needs of LEI students. But when it comes to digitizing LEI's student evaluations, this walkthrough demonstrated that Google Forms would be most effective from the perspective of LEI staff.

4.3.4 First LEI Student Pilot Program Outcomes

The pilot program held on March 28, 2017 was the first pilot program I have ever run, and it was certainly a learning experience. One key takeaway from the program was that the eight young women shared one important characteristic in common with their peers: they were easily distracted by the Internet. This tendency toward distraction is something LEI will need to take into account should the organization move forward with its plan to digitize the student evaluation process.

Another key takeaway from the first pilot program was that at least one pair of LEI students submitted an open response answer in Spanish. This action indicates a greater comfort with the Spanish language, and thereby emphasizes the importance of having a multilingual platform for LEI's student evaluations. Providing a Spanish-capable digital platform would encourage personal expression for Spanish-fluent students and perhaps allow for a more engaging survey.

I also learned from the first pilot group that LEI students have completed online assignments in the past through their regular schooling. Since LEI students are already familiar with online assignments, the learning curve associated with transitioning to a digital mode of evaluation should be limited. However, none of the students had ever completed an LEI evaluation online. The students expressed mixed reactions to this new approach.

Participants complained about the amount of time it took to load new problems and that typing could be bothersome if a student had to split their eyesight between the keyboard and the screen. However, this would not be an issue for touch-typers, and multiple students said that it felt like a

more easy-going experience to do the evaluations online. At least one student felt that it was easier to type than to handwrite.

My first pilot program also had some structural issues. A number of questions made the students feel that a more in-depth answer was required, and this led to the students taking more time than expected to complete the model LEI evaluation. For example, the question "What do you think of your high school?" is a complex and thought-provoking prompt for someone currently attending high school. I also had not prepared individual accounts for each student, so I let the participants use my own personal ASSISTments account to complete the evaluation. I also asked six out of the eight participants to complete the model LEI evaluation in pairs to save time. These factors complicated the nature and results of my pilot program.

4.3.5 Second LEI Student Pilot Program Outcomes

I sought to correct the structural issues described above and document more detailed student responses by hosting a second pilot program with a different group consisting of six female students and one male student . This second program was structured as described in the previous chapter. The new program structure proved much more efficient, which allowed for a more relaxed atmosphere since time was in ample supply.

I found that this group of LEI students preferred digital evaluations to paper evaluations by consensus, but that they were somewhat divided on whether ASSISTments or Google Forms was best. On the little pieces of paper that I handed out, the students cast 5 votes for ASSISTments, 2 votes for Google Forms, and 0 votes for paper evaluations. The overarching preference for digital evaluations was due in part to the ease of typing. During the discussion stage of the pilot program, multiple students mentioned that it was easier to type. None of the students opined the opposite.

The mini-survey results also indicated a general preference for ASSISTments. This finding surprised me, since LEI Assistant Director Hilda Ramirez and myself both preferred Google Forms. Students perceived ASSISTments as more official or professional than Google Forms. One student also remarked that Google Forms was bland. However, the students also noticed that

ASSISTments could take a while to load the evaluation questions. This may be because multiple students were accessing the same problem set at roughly the same time. Yet it is also an inconvenience that does not exist with Google Forms. Furthermore, at least one student viewed ASSISTments negatively at the beginning of the pilot program because he associated the platform with the challenging ASSISTments-based homework of his math class.

Although this small sample of LEI students indicated a relatively strong preference for ASSISTments over Google Forms, their experience with each platform was incomplete. I logged into ASSISTments and opened the Google Forms survey on each computer before the students even arrived. This made the evaluation process more efficient at the expense of a less holistic interaction with the software. In the discussion phase of the pilot program, however, I learned that there was a general consensus among the students that accessing an LEI evaluation by simply typing in a link was preferable to accessing one by logging into a personal account. The students seemed to appreciate the ease of entering a web address and did not want to have to remember a password for a personal account.

The above feedback further complicated the results of my second pilot program. On the one hand, the students claimed to prefer ASSISTments to Google Forms by a 5-to-2 margin. But on the other hand, the students expressed some opinions that made it sound like their preference was not as overwhelming as one might imagine.

