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Research Article

Classroom observations of a cross-age peer tutoring mathematics program in elementary and middle schools

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ABSTRACT

A growing body of research has shown the positive effects of peer tutoring on students' academic achievement, self-concept, attitude, social, and behavioral outcomes. There is, however, a paucity of research that focuses on peer-tutoring interventions for Hispanic students. The current study examined classroom practices, as well as program teachers' and students' behaviors within a cross-age peer-tutoring program implemented in elementary and middle schools that serve predominantly Hispanic students. Classroom observations were used to investigate the implementation of the peer-tutoring program. The results indicated that the program's strengths included the development of positive emotions and relationships among students and a classroom environment that fostered warm and supportive relationships. The findings also indicated several weaknesses in the implementation of the program. Practitioners can use the findings to improve the effectiveness of future peer-tutoring programs in mathematics.

Keywords: peer tutoring, mathematics education, Hispanic students, classroom observations

INTRODUCTION

Achievement levels in mathematics for Hispanic students in elementary and secondary US schools continue to be of concern. Although, national statistics show a slight increase from 2017 to 2019 for elementary-school Hispanic students, overall Hispanic students at the elementary and middle school levels continue to underperform in mathematics when compared with their white counterparts (US Department of Education, 2019a). Recently, a special administration of the National Assessment of Educational Progress long-term trend reading and mathematics assessments for nine-year old students were administered to examine student achievement during the COVID-19 pandemic. Average scores for all students declined seven points in mathematics when compared to scores in 2020, for Hispanic students the decline was eight points (US Department of Education, 2020, 2022).

Educational problems among Hispanic students have been attributed to several factors such as social, economic, and educational conditions, including very limited household income, scarce social services, lack of educational resources, language barriers, and low-quality education (The Crisis in the Education of Latino Students, 2017; Waxman et al., 2007). In addition, other factors such as:

(a) the shortage of qualified teachers prepared to fulfill the diverse needs of Hispanic students,

(b) at-risk school environments, and

(c) inappropriate teaching practices (Padrón et al., 2002; Waxman et al., 2020) can also impact the education of Hispanic students.

Considering these factors, it is critical to improve the academic outcomes of Hispanic students in mathematics by implementing effective instructional strategies to help them overcome persistent academic problems. Research findings have found that peer tutoring has positive effects in classrooms that educate minority, low-income, and urban children. For example, the meta-analytic reviews conducted by Ginsburg-Block et al. (2006) and Rohrbeck et al. (2003) found that peer-assisted learning interventions were more effective with low-income, urban, and minority students than higher income, suburban, nonminority students, and students at risk of academic failure (Dietrichson et al., 2021).

Peer tutoring incorporates teaching, learning, and emotional factors generated by the unique dyad partnership where the tutor assumes the role of teacher and the tutee learns from the tutor (Alegre et al., 2020; Cohen, 1986; Molimar & Alegre, 2020). Since the responsibility of teaching is transferred from teachers to tutors, tutor training is a key factor in the success of a peer-tutoring program in mathematics (Greenfield & McNeil, 1987). Cross-age peer tutoring involves a one-to-one teaching and learning process in which older students in higher-grade levels tutor younger students in lower grade levels (Robinson et al., 2005; Zendler & Greiner, 2020).

Although a substantial body of research has reported the positive effects of peer tutoring on academic, social, and emotional outcomes in mathematics (Alegre et al., 2020; Made et al., 2019; Moliner & Alegre, 2020); however, there is a dearth of studies about peer-tutoring interventions for minority students, including Hispanic children (Robinson et al., 2005). In addition, several studies have found that peer-tutoring has been found to be an effective instructional strategy for elementary (Rohrbeck et al., 2003) and middle (Moliner & Alegre, 2022) school students. Much of the research on peer-tutoring interventions, however, has been devoted to examining its effectiveness on academic achievement rather than focused on the tutoring processes such as the training of tutors. Therefore, this study uses systematic classroom observations to examine the classrooms practices and behaviors of program teachers and students during tutor training within a cross-age tutoring program that enrolled predominantly Hispanic students in elementary and middle schools.

The following research questions were addressed:

1. What content standards are implemented during the cross-age peer-tutoring sessions?
2. What are instructional strategies implemented in a cross-age peer-tutoring intervention for Hispanic students?
3. What are the teacher behaviors observed in a cross-age peer-tutoring intervention for Hispanic students?
4. What are the student behaviors observed in a cross-age peer-tutoring intervention for Hispanic students?
5. What is the classroom environment observed in a cross-age peer-tutoring intervention for Hispanic students?

LITERATURE REVIEW

Mathematics achievement for Hispanic students in the USA continues to lag that of white students. The 2019 nation's report card indicated that only 28% of Hispanic fourth-graders, 20% of eighth graders and 11% of twelfth graders reached at or above proficiency levels in mathematics. In comparison 52% of White fourth-grade students, 44% of White eighth and 32% twelfth grade students achieved at or above proficiency (US Department of Education, 2019b). While the academic achievement remains low, the enrollment of Hispanic student continues to grow (US Department of Education, 2019a).

Educational problems among Hispanic students have been attributed to several factors that limit their educational opportunities (Padrón et al., 2002; The Crisis in the Education of Latino Students, 2017; Waxman et al., 2020). Schools that educate predominantly Hispanic students, often do not have the necessary resources to offer them the quality of education they need to achieve higher levels of academic performance. Inappropriate teaching practices in schools that serve Hispanic students, and at-risk school environments have also been identified as a factor that has the potential to contribute to the lack of achievement of Hispanic students (Padrón et al., 2002; Waxman et al., 2020). For example, one of most common classroom practice is direct instruction, where most of the instructional time is devoted to lecture, seatwork, drill, and memorization, therefore, it is important to select research-based teaching practices that significantly improve the academic success of Hispanic students (Padrón et al., 2002; Waxman et al., 2020).

