Abstract

The growth of English Language Learners (ELLs) in the K-12 education system has sparked discussions regarding STEM teachers’ ability to meet the needs of these learners. STEM teachers have reported that they do not feel prepared and often lack professional development opportunities to develop the necessary skills to meet these needs. (August & Shanahan, 2010; Ballantyne, Sanderman, & Levy, 2007; Janzen, 2008, U.S. Department of Education, NCES, 2001). However, STEM teachers’ preparation for ELLs, their participation in ELL specific professional development activities, and the degree of inclusion of ELL students in STEM disciplines is relatively unexplored. The most recent School and Staffing Survey Teacher Questionnaire was used to analyze STEM teachers’ credentialing related to ELLs, their participation in ELL specific professional development activities, and the degree of ELL student participation in STEM classrooms. It was found that very few STEM teachers had ELL credentialing. While more than half indicated having ELLs in their service load, less than 25% participated in any ELL specific professional development activities.

Keywords: STEM education, School and Staffing Survey Teacher Questionnaire, English Language Learners

Background

The fastest-growing student population in U.S. schools today is children of immigrants; half of whom do not speak English fluently (Calderón, Slavin, & Sánchez, 2011; McFarland et al., 2017; NCES, 2016; U.S. DOE, & U.S. DOJ, 2015). These individuals are often referred to as English language learners (ELLs). The ongoing growth of the population of ELLs has led to increased attention on this unique population within the K-12 educational environment (NCES, 2016). Nationally, ELLs constitute nine percent of all public school students and are enrolled in 75% of public schools (U.S. DOE, & U.S. DOJ, 2015).

As the population of ELLs has grown, it has become clear that teachers are not well prepared to meet the needs of this demographic (García, Arias, Harris, & Serna, 2010). The growing linguistic diversity within schools in the United States has produced a sense of urgency toward helping teachers support the academic success of language minority students (Molle, 2013). There is an ongoing push in educational literature for all teachers and policymakers to familiarize themselves with the unique demands of educating ELLs (Liu, Thurlow, Erickson, Spicuzza, & Heinez, 1997). Despite the widespread call for professional development related to building teachers’ aptitude to best meet the needs of ELLs, these resources are sparse (August, & Shanahan, 2010; Ballantyne, Sanderman, & Levy, 2007; Janzen, 2008, U.S. Department of Education, NCES, 2001; Zehler, et al., 2003b).

For ELL students to have adequate opportunity for academic achievement in STEM classes, teachers will need to develop knowledge and skills specific to ELLs (Samson, & Collins, 2012). To help ELLs catch up when they fall short in core knowledge, it has been suggested that all disciplines should practice vocabulary knowledge, reading, and writing instruction (Calderón, Slavin, & Sánchez, 2011). However, the educational environment ELLs often face clearly illustrates the shortcomings of the educational system in meeting the needs of this group. Outside of the core content classes, ELLs are often in classrooms and schools filled with nothing but ELLs, learning English from, and practicing it with, one another (Fillmore, 2014).

Criticisms of educational environments that isolate ELLs from language-rich interaction with their peers who are fluent in English provide further support for the necessity of preparing teachers to accommodate ELLs needs within the context of the traditional classroom. Despite the increased demand for teachers to focus on the needs of ELLs, they often lack the knowledge and institutional support necessary to address the complex educational needs of ELLs (Lee, 2005). Ballantyne, Sanderman, and Levy (2007, p.10) commented on this issue, stating, “The recent increase in ELLs in U.S. classrooms has been rapid, and teacher education and professional development has not yet caught up with the demographic shift.”

