Use of Native Language and Culture (NLC) in Elementary and Middle School Instruction as a Predictor of Mathematics Achievement

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Abstract

Because students from American Indian/Alaska Native (AI/AN) backgrounds tend to lag behind their peers in academic achievement, researchers have recommended integrating Native Language and Culture (NLC) into instruction. However, existing evidence from large-scale studies finds a *negative* effect of the use of NLC on achievement, although this research does not take into account aspects of student background and the learning context. Using a nationally representative dataset, we found that use of NLC had a less negative and/or more positive effect on achievement among students whose families identified more strongly with their Native culture and who were in schools with larger percentages of AI/AN students. Our results support earlier contentions that the use of NLC can be effective in enhancing achievement for at least some AI/AN students; they also suggest that existing approaches to NLC should be expanded to accommodate AI/AN students in a wider range of contexts.

Keywords: Native Language and Culture; National Indian Education Study; academic achievement; moderation

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Research on American Indian/Alaska Native (AI/AN) students has found that they lag behind their non-AI/AN peers in academic achievement and graduation rates and have higher rates of drop-out (Aud et al., 2012; Faircloth & Tippeconnic, 2010; NEA, 2010-2011). To improve outcomes for AI/AN students, the research community has recommended that educators integrate Native Language and Culture (NLC) into instruction (Bishop, Berryman, Cavanagh, & Teddy, 2009; Brayboy & Castagno, 2009; Brayboy, Faircloth, Lee, Maaka, & Richardson, 2015; Castagno & Brayboy, 2008; Chavers, 2000; Martinez, 2014; McCarty & Lee, 2014). Use of NLC in instruction can include, among other things: (1) incorporation of Native languages, Native cultural practices, and/or traditional knowledge (Bishop et al., 2009; Brayboy et al., 2015; Brayboy & Castagno, 2009); (2) promoting the presence of Native elders, traditions, and ceremonies in the school (Castagno & Brayboy, 2008; CHiXapkaid et al., 2008; Keeshig-Tobias, 2003; McCarty & Lee, 2014); and, (3) promoting an understanding of the history of tribal self-determination, the impact of institutionalized racism on Native people, and the need for creating change on a systems level (Castago & Brayboy, 2008; McCarty & Lee, 2014). The research community suggests that schools that integrate these aspects of NLC into instruction may be able to positively impact the behavior and academic performance of AI/AN students (Bishop et al., 2009; Castagno & Brayboy, 2008; Chavers, 2000; Demmert, Towner, & Yap, 2003; McCarty & Lee, 2014; Trujillo & Alston, 2005). This hypothesis is based on qualitative or small-scale studies indicating that AI/AN students are more successful in academic settings that incorporate their language and culture (Apthorp, D'Amato, & Richardson, 2003; August, Goldenberg, & Rueda, 2006; Brayboy & Castagno, 2009;

Smallwood, Haynes, & James, 2009).

However, existing evidence from multiple large-scale quantitative studies finds a *negative* effect of the use of NLC on student achievement. For example, López, Heilig, & Schram (2013) found that "the more students reported perceiving AI/AN culture was incorporated into instruction, the worse their achievement" (p. 530). They also found that teacher-reported use of NLC had no effect on achievement. Similarly, Jesse, Meyer, & Klute (2014) found negative relationships between student-report use of NLC and grade 4 and 8 mathematics and grade 8 reading achievement (but no effects for grade 4 reading achievement), and found no relationship between teacher-reported use of NLC and student achievement; in addition, they found that school administrator-reported use of NLC was negatively related to grade 8 reading achievement (but no effects on grade 4 reading or math achievement or grade 8 math achievement).

One limitation to this large-scale quantitative research is that it does not take into account important aspects of the learning context, despite evidence that academic achievement among AI/AN populations can be influenced by contextual factors, both in the home and in the school. For example, Powers (2006) found that individual students' cultural identification moderated the effects of use of NLC in the classroom such that students who identified more closely with their Native culture received more benefit from NLC. This finding was based upon the notion that learning practices that are a part of many Native cultures may not be compatible with the Western approach to education that is the instructional foundation for most schools, and this discontinuity can contribute to the achievement deficits of AI/AN students. Further, the degree to which AI/AN individuals and families identify with their traditional culture can be expected to vary within a population (Gutiérrez & Rogoff, 2003); thus, those students whose cultural identity is more closely aligned to traditional beliefs and practices could be expected to gain the most from NLC in schools because their educational experience would more closely align with their cultural traditions (Tyler et al., 2008).

Similarly, Tsethlikai and Rogoff (2013) found that teaching practices that more closely mirrored traditional AI/AN ways of learning (i.e., attentive involvement in family and community practices and events) were more beneficial to students with a stronger cultural identification. The authors hypothesized that learning through listening may be an especially powerful approach for children whose cultural practices include oral traditions. Here again we find the notion of alignment, in which learning practices that incorporate cultural traditions can be more effective and more appealing to AI/AN students (Tsethlikai, 2011).

Achievement of AI/AN students may also be influenced by the cultural context of the school itself. Although the density of AI/AN students in a school has been linked to lower overall achievement (Richards, Vining, & Weimer, 2010), AI/AN density can also be seen as an indicator of the cultural identity of a school (Beaulieu, 2006); thus, it would be reasonable to hypothesize that use of NLC would be more beneficial in schools with higher AI/AN density (i.e., a more Native cultural context).

In this study, we applied these ideas in a quantitative analysis of an existing large-scale dataset. Our research questions (RQ's) were:

1. Can cultural identity (as measured by the family's use of Native language in the home and their degree of participation in Native gatherings) moderate the effects of NLC on mathematics achievement?
2. Can the school cultural context (as measured by the density of AI/AN students in the school) moderate the effects of NLC on mathematics achievement?

3. Can the school cultural context moderate the effects of cultural identity on the relationship between NLC and mathematics achievement?

Given the results presented by Powers (2006) and Tsethlikai and Rogoff (2013), we hypothesize that cultural identity will serve as a significant moderator, such that students with a stronger cultural identity will be linked to less negative and/or more positive effects of NLC on mathematics achievement (i.e., the first research question, or RQ 1). The second and third research questions are exploratory in nature given the paucity of existing literature, but are included to evaluate (a) whether students in schools with a higher density of AI/AN students will experience greater benefit from NLC in terms of less negative and/or more positive effects on mathematics achievement (i.e., RQ 2); and, (b) whether schools with a higher density of AI/AN students will enhance or amplify the salutary effect of family context on the link between NLC and mathematics achievement, such that effects of family context are stronger in higher density schools (i.e., RQ 3).