Studies examining peer-tutoring programs have found that these programs have a positive impact on academic achievement in mathematics (e.g., Bar-Eli & Raviv, 1982; Cohen et al., 1982; Heller & Fantuzzo, 1993; Menesses & Gresham, 2009; Sharpley et al., 1983; Thurston et al., 2020). In addition, several researchers have reported positive effects of peer tutoring for minority, low-income, and urban students (e.g., Ginsburg-Block et al., 2006; Rohrbeck et al.,2003). Furthermore, peer tutoring can help transform teacher-centered instruction to student-centered learning (Cole, 2014). The effectiveness of peer-assisted learning can be linked to student-center learning environments since they promote gains in achievement, self-esteem, and self-concept (Alegre et al., 2020; Ginsburg-Block et al., 2006). In addition, Topping et al. (2003) found that peer tutoring improved cooperation among students since tutor and tutee have multiple opportunities to discuss and work together.

Peer-tutoring programs have also been found to be a more cost-effective way to improve math performance than many other alternatives such as computer-assisted instruction, lengthening the school day by 60 minutes, hiring teachers with a master's degree or with more experience, and increasing teacher salaries (Yeh, 2010). Considering that research has reported positive effects of peer tutoring on academic and nonacademic outcomes and that peer tutoring is a very cost-effective instructional strategy, the implementation of peer tutoring in public schools could help to alleviate the academic difficulties in mathematics faced by Hispanic students.

In addition, research on peer-tutoring program has indicated that the strength and fidelity of treatment are key to the success and effectiveness of a tutoring program (Greenwood et al., 1992). Strength has been associated to the duration and intensity of the tutoring sessions (e.g., 20 weeks, 60 minutes a week). Fidelity involves the accuracy and consistency of the different components of the tutoring program. Implementation problems have been found to affect students' outcomes (Greenwood et al., 1992). Important elements in the program implementation include teacher training, tutor training and the one-to-one instruction provided by tutors to tutees.

Another important element in implementing successful tutoring programs is tutor training. Wepner (1985) indicated that tutors must be prepared to address the diverse instructional needs of tutees and deliver lessons using a variety of instructional approaches or strategies. An effective tutor training is necessary because mathematics instruction could be a difficult task for tutors, especially if they are inexperienced elementary or middle school students. Tutors need to know not only the content to be taught but also strategies to help enhance comprehension, provide helpful feedback, and help tutees improve cognitive and affective areas (Wepner, 1985).

Although tutor training and one-to-one instruction in the dyads is very important to ensure the effectiveness of any tutoring program, research has generally focused on the effects of tutoring interventions on academic outcomes, leaving aside the study of instructional practices and process during tutor training and tutoring sessions. Consequently, more research about the instructional practices and behaviors within the tutoring sessions is greatly needed.

METHODOLOGY

This study used secondary data collected as part of a larger investigation on peer tutoring in mathematics implemented in elementary and secondary schools. All the schools were in a large, urban city in the southwest region of the USA.

Participants

Participants in the current study were students enrolled in one elementary and three public middle schools in the southwest region of the USA. There was a total of 105 Hispanic, 17 African American, four Asian, four White, and two other race/ethnicity students; 51.5% were male and 48.5% were female. Most students in these schools were from families with a disadvantaged socio-economic status and 71.2% indicated that they spoke Spanish at home.

Tutors and tutees

All students (i.e., tutors and tutees) were low-achieving students in mathematics. Low achieving students were selected with the expectation that their participation in the program would have a positive impact on their academic, emotional, and social development. Tutors were two grade levels above tutees. In the secondary schools, for example, tutors in eighth grade tutored students in the sixth grade. In the elementary school, a tutor in fifth grade tutored students in third grade. Each tutor and tutee worked together for the entire program. There was a total of 67 students who had the role of tutor, and 65 students had the role of tutees.

Selection of tutors and tutees

Mathematics teachers selected tutors and tutees using the following criteria:

(a) fifth grade underachievers as tutors of third grade underachievers in elementary school,

(b) eighth grade underachievers as tutors of sixth grade underachievers in middle school.

In addition, teachers nominated students categorized as "bubble" (i.e., students who were no more than one year behind their peers and underachieving students) who they believed had the potential to improve their academic outcomes with additional help.

Program teachers

A total of six program teachers provided training to tutors during weekly tutoring sessions and monitored the tutor-tutee sessions. The program teachers worked for a non-profit agency that sponsored the peer-tutoring program. All program teachers held a bachelor's degree, however, none had professional teaching certification in mathematics. All program teachers participated in a two-day workshop that addressed the purpose and procedures of the peer-tutoring program, reviewed the curriculum, and were provided with materials.

Data Collection

Classroom observations were conducted to document instructional strategies as well as teacher and student behaviors during the peer-tutoring sessions. Two instruments were used to conduct the classroom observations: *the overall classroom observation for the tutor preparation session* (OCOTPS) and *the overall classroom observation for the tutor-tutee session* (OCOTTS). Either OCOTPS or OCOTTS was used at the end of each tutoring session. Both instruments use a three-point scale (i.e., one for not observed at all, two for observed to some extent, and three observed to a great extent) to record the extent to which certain classroom behaviors, instructional strategies, and teacher-tutor or tutor-tutee interactions are evident during the tutor training sessions.

These instruments were adapted from previous research and classroom observations instruments to include the characteristics of the tutoring program (Alford et al., 2013; Padrón et al., 2012; Ross & Smith, 1996; Valle et al., 2013). The inter-rater reliability of the classroom observation instruments for the present study was 0.77 which indicates an adequate degree of consistency across the four trained classroom observers.