4.4 Identification of Future Improvements

My fourth objective was to identify ways in which the internationalization of ASSISTments could be further improved in the future. I achieved this objective by synthesizing the opinions given by Hilda Ramirez, the feedback provided by pilot program participants, and the ideas I had gleaned from relevant software development literature. I also requested feedback from Worcester Public Schools teachers but did not receive it before the conclusion of this project.

4.4.1 Further Internationalization

The translation capabilities that I added to the ASSISTments Tutor are important steps forward in the internationalization process. However, much more needs to be done before ASSISTments

can be considered fully internationalized web service. In particular, the ASSISTments team should improve the general user experience, expand language internationalization, and introduce internationalization for less obvious components such as numbers, dates, images, and symbols.

With regards to improving the general user experience, my walkthrough with Hilda Ramirez made it clear that the downloadable Item Report had three specific enhancement opportunities. Removing the unnecessary HTML tags would improve legibility; adding the problem prompts would improve clarity; and using UTF-8 text encoding would ensure that users can have different languages not only on the website, but also in the Item Report downloads. Addressing these three shortcomings would significantly improve the user experience of teachers all around the world who use the ASSISTments web service.

Expanding language internationalization would also improve the user experience of international teachers and students—and even of domestic teachers and students who are simply more comfortable with a language other than English. Only the ASSISTments Tutor has been internationalized for language thus far. By internationalizing other areas of the ASSISTments website, the ASSISTments team can provide its users with a more integrated and appealing experience in their native language. Introducing localizations for additional languages would also further expand the global presence of ASSISTments.

Lastly, I would recommend that the ASSISTments team also attempt to internationalize the numbers, dates, images, and symbols included in the web service. For example, ASSISTments relies heavily on green check marks and other symbols to communicate important messages to the user. Although check marks generally mean "correct" in the United States, they can mean "incorrect" in different cultures. And in Japan, a user might expect to see "correct" represented by a red circle instead. This aspect of internationalization is less obvious and pressing than language internationalization, but it is nevertheless crucial for ensuring that each user is presented with a version of the website with appropriate cultural nuance. And it is especially important for ASSISTments due to the service's heavily reliance on symbolism.

4.4.2 Making the Change

I created a tutorial video for the ASSISTments team that teaches how the team can maintain the internationalization and localization I have done during this project, and how the team can expand upon my work in the future. The script of this video is included in **Appendix G**. The video itself can be viewed by visiting the [ASSISTments team's official channel on YouTube](#).

4.5 Digitizing LEI Evaluations and Providing Training Resources

By analyzing my software requirements matrix, conducting walkthroughs with LEI Assistant Director Hilda Ramirez, and hosting two student pilot programs, I came to the conclusion that Google Forms would be the optimal evaluation platform for LEI.

It became clear from my discussions with Hilda Ramirez that Google Forms far surpassed ASSISTments in terms of data processing and analysis. The strong performance of Google Forms on this front was highly impactful on my final recommendation since LEI conducts evaluations for the express purpose of gathering and analyzing data about its programs. Google Forms would also integrate easily and effectively into LEI's current practices, since LEI already uses Google Drive and other Google services on a daily basis. This pre-existing familiarity with Google products meant that LEI staff and volunteers would require less training – and thus less time – to become skillful users of the platform.

My student pilot programs did complicate my decision to recommend Google Forms over ASSISTments. When participants in from second pilot program were asked directly whether they preferred ASSISTments or Google Forms, 5 out of 7 chose the former. Yet at the same time, the students also expressed a preference for typing in a link instead of having to remember a password, indicating that Google Forms still had certain advantages over ASSISTments. The students also agreed by consensus that completing an evaluation online was easier and preferable to completing an evaluation on paper.

With the above findings in mind, I determined that Google Forms still achieved a number of benefits for LEI students although ASSISTments may have been more preferable to some

students. I also placed significant weight on the fact that Google Forms provided exemplary data processing abilities for staff and volunteers. As a result, I concluded that Google Forms was the optimal platform for LEI. ASSISTments would still work for LEI, but Google Forms proved a more optimal service for the particular purpose of digitizing the student evaluation process.

