Geospatial analysis of L2 reading achievement: Challenges and opportunities

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> The patterns of language use of the children of Roadville and Trackton before they go to school stand in sharp contrast to each other and to those of the youngsters from townspeople families. Though parents in all three communities want to 'get ahead,' their constructions of social activities the children must engage in for access to language, oral and written, vary greatly. The sequence of habits Trackton children develop in learning language, telling stories, making metaphors, and seeing patterns across items and events do not fit the developmental patterns of either linguistic or cognitive growth reported in the research literature on mainstream children. Roadville children, on the other hand, seem to have developed many of the cognitive and linguistic patterns equated with readiness for school, yet they seem not to move outward from these basics to the integrative types of skills necessary for academic success (Heath, 1983, p. 324).

This special issue is dedicated to understanding how to best support positive educational outcomes for all students. While reading strategies, course design and methods, testing and assessment, and a variety of other factors are all integral to L2 reading outcomes, policies constructed at the federal, state, district, and school level play an important role in supporting, or failing to support, reading achievement. As Heath (1983) noted, literacy development takes place in context, and part of that context is defined by policy decisions. These policy decisions are often made based on limited data and limited understanding of the environments in which learning occurs. In this commentary, I suggest that Geographic Information Systems (GIS) research offers a particular advantage to policy stakeholders at all levels of educational systems, but that a lack of high-quality data about diverse learners limits the efficacy and availability of this research.

First, one important understanding for policy-makers and district administrators is that literacy development takes place in context. That is, there are multiple sources of influence that shape a child's learning and development (Lee, 2008). As Heath (1983) noted, different communities experience and develop literacy in different ways. While this is true for L1 learners, there are also strong sociocultural influences on L2 reading achievement (Geva & Verhoeven, 2014). These influences offer an ecological framework through which literacy development, and L2 reading development, can be viewed. This suggests a complexity of community activity that calls for a deeper analysis of community ecology, moving beyond the idea of a bounded, homogenous community to one that allows organic qualities of communities to emerge (Gutierrez & Arzubiaga, 2012). Understanding these communities, and community characteristics, is thus integral to policy stakeholders because learning is so highly dependent on the context in which it

occurs (Sweetland & Hoy, 2000).

Sociocultural factors have long been recognized to influence L2 development and attainment (Perry, 2012). Sociocultural factors have been established in the research to have far-reaching and disparate effects on how students process and learn, impacting L2 reading achievement (Birch, 2014; Lantolf, Thorne & Poehner, 2015). While these are important considerations for teacher education programs as well as in L2 classrooms (Johnson & Golombek, 2016), sociocultural factors also should be assessed and considered by policy stakeholders at all levels of educational decision-making. GIS offer a new an innovative way to map out these relationships, allowing natural communities to emerge, and making them particularly accessible to a lay audience such as a school board. This technique may be particularly helpful in understanding where communities of English Language Learners (ELLs) are located, which can then facilitate a better understanding of individual ethnic enclaves. Just the identification of these communities can allow schools and districts to better understand the communities they serve, and thus to apply research about specific social or cultural groups in order to adopt the most efficacious teaching practices. This also helps broaden the applicability of research about specific methods, profession development, and other teaching and learning strategies.

GIS and specifically geographic weighted regression offer a new lens through which to view the complex relationships of school context and L2 reading attainment. Geographic Weighted Regression (GWR) provides local R^2 values and their geographic weights to determine nonstationarity in relationships across districts. Stationarity refers to the idea that relationships are stable across a geographic area (Fotheringham, Brunsdon & Charlton, 2002). These local R^2 values can then be mapped, as well as statistically significant relationships and the *t*-value beta coefficients.

Like multi-level modeling (MLM), GWR allows relationships to vary across groups, but also takes into account the underlying spatial continuum not included within MLM (Fotheringham, Burnsdon, & Charleton, 2002). Because district-level data is inherently geographically distributed, it is additive to use spatial statistics to analyze this data. One of the assumptions of regression analysis is that the observations are independent of one another. With spatially autocorrelated map distributions, however, units are spatially dependent (Meade & Emch, 2010). Therefore, geographic weighted regression (GWR) can be used to understand how spatial relationships vary in space (Meade & Emch, 2010). Mapping the GWR results illustrates the stationarity of the relationships. These maps, then, can be used to understand what factors matter where, whether at the school or district level.

While it is not always possible to reach a concrete conclusion about the effects of these variables or the variable relationship, what is important is that this research shows the nonstationarity of these relationships. Because the effects of the variables are not stationary across the state, and this variation needs to be accounted for both in research and in policy.

For example, below is a set of three maps examining the correlation between L1 achievement for high school students and socioeconomic status in the state of Missouri. As shown in Figure 1 the highest local R^2 values for socioeconomic status and the English II end-of-course exam were found in the bootheel, the southeast corner of the state, with the highest value approximately 0.36.