Many teachers have a fundamental misunderstanding about how long it takes for a student to acquire a new language, how speaking a language other than English at home impacts a student’s learning of English, and the correlation between speaking ability in English and English comprehension (Ballantyne, Sanderman, & Levy, 2007; Karabenick, & Clemens Noda, 2004; Reeves, 2006). Addressing these issues is fundamental to preparing teachers to meet the needs of ELL students, and the absence of this knowledge is also reflected in teachers’ perceptions of their own abilities. Research on teachers’ perception shows that they are not confident in their ability to effectively teach ELLs (Reeves, 2006; U.S. Department of Education, NCES, 2001), and that they would like to have more instruction on this topic (Alexander, Heaviside, & Farris, 1999).

The National Education Association (2011) advocated that teachers be provided practical, research-based information, resources, and strategies to teach, evaluate, and nurture ELL students if they are to succeed. However, access to these resources in practice is often limited. Samson and Collins (2012, p.20) reported, “In our review of the research, we identified oral language development, academic language, and cultural diversity as critical bodies of knowledge and skill areas for all teachers of ELLs that were noticeably absent in the areas of policy and practice.”

As the needs of ELLs gain national attention, educational researchers continue to advocate that expectations for improved student outcomes should be rooted in support for teachers (Calderón, Slavin, & Sánchez, 2011).

In concurrence with the push for reforms in teacher education and training to meet the needs of ELLs, there is also a call for research on effective strategies for educating this group of students. August and Shanahan (2010) stated there still are not enough studies exploring what works with English learners. In discipline specific investigations, there has been a noted absence of research on effective ways to prepare Mathematics and Science teachers to work with ELLs in mainstream Mathematics and Science classrooms (DelliCarpini & Alonso, 2014; Lee, 2005).

This lack of research into effective strategies for educating ELLs and preparing teachers to implement such strategies highlights a need for further investigations into these issues from multiple fields of research. Samson and Collins (2012, p.8) broadly stated that, “Currently, at the various stages of teacher preparation, certification, and evaluation, there is insufficient information on what teachers should know about teaching ELLs.”
There is a growing body of literature on STEM educational initiatives that show overlapping interest with work on ELLs’ educational needs. Collaborative groups are a core feature of modern STEM education principles (Breiner, Harkness, Johnson, & Koehler, 2012) and the use of cooperative learning to support the needs of ELLs is widely supported by researchers (August, & Shanahan, 2010; Calderón, Slavin, & Sánchez, 2011; Fillmore, 2014; Krashen, 1981; Pereira & de Oliveira, 2015). Furthermore, tactile activities that utilize hands-on learning experiences and manipulatives, are also characteristic of STEM education and have been reported as an effective tool for educating ELLs (Honigsfeld, & Dunn, 2009).

The “context of reception” (Portes, & Rumbaut, 2001; Schwartz, et al., 2014) that these students face when entering into the K-12 education system is heavily impacted by the level of preparedness of their educators. An educational system that fails to meet the needs of diverse learners contributes to a negative perception of opportunities within the educational environment and in the labor market beyond school (Portes, & Böröcz, 1989; Portes, & Rumbaut, 2014). Due to their specific language needs, ELLs are at greater jeopardy of struggling academically (Honigsfeld, & Dunn, 2009). However, STEM teachers’ preparedness to meet the needs of these learners has been relatively unexplored.

Research Questions

In the United States, the fastest-growing student group is children who are categorized as ELLs (Calderón, Slavin, & Sánchez, 2011). As the nation turns its focus toward preparing the next generation to fill positions in STEM careers, there is a growing need for research that investigates STEM teacher preparedness for working with ELLs. This investigation was guided by questions regarding the education of ELLs in STEM education. It involved examining the case loads of ELL students in STEM classrooms, the credentialing of STEM educators in relation to ELLs, and professional development related to the education of ELLs. In an effort to construct a national profile of STEM educators the following questions were specifically addressed:

1. Nationally, what are STEM teachers’ service loads of ELLs?
2. Are there regional variations in service loads?
3. Nationally, what percentage of STEM teachers hold Linguistic related credentials?
4. Are there regional differences in Linguistic related credentials?
5. Nationally, what percentage of STEM teachers hold Culture related credentials?
6. Are there regional differences in Culture related credentials?
7. Nationally, what amount of ELL focused professional development do STEM teachers participate in yearly?
In addition, response codes to questions regarding state-level certification areas indicate that a participant holds credentials that certify them to teach in the subject matter indicated by their response codes. The response codes used for degree and graduate certificate content areas were identical to those used for state certifications and thus the same rationale was used to choose the specific codes that best fit the categories of Cultural and Linguistic credentials in regards to any degrees or graduate certificates a participant held.