Instruments

OCOTPS was designed to collect specific information about classroom behaviors and educational practices during the tutor preparation sessions in the following areas:

(a) knowledge and skills addressed in the lesson,

(b) instructional strategies used by the program teachers,

(c) teacher activities,

(d) student activities,

(e) classroom management and environment,

(f) student engagement,

(g) positive/negative relationships between the teacher and students,

(h) student's accomplishment, and

(i) reinforcement and feedback.

The instrument was completed after each training session. The average inter-rate reliability for the observers was .77 which indicates that the observers were consistent in their observations.

OCOTTS was used after the tutoring session, researchers use the OCOTTS to collect information about the following areas:

(a) knowledge and skills covered in the lesson,

(b) instructional strategies used by the tutor,

(c) tutor math activities,

(d) tutee math activities,

(e) classroom management/environment,

(f) positive/negative emotions of tutees toward their tutors,

(g) tutee engagement,

(h) existence of positive/negative relationships between tutors and tutees,

(i) tutee accomplishments during the session, and

(j) reinforcement and feedback provided by tutors.

The average inter-rate reliability for the observers was .77 which indicates that the observers were consistent in their observations.

Description of the Peer-Tutoring Program

The tutoring program was designed to provide one-to-one peer tutoring instruction to underachieving students in mathematics. The purpose of the program was to integrate mathematics with other content areas, teach students fundamental mathematics skills, promote critical thinking skills, and foster problem-solving abilities in one-on-one environments (Learning Together, 2014).

The peer-tutoring curriculum was designed by Learning Together (2014). It was aligned to common core state standards that define the knowledge and skills students should achieve in mathematics (Learning Together, 2014). The peer-tutoring curriculum included instruction targeted to enhance students' abilities in the following standards:

(a) number and operations,

(b) algebra,

(c) measurement,

(d) geometry, and

(e) data analysis and probability.

These standards were outlined and recommended by the National Council of Teachers of Mathematics (NCTM, 2000) to ensure excellence in instructions provided in K-12 mathematics classrooms. The program included 30 lessons, four optional review lessons, four quizzes, one pre-test and one post-test. Each lesson had eight basic components:

(a) warm-up activities designed to motivate students and prepare them for the new math lesson,

(b) activating prior knowledge,

(c) exploring and practicing math facts,

(d) modeling,

(e) shared reading,

(f) problem-solving,

(g) journal writing, and

(h) debriefing (Learning Together, 2015).

Each lesson lasted approximately 60 minutes.

Peer-Tutoring Program Training for Teachers, Administrators, and Program Teachers

The training for the peer-training program was developed and conducted by Learning Together (2014), a private company offering educational interventions for below-level learners. The training lasted for two full days (16 hours) before the implementation of the program. Teachers and administrators from the schools that implemented the tutoring program participated in the training as well as program teachers who worked for the non-profit organization that sponsored the program. In addition, independent researchers who conducted the evaluation of the program also participated in the training.

During the training, instructors explained the purpose and procedures of the cross-age peer-tutoring program as well as the content of the curriculum. The training also included a comprehensive review of several mathematics lessons. Program teachers were asked to play the role of tutors and tutees to create the environment of cross-age tutoring sessions. In addition, participants watched short videos that portrayed the positive experiences of principals, teachers, coordinators, and students who have participated in previous peer-tutoring programs.

Lessons were scripted to facilitate the tutor's instruction. After whole group discussions, participants worked in pairs to play the role of tutors and tutees to practice implementing lessons using several instructional strategies. The strategies proposed for this program were the following:

(a) use of manipulative materials,

(b) visual representations,

(c) use of calculators, and

(d) the problem-solving heuristic model (SOLVE), which guides students through five steps to solve a problem (i.e., study the problem, organize the facts, line up plan, verify, and examine the answer) (Freeman-Green et al., 2015; National Training Network, 2016).

In summary, the objectives of the program were to:

(a) integrate mathematics with other content areas,

(b) teach students fundamental mathematical skills,

(c) enhance critical thinking skills,

(d) improve problem-solving ability,

(e) develop academic language,

(f) increase students' self-confidence as mathematics learners,

(g) enhance students' motivation, and

(h) encourage students to investigate math conjectures (Learning Together, 2015).

Peer-Tutoring Program Training for Tutors

Before tutors provided instruction to tutees, they were trained by program teachers in weekly sessions of 45 to 60 minutes. During the tutor training sessions, program teachers explained to tutors how to deliver the mathematics lessons, reviewed materials, and instructional strategies, and modeled peer-tutoring procedures for the students. Tutors followed these steps when teaching lessons to their tutees:

(a) warm-up activity,

(b) review of math concepts,

(c) read a story,

(d) solved problems, and

(e) wrote a reflection about the lesson.

Warm-up activities were used by program teachers to motivate students (i.e., tutors) and engage them in classroom activities. After the warm-up activity, the teacher introduced math facts related to the lesson. For example, during a "measurement of length" lesson, tutors

(a) explored non-standard and standard units for measuring length such as teaspoon, cup, meter, centimeter, kilometer, etc.,

(b) read a story that includes distances traveled by historic characters,

(c) solved problems about distance, which involved traveling from one place to another, and

(d) wrote their reflections on the lesson.

During the training session, the tutors worked in pairs: one student played the role of tutor and the other the role of tutee. Tutors followed all the steps in the scripted lesson. Program teachers monitored students' activities. They asked and responded to questions and filled in gaps of information missed by tutors. After participating in the training session, the tutors were ready to apply what they learned during the lesson in the next tutor-tutee session.