After deciding to recommend Google Forms to LEI, I added two official evaluations to Google Forms and created a document that contained training resources for LEI staff and volunteers. These resources were shared with LEI through Hilda Ramirez.

5 Conclusion

As a student of both Computer Science and International & Global Studies, I wanted to apply my technical expertise in a way that benefited society. In this project, I found a way to do so. And as a result of my work, two nonprofit organizations in the city of Worcester are now better equipped to better serve the community.

Through my research, I have provided the Latino Education Institute of Worcester State University with well-informed recommendations on how it can effectively digitize its student evaluations. Google Forms will prove extremely useful in reducing the burden placed on LEI staff in terms of both time and effort. LEI is making a real difference in the lives of students, and with a digital evaluation process, it will now be able to spend less time dealing with outdated modes of evaluation, and more time helping local students and their families. And although I recommended Google Forms over ASSISTments for LEI evaluations, I still identified a place for ASSISTments at LEI as a supplementary tutoring resource.

Furthermore, I have provided the ASSISTments team with an internationalized Tutor that has working localizations for English, Spanish, French, and Arabic. The team has also received my recommendations and documentation on how to expand upon my work in the future. In particular, introducing additional languages to the Tutor, translating more of the ASSISTments website, and internationalizing symbols would go a long way towards making ASSISTments more globally accessible. In the end, my deliverables will allow ASSISTments to further expand its global reach, thereby helping more teachers and students around the globe.

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Appendix A: Examples of Internationalized Code

This appendix showcases a couple instances of internationalized Java and ui.xml code from the ASSISTments Tutor code base. But first, it demonstrates the appearance and structure of a Java Messages interface.

```java
StudentTutorMessages.java

1  package org.assistments.gwt.student;
2
3  import com.google.gwt.core.client.GWT;
5
6  public interface StudentTutorMessages extends Messages
7  {
8      /// INTERNATIONALIZATION FOR WebApp/gwt/student
9      public static final StudentTutorMessages STM = GWT.create(StudentTutorMessages.class);
10
11     // view/CommentDialog.java
12     String view_sendComment();
13     String view_typeComment();
14     String view_cancel();
15
16     // view/ProgressPanelView.java
17     String view_problemID();
18     String view_moreToCome();
19     String view_loadingProblem();
20
21     // view/StudentResponsesView.java
22     String view_myResponses();
23
24     // view/VerticalMultiContentView.java
25     String view_assignment();
```

Figure 19: A sample Messages interface

Figure 20: An example of text internationalization in a Java file

Figure 21: A ui.xml file needs to "import" an interface before calling the interface's functions

Figure 22: An example of text internationalization in a ui.xml file

Appendix B: Model LEI Evaluation for Pilot Group 1

This appendix contains the ten questions I placed in the model LEI evaluation for my first student pilot program.

1. **Ungraded Open Response Question:**

   What do you think of your high school?

   ¿Qué piensa usted de su escuela secundaria?

2. **Ungraded Open Response Question:**

   What is your favorite class?

   ¿Cuál es su clase favorita?

3. **Ungraded Open Response Question:**

   What is your least favorite class?

   ¿Cuál es su clase menos favorita?

4. **Ungraded Open Response Question:**

   Do you have an idea what career or major you are interested in? If so, list it.

   ¿Tiene alguna idea de qué carrera o especialidad le interesa? Si es así, anótelo.

5. **Multiple Choice Question:**

   Do you feel that you have good time management skills?

   ¿Siente que tiene buenas habilidades de manejo del tiempo?

   Choices:

   Yes / Sí

   No

   Somewhat / Un poco

   Unsure / No lo sé

6. **Multiple Choice Question:**

On a scale from 1 to 5, please indicate how interested you are in attending college.

En una escala de 1 a 5, por favor indique cuánto interés Ud. tiene en asistir a la universidad.

