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Effects of Cross-Age Tutors With EBD for Kindergarteners At Risk of Mathematics Difficulties

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Watts, Gavin W.; Bryant, Diane Pedrotty; and Roberts, Garrett J., "Effects of Cross-Age Tutors With EBD for Kindergarteners At Risk of Mathematics Difficulties" (2019). *Special Education Faculty Publications*. 6. https://digitalcommons.tamusa.edu/sped_faculty/6

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Journal of Emotional and Behavioral Disorders

Effects of Cross-Age Tutors with EBD for Kindergarteners At-risk for Mathematics Difficulties

Journal:	<i>Journal of Emotional and Behavioral Disorders</i>
Manuscript ID	JEBD-05-2019-047.R1
Manuscript Type:	Original Manuscript
Keyword:	mediated procedures < Peer(s), math < Instruction, Positive behavioral supports, academic < Interventions, behavioral < Interventions

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Effects of Cross-Age Tutors with EBD for Kindergarteners At-risk for Mathematics Difficulties

Abstract

Challenges with numerical proficiency at an early age can lead to substantial gaps in learning and are associated with detrimental long-term outcomes. Additionally, students with emotional-behavioral disorders (EBD) can have some of the most challenging behavioral and academic needs to address. The purpose of this study was to identify the effects and collateral outcomes of utilizing cross-age tutors (i.e., older students) with/at-risk for EBD to deliver a number line board game intervention to kindergarten students at-risk for mathematics disabilities. A multiple baseline design across participants was utilized to evaluate the following research questions: (1) What are the effects of a number line game delivered by a cross-age tutor with EBD on the mathematics performance of kindergarten students with mathematics difficulties? (2) Can students with EBD implement tutoring procedures with fidelity? (3) What are the effects of the cross-age tutoring training and implementation on the tutors' classroom behaviors and risk-status for EBD? Tutoring sessions took place for 25–30 minutes, three times per week, over 10 weeks. Results suggest cross-age tutoring to be an effective and feasible model for improving mathematics performance of kindergarteners at-risk and, to a lesser extent, the behavioral performance of students with EBD.

Keywords: emotional-behavioral disorders, cross-age tutoring, mathematics, number line

Effects of Cross-Age Tutors with EBD for Kindergarteners At-risk for Mathematics Disabilities

Young children with difficulties in mathematics achievement often challenged with basic number sense knowledge and skills (Mazzocco, Feigenson, & Halberda, 2011). Students with mathematics difficulties frequently struggle to develop adequate number sense knowledge and skills required to facilitate later fact and computation skills (Locuniak & Jordan, 2008). Early discrepancies in number competence have been shown to have significant short-term and long-term outcomes for this population (Jordan, Glutting, & Ramineni, 2010). In the short term, if students are identified with mathematics deficits by age 7 or 8, it is likely they were correctly identified as being at-risk in kindergarten (Toll, Van der Ven, Kroesbergen, & Van Luit, 2011). Long-term, students with deficits in early numeracy knowledge and skills show continuing low performance on future measures of mathematics achievement (Jordan, Kaplan, Locuniak & Ramineni, 2007). Children with low performance in early numeracy knowledge and skill areas may also struggle to develop the conceptual foundations that will support the learning of more advanced mathematics (Van Luit & Schopman, 2000).

The National Mathematics Advisory Panel (NMAP, 2008) emphasizes the importance of early mathematics interventions, and preventative interventions, that have a strong foundation in whole number concept development and proficiency. Early intervention in these foundational concepts and skills is supported, in an effort to deter long-term deficits and future barriers to learning advanced mathematical concepts (NMAP, 2008). If not addressed effectively, early difficulties in acquiring essential numeracy skills can persist into long-term challenges that may become impervious to intervention (Jordan, Kaplan, Ramineni, & Locuniak, 2009). One early numeracy intervention with a foundation in whole number concepts is a number line board game, which is based on theoretical frameworks and

empirical research connections to the mental number line (Laski & Siegler, 2014). To implement number line board games requires only minimal training time, costs (i.e., materials), and prerequisite mathematics skills (e.g., Ramani, Siegler, & Hitti, 2012). Considering these accessible requirements, the ease of implementation may allow non-teachers such as older students (i.e., cross-age tutors) to deliver the intervention, with high levels of fidelity, allowing for teachers to arrange smaller instructional groupings of students in need of individualized, explicit instruction (Clarke et al., 2017; Doabler et al., 2017).