To address these research questions, we used data collected by the National Assessment of Educational Progress (NAEP) and the National Indian Education Study (NIES) in 2011. NAEP is an ongoing assessment of students' educational progress, and includes assessments of student performance in a range of subject areas, including reading, writing, mathematics, science, arts, U.S. history, and geography (see http://nces.ed.gov/nationsreportcard/about/); in this study, we limited our scope to mathematics. In 2011, NAEP conducted national and state assessments in mathematics at grades 4 and 8 in nationally representative schools.

NIES was carried out during NAEP assessments in grades 4 and 8 in schools that had one or more AI/AN students who were selected for NAEP. Administered biannually from 2005 to 2011, NIES data collection has now changed to four-year intervals; the 2011 data, therefore, represents the most recent NIES data available (NAEP grade 4 and 8 reading and math achievement data was released in October 2015, but NIES survey data from 2015 are not yet available). The data collected by NIES included the school survey (completed by school administrators), the teacher survey, and the student survey. These surveys provide a number of variables related to use of NLC in education, such as: (a) the frequency of AI/AN community member visits to schools, (b) the frequency of AI/AN community officials and elders' meeting with school officials, (c) the number of courses about AI/AN traditions and cultures offered by the school, (d) whether instruction in AI/AN language and culture is offered, (e) availability of materials on AI/AN language and culture, (f) teacher use of AI/AN languages during instruction, (g) teacher integration of AI/AN materials into the reading curriculum, and (f) teacher integration of AI/AN materials into the mathematics curriculum. In a previous article, we use exploratory and confirmatory factor analysis to derive a set of statistically defensible constructs to be used in future research on NLC in instruction (Author et al., 2016).

Method

Participants

For the analyses in this paper, we used NAEP/NIES data from 2011, which consists of about 10,200 AI/AN 4th graders in approximately 1,900 schools, and of about10,300 AI/AN 8th graders in approximately 2,000 schools. In addition, the sample includes about 3,000 grade 4 teachers and 4,600 grade 8 teachers. For more information, refer to National Center for Education Statistics (2013).

Procedures

The schools and students participating in NAEP assessments are selected to be representative both nationally and at the state level. Samples of schools and students are drawn from each state and from the District of Columbia, and the results are combined to provide accurate estimates of the overall performance of students in the nation and in individual states.

NAEP data collection uses a two-stage sampling procedure. First, a nationally representative sample of schools is selected; then, a representative sample of students is selected from the participating schools. To allow detailed examination of AI/AN students' school experiences and performance, BIE schools and AI/AN students are oversampled; all grade 4 and 8 students who were coded by the school as AI/AN, and who participated in a NAEP mathematics, reading, or science assessment, were included in the NIES sample and eligible for participation in the NIES survey unless the parent exercised the option of not having their child answer the NIES questions. Although NIES achievement data are comprised of NAEP mathematics and reading assessments, and NIES survey results included AI/AN students who took the NAEP science assessment instead of mathematics or reading, our results were limited to those AI/AN students for whom we had mathematics scores.

Teachers were selected based upon the student sampling procedure; for each sampled student, his/her teacher was requested to fill out the NIES surveys. There was no explicit sampling of teachers, so teacher data must be considered to be at the student level in multi-level models. Although a teacher can be linked to more than one student, which may create bias in the results, the alternative approach (i.e., creating a teacher level in a multi-level model) is not tenable due to the lack of sampling weights for teachers.

Because NAEP assessments include more questions than any one student could answer, they are designed such that each student takes a randomly selected portion that is representative of the overall assessment. This design allowed for maximum coverage of the content area at grades 4 and 8 while minimizing the time burden on students.

To collect NIES survey data, the questions were read aloud to all students in grade 4 who needed assistance (questions were not read aloud to students in grade 8). Representatives were available to answer any questions that students had as they took the surveys.

Measures

The NAEP Mathematics Framework for grades 4 and 8, developed by the National Assessment Governing Board, was used to guide the development of the mathematics items. These items focused on five mathematics content areas: number properties and operations, measurement, geometry, data analysis, statistics, and probability, and algebra (grade 8 only).

Proficiencies in these content areas were summarized through Item Response Theory (IRT) models. Proficiency values, or “plausible values,” were drawn at random from a conditional distribution for each NAEP respondent, given his or her response to their subset of mathematics items and a specified group of background variables. These plausible values are considered to be estimates of how a student would have scored if he/she had actually completed every item in the assessment. The plausible values for each content area were combined to generate a set of overall plausible values for mathematics, and these were used as the outcome variables for our analyses.

NIES student, teacher, and administrator surveys were developed by a Technical Review Panel including Native scholars. From these items, we used exploratory and confirmatory factor analysis to derive the following set of constructs representing use of NLC in the classroom (see Author et al., 2016, for details). The creation of composite variables to represent each aspect of NLC was necessary given the complexity of the models and the analysis framework we selected (i.e. Hierarchical Linear Modeling, see Analysis Plan below). The individual constructs we used in our analysis are presented below.

Live exposure (student-report). In the 4th grade, this variable measured the degree to which students were given live access to AI/AN traditions and culture in the classroom through use of language (item 4), school visitors (item 5), and field trips (item 6). Items 5 and 6 were reverse coded so that higher scores indicated more access. Since the items were on different scales (i.e., yes/no vs. 3- or 4-item Likert scales), all items were standardized; the standardized items were then averaged to form a single composite.

In the 8th grade, this variable measured the degree to which students were given live access to AI/AN culture in the classroom through presentations on Native traditions and customs (item 6a), arts and crafts demonstrations (item 6b), music and dance (item 6c), and field trips to museums or Native communities (item 6d). All items were reverse coded to ensure that higher scores indicated more exposure. Items were on the same scale and were averaged to form a single composite.

Media exposure (student-report). In the 4th grade, this variable measured the degree to which students were exposed to learning materials with AI/AN themes (items 7, 8, and 12). Items 7 and 8 were reverse coded so that higher scores indicated more access. Since the items were on different scales (i.e., yes/no vs. 3-item Likert scale), all items were standardized; the standardized items were then averaged to form a single composite.

In the 8th grade, this variable included items 7a-b and 8a-b. All items were reverse coded to ensure that higher scores indicated more exposure. Items were on the same scale and were averaged to form a single composite.

Teacher preparation (teacher-report). For teachers of 4th grade students, this variable measured the degree to which teachers made use of available resources and professional development opportunities in order to improve their teaching and, in turn, the academic performance of their AI/AN students (items 5a-e and 6). Items were on the same scale and were averaged to form a single composite. For teachers of 8th grade students, this variable was created in an identical manner but used items 4a-e and 6 instead of items 5a-e and 6.