Choices:

1 Not interested at all / No interesad@ en absoluto

2 Not interested at all but will consider / No interesad@ en absoluto pero lo consideraré

3 Somewhat interested / Un poco interesad@

4 Very interested / Muy interesad@

5 Extremely interested / Extremadamente interesad@

7. **Ungraded Open Response Question:**

Write one thing that you feel you still need to know about college or career readiness.

Escriba una cosa que cree que todavía necesita saber acerca la preparación para la universidad o la carrera.

8. **Graded Open Response Question:**

What does GPA stand for?

¿Qué significa GPA, en inglés?

Answers:

"Grade Point Average" or "Grade-Point Average" case insensitive.

9. **Graded Multiple Choice Question:**

How long do Bachelors degree programs typically last?

¿Cuánto tiempo duran los programas de licenciatura?

Choices:

1 year / año

2 years / años

4 years / años (This was the correct answer.)

6 years / años

10. **Graded Multiple Question:** Is the following statement true or false? "If you have a learning disability or are struggling in a course, no one is available to help you in college."

¿Es la siguiente expresión cierta o falsa? "Si usted tiene una discapacidad de aprendizaje o está luchando en un curso, nadie está disponible para ayudarle en la universidad."

Choices:

True

False (This was the correct answer.)

Appendix C: Planned Questions for Pilot Group 1

This appendix includes the five main discussion questions I had planned to ask the participants of my first student pilot program.

1. Have you ever completed an LEI evaluation on the computer before?
2. Do you think completing an evaluation on the computer is any different, and if so, how?
3. Is there anything you like about completing an LEI evaluation online?
4. Is there anything you dislike about completing an LEI evaluation online?
5. If you were asked to recommend any changes to the ASSISTments website, what would you suggest, if anything?

Appendix D: Model LEI Evaluation for Pilot Group 2

This appendix contains the six questions I placed in the model LEI evaluation for my second student pilot program.

1. **Graded Multiple Choice Question:**

   How long do Bachelors degree programs typically last?

   ¿Cuánto tiempo duran los programas de licenciatura?

   Choices:

   1 year / año

   2 years / años

   4 years / años (This was the correct answer.)

   6 years / años

2. **Ungraded Open Response Question:**

   What is the name of your high school?

   ¿Cuál es el nombre de su escuela secundaria?

3. **Ungraded Open Response Question:**

   What is your favorite class?

   ¿Cuál es su clase favorita?

4. **Ungraded Open Response Question:**

   What is your least favorite class?

   ¿Cuál es su clase menos favorita?

5. **Multiple Choice Question:**

   On a scale from 1 to 5, please indicate how interested you are in attending college.

   En una escala de 1 a 5, por favor indique cuánto interés Ud. tiene en asistir a la universidad.

   Choices:

1 Not interested at all / No interesad@ en absoluto

2 Not interested at all but will consider / No interesad@ en absoluto pero lo consideraré

3 Somewhat interested / Un poco interesad@

4 Very interested / Muy interesad@

5 Extremely interested / Extremadamente interesad@

6. **Graded Open Response Question:**

What does GPA stand for?

¿Qué significa GPA, en inglés?

Answers:

"Grade Point Average" or "Grade-Point Average" case insensitive.

Appendix E: Planned Questions for Pilot Group 2

This appendix includes the eight main discussion questions I had planned to ask the participants of my second student pilot program.

1. Have you ever completed an LEI evaluation on the computer before?
2. Do you think completing an evaluation on the computer is any different, and if so, how?
3. Is there anything you like about completing an LEI evaluation online?
4. Is there anything you dislike about completing an LEI evaluation online?
5. If you were asked to recommend any changes to the ASSISTments website, what would you suggest, if anything?
6. If you were asked to recommend any changes to the Google Forms website, what would you suggest, if anything?
7. Is there anything that Google Forms seems better at doing than ASSISTments?
8. Is there anything that ASSISTments seems better at doing than Google Forms?

Appendix F: Software Requirements Matrix Sources

This appendix describes the sources I utilized when creating the software requirements matrix.