**Procedures**

This study was a secondary analysis of the most recent 2011-2012 SASS TQ restricted-use license dataset and employed methodology was similar to Ernst and Williams (2014, 2015) and Williams, Kaui, and Ernst (2015). Data were analyzed using AM Statistical Software. Data were weighted using the Teacher Final Sampling Weight (TFNWGT) variable and the SASS TQ supplied 88 replicate weight variables. The methodology included appropriate protocols as required by the Institute of Education Sciences (IES). Specific reporting protocols require the results intended for dissemination be sent to IES for approval and authorization for release. The results were approved for dissemination.

Additionally, the National Center for Educational Statistics (NCES) and IES require that all weighted n’s were rounded to the nearest 10 to assure participant anonymity. As such, the data included in tables may not add to the total N reported due to rounding adjustments. Per NCES and IES recommendations when analyzing data from the SASS TQ, weighted response value of less than 50 were noted as not being stable. Weighted data found to be unstable were replaced with an asterisk in the tables.

**Results**

The results from the descriptive analysis of 2011-2012 SASS TQ dataset regarding STEM teachers’ service loads of ELLs, their credentialing related to ELLs, and their professional development participation regarding ELLs are summarized in Tables 3 and 4. These tables include national and regional data.
a higher mean number of ELLs in service loads than STEM teachers from the South, STEM teachers in the West had slightly lower rates of state-level Linguistic certifications than the corresponding rates for STEM teachers from the South. However, the rates of state-level Linguistic certifications for STEM teachers in the West were slightly higher than the national rates. A notable difference in credentialing in the West is the percentage of Technology teachers, 5.52%, who reported having a Cultural degree. This rate is well above the national rate of 1.21% for Technology teachers.

**Professional Development**

Despite over half of all teachers in the STEM disciplines reporting that they had ELL students in their service loads, less than a quarter of teachers in any of the STEM disciplines participated in ELL specific professional development activities in the last year. Table 4 shows the number of hours of professional development nationally and by region. Mathematics teachers had the highest rate of participation in ELL specific professional development activities nationally with 24.82% having taken part in some amount of professional development. For Science teachers, 23.38% had taken part in some amount of ELL specific professional development within the last year and 19.87% of Technology teachers had done so. Of all the STEM teachers who had participated in ELL specific professional development activities, the majority of participants indicated that they had spent 8 hours or less on these activities.

The percentage of STEM teachers in the Northeast who participated in ELL specific professional development activities were lower than the national average for all of the STEM disciplines. Technology teachers in the Northeast were closest to the national rates with Science or Mathematics teachers lower than their associated national rates. STEM teachers in the Midwest had the lowest rates of participation in ELL specific professional development activities among the four regions. For Mathematics and Technology teachers in the Midwest, the rates of participation in ELL specific professional development activities were less than half of their respective national rates. The percentage of STEM teachers in the South who participated in ELL specific professional development activities were higher than the national rates for each discipline. The percentage of STEM teachers in the West who participated in ELL specific professional development activities in the last year was higher than the national rates and also higher than the regional rates for each discipline.