Math instruction (teacher-report). For teachers of 4th grade students, this variable measured the degree to which teachers incorporated AI/AN culture and history into their mathematics instruction (items 9, 16, 17, and 18a-d). Since the items were on different scales (i.e., 4- vs. 5-item Likert scales), all items were standardized; the standardized items were then averaged to form a single composite.

For teachers of 8th grade students, this variable was created in an identical manner but used items 19, 20, 21, and 22a-d instead of items 9, 16, 17, and 18a-d. Since the items were on different scales (i.e., 4- vs. 5-item Likert scales), all items were standardized; the standardized items were then averaged to form a single composite.

Local involvement (administrator-report). This variable measured the degree to which school administrators for 4th grade students involved local representatives of AI/AN tribes in their school (items 9a-c, 10a-b). Items were on the same scale and were averaged to form a single composite. For 8th grade, this variable was created in an identical manner.

Cultural instruction (administrator-report; 4th grade). This variable measured the extent to which administrators for 4th grade students believed that students in their school received instruction in Native history, traditions, arts, and tribal government (items 14c-f). Items were on the same scale and were averaged to form a single composite. For 8th grade, this variable was created in an identical manner.

Family/school context. We used two variables independently to indicate the family cultural context: the degree to which the family spoke a Native language in the home (1=*Never* *or hardly ever*, 2=*Once or twice a month*, 3=*Once or twice a week*, 4=*Every day or almost*); and, the frequency with which the family attended Native ceremonies and gatherings (1=*Never*, 2=*Every few years*, 3=*At least once a year*, 4=*Several times a year*). The school context was indicated by a single variable representing the percentage of AI/AN students in the school.

Student covariates. We controlled for factors that could be expected to predict math achievement, including: whether the student was eligible for free or reduced-price lunch (0=*no*, 1=*yes*); whether the student was classified as an English Language Learner (ELL; 0=*no*, 1=*yes*); whether the student had an Individual Education Plan (IEP; 0=*no*, 1=*yes*); and, the students self-rating in math (1=*poor*, 2=*average*, 3=*good*, 4=*very good*).

Analysis Plan

We conducted the analyses using Hierarchical Linear Modeling (HLM 7.0; Raudenbush & Bryk, 2002). HLM supports the use of plausible values as outcomes; since NAEP used 5 plausible values for mathematics achievement, HLM performed each analysis 5 times and then aggregated the results, adjusting the standard errors to reflect the variance in the regression coefficients across the 5 sets of results. HLM also supports the use of weighting at each level, which was required in our analysis due to the school and student sampling mechanism in NAEP/ NIES. We used a two-level model, with students at level 1 nested within schools at level 2. As discussed above, a separate level for teachers (i.e., a three-level model with students nested within teachers nested within schools) was not possible given that teachers were not deliberately sampled, and thus no weighting variable for teachers was provided in the dataset.

To test whether the effects of NLC were moderated by family and school context, we used interaction terms. For RQ 1, to test the interaction between NLC (e.g., student-report live exposure) and the family context (e.g., frequency of Native language spoken in the home), we multiplied these variables together to form an interaction term, and then included the interaction term in the model along with the main effects (i.e., the variables themselves). If this interaction term was statistically significant, it would indicate that the effect of NLC on mathematics achievement varied across the levels of family context (i.e., from low to high frequency of Native language spoken in the home).

To test whether school-level percentage of AI/AN students can moderate the effects of student- or teacher-report NLC (which is part of RQ 2) cross-level interactions were created in HLM. To evaluate the potential for the school context to moderate the effect of family context on the link between NLC and instruction (i.e., RQ 3), we used 3-way interactions, which are conceptually similar to two-way interactions (e.g., between family context and NLC) but involve the addition of a third variable (e.g., school context). As is standard practice, we included all relevant main effects in the model when testing interactions. Grand-mean centering for all variables was used, i.e., variables without meaningful zero values were averaged across the entire sample; this ensures that the intercept values from the models are interpretable as the scores for the average student. Random effects for each level 1 predictor were tested and discarded if they were not significant; these effects enable HLM to model differences among students within schools.

We conducted three sets of analyses for both 4th and 8th grade; in each case, we first explored the effects of teacher-report NLC, then student-report, then administrator-report, and we controlled for key covariates in each model (e.g., ELL, IEP). In each set of models, we first evaluated main effects for NLC (Model 1), then we explored moderation by family context (Models 2a and 2b, corresponding to RQ 1), and finally we explored moderation by family and school context simultaneously (Models 3a and 3b, corresponding to RQ 2 and 3). A sample model is presented below evaluating moderation of one aspect of student-report NLC (i.e., live exposure) by both family and school context:

(level 1 – student) $Math_{ij} = \pi_{0j} + \pi_{1j}$ (Live Exposure)$_{ij}$ + π_{2j} (Family Context)$_{ij}$

+ π_{3j} (Interaction)$_{ij}$ + π_{4j} (Student Covariate)$_{ij}$ + e_{ij}

(level 2 – school) $\pi_{0j} = \beta_{00k} + \beta_{01k}$ (Percent Native Students)$_{jk}$ + r_{0jk}

(level 2 – school) $\pi_{1jk} = \beta_{10k} + \beta_{11k}$ (Percent Native Students)$_{jk}$ + r_{1jk}

(level 2 – school) $\pi_{2jk} = \beta_{20k} + \beta_{21k}$ (Percent Native Students)$_{jk}$ + r_{2jk}

(level 2 – school) $\pi_{3jk} = \beta_{30k} + \beta_{31k}$ (Percent Native Students)$_{jk}$ + r_{3jk}

(level 2 – school) $\pi_{4jk} = \beta_{40k} + r_{4jk}$

In this model, the regression coefficients (β's) are interpreted in terms of their effects on the outcome variable (i.e., mathematics achievement) and have the following interpretation:

β_{00k}: the regression intercept

β_{01k}: the main effect for the school's Percent Native Students (i.e., density)

β_{10k}: the main effect for Live Exposure

β_{11k}: the interaction between Live Exposure and Percent Native Students (i.e., RQ 2)

β_{20k}: the main effect for Family Context

β_{21k}: the interaction between Family Context and Percent Native Students

β_{30k}: the interaction between Live Exposure and Family Context (i.e., RQ 1)

β_{31k}: the interaction between Live Exposure, Family Context, and Percent Native Students (i.e., RQ 3)

β_{40k}: the main effect for a Student Covariate (e.g., ELL; no interaction with Percent Native Students was tested)

Results

Descriptive data are presented in Table 1. In each of our results tables (Tables 2 and 4-8), Model 1 evaluates the main effects of NLC (to serve as a comparison with previous research), Models 2a and 2b refers to moderation of NLC by family context (i.e., RQ 1), and Models 3a and 3b add a consideration of school context (i.e., RQ's 2 and 3). We present the key regression coefficients in the text below to aid the reader's interpretation of the tables.