When determining the ratings for Blackboard, I referred to "Access Another Instructor's Course Contents"; "BLACKBOARD 9.1: Copy Items into a Different Course"; "Language FAQs"; "Test and Survey Results"; and "Your day. Made easier."

When determining the ratings for Canvas, I referred to "Can I download all of my students' quiz answers?"; "Canvas Account Comparisons"; "How do I copy content from another Canvas course?"; "How do I view analytics for a student in a course?"; "How do I view survey results in a course?"; "How to export quiz free response answers as text/excel file?"; "How to print student exam answers"; "Support Terms"; "Viewing Quiz Statistics"; and "What languages does Canvas support?"

When determining the ratings for Google Forms, I referred to Curts, Eric; "How do you change the language setting on buttons in a form?"; "Save time and stay connected"; and "View and manage form responses"; and "Program benefits."

When determining the ratings for Moodle, I referred to "About Moodle"; "Building Quiz"; "Grade Book: Exporting Grades"; "Language packs"; "Moodle in English: obtaining datasets & graphs of questionnaire responses"; "Moodle Tips: Sharing questions between courses"; "Moodle.org: Contact"; "Quiz reports"; and "Quiz responses report."

When determining the ratings for Qualtrics, I referred to "Export Formats"; "Reports Overview"; "Sharing a Project"; "Translate Survey"; and "Trial Accounts FAQ."

Appendix G: Internationalization Tutorial Script

This appendix contains the rough draft script of the internationalization tutorial video that I produced for the ASSISTments team. The full video is available on the [ASSISTments YouTube channel](#).

In this video, I'm going to be talking about internationalization.

Internationalization is "The process of planning and implementing products and services so that they can easily be adapted to specific local languages and cultures, a process called localization" ("What is internationalization (I18N)?")

Internationalization can include changing the way numbers, dates, images, and symbols are displayed, depending on the end user's culture.

But one of the most obvious and common examples of internationalization is translating text according to user preference.

Right now, the ASSISTments Tutor has some of this text internationalization.

This allows us to display the Tutor in English, Spanish, and other languages that have been localized.

Maintaining and expanding internationalization in the Tutor and elsewhere on the ASSISTments website is important because it helps us help more teachers, students, and researchers.

Now, the approach to internationalization in the Tutor that I'm about to describe is specifically for GWT, so it is slightly different than regular Java internationalization.

The Tutor's internationalization is composed of three parts: properties files that hold the translations, Java and UI XML files that need the translations, and Java interfaces that connect the properties files to those other files.

Properties files map a key to a value.

In the Tutor, the key is the shorthand version of a message we want to store, and the value is the translated message itself.

Here you can see an English properties file.

The key naming convention we chose was the name of the package, underscore, and then an abbreviated version of the actual message represented by the key.

And here you can see a Spanish properties file.

To add another language, all you have to do is add another properties file with the proper two-character suffix, as seen here with "es" representing Spanish.

English is the default so you don't need an "en" at the end of the properties file name.

Now onto the Java interfaces.

The keys are referenced in the Java interfaces as function names.

These function names are then called by Java and UI XML files, when the files want to access the translated strings.

We made a public static final instance of this Messages interface to make it easier to call its functions in Java and UI XML files.

Here is one example of internationalization in a Java file.

As you can see, with our implementation it takes just one line.

The key called "tutor_finishedPreviewing" is called, which returns the appropriately translated message of "You are finished previewing this content."

And here is an example of internationalization in a UI XML file.

Before any text can be internationalized, we have to import the right interface by defining a new ui:msg element as seen here.

We can then call the interface's functions as seen here.

By calling the "view_account" key, we can replace the default text – Account – with the appropriate translation.

In the end, this internationalization allows us to change the displayed language between Spanish, English, or any other language that has been localized.

ASSISTments decides which language to use based on the user's current browser preference or ASSISTments language setting.

This isn't something that most developers will need to worry about or change.

At any rate, it is important for the ASSISTments team to maintain and expand the Tutor's internationalization in the future.

Hopefully this video has proven a helpful, if brief, tutorial on how you can internationalize more of the Tutor, and even add other languages such as Italian or German as well.

Thanks for watching!