**Discussion and Conclusion**

The growing ELL population across the nation has led researchers to emphasize the need for general education teachers to adapt instructional methodologies to better suit the needs of ELLs in their classrooms (Lee, 2005; Janzen, 2008). This initiative has also highlighted the need for large-scale investigations into the current state of educators' preparedness to meet the needs of ELLs in the K-12 system. Concurrent with the national attention on STEM education courses, this study examined potential indicators of STEM teachers' preparedness to educate ELLs. Literature states that STEM teachers are not well prepared to meet the needs of ELLs (DelliCarpini & Alonso, 2014; García, Arias, Harris, & Serna, 2010) and further investigation of the relationship between STEM teachers and ELLs has been called for (DelliCarpini & Alonso, 2014; Lee, 2005). Data gathered from the 2011-2012 SASS TQ showed the wide degree of variation in STEM teachers' professional development activities, their credentialing, and their professional development participation rates related to ELLs both nationally and regionally.

There are differences between the frequency and intensity of ELL participation in STEM service loads. Nationally, across all of the STEM disciplines, more than half of the teachers indicated having ELLs in their service load. Technology teachers had the lowest percentage with

<table>
<thead>
<tr>
<th>Region</th>
<th>Teachers with ELLs</th>
<th>Service Load</th>
<th>Cultural Certification</th>
<th>Cultural Degree</th>
<th>Linguistic Certification</th>
<th>Linguistic Degree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nationally</td>
<td>58.4%</td>
<td>7.10</td>
<td>0.19%</td>
<td>1.31%</td>
<td>3.00%</td>
<td>0.44%</td>
</tr>
<tr>
<td>Science</td>
<td>59.1%</td>
<td>5.98</td>
<td>0.02%</td>
<td>0.53%</td>
<td>1.77%</td>
<td>0.71%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>50.8%</td>
<td>7.60</td>
<td>0%</td>
<td>1.21%</td>
<td>1.03%</td>
<td>0.16%</td>
</tr>
<tr>
<td>Northeast</td>
<td>46.6%</td>
<td>4.61</td>
<td>0%</td>
<td>3.65%</td>
<td>0.81%</td>
<td>0.35%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>52.5%</td>
<td>4.42</td>
<td>0%</td>
<td>0.25%</td>
<td>1.32%</td>
<td>0.07%</td>
</tr>
<tr>
<td>Technology</td>
<td>44.3%</td>
<td>5.53</td>
<td>0%</td>
<td>0.65%</td>
<td>0.00%</td>
<td>*</td>
</tr>
<tr>
<td>Midwest</td>
<td>43.1%</td>
<td>2.80</td>
<td>0.41%</td>
<td>0.23%</td>
<td>1.54%</td>
<td>0.37%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>41.1%</td>
<td>3.13</td>
<td>*</td>
<td>0.10%</td>
<td>1.36%</td>
<td>0.19%</td>
</tr>
<tr>
<td>Technology</td>
<td>43.1%</td>
<td>3.35</td>
<td>0%</td>
<td>0.43%</td>
<td>0%</td>
<td>0%</td>
</tr>
<tr>
<td>South</td>
<td>63.5%</td>
<td>7.06</td>
<td>0.09%</td>
<td>0.60%</td>
<td>4.39%</td>
<td>0.32%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>61.8%</td>
<td>4.55</td>
<td>0%</td>
<td>0.76%</td>
<td>2.18%</td>
<td>0.08%</td>
</tr>
<tr>
<td>Technology</td>
<td>50.6%</td>
<td>7.01</td>
<td>0%</td>
<td>*</td>
<td>2.19%</td>
<td>0%</td>
</tr>
<tr>
<td>West</td>
<td>78.5%</td>
<td>15.15</td>
<td>0.34%</td>
<td>1.58%</td>
<td>4.11%</td>
<td>0.86%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>80.3%</td>
<td>14.35</td>
<td>*</td>
<td>0.80%</td>
<td>1.82%</td>
<td>2.38%</td>
</tr>
<tr>
<td>Technology</td>
<td>73.3%</td>
<td>18.78</td>
<td>0%</td>
<td>5.52%</td>
<td>1.84%</td>
<td>0.86%</td>
</tr>
</tbody>
</table>

Note. ELL is English language learner. * denotes that estimate did not meet IES reporting requirements.
50.8% of teachers indicating that they had ELLs in their service load. However, they had the highest mean number of ELLs in their service load with an average of 7.60.