Procedures

The elementary school offered the peer-tutoring instruction for 27 weeks. The program in the three middle schools lasted 27, 26, and 22 weeks, respectively. Classroom observations of tutor training were conducted at the beginning, middle and end of the peer-tutoring program by four trained observers. A total of 14 classroom observations were conducted by trained researchers in both the elementary and middle schools offering the peer-tutoring program. Each tutor-training session lasted approximately 45 to 60 minutes. The researchers conducted systematic observations using the two observations instruments described above.

RESULTS

Results are presented in two sections. The first section reports the results of classroom observations of the tutor preparation sessions. The second part presents the findings of classroom observations during the tutoring sessions (i.e., tutors and tutees in one-to-one dyads).

Results of the Observations of the Tutor-Training Sessions

This section reports the results of the overall classroom observations of the tutor-training sessions. The mean (M) values calculated for each section ranged from one to three with a mean value of three indicating that the mathematics content standards, instructional strategy, or behavior was observed most of the time, whereas a mean value of one indicates that the instructional strategy or behavior was not observed at all.

The academic objectives of the peer-tutoring curriculum focused on standards that would ensure excellence in instruction provided in K-12 mathematics (NCTM, 2000). These standards included:

(a) number and operations,

(b) algebra,

(c) measurement,

(d) geometry, and

(e) data analysis and probability.

Table 1 shows the overall descriptive statistics for the content standards observed during the tutor training sessions. The results indicate that program teachers emphasized the development of number and operations (M=2.50, standard deviation [SD]=0.67). In contrast, they neglected to develop other important national standards for school mathematics, such algebra (M=1.17, SD=0.39), geometry (M=1.17, SD=0.58), measurement (M=1.08, SD=0.29). The means are very close to one, suggesting that instruction for these standards was rarely provided. Finally, **Table 1** shows a mean of 1.0 for data analysis and probability, which indicates that instruction related to this standard was never evident during classroom observations.

Table 1. Tutor peer-tutoring sessions overall classroom observations: Content standards

Instruction	M	SD
Number and operations	2.50	0.67
Algebra	1.17	0.39
Geometry	1.17	0.58
Measurement	1.08	0.29
Data analysis and probability	1.00	0.00

Note. 1: Not observed at all; 2: Observed to some extent; & 3: Observed to a great extent

Table 2. Peer-tutoring sessions overall classroom observations: Instructional strategies

Instructional strategies	M	SD
Asking questions to monitor comprehension	2.25	0.45
Modeling how to analyze information and solve problems	2.08	0.67
Providing timely feedback	2.08	0.67
Relating math to real-world experiences	1.83	0.39
Providing ample waiting time for student responses	1.83	0.58
Activating prior knowledge	1.75	0.45
Promoting academic language development	1.67	0.65
Emphasizing calculator use	1.67	0.78
Helping students build connections between mathematical ideas and visual representations	1.58	0.67
Encouraging students to think critically and creatively to solve problems	1.50	0.52
Motivating students to solve problems in more than one way	1.42	0.67
Encouraging students to think aloud when solving problems & have them give oral explanations of her thinking	1.42	0.51
Assisting students to connect mathematical ideas with content areas	1.17	0.39
Using manipulatives to help students understand mathematical ideas and concepts	1.08	0.29

Note. 1: Not observed at all; 2: Observed to some extent; & 3: Observed to a great extent

Table 2 reports the instructional strategies observed during tutor training sessions. The strategies most frequently used were asking questions to monitor comprehension (M=2.25, SD=0.45), modeling how to analyze information and solve problems (M=2.08, SD=0.67), providing timely feedback (M=2.08, SD=0.67), providing ample waiting time for student responses (M=1.83, SD=1.58), and relating math to real-world experiences (M=1.83, SD=0.39). Instructional strategies seldom used included: using manipulatives to help students understand mathematical ideas and concepts (M=1.08, SD=0.29), assisting students to connect mathematical ideas with content areas (M=1.17, SD=1.39), and motivating students to solve problems in more than one way (M=1.42, SD=0.67).

The most frequently observed student (i.e., tutors) behaviors (**Table 3**) were: listening to the teacher (M=2.15, SD=0.55), answering questions from the teacher (M=2.08, SD=0.64), and reading aloud (M=2.0, SD=0.71). The student behaviors that were less frequent were: Connecting mathematical ideas with other content areas (M=1.15, SD=0.38), using manipulative materials to make connections between concrete and abstract ideas (M=1.15, SD=0.38), asking for clarification of unfamiliar words during math activities or problem solving (M=1.15, SD=0.38), and exploring several ways to solve a problem (M=1.23, SD=0.44).

Table 3. Tutor peer-tutoring sessions overall classroom observations: Student activities

Student activities	M	SD
Engaging in listening to the teacher	2.15	0.55
Answering questions from teacher	2.08	0.64
Reading aloud	2.00	0.71
Using visual as a tool to represent mathematical ideas and solve problems	1.77	0.60
Communicating his/her thinking orally while solving problems and gave oral explanations of his/her thinking	1.54	0.52
Connecting what they already knew to new ideas	1.46	0.52
Relating math to real-world experiences	1.46	0.52
Building connections between mathematical ideas and visual representations	1.46	0.66
Asking clarification questions	1.46	0.52
Exploring several ways to solve a problem	1.23	0.44
Connecting mathematical ideas with other content areas	1.15	0.38
Using manipulatives materials to make connections between concrete and abstract ideas	1.15	0.38
Asked for clarification of unfamiliar words during math activities or problem solving	1.15	0.38
Using calculator as a tool to solve problems	1.00	0.00

Note. 1: Not observed at all; 2: Observed to some extent; & 3: Observed to a great extent

Table 4. Peer-tutoring sessions overall classroom observations: Classroom management

Classroom management/environment	M	SD
Activities started on time	2.38	0.87
Transitions were quick and efficient	2.38	0.65
Materials and/or manipulatives were available	2.23	0.60

Note. 1: Not observed at all; 2: Observed to some extent; & 3: Observed to a great extent

It is interesting to note that students were not observed using calculators to solve the problems, even though calculators were part of the toolbox that they received at the beginning of the tutoring program and the use of calculators was one of the objectives proposed by the program.