While some of these values were statistically significant, there were few statistically significant relationships in total, with small clusters in the southern portion of the state, and one statistically significant district in northern Missouri (see Figure 2). The *t*-values for the relationships were distributed so that the negative relationships were seen in the two metropolitan areas, extending into the bootheel, while a large number of non-significant positive relationships extended through the central part of the state (see Figure 3). Interestingly, one small significant cluster in the southwestern corner of the state demonstrated a positive relationship, meaning that a higher proportion of poverty was associated with higher English II scores (see Figure 3).
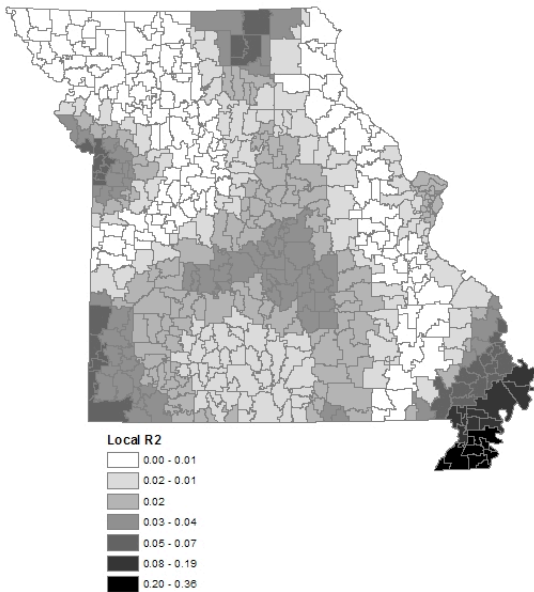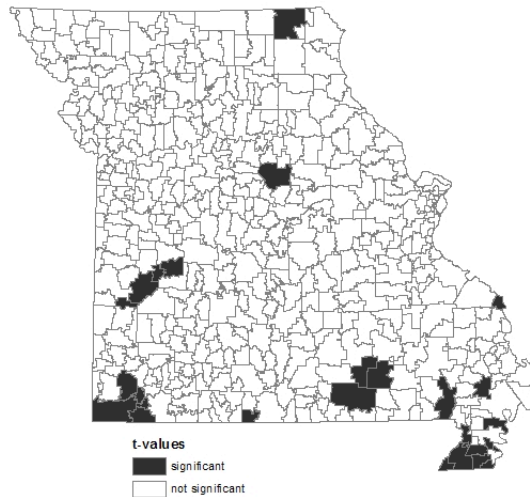

Figure 1. SES, English II (R^2)

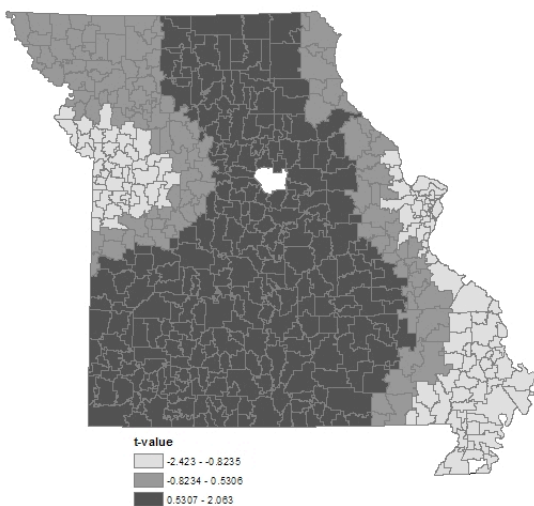**Figure 2.** SES, English II (significant beta coefficients)

Figure 3. SES, English II (beta coefficients, *t* test values)

Unfortunately, there are some limitations of the applicability of this technique to L2 research. There is a clear paucity of data on L2 learners in Missouri. The state of Missouri doesn't require districts to collect data on linguistically diverse learners, including such information as English Language Learners served, number of students speaking more than one language, number of students who have emigrated from another country to the United States, as well as others. This lack of data on linguistically diverse learners is a hindrance to researchers wishing to better understand the underlying factors impacting literacy development. As the state continues to grow in diversity, such data could be useful at the school, district, and state levels. With the data collection mechanism already in place, there is a strong argument for state-level education administrators to broaden the variables collected in order to better understand Missouri's diverse student population.

While the maps presented here look at the district and state, it is also possible to apply these techniques to examine one region or district. School-level data could be applied to allow a district administrator to deduce which schools serve which communities.

Place and the geography of opportunity are well established in the literature, and mapping of those spaces has been used to study the geography of opportunity (see de Souza Briggs, 2005; Gordon, 2008; Hogrebe & Tate, 2012; Jargowsky, 1997). Geographic effects on academic achievement and educational outcomes, though, remain under-researched (Zhang & Cowen, 2009). The analytical technique presented here, then, offers analysis of the actual effects of geographic location on these statistical relationships. The maps provided by this analysis offer easily accessible visual representation of significant, nonstationary relationships. Because these maps are easy to read, they are useful both to practitioners and researchers, broadening the potential impacts of this research. At the same time, this research goes beyond just identifying the significant relationships to elucidate where the correlations are the strongest, the direction of the relationship, and the strength of the correlation of the relationship.

This type of analysis thus offers potential insights as to what policies are best suited at the state, district, and school level. In order for the full capability of this technique to emerge when examining L2 learning, though, the state of Missouri must commit to collecting more and better data about the diverse set of learners served by public education in the state.

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