Regional analysis of STEM teachers’ preparation for educating ELLs showed the vast differences across the nation. The West had the highest percentage of teachers with ELLs in their service loads for every discipline and the Midwest had the lowest. Relatedly, STEM teachers in the West also reported the highest rates of participation in ELL specific professional development activities. Findings from regional analysis suggest a link between the percentage of STEM teachers in a region with ELLs in their service load and participation in ELL specific professional development opportunities. These findings can lead to insights on the situation nationally and regionally as well as serving to direct future efforts to improve the educational experiences of ELLs in STEM disciplines.

This study found that nationally over half of all STEM teachers have ELLs in their classes yet less than a quarter of STEM teachers participated in ELL specific professional development activities. These comparative rates of ELLs in classes to the professional development participation could encourage programs to provide more professional development opportunities. While it is reported that ELLs constitute 9% of all public school students (U.S. DOE & U.S. DOJ, 2015), this information may be less impactful to some than the fact that nationally in STEM fields the majority of teachers indicated having ELLs in their service loads of students. Even in regions where ELLs were less common, across all of the STEM disciplines more than 40% of teachers reported having ELLs in their classes.

These findings also show that both nationally and in all regions for all of the STEM disciplines the majority of participants who indicated that they had taken part in ELL specific professional development in the last year indicated having eight or less hours of these activities. While professional development opportunities are supported as a means to build skills for working effectively with ELLs (Ballantyne, Sanderman, & Levy, 2007; Calderón, Slavin, & Sánchez, 2011), some researchers advocate for long-term programs (García, Arias, Harris, & Serna, 2010). As teachers adapt instructional methods to better suit the needs of their ELLs, there will continue to be a need for studies that investigate effective instructional practices of STEM teachers working with ELLs as well as impactful professional development models for empowering teachers with these research-based skills and understandings.

The findings of this study could be further advanced through studies of specific issues STEM teachers face when working with ELLs and how targeted professional development models could serve to build appropriate methods for adapting STEM curriculum to best suit the needs of this population of learners. Furthermore, longitudinal studies could lend insight into how STEM educators are preparing to meet the needs of this growing population of ELLs nationally and regionally. Targeted efforts should also be made in encouraging collaboration between experts in STEM disciplines and language specialist to make efficient use of the practices and methodologies that are best suited to engage ELLs in STEM disciplines in ways that support their unique learning needs.

Table 4. STEM teachers’ ELL related professional development.

<table>
<thead>
<tr>
<th>Region</th>
<th>Teachers with ELLs</th>
<th>ELL PD 8 or Less Hours</th>
<th>9-16 Hours</th>
<th>17-32 Hours</th>
<th>33 or More Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nationally</td>
<td>58.4%</td>
<td>23.38%</td>
<td>16.90%</td>
<td>3.86%</td>
<td>1.36%</td>
</tr>
<tr>
<td>Science</td>
<td>46.6%</td>
<td>13.69%</td>
<td>10.07%</td>
<td>1.25%</td>
<td>1.21%</td>
</tr>
<tr>
<td>Mathematics</td>
<td>52.5%</td>
<td>16.78%</td>
<td>11.38%</td>
<td>2.85%</td>
<td>2.17%</td>
</tr>
<tr>
<td>Technology</td>
<td>44.3%</td>
<td>14.05%</td>
<td>11.18%</td>
<td>*</td>
<td>1.65%</td>
</tr>
</tbody>
</table>

Note. ELL is English language learner. PD is professional development. * denotes that estimate did not meet IES reporting requirements.

References


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