Overall, the lessons did not address the student's academic deficits in mathematics as planned. The instructional strategies used, for example, are not considered critical thinking skills. Also, during the tutor instruction sessions by the program teachers the activities that students worked on were generally limited to the solution of one- or two-word problems. Many students completed their assignments early and they were not provided with other activities after they finished their assignments. The lack of focus on critical thinking skills and additional learning activities may contribute to the loss of academic learning time.

Table 4 reports the findings from observations related to classroom management. Overall, activities started on time (M=2.38, SD=0.87), transitions were quick and efficient (M=2.38, SD=0.65), and materials and/or manipulative available (M=2.23, SD=0.60). Comparing the results in **Table 2**, **Table 3**, and **Table 4** we can see that even though manipulative materials were frequently available, program teachers and students rarely used them during the tutor training classroom activities.

Results in **Table 5** suggest that a positive learning environment was created during the tutor training sessions. The following behaviors were frequently observed: Program teachers enjoyed teaching in the class (M=2.31, SD=0.48) and students displayed positive affect toward their program teachers (M=2.23, SD=0.44). In addition, students appeared to be happy (M=2.15, SD=0.55), and to enjoy being in class (M=2.15, SD=0.55), while program teachers appeared to have warm, supportive relationships with tutors (M=2.15, SD=0.38).

Table 5. Tutor peer-tutoring sessions overall classroom observations: Positive emotions & relationships, engagement & meaning, accomplishment, & growth mindset

Positive emotions and relationships	M	SD
Teacher enjoyed teaching the class	2.31	0.48
Students displayed positive affect toward the teacher	2.23	0.44
Students appeared to be happy in the class	2.15	0.55
Students appeared to enjoy being in this class	2.15	0.55
Teacher appeared to have warm, supportive relationships with students	2.15	0.38
Engagement and meaning		
Students were engaged in math activities	2.15	0.55
Students concentrated on activities	1.69	0.63
Students were eager to answer questions	1.62	0.65
Students enjoyed solving problems	1.54	0.52
Teacher related concepts to student's lives	1.46	0.52
Students were absorbed by exploring math ideas and searching for multiple paths to solve problems	1.08	0.28
Accomplishment and growth mindset		
Students focused on accomplishing the assigned work	1.77	0.83
Teacher provided opportunities for the student to assume responsibility in activities	1.62	0.51
Teacher let student know that he/she had worked hard	1.54	0.66
Teacher encouraged students to keep trying to answer questions and solve problems	1.54	0.66
Teacher encouraged students' persistence on learning activities	1.38	0.51
Students initiated and assumed responsibility for learning activities	1.31	0.63
Teacher provided opportunities for students to be creative and/or generate his/her own ideas and/or products	1.15	0.38
Teacher provided feedback to student that he/she is smart.	1.00	0.00

Note. 1: Not observed at all; 2: Observed to some extent; & 3: Observed to a great extent

Results for engagement and meaning displayed indicate that students were engaged in math activities (M=2.15, SD=0.55); however, they rarely were observed exploring math ideas and searching for multiple paths to solve problems (M=1.08, SD=0.28). There is little evidence that teacher related concepts to student's lives (M=1.46, SD=0.52), students enjoyed solving problems (M=1.54, SD=0.52), were eager to answer questions (M=1.62, SD=0.65), or concentrated on activities (M=1.69, SD=0.63).

These results revealed that there was little effort devoted to addressing the social and emotional skills of students. Mathematics activities merely focused on the solution of one or two problems during each session. Program teachers did not create cognitive challenging activities for students by guiding students to solve more challenging problems. The results of the observations related to accomplishment and growth mindset indicate that students focused on accomplishing the assigned work to some extent (M=1.77, SD=0.83). Furthermore, the following teacher and students 'behaviors suggest that accomplishment and growth mindset during tutor training were rarely evident during tutor training sessions. Program teachers, for example, seldom provided opportunities for students to be creative and/or generate his/her own ideas and/or products (M=1.15, SD=0.38), nor provided opportunities for the student to assume responsibility in activities (M=1.62, SD=0.61), while students seldom initiated and assumed responsibility for learning activities (M=1.31, SD=0.51).

Results of Observations from Peer-Tutoring Sessions

This section reports the results of the overall classroom observations during the peer-tutoring sessions**.** Mean values for each scale range from one to three. A mean scale close to the value of three indicates that a behavior or interaction was observed to a great extent, a mean value of two indicates that it was observed to some extent, and a mean score of one indicates that a behavior or interaction was not observed at all.

Content standards covered during instruction provided by tutors during tutoring interventions are shown in **Table 6**. Tutors focused on number and operations, while instruction on geometry and measurement was rarely observed. In addition, instruction related to algebra and data analysis and probability was never observed. Not surprisingly, the content standards that were addressed in the peer-tutoring sessions followed a similar pattern of what was taught during the peer-tutoring training sessions (**Table 1**).