We present the results from teacher-report NLC predicting 4th grade math achievement in Table 2. Unlike previous results that found no effects for teacher-report of NLC (Jesse et al., 2014), we find significant negative effects for one aspect of teacher-report use of NLC (i.e., teacher use of Native materials in preparation; $B = -4.19^{*}$) but not for the other (i.e., use of Native concepts in math instruction; $B = -1.36$; see Model 1). In Models 2a and 2b, the significant interaction terms suggest that both aspects of NLC are moderated by the family context; specifically, both depend on the degree to which the family speaks a Native language (i.e., $B = 1.89^{*}$ and $B = 2.67^{**}$) and the impact of NLC in math instruction on student math achievement also depends on the degree to which the family attends Native ceremonies and gatherings ($B = 1.38^{*}$). The magnitude and positive sign of these interaction terms suggest that students from families who speak a Native language and/or attend a Native gathering often may experience a less negative and/or more positive effect for teacher-report NLC as compared to other students. In Model 3a, the significant interaction term (i.e., $B = .05^{*}$) suggests that students in schools with higher percentages of AI/AN students will experience less negative and/or more positive effects from teacher-report NLC (i.e., teacher preparation); the three-way interactions were not significant. In Model 3b, the significant three-way interaction ($B = .06^{*}$) suggests that students whose families speak Native language more often will experience a less negative and/or more positive effect of NLC on achievement, and that this effect is amplified for students in schools with higher percentages of AI/AN students. Finally, the student covariates all had significant effects in the expected directions (e.g., the presence of an IEP had a negative effect). This aspect of our results was consistent across all analyses.

To aid the understanding of these interaction terms, we provide a set of predicted effects for both aspects of teacher-report NLC in different contexts in Table 3. The first number in each column represents the "main" effect, or the overall effect of each aspect of NLC for the entire sample. The next four numbers represent the effect of NLC for students whose families have varying degrees of identification with Native culture; as the numbers suggest, the effects of NLC become more positive as students' families report a greater degree of Native identification. Following this, we provide three sets of numbers to document how those families would perform in schools that were mostly non-AI/AN (only 5% AI/AN), evenly split between AI/AN and non-AI/AN (50% AI/AN), and mostly AI/AN (95% AI/AN)[1]. As discussed above, the effects of teacher-report NLC across the range of family cultural identification becomes less negative and/or more positive as the AI/AN density increases.

In Table 4, we present the results from student-report NLC predicting 4th grade math achievement. In Model 1, we found a significant negative effects for NLC (i.e., live exposure; $B = -7.02^{***}$), which echoes previous work (e.g., Jesse et al., 2014); the other aspect of NLC (i.e., media exposure) has no significant effect. In Model 2a, we find that the negative effect for live exposure is moderated by the family context (i.e., the degree to which the family speaks a Native language; $B = 4.04^{**}$); the magnitude and positive sign of the interaction term suggests that students from families who speak a Native language often may experience a less negative and/or more positive effect for student-report NLC as compared to students from families who

[1] These percentages were chosen to highlight the way different school contexts may impact AI/AI student math achievement, and therefore they differ from the standard NIES definition of low density as less than 25% AI/AN students and high density as 25% or more AI/AN students.

don't speak a Native language at home (in Model 2b, we find no moderating effects for media exposure). In Model 3a, there is a significant three-way interaction between NLC (i.e., live exposure), family context (i.e., frequency of attending Native gatherings), and school context (i.e., percent AI/AN students in the school; $B = .04^{*}$); the positive sign of the interaction term suggests that students whose families attend Native gatherings more frequently will experience a less negative and/or more positive effect of NLC on achievement, and that this effect is amplified for students in schools with higher percentages of AI/AN students. In Model 3b, we find a significant interaction between NLC (i.e., media exposure and the school context (i.e., percent AI/AN students; $B = .05^{*}$), suggesting that this aspect of NLC is more effective in schools with higher AI/AN density.

Table 5 contains the results for administrator-report use of NLC. As in previous research (e.g., Jesse et al., 2014), Model 1 suggests that use of NLC (i.e., local involvement) has a negative effect on math achievement (cultural instruction has no effect; $B = -8.10^{***}$). Model 2a suggests that this effect is moderated by the family context (i.e., the degree to which the family speaks a Native language; $B = 1.66^{*}$); as with both student- and teacher-report NLC, the magnitude and positive sign of the interaction term suggests that students from families who speak a Native language often may experience a less negative and/or more positive effect for administrator-report NLC, whereas students from families who don't would experience a more negative effect (there were no moderating effects for cultural instruction). In Models 3a and 3b, we find no moderating effects for school context (i.e., AI/AN density) on administrator-report use of NLC, but we do find a significant positive interaction between the family context (i.e., the degree to which the family attends Native gatherings) and the school context (i.e., percent AI/AN students in the school; $B = .03^{*}$; see Model 3a), suggesting that students who attend

Native gatherings more often score higher in mathematics achievement in schools with greater AI/AN density.

In the next set of analyses, we examined effects of NLC on 8th-grade mathematics achievement. In Table 6, we find results similar to those reported above for teacher-report NLC, i.e., a negative effect for teacher-report use of Native materials for preparation ($B = -5.48^{***}$), but no significant effect for use of Native concepts in math instruction (see Model 1); interestingly, we also see a significant and negative main effect for use of Native language in the home ($B = -3.33^{***}$), suggesting that students who speak Native language in the home more often may score lower on the achievement tests. As with previous results, we found a significant positive interaction term for the family context, such that students whose families attend Native gatherings more often may experience a less negative and/or more positive effect for NLC (i.e., teacher preparation; $B = 1.67^{*}$; see Model 2a); the parallel effect in Model 2b (i.e., use of NLC in math instruction) was close to significance ($B = 2.84$; $p = .05$). Finally, again mirroring our previous results, we find that these relationships are moderated by the school context, with students whose families spoke Native language in the home more often experiencing less negative and/or more positive effects in schools with higher percentages of AI/AN students ($B = .07^{*}$ and $B = .09^{*}$; see models 3a and 3b).

In Table 7, we find significant negative effects for both aspects of student-report use of NLC (i.e., live exposure and media access; $B = -4.54^{***}$ and $B = -10.05^{***}$; see Model 1). In Models 2a and 2b, we find no significant interaction with the family context, but in Model 3a, we do find a significant interaction between live exposure and the school context (i.e., AI/AN density; $B = .08^{*}$), suggesting that the effect of live access is less negative and/or more positive in schools with greater percentages of AI/AN students; however, the effect of media access is not moderated (see Model 3b).