Students with EBD as Cross-age Tutors

The academic and behavioral needs of students with emotional-behavioral disorders (EBD) are some of the most challenging to address (Kern, 2015). Additionally, the high priority placed on special educators' planning and instructional time has demanded a need for instructional techniques that are practical, low- or no-cost, and above all, effective (Bettini, Kimerling, Park, & Murphy, 2015). With these considerations in mind, special educators may need to focus on underutilized resources within their own schools, such as peers, to provide individualized instruction that meets both academic and behavioral needs. One peer-mediated model that has shown effectiveness is cross-age tutoring.

Cross-age tutoring utilizes an older student as the more knowledgeable and experienced peer in a coaching or instructional role, called the 'tutor', while the students receiving coaching or instruction from a tutor are called 'tutees'. An increasing research base in cross-age tutoring suggests that it can be an effective model for teaching academic and social skills to students with disabilities (Okilwa & Shelby, 2010). Blake, Wang, Cartledge, and Gardner (2000) found students with challenging behaviors to be effective instructors of social skills for younger students, with the proper training and supervision. Additionally, these tutors may also obtain collateral academic and/or behavioral skill improvement through

1
2 this role (Watts, Bryant, & Carroll, 2019). This role may be appropriate for students with
3
4 EBD due to the unique interactions and behavioral requirements that the position facilitates.
5
6 Given the academic and behavioral challenges of students with EBD, utilizing cross-age
7
8 tutoring may provide direct, individualized instruction, as well as provide opportunities for
9
10 the tutor with EBD to practice and develop social, behavioral, and academic skills in an
11
12 instructional setting.
13
14

15 **Purpose and Research Questions**

16
17 To date, cross-age tutoring, with students with EBD as tutors, has been evaluated
18
19 infrequently in regards to its effectiveness in promoting mathematics skills in the early
20
21 grades (Watts, Bryant, & Carroll, 2019). The following research questions guided this study:
22
23 (1) What are the effects of a number line board game on the mathematical performance of
24
25 kindergarten students at-risk for mathematics difficulties, when delivered by older tutors (i.e.,
26
27 5th-6th graders) with/at-risk for EBD? (2) To what extent can students with EBD effectively
28
29 serve as cross-age tutors and deliver early numeracy instruction through number line board
30
31 games, as measured by the fidelity of implementation? (3) What are the effects of the tutor
32
33 training and implementation of the cross-age model on the tutors' (with EBD) Check-
34
35 in/Check-out (CICO) behavioral point sheet scores?
36
37
38
39
40

41 **Method**

42 **Setting and Participants**

43
44 University and school IRB approved all protocols prior to the start of the study. The
45
46 study took place at a public elementary school in a suburban school district in central
47
48 Colorado. The school served students in preschool through sixth-grade. School records from
49
50 2016 showed that 40.4% of the students qualified to receive free or reduced-price lunch. All
51
52 tutor training and tutoring sessions took place in an unoccupied general education classroom.
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1
2 **Tutees.** A kindergarten teacher nominated students based on perceived difficulties in
3
4 early numeracy knowledge and skills. Students were included if their Test of Early
5
6 Mathematics Ability-Third Edition (TEMA-3) pre-test score fell below the average standard
7
8 score range of 90-110 (Ginsburg & Baroody, 2003). Students currently receiving
9
10 supplemental support to their business as usual (BAU) mathematics instructional minutes
11
12 were excluded. Table 1 provides information on the five kindergarten students who
13
14 participated as tutees (i.e., students receiving instruction from tutors). Across tutees, pre-test
15
16 results showed a mean standard score of 76.2 ($SD = 2.9$, range = 72-80).
17
18
19