Table 6. Peer-tutoring sessions overall classroom observations: Content standards

Instruction	M	SD
Number and operation	2.50	0.67
Geometry	1.17	0.58
Measurement	1.17	0.59
Algebra	1.00	0.00
Data analysis and probability	1.00	0.00

Note. 1: Not observed at all; 2: Observed to some extent; & 3: Observed to a great extent

Table 7. Peer-tutoring sessions overall classroom observations: Instructional strategies

Instructional strategies	M	SD
Peer tutoring	2.83	0.67
Asking literal questions	1.75	0.45
Encouraging tutee to talk or respond	1.75	0.45
Modeling how to analyze information and solve problems	1.67	0.49
Providing timely feedback	1.42	0.67
Helping tutee build connections between mathematical ideas and visual representations	1.33	0.65
Providing ample time for student responses	1.33	0.49
Relating math to real-world experiences	1.25	0.62
Encouraging tutees to think aloud when solving problems & have them give oral explanations of her thinking	1.25	0.45
Using visual materials to explore concepts and construct meaning	1.25	0.62
Assisting students to connect mathematical ideas with content areas	1.08	0.29
Using manipulatives to help tutees to understand mathematical ideas and concepts	1.08	0.29
Modeling how to make connections from reading to math	1.08	0.29
Activating prior knowledge	1.00	0.00
Promoting academic language development	1.00	0.00
Clarifying unfamiliar words during math activities	1.00	0.00
Emphasizing calculator use	1.00	0.00

Note. 1: Not observed at all; 2: Observed to some extent; & 3: Observed to a great extent

Table 7 shows that the instructional strategy most frequently used by the tutor during tutor-tutee sessions was peer tutoring (M=2.83, SD=0.67).

This result was expected because of the focus of this intervention program. On the other hand, instructional strategies that previous research has found to helped minority students to succeed in mathematics were rarely used. For example, tutors seldom used instructional strategies such as: using manipulatives to help tutees to understand mathematical ideas and concepts (M=1.08, SD=0.29), assisting tutee to connect mathematical ideas with content areas (M=1.08, SD=0.29), relating mathematics with real-world experiences (M=1.25, SD=0.62), helping the tutee build connections between mathematical ideas and visual representations (M=1.33, SD=0.65), and providing timely feedback (M=1.42, SD=0.67). Furthermore, some instructional strategies, that were included in the initial plan of the program, were never observed. Tutors, for example, were never observed using instructional strategies such as promoting academic language development, clarifying unfamiliar words during math activities, and using calculators.

Table 8 reports the results of classroom observations of the tutee activities used by tutees during the peer-tutoring sessions. Tutees were frequently observed: listening to the tutor (M=2.58, SD=0.51), responding orally or discussing with the tutor (M=2.00, SD=0.00), and answering questions from tutor (M=1.92, SD=0.29). Tutors were seldom observed relating using manipulative materials to make connections between concrete and abstract ideas (M= 1.08, SD=0.29), relating math to real-world experiences (M=1.17, SD=039.), connecting mathematical ideas with other content areas (M=1.17, SD=0.39). Moreover, tutors were never observed connecting what they already knew to new ideas, exploring several ways to solve a problem nor asking for clarification of unfamiliar words during math activities.

Table 8. Peer-tutoring sessions overall classroom observation: Tutee activities

Tutee activities	M	SD
Listening to tutors	2.58	0.51
Responding orally or discussing	2.00	0.00
Answered questions from tutor	1.92	0.29
Modeling how to analyze information and solve problems	1.67	0.49
Asking clarification questions	1.58	0.51
Using visuals as a tool to represent mathematical ideas and solve problems	1.50	0.67
Engaging in writing activities	1.50	0.52
Building connections between mathematical ideas and visual representations	1.25	0.62
Communicating his/her thinking orally while solving problems and gave oral explanations of his/her thinking	1.25	0.45
Relating math to real-world experiences	1.17	0.39
Connecting mathematical ideas with other content areas	1.17	0.39
Making connections from reading to math activities	1.17	0.39
Using manipulative materials to make connections between concrete and abstract ideas	1.08	0.29
Connecting what the student already knew to new ideas	1.00	0.00
Exploring several ways to solve a problem	1.00	0.00
Asking clarification of unfamiliar words during math activities and problem solving	1.00	0.00
Using calculator as a tool to solve problems	1.00	0.00

Note. 1: Not observed at all; 2: Observed to some extent; & 3: Observed to a great extent

Table 9. Peer-tutoring sessions overall classroom observation: Classroom management

Classroom management/environment	M	SD
Transitions were quick and efficient	2.17	0.83
Activities started on time	2.08	0.79
Materials and/or manipulatives were available	1.92	0.79

Note. 1: Not observed at all; 2: Observed to some extent; & 3: Observed to a great extent

Table 9 shows the results of classroom management observed during tutor-tutee sessions. Results indicate that transitions were quick and efficient (M=2.17, SD=0.83) and activities started on time (M=2.08, SD=0.79). Materials and/or manipulatives, however, were not always available at the start of the session. Overall, the observations suggest that during the tutor-tutee sessions, the classroom environment was conductive to learning.

The results of emotions and relationships observed during tutor-tutee sessions are shown in **Table 10**. Overall, the emotion and relationships that were observed during the peer-tutoring sessions were positive. The tutees, for example, exhibited a positive affect towards the tutor (M=2.25, SD=0.62), engaged positively with tutor and enjoyed being in the class (M=2.17, SD=0.58). Other positive behaviors that were observed to some extend included: Tutors appearing to have warm supportive relationships with tutees (M=2.08, SD=0.51), tutors enjoyed teaching in this class (M=2.08, SD=0.51), tutees appeared to be happy in this class (M=2.08, SD=0.51). Results for engagement and meaning indicate that tutees were engaged in math activities: however, they were rarely eager to answer questions or enjoyed solving problems (**Table 10**). Furthermore, tutees never appeared to be absorbed in exploring math ideas and searching for multiple paths to solve problems. Tutors never related concepts to tutee's lives.