Finally, in Table 8, we find that administrator report of local Native involvement has a negative effect on math achievement (*B* = -6.67**) but cultural instruction does not (see Model 1). In Models 2a and 2b, we find no significant interaction with the family context, but in Models 3a and 3b, we do find interaction terms suggesting that the effects of both aspects of administrator-report NLC are less negative and/or more positive for students whose families attend Native gatherings more often, with these effects are amplified for students in schools with greater percentages of AI/AN students (*B* = 1.21, p = .05; and *B* = 1.76*)

Discussion

Previous large-scale research exploring the use of Native Language and Culture (NLC) on academic achievement has found negative effects (Jesse et al., 2014; López et al., 2013), which directly contradicts much of the theory and small-scale research supporting the use of NLC in schools (August et al., 2006; Brayboy et al., 2015; McCarty & Lee, 2014; Smallwood et al., 2009). In this study, we find that a student's family context can moderate these negative links (at least with regards to math achievement); both the degree to which the family spoke a Native language in the home and the frequency with which the family attended native gatherings emerged as moderators. As argued by Powers (2006), we can understand these findings in terms of cultural alignment between home and school: students whose cultural identity is more aligned to traditional Native beliefs and activities should gain the most from Native-focused educational programs.

There were also significant effects related to the school context, and these effects suggested that, in many cases, the school context was able to amplify the moderating impact of the family cultural context such that NLC was most successful with students who possessed the strongest Native cultural identification and who attended schools with the highest percentages of AI/AN students. These findings suggest that greater cultural alignment between home and school can be beneficial for AI/AN students. There were also suggestions that the school context may moderate the use of NLC directly, as with the significant two-way interaction with student-report NLC (see Table 7, Model 3a; $B = .04^{*}$).

Our analysis also produced some interesting results unrelated to NLC. For example, in Table 5, Model 3a contained a significant interaction effect between the family and school context ($B = .03^{*}$), suggesting that students whose families attended Native gatherings with more frequency had higher test scores when they attended schools with higher percentages of AI/AN students. These results stand in contrast with previous research finding a negative effect for AI/AN density (Richard et al., 2010) and again emphasize the importance of cultural alignment between the home and school in terms of promoting the achievement of AI/AN students.

If we are to acknowledge that use of NLC may be more effective for AI/AN students whose family and school contexts reflect more Native-centric cultural identification, then we must also consider that NLC may be less effective, or perhaps even detrimental, to AI/AN students whose cultural identification is less Native-centric and/or who are in schools with lower AI/AN density. One possible explanation for this phenomenon is *stereotype threat*, in which students from ethnic minorities may score lower when negative stereotypes regarding their ethnicity are more salient (Fryberg, Markus, Oyserman, & Stone, 2008; Steele & Aronson, 1995). Stereotypes regarding AI/AN students are likely to be more salient in schools with lower AN/AI densities, which is precisely the situation in which, our results suggest, students will be more negatively impacted by the use of NLC. For AI/AN students in mostly non-Native schools, the use of NLC may represent a reminder of their own Native heritage, which may create a context of lowered expectations and/or pressure to perform that contributes to more negative outcomes.

This hypothesis may also explain why the results from NAEP/NIES (i.e., negative overall effects for NLC) have been at variance with previous research, which generally finds a positive effect for NLC. Specifically, NAEP/NIES contain results from AI/AN students in a wide variety of schools, whereas smaller-scale research that focuses on NLC is often held in contexts of higher AI/AN density and/or families with stronger cultural identification in which NLC can be expected to have more positive results. Thus, although they have previously shed a negative light on the use of NLC, the results from NAEP/NIES can provide a broader assessment of NLC that can contribute to a more nuanced understanding of how best to implement NLC in different contexts.

In planning for the implementation of NLC for AI/AN students with lower levels of cultural identification and/or in contexts of lower AI/AN student density, the literature on stereotype threat can provide useful guidance. For example, if students are encouraged to view intelligence as a malleable rather than fixed capacity, then they are less vulnerable to negative racial stereotypes regarding intelligence (Aronson, Fried, & Good, 2002; Good, Aronson, & Inzlicht, 2003). Similarly, blurring intergroup boundaries and reducing intergroup bias can reduce the impact of stereotype threat (Rosenthal & Crisp, 2006), as can reminding students of their membership in groups for which there are *positive* performance expectations (McGlone & Aronson, 2006). Research also suggests that simply teaching about stereotype threat before an assessment can reduce its negative effects (Johns, Schmader, & Martens, 2005). These findings suggest that an expanded approach to NLC that includes these components may be more broadly effective with AI/AN students across a range of contexts.

Limitations and conclusion

There are several limitations to these results that should temper their interpretation. First, although NAEP/NIES is designed to be nationally representative, non-response among students, teachers, and administrators may create an unknown degree of bias in the results; additional replication of these results with other datasets is warranted. Second, the limitations of NIES surveys did not permit us to examine more nuanced aspects of use in NLC in the classroom (e.g., how the teacher presented these concepts or activities, how the students reacted, etc.). Further research is required to assess these details. Third, given the way in which teacher data were collected, we could not consider teachers as their own level in a nested/multi-level model. Thus, the results related to teachers may be biased to an unknown degree. Finally, since the data are cross-sectional (i.e., gathered at the same time), it is difficult to establish causality; it could be, for example, that causality is in the opposite direction that what was expected, such that schools with lower test scores were in the process of implementing NLC as a response mechanism, and that the actual effects of NLC will be realized in future waves of data. Such hypotheses are not testable given the current structure of NAEP/NIES.

In spite of these limitations, our results add to the existing research by suggesting a more nuanced effect of NLC on student math achievement, which in turn calls for a more contextualized approach to the use of NLC in school settings. Rather than providing definitive answers how to improve AI/AN students' academic achievement, our findings offer an important starting point for re-considering how NLC can impact AI/AN students given their diversity in family backgrounds and learning environments.