20 **Tutors.** Fifth- and sixth-grade students qualified as tutors if they had IEPs identifying
21
22 them as having EBD. The special educator also nominated additional students with
23
24 disabilities who had challenging classroom behaviors and/or IEP goals directly related to
25
26 social or behavioral skill development. Students were excluded if they had a history of
27
28 violent or aggressive behaviors, or daily attendance rates below 90% during the previous
29
30 school year. The Student Risk Screening Scale-Internalizing and Externalizing (SRSS-IE;
31
32 Drummond, 1994; Lane & Menzies, 2009) was administered at pre-test and post-test and is
33
34 further described under measures. Students qualified to participate as cross-age tutors if
35
36 either their externalizing or internalizing score fell within the moderate to high ranges. Table
37
38 2 displays tutors' demographic information and pre-test scores.
39
40
41
42

43 **Measures**

44
45 **Test of Early Mathematics Ability.** A researcher administered the TEMA-3
46
47 (Ginsburg & Baroody, 2003) which served as a pre-test and post-test of mathematics
48
49 knowledge and skills. The TEMA-3 is a norm-referenced, diagnostic tool for determining
50
51 mathematical strengths and weaknesses of students, ages 3 through 8, and consists of 72
52
53 items in the domains of informal and formal mathematics. Informal items evaluate four
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domains: numbering skills, number-comparison facility, calculation skills, and understanding of concepts. Formal items evaluate numerical literacy, mastery of number facts, calculation skills, and understanding of concepts. Reliability coefficients range from $r = .94$ to $.96$, and alternate-form coefficients range from $r = .93$ to $.97$. Test-retest reliability coefficients are $r = .82$ to $.93$ (Ginsburg & Baroody, 2003). A trained researcher with a background in special education, and familiar with the TEMA-3 procedures, observed, more than 25% of the administrations of the TEMA-3 to prospective tutees. A checklist aligned with the scripted prompts of the TEMA-3 measured fidelity of assessment procedures. Mean fidelity of assessment was 97% (range = 94% to 100%).

Student Risk Screening Scale. The elementary school measure is an adapted version of the SRSS (Drummond, 1994), consisting of one subtest for externalizing behaviors (SRSS-E7; 7 items) and one subtest for internalizing behaviors (SRSS-I5; 5 items). All items are rated on a 4-point Likert-type scale. Externalizing subtest (SRSS-E7) cut scores are as follow: low-risk = 0-3 points; moderate-risk = 4-8 points; and high-risk = 9-21 points. Internalizing subtest (SRSS-I5) cut scores are as follow: low-risk = 0-1 points; moderate-risk = 2-3 points; and high-risk = 4-15 points (Lane et al., 2015).

The Texas Early Mathematics Inventory–Aim Checks. The Texas Early Mathematics Inventory–Aim Checks (TEMI–AC; University of Texas System/Texas Education Agency, 2009) were administered weekly, as a progress monitoring tool, to assess tutees' mathematical performance. The validated early numeracy measure contains four subtests: magnitude comparisons, number identification, number sequences, quantity recognition. Each subtest is a 2 min timed assessment. The raw scores for the four subtests are then summed to provide a total score. This assessment has five forms, and measures numerical and operational skills and knowledge, found to be directly related to critical

numerical competency and early mathematics skills. The TEMI-AC alternate-form reliability, across five forms, is above .80. The special educator administered the TEMI-AC following the last tutoring session each week, and during approximately the same time in baseline and maintenance phases.

Check-In/Check-out Point Sheets. CICO behavioral point sheets served as the progress monitoring measure for tutors' classroom behavior. Typically, CICO procedures include components related to teacher-provided attention for participating students, such as providing feedback/reinforcement for behavioral progress on daily CICO sheets (Hawken, Bundock, Kladis, O'Keeffe, & Barrett, 2014). These components were intentionally omitted in an attempt to control outside influences on potential effects of the tutoring program on classroom behaviors. Thus, the CICO point sheets served solely as a data collection tool to index the social functioning of tutors outside of the tutoring environment. None of the tutors participated in any CICO procedures/programming prior to the intervention. Tutors' classroom teachers (i.e., general education teachers for inclusion classes and a paraprofessional for special education classes) scored CICO sheets after each instructional period. The investigator calculated weekly CICO mean scores and graphed the data accordingly.