Table 10. Peer-tutoring sessions overall classroom observations: Positive emotions and relationships

Positive emotions and relationships	M	SD
Tutee displayed positive affect toward the tutor	2.25	0.62
Tutee displayed positive engagement with tutor	2.17	0.58
Tutee enjoyed being in this class	2.17	0.58
Tutee appeared to be happy in the class	2.08	0.51
Tutor enjoyed teaching in this class	2.08	0.51
Tutor appeared to have warm, supportive relationships with tutee	2.08	0.51
Engagement and meaning		
Tutees were engaged in math activities	2.08	0.29
Tutees concentrated on activities	1.83	0.58
Tutees enjoyed solving problems	1.17	0.39
Tutees were eager to answer questions	1.08	0.29
Tutees were absorbed by exploring math ideas and searching for multiple paths to solve problems	1.00	0.00
Tutor related concepts to tutee's lives	1.00	0.00
Accomplishment and growth mindset		
Tutee focused on accomplishing the assigned work	1.67	0.65
Tutee assumed responsibility for learning activities	1.58	0.67
Tutees initiated and assumed responsibility for learning activities	1.42	0.67
Tutor provided opportunities for the tutee to assume responsibility in activities	1.42	0.51
Tutor let student know that he/she had worked hard	1.25	0.45
Tutor provided opportunities for tutees to be creative and/or generate his/her own ideas and/or products	1.08	0.29
Tutor provided feedback to student that he/she is smart	1.00	0.00
Tutor encouraged tutees to keep trying to answer questions and solve problems	1.00	0.00
Tutor encouraged tutee's persistence on learning activities	1.00	0.00

Note. 1: Not observed at all; 2: Observed to some extent; & 3: Observed to a great extent

Table 10 shows low levels of accomplishment among tutees. They seldom assumed responsibility for learning activities (M=1.42, SD=0.67), or focused on accomplishing the assigned work (M=1.67, SD=0.65). Tutors rarely provided opportunities for tutees to be creative and/or generate his/her own ideas and products (M=1.08, SD=0.29). Furthermore, tutors seldom provided opportunities for the tutee to assume responsibility in activities (M=1.58, SD=0.67), or let tutees know that he/she had worked hard (M=1.25, SD=0.45). Furthermore, tutors never encouraged tutee's persistence on learning activities or to keep trying to answer questions and solve problems (M=1.0, SD=0.00).

DISCUSSION

Mathematical skills are important for students' academic success and to prepare them to be an effective participant in a complex and changing global job market. Consequently, it is necessary to help students who struggle in mathematics by using research-based instructional strategies. A growing body of research supports the use of peer tutoring in mathematics classroom as an effective strategy that can improve students' academic outcomes, attitudes toward school, motivation, self-esteem, and social and behavioral skills (Alegre et al., 2020; Dietrichson et al., 2021; Ginsburg-Block et al., 2006; Made et al., 2019; Moliner & Alegre, 2020; Pellegrini et al., 2021; Rohrbeck et al., 2003). Research has found that peer-tutoring interventions that focus on improving academic achievement can also improve students' feelings about their academic competence.

The current cross-age tutoring program examined in the present study included objectives that ranged from NCTM (2020) academic standards to the socioemotional outcomes that students were supposed to achieve because of their participation in the program. Classroom observations were carried out for the purpose of evaluating the effectiveness of the program in achieving the program's objectives. Trained observers recorded whether program teachers and tutors implemented instructional practices as designed, their ability to keep students motivated and engaged in the lessons, and their ability to foster critical thinking skills to solve mathematical problems.

The results of the present study found that the quality of instruction provided by program teachers may have impacted the effectiveness of the peer-tutoring intervention. Previous research, for example, has indicated that the quality of instruction offered to Hispanic students is limiting their opportunities for learning mathematics (Valle et al., 2013). These researchers found that the most frequently used instructional practice in mathematics classroom is teacher-directed, whole-class instruction, which limits student participation and collaboration with other students. Unfortunately, these widespread educational practices promote memorization and rote learning instead of critical thinking (Padrón et al., 2002; Waxman et al., 2020). Mathematics requires a very dynamic type of thinking since students need a fluid, flexible, and meaningful number sense to allow them to understand the meaning of numbers, math concepts and to apply them in different scenarios (Faulkner & Cain, 2013).

As previously mentioned, the academic objectives of this tutoring training involved the improvement of students' knowledge and skills contained within the following mathematics standards recommended by NCTM (2000, 2020):

(a) number and operations,

(b) algebra,

(c) measurement,

(d) geometry, and

(e) data analysis and probability.

Including these standards would ensure high quality mathematics education for all students. However, the results indicated that during tutor training, program teachers focused only on instruction related to number and operations. They rarely provided instruction related to algebra, geometry, and measurement. Instruction related to data analysis and probability was never observed. Observations during the tutor-tutee sessions revealed that tutors followed similar instructional patterns. For example, tutors focused on number and operations just as they been taught by the program teachers. There was little instruction that addressed important areas such as algebra, measurement, geometry, data analysis and probability.

Instruction balanced across all mathematics standards is needed to help students connect their ability to do calculations to other areas of mathematics and to other subjects. For example, when students calculate the mean and standard deviation in statistics, they need to connect what they know about basic operations with statistical concepts. In doing that, they need to reason quantitatively, analyze data, and interpret results of numerical computations. This could be extremely difficult for students that were not trained to use their basic computational skills in all mathematical areas.

Further, Collier and Thomas (2011) indicated that some teachers tend to simplify the classroom instruction for low-achieving students because they don't believe that students can handle more challenging tasks. In this peer tutoring program low expectations and low cognitive complexity of lessons prevented students from making adequate academic progress. Consequently, students at-risk should be challenged with cognitive challenging age-appropriate work (Collier & Thomas, 2011).

Classroom observations provided evidence of the program teachers' lack of expectations for students participating in the program. The math activities and content were too simple, and the application of the mnemonic strategy SOLVE was limited to one or two problem solving applications for lesson. The mnemonic SOLVE seemed to help students to analyze the information and remember the logical steps to solve the problem. Program teachers' low expectations of the students' ability to solve problems, however, resulted in the loss of instructional time since most of the students were able to solve one or two problems but were not provided with additional problems to solve.