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Table 1

Descriptive data

	4th grade (N = 4500)		*8th grade (N = 3300)*	
Level 1 (students)	Mean	SD	Mean	SD
School lunch eligibility	.80	.40	.75	.43
Student classified as ELL	.16	.36	.12	.32
Student has an IEP	.15	.35	.13	.33
Math self-rating	3.40	1.43	2.56	.90
Family speaks Native language	2.22	1.28	2.24	1.29
Family attends Native gatherings	2.37	1.21	2.71	1.18
Live exposure (student-report)	.00	.66	1.85	.68
Media exposure (student-report)	.00	.72	.45	.36
Teacher preparation (teacher-report)	2.26	.85	2.12	.84
Math instruction (teacher-report)	.00	.81	.00	.79
	4th grade (N = 1200)		*8th grade (N = 1000)*	
Level 2 (schools)	Mean	SD	Mean	SD
Percent AI/AN students	23.39	34.87	23.79	35.25
Local involvement (admin-report)	1.57	.60	1.59	.65
Cultural instruction (admin-report)	.68	.32	.62	.38

Table 2

Results predicting math achievement in 4th grade using teacher reports of NLC (unstandardized coefficients and standard errors)

	Model 1	*Model 2a*	*Model 2b*
Level 1 (students)			
School lunch eligibility	-11.24*** (1.15)	-10.69*** (1.19)	-10.90*** (1.17)
Student classified as ELL	-18.42*** (2.63)	-17.08*** (2.51)	-17.72*** (2.63)
Student has an IEP	-23.52*** (1.66)	-23.49*** (1.74)	-23.14*** (1.66)
Math self-rating	6.35*** (.78)	6.27*** (.73)	6.19*** (.74)
Family speaks Native language	-1.77* (.71)	-1.53* (.77)	-1.27 (.71)
Family attends Native gatherings	-.71 (.46)	-.73 (.50)	-.49 (.49)
Teacher preparation (teacher-report)	-4.19* (1.22)	-5.24** (1.37)	-4.43 (1.41)
Math instruction (teacher-report)	-1.36 (1.44)	-.78 (1.58)	-1.86 (1.49)
Interaction (prep * language)	-	1.89* (.73)	-
Interaction (prep * gatherings)	-	-.11 (.58)	-
Interaction (math * language)	-	-	2.67** (.82)
Interaction (math * gatherings)	-	-	1.38* (.70)
Level 2 (schools)			
	-	-	-

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 2 (continued)

Results predicting math achievement in 4th grade using teacher reports of NLC (unstandardized coefficients and standard errors)

	Model 3a	*Model 3b*
Level 1 (students)		
School lunch eligibility	-9.39*** (1.17)	-9.48*** (1.15)
Student classified as ELL	-16.59*** (2.62)	-16.94*** (2.67)
Student has an IEP	-23.04*** (1.64)	-23.35*** (1.65)
Math self-rating	6.28*** (.73)	6.37*** (.76)
Family speaks Native language	-2.31* (.99)	-2.84* (1.04)
Family attends Native gatherings	-1.85 (1.62)	-1.29 (1.18)
Teacher preparation (teacher-report)	-3.14 (1.60)	-3.31 (1.52)
Math instruction (teacher-report)	-.35 (1.37)	-1.48 (2.11)
Interaction (prep * language)	.39 (.85)	-
Interaction (prep * gatherings)	-1.32 (.89)	-
Interaction (math * language)	-	-2.11 (1.85)
Interaction (math * gatherings)	-	-.64 (1.87)
Level 2 (schools)		
Percent AI/AN students	-.12*** (.03)	-.10*** (.03)
Interaction (percent * language)	.04* (.02)	.06* (.02)
Interaction (percent * gatherings)	.03 (.02)	.02 (.02)
Interaction (percent * prep)	.05* (.03)	-
Interaction (percent * prep * language)	-.03 (.02)	-

Interaction (percent * prep * gatherings)	.02 (.02)	-
Interaction (percent * math)	-	.00 (.03)
Interaction (percent * math * language)	-	.06* (.03)
Interaction (percent * math * gatherings)	-	.03 (.03)

*$p < .05$. **$p < .01$. ***$p < .001$.

Table 3

Main and moderated effects of teacher-report NLC on 4th grade math achievement

	Teacher preparation	*Math instruction*
Main effect (Model 1)	-4.19	-1.36
Moderated effect – Family context		
Never/rarely (speak Native language)	-6.91	-5.51
Sometimes (speak Native language)	-5.43	-2.27
Often (speak Native language)	-3.92	.98
All the time (speak Native language)	-2.41	4.22
Moderated effect – Family and school context		
Mostly non-AI/AN school (5% AI/AN students)		
Never/rarely (speak Native language)	-3.24	-1.75
Sometimes (speak Native language)	-2.93	-1.51
Often (speak Native language)	-2.62	-1.27
All the time (speak Native language)	-2.31	-1.03
Evenly split school (50% AI/AN students)		
Never/rarely (speak Native language)	-.99	-4.18
Sometimes (speak Native language)	-.68	-1.78
Often (speak Native language)	-.37	.62
All the time (speak Native language)	-.06	3.02
Mostly AI/AN school (95% AI/AN students)		
Never/rarely (speak Native language)	1.26	-6.61

Sometimes (speak Native language)	1.57	-2.05
Often (speak Native language)	1.88	2.51
All the time (speak Native language)	2.20	7.07

Table 4

Results predicting math achievement in 4th grade using student reports of NLC (unstandardized coefficients and standard errors)

	Model 1	*Model 2a*	*Model 2b*
Level 1 (students)			
School lunch eligibility	-11.76*** (1.18)	-11.07*** (1.17)	-11.80*** (1.17)
Student classified as ELL	-18.33*** (2.35)	-17.32*** (2.24)	-18.34*** (2.35)
Student has an IEP	-23.10*** (1.34)	-23.12*** (1.34)	-23.15*** (1.35)
Math self-rating	6.40*** (.73)	6.25*** (.72)	6.38*** (.73)
Family speaks Native language	-.69 (.46)	-1.31 (.76)	-.60 (.69)
Family attends Native gatherings	-.48 (.44)	-.42 (.45)	-.43 (.89)
Live exposure (student-report)	-7.02*** (1.04)	-6.80*** (1.65)	-7.03*** (1.04)
Media exposure (student-report)	-.24 (.80)	-.57 (1.28)	-.61 (.81)
Interaction (live * language)	-	4.04** (1.56)	-
Interaction (live * gatherings)	-	-.40 (1.36)	-
Interaction (media * language)	-	-	-.93 (.81)
Interaction (media * gatherings)	-	-	-1.05 (.74)
Level 2 (schools)			
	-	-	-

*$p < .05$. **$p < .01$. ***$p < .001$.