The paper-based CICO sheets consist of three behavioral indicators/goals and were scored by classroom teachers on a scale from zero to two points, dependent upon the number of redirections required for a given behavior during the class period. The three behavioral indicators aligned with the school-wide Positive Behavioral Interventions and Supports (PBIS; Sugai & Horner, 2006) domains within the behavioral expectations matrix: 'be respectful', 'be responsible', and 'be safe'. Each domain consists of PBIS school-wide behavioral expectations and examples, and are taught to the students through PBIS classroom

1
2 lessons throughout the school year.

3 4 **Social Validity**

5
6 After the intervention, tutees, tutors, and teachers completed a researcher-developed
7
8 social validity questionnaire comprised of 5-point Likert-type scale questions (9 questions for
9
10 tutors; 8 questions for teachers; 7 questions for tutees). Questions addressed participants'
11
12 understanding of the program and responsibilities, potential change(s) in students'
13
14 performance in mathematics/classroom behaviors, self-assessment of participation as
15
16 tutor/tutee, feasibility/ease of implementation, and whether they would like to participate in
17
18 future incarnations of the program.
19
20
21

22 **Interscorer Agreement**

23
24 The investigator trained the special educator and kindergarten teacher on
25
26 administration and scoring procedures for the TEMI-AC in a 45 min session. Initial
27
28 interscorer agreement was calculated on dummy coded, practice TEMI-AC forms at 97.8%
29
30 across all forms. Interscorer agreement on student responses was calculated by summing the
31
32 total number of agreements and dividing by the total number of agreements plus
33
34 disagreements and multiplying by 100. Across each phase of the study, interscorer agreement
35
36 was calculated on a minimum of 25% of the tests. The mean interscorer agreement across all
37
38 phases was 98.3%.
39
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41
42

43 The investigator also trained four general education teachers and a special education
44
45 paraprofessional on CICO scoring procedures. Reliability was assessed through practice
46
47 scenarios in the natural instructional environment by scoring the class periods immediately
48
49 following the training session. Interobserver/scorer agreement was calculated by totaling the
50
51 number of agreements between the teacher and the researcher scores for each behavioral
52
53 indicator for each student, dividing by the total number of comparisons (i.e., items) and
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1
2 multiplying by 100. Interscorer agreement ranged from 81.8% to 100% across all observed
3
4 class periods ($M = 89.6\%$).
5

6 **Research Design and Procedures**

7
8 Two sets of concurrent multiple baseline designs (Kennedy, 2005) were implemented
9
10 to evaluate the effects of the tutoring program on (1) tutees' mathematics performance on
11
12 weekly progress monitoring measures, and (2) tutors' weekly mean scores on CICO
13
14 behavioral point sheets. The independent variable for tutees was attending cross-age tutoring
15
16 sessions in which they participated in number line board games for 25-min per day, 3 days
17
18 per week, over 10 weeks. The tutors' intervention consisted of two components: (1) tutor
19
20 training sessions in which the tutor received instruction on tutoring skills, number line board
21
22 game procedures, and positive behavioral reinforcement strategies; and (2) attendance and
23
24 implementation of the cross-age tutoring sessions with their tutee.
25
26
27
28

29 The number line board games followed the specifications and designs used by Laski
30
31 and Siegler (2014), where spaces contained numerals 0-100. Teacher training sessions took
32
33 place during two, 45 min teacher planning periods over two consecutive days. Both the
34
35 kindergarten and special education teacher were trained on tutoring session supervision roles
36
37 and responsibilities. The special educator took the role of the lead supervisor of the tutoring
38
39 sessions due to his familiarity with the tutors and their behavioral needs. Supervision
40
41 responsibilities included monitoring and supporting individual tutoring dyads (e.g., providing
42
43 redirection if needed), providing positive reinforcement (e.g., specific verbal praise), and
44
45 managing the time of the sessions. The kindergarten teacher observed and documented
46
47 tutors' fidelity of implementation of the tutoring procedures with a fidelity checklist. The
48
49 investigator conducted interobserver agreement checks and follow-up training sessions with
50
51 the individual teachers at scheduled times throughout the intervention.
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Baseline Phase

During the baseline phase, tutors and tutees attended their BAU class schedules. The TEMI-AC was administered to