Furthermore, another important objective of this program was the implementation of instructional strategies that support the mathematics skills that students needed to develop. However, the results from classroom observations revealed that instructional strategies were not implemented as planned. Program teachers seldom used most of the recommended instructional strategies that could have helped students improve their math performance, such as relating math to real-world experiences, connecting mathematical ideas with other content areas, using manipulative materials to make connections between concrete and abstract ideas, using visual materials to explore concepts and construct meaning, and exploring several ways to solve a problem. Not surprisingly, tutors during the tutoring sessions followed the same pattern as the program teachers had used in the tutoring training session, that is tutors rarely used the instructional strategies that support mathematical skills.

The objectives of the program related to the improvement of students' motivation and self-confidence were not supported by program teachers' behaviors during the tutor training. For example, program teachers were seldom observed telling students that they were working hard or encouraging students to persist in learning math ideas, solving problems, or completing classroom activities. During one-to-one peer tutoring sessions, some program teachers kept distant from students while they were working in pairs and therefore did not monitor students' work.

CONCLUSION

Enhancing academic achievement in mathematics for Hispanic students involves overcoming barriers of instructional classroom practices, motivational, and other non-academic factors. Research has reported positive effects of peer tutoring on students' outcomes across content areas (Pellegrini et al., 2021). Peer tutoring programs could be a viable strategy to help Hispanic students who struggle in mathematics classrooms, not only for the potential benefits suggested by research findings but also because peer tutoring is a cost-effective strategy, which means that schools can obtain greater academic benefits for each dollar invested in this instructional intervention compared to other available options. In addition, peer tutoring can enhance academic language development, which can allow students to understand the mathematics ideas and concepts included in every lesson. Topping et al. (2003), for example, found that peer tutoring promoted meaningful instructional conversations among students.

Findings in this study revealed that some strengths of this tutoring program involved the creation of student-centered learning environments that enhance the communication skills that students need to collaborate with others (Damon & Phelps, 1989). In addition, peer tutoring promoted student interactions, and therefore provided opportunities for students to develop their social skills and form positive relationships with peers (Damon & Phelps, 1989).

Another strength of the program is the benefits of using the mnemonic strategy SOLVE. Observers stated that this strategy was helping students to improve their ability to solve problems. Students used this strategy to understand and organize the information in word problems. Empirical research supports heuristic strategies to improve problem-solving skills by facilitating the interpretation, planning, and solution of word problems. Hohn and Frey (2002) found that elementary students who used the heuristic method SOLVED achieved greater improvements in problem-solving skills than students in control groups. They concluded that the use of heuristic approaches leads to superior leaning rates and long-term performance improvement. It is pertinent to note that both SOLVE and SOLVED are mnemonic heuristic strategies; however, SOLVED, created by Hohn and Frey (2002), stands for state the problem, options to use, links to the past, visual aid, execute your answer, and do check back. The heuristic strategy SOLVE used in the present study stands for study the problem, organize the facts, line up plan, verify, and examine.

The results of classroom observations indicated that program teachers seldom used instructional strategies that could have helped to promote both students' outcomes in mathematics classrooms. Program teachers rarely used visuals materials as a tool to improve understanding of difficult mathematical concepts or manipulative materials to help students understand mathematics by connecting concrete objects with abstract concepts. Furthermore, program teachers almost never encouraged students to connect mathematics with other content areas, even though an important component of the lesson was shared reading. The use of the above research-based strategies could improve the students' outcomes in future tutoring interventions.

The dearth of positive reinforcement from program teachers related to individual student efforts to complete the math activities could have affected students' self-efficacy in mathematics. Program teachers rarely encouraged students' persistence on learning activities and were never observed telling students that they select smart ways to analyze data or solve problems. Children need this kind of emotional support to overcome difficult mathematics tasks.

Another weakness of the program is the ineffective use of academic learning time. After completing the reading activity students had to solve only one- or two-word problems. When they finished there was not anything else that they could do. This wasted valuable instructional time could have been used to improve the mathematical ability of tutors and tutees.

While the enrolment of Hispanic students in public schools continue increasing, their academic achievement remains low (US Department of Education, 2019a, 2019b). Future research about instructional interventions that can help this group of students to succeed in mathematics is highly needed. As we mention above, one effective intervention for minority students supported by research is peer tutoring (Pellegrini et al., 2021). The present study contributes to the knowledge about peer tutoring programs by examining the classroom practices, behaviors, and activities during tutor training and tutor-tutee sessions. In addition, the present study identified several aspects of peer-tutoring programs that are particularly effective for Hispanic students. The program examined in this study, nonetheless, found several weaknesses that need to be consider when developing peer tutoring programs not only for Hispanic students, but perhaps for all students.

Recommendations

Future studies should focus on the factors that contribute to the successful implementation of peer-tutoring programs for Hispanic students. This includes effective professional development of the teachers in implementing peer-tutoring programs that enhance the academic achievement in mathematics for Hispanic students, but also addresses the unique needs of this student population. This professional development should focus on how to implement a mathematics curriculum that addresses current effective, research-based instructional classroom practices rather than just focusing on the low levels of the curriculum (Waxman et al., 2020). Finally, this professional development should provide support to teachers on how to develop positive classroom environments and addressing issues such as opportunities for language development.

Results from this study indicate that peer tutoring for Hispanic students can have benefits for tutors and tutees. Future research, however, should investigate

(a) how to maximize these benefits,

(b) how teachers could more effectively use the instructional time, and

(c) the processes that enhance students' academic outcomes, motivation, and engagement.

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