Table 4 (continued)

Results predicting math achievement in 4th grade using student reports of NLC (unstandardized coefficients and standard errors)

	Model 3a	*Model 3b*
Level 1 (students)		
School lunch eligibility	-9.97^{***} (1.13)	-10.10^{***} (1.13)
Student classified as ELL	-16.31^{***} (2.33)	-15.90^{***} (2.26)
Student has an IEP	-23.33^{***} (1.35)	-23.43^{***} (1.39)
Math self-rating	6.32^{***} (.73)	6.33^{***} (.73)
Family speaks Native language	-1.26 (.67)	-1.50 (.90)
Family attends Native gatherings	-1.18 (.70)	-.48 (.98)
Live exposure (student-report)	-5.20^{***} (1.09)	-6.11^{***} (1.08)
Media exposure (student-report)	-.54 (.78)	-2.34^{*} (.92)
Interaction (live * language)	3.90^{**} (.99)	-
Interaction (live * gatherings)	-2.41 (1.85)	-
Interaction (media * language)	-	-2.20 (1.19)
Interaction (media * gatherings)	-	-1.64 (.85)
Level 2 (schools)		
Percent AI/AN students	$-.12^{***}$ (.02)	$-.12^{***}$ (.02)
Interaction (percent * language)	$.03^{*}$ (.01)	$.04^{*}$ (.01)
Interaction (percent * gatherings)	$.04^{*}$ (.02)	.03 (.02)
Interaction (percent * live)	-.03 (.02)	-
Interaction (percent * live * language)	-.03 (.02)	-

Interaction (percent * live * gatherings)	.04* (.02)	-
Interaction (percent * media)	-	.05* (.02)
Interaction (percent * media * language)	-	.02 (.02)
Interaction (percent * media * gatherings)	-	.02 (.02)

*$p < .05$. **$p < .01$. ***$p < .001$.

Table 5

Results predicting math achievement in 4th grade using administrator reports of NLC (unstandardized coefficients and standard errors)

	Model 1	*Model 2a*	*Model 2b*
Level 1 (students)			
School lunch eligibility	-11.16^{***} (1.15)	-10.95^{***} (1.13)	-11.12^{***} (1.15)
Student classified as ELL	-18.77^{***} (2.33)	-18.78^{***} (2.34)	-18.78^{***} (2.32)
Student has an IEP	-24.44^{***} (1.37)	-24.04^{***} (1.35)	-24.35^{***} (1.38)
Math self-rating	6.06^{***} (.75)	6.10^{***} (.76)	6.04^{***} (.74)
Family speaks Native language	-1.36^{*} (.66)	-1.99^{**} (.74)	-1.41^{*} (.66)
Family attends Native gatherings	-.51 (.83)	-.03 (.84)	-.51 (.88)
Level 2 (schools)			
Local involvement (admin-report)	-8.10^{***} (1.37)	-7.91^{***} (1.40)	-8.07^{***} (1.36)
Cultural instruction (admin-report)	.74 (2.81)	.63 (2.81)	.91 (3.01)
Interaction (local * language)	-	1.66^{*} (.63)	-
Interaction (local * gatherings)	-	-1.39 (1.36)	-
Interaction (cultural * language)	-	-	1.11 (1.30)
Interaction (cultural * gatherings)	-	-	-.07 (1.43)

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 5 (continued)

Results predicting math achievement in 4th grade using administrator reports of NLC (unstandardized coefficients and standard errors)

	Model 3a	*Model 3b*
Level 1 (students)		
School lunch eligibility	-9.88*** (1.11)	-9.92*** (1.13)
Student classified as ELL	-17.09*** (2.33)	-17.17*** (2.28)
Student has an IEP	-24.14*** (1.36)	-24.44*** (1.41)
Math self-rating	6.14*** (.74)	6.06*** (.73)
Family speaks Native language	-2.27* (.89)	-2.36** (.87)
Family attends Native gatherings	-.38 (.97)	-.73 (1.04)
Level 2 (schools)		
Local involvement (admin-report)	-3.78 (2.06)	-3.54 (1.91)
Cultural instruction (admin-report)	1.40 (2.60)	-.01 (3.02)
Interaction (local * language)	.29 (1.17)	-
Interaction (local * gatherings)	-3.09 (2.21)	-
Interaction (cultural * language)	-	-.40 (1.72)
Interaction (cultural * gatherings)	-	-.12 (1.42)
Percent AI/AN students	-.13*** (.03)	-.10*** (.03)
Interaction (language * percent)	.03 (.02)	.03 (.02)
Interaction (gatherings * percent)	.03* (.02)	.02 (.02)
Interaction (local * percent)	.07 (1.13)	-
Interaction (local * percent * language)	.15 (.51)	-

Interaction (local * percent * gatherings)	.27 (.50)	-
Interaction (cultural * percent)	-	-1.64 (.99)
Interaction (cultural * percent * language)	-	.66 (.49)
Interaction (cultural * percent * gatherings)	-	-.45 (.45)

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 6

Results predicting math achievement in 8th grade using teacher reports of NLC (unstandardized coefficients and standard errors)

	Model 1	*Model 2a*	*Model 2b*
Level 1 (students)			
School lunch eligibility	-10.19*** (1.91)	-10.12*** (1.94)	-10.39*** (1.86)
Student classified as ELL	-19.84*** (3.13)	-19.76*** (3.20)	-19.06*** (3.16)
Student has an IEP	-29.37*** (2.15)	-28.94*** (2.16)	-28.95*** (2.23)
Math self-rating	12.80*** (.71)	12.78*** (.70)	12.66*** (.87)
Family speaks Native language	-3.33*** (.89)	-3.63*** (.89)	-3.51** (.87)
Family attends Native gatherings	-1.39 (.98)	-1.02 (.90)	-.73 (1.07)
Teacher preparation (teacher-report)	-5.48*** (1.43)	-5.47*** (1.49)	-5.94** (1.56)
Math instruction (teacher-report)	-.73 (1.49)	-.77 (1.74)	-.29 (1.67)
Interaction (prep * language)	-	-.85 (.97)	-
Interaction (prep * gatherings)	-	1.67* (.80)	-
Interaction (math * language)	-	-	.52 (1.45)
Interaction (math * gatherings)	-	-	2.84† (1.42)
Level 2 (schools)			
	-	-	-

† p = .05. * p < .05. ** p < .01. *** p < .001.

Table 6 (continued)

Results predicting math achievement in 8th grade using teacher reports of NLC (unstandardized coefficients and standard errors)

	Model 3a	*Model 3b*
Level 1 (students)		
School lunch eligibility	-9.72*** (2.03)	-9.86*** (1.98)
Student classified as ELL	-19.85*** (3.16)	-18.84*** (3.19)
Student has an IEP	-28.34*** (2.10)	-28.99*** (2.14)
Math self-rating	12.63*** (.70)	12.80*** (.72)
Family speaks Native language	-4.23** (1.27)	-4.92*** (1.27)
Family attends Native gatherings	-2.25 (1.36)	-.64 (1.48)
Teacher preparation (teacher-report)	-6.38*** (1.81)	-4.90** (1.50)
Math instruction (teacher-report)	-1.49 (2.50)	-.69 (2.77)
Interaction (prep * language)	-1.92 (1.33)	-
Interaction (prep * gatherings)	.19 (1.08)	-
Interaction (math * language)	-	-3.61 (3.00)
Interaction (math * gatherings)	-	3.03 (2.24)
Level 2 (schools)		
Percent AI/AN students	-.04 (.04)	-.03 (.03)
Interaction (percent * language)	.02 (.02)	.02 (.02)
Interaction (percent * gatherings)	.04 (.02)	.03 (.03)
Interaction (percent * prep)	.02 (.04)	-
Interaction (percent * prep * language)	.07* (.03)	-

Interaction (percent * prep * gatherings)	.02 (.02)	-
Interaction (percent * math)	-	-.02 (.05)
Interaction (percent * math * language)	-	.09* (.04)
Interaction (percent * math * gatherings)	-	-.05 (.03)

*$p < .05$. **$p < .01$. ***$p < .001$.

Table 7

Results predicting math achievement in 8th grade using student reports of NLC (unstandardized coefficients and standard errors)

	Model 1	*Model 2a*	*Model 2b*
Level 1 (students)			
School lunch eligibility	-10.41*** (1.45)	-10.42*** (1.47)	-10.30*** (1.46)
Student classified as ELL	-21.31*** (3.40)	-20.80*** (3.26)	-20.70*** (3.26)
Student has an IEP	-30.80*** (2.01)	-30.77*** (2.01)	-30.86*** (1.98)
Math self-rating	12.08*** (.80)	12.18*** (.82)	12.20*** (.82)
Family speaks Native language	-3.07*** (.60)	-2.61** (.80)	-2.57** (.82)
Family attends Native gatherings	-1.41 (.80)	-.97 (.94)	-1.01 (.98)
Live exposure (student-report)	-4.54*** (.97)	-4.79*** (1.09)	-5.10*** (1.05)
Media exposure (student-report)	-10.05*** (1.87)	-9.44*** (2.08)	-8.94*** (2.11)
Interaction (live * language)	-	.19 (.72)	-
Interaction (live * gatherings)	-	.83 (.68)	-
Interaction (media * language)	-	-	.46 (.79)
Interaction (media * gatherings)	-	-	.45 (.72)
Level 2 (schools)			
	-	-	-

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 7 (continued)

Results predicting math achievement in 8th grade using student reports of NLC (unstandardized coefficients and standard errors)

	Model 3a	*Model 3b*
Level 1 (students)		
School lunch eligibility	-9.78*** (1.57)	-9.79*** (1.56)
Student classified as ELL	-19.29*** (3.26)	-19.04*** (3.24)
Student has an IEP	-31.00*** (2.00)	-31.01*** (2.00)
Math self-rating	12.13*** (.82)	12.22*** (.81)
Family speaks Native language	-2.56* (1.00)	-2.39* (1.12)
Family attends Native gatherings	-1.18 (1.04)	-1.64 (1.18)
Live exposure (student-report)	-4.83*** (1.36)	-3.75** (1.24)
Media exposure (student-report)	-8.01*** (2.16)	-8.44*** (2.44)
Interaction (live * language)	-.46 (1.03)	-
Interaction (live * gatherings)	.63 (.89)	-
Interaction (media * language)	-	.34 (1.08)
Interaction (media * gatherings)	-	.07 (.83)
Level 2 (schools)		
Percent AI/AN students	-.07* (.03)	-.06* (.03)
Interaction (percent * language)	.00 (.02)	.00 (.02)
Interaction (percent * gatherings)	.04* (.02)	.04* (.02)
Interaction (percent * live)	.08* (.03)	-
Interaction (percent * live * language)	.01 (.02)	-

Interaction (percent * live * gatherings)	-.02 (.02)	-
Interaction (percent * media)	-	-.10 (.07)
Interaction (percent * media * language)	-	.01 (.02)
Interaction (percent * media * gatherings)	-	.01 (.02)

$^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$.

Table 8

Results predicting math achievement in 8th grade using administrator reports of NLC (unstandardized coefficients and standard errors)

	Model 1	*Model 2a*	*Model 2b*
Level 1 (students)			
School lunch eligibility	-11.11*** (1.43)	-10.72*** (1.52)	-10.84*** (1.51)
Student classified as ELL	-20.97*** (3.16)	-19.76*** (3.14)	-19.88*** (2.94)
Student has an IEP	-31.88*** (1.97)	-31.54*** (1.94)	-31.84*** (1.95)
Math self-rating	11.91*** (.79)	12.13*** (.73)	12.11*** (.85)
Family speaks Native language	-3.09*** (.78)	-2.99** (.94)	-3.16*** (.82)
Family attends Native gatherings	-1.39 (.95)	-1.57 (1.05)	-1.37 (.99)
Level 2 (schools)			
Local involvement (admin-report)	-6.67** (1.69)	-6.72** (1.72)	-6.93** (1.72)
Cultural instruction (admin-report)	-2.64 (2.36)	-2.82 (2.43)	-1.89 (2.48)
Interaction (local * language)	-	-.57 (.86)	-
Interaction (local * gatherings)	-	1.25 (.83)	-
Interaction (cultural * language)	-	-	-.71 (1.59)
Interaction (cultural * gatherings)	-	-	2.61 (1.60)

†p = .05. *p < .05. **p < .01. ***p < .001.

Table 8 (continued)

Results predicting math achievement in 8th grade using administrator reports of NLC (unstandardized coefficients and standard errors)

	Model 3a	*Model 3b*
Level 1 (students)		
School lunch eligibility	-10.68*** (1.56)	-10.96*** (1.52)
Student classified as ELL	-16.84*** (3.80)	-16.99*** (3.69)
Student has an IEP	-30.27*** (2.16)	-30.56*** (2.16)
Math self-rating	11.41*** (.90)	10.49*** (.88)
Family speaks Native language	-2.84* (1.89)	-3.03** (1.08)
Family attends Native gatherings	-1.69 (1.15)	-1.89 (1.11)
Level 2 (schools)		
Local involvement (admin-report)	-5.95* (2.46)	-5.43* (2.35)
Cultural instruction (admin-report)	-2.65 (3.16)	-2.32 (3.45)
Interaction (local * language)	-.58 (1.78)	-
Interaction (local * gatherings)	-.83 (1.53)	-
Interaction (cultural * language)	-	-.70 (1.87)
Interaction (cultural * gatherings)	-	.57 (1.78)
Percent AI/AN students	-.06 (.04)	-.08* (.04)
Interaction (language * percent)	.01 (.02)	.01 (.02)
Interaction (gatherings * percent)	.01 (.02)	.01 (.02)
Interaction (local * percent)	.22 (.89)	-
Interaction (local * percent * language)	-.11 (.71)	-

Interaction (local * percent * gatherings)	1.21[†] (.61)	-
Interaction (cultural * percent)	-	1.58 (.97)
Interaction (cultural * percent * language)	-	-.30 (.83)
Interaction (cultural * percent * gatherings)	-	1.76[*] (.74)

[†]*p* = .05. [*]*p* < .05. [**]*p* < .01. [***]*p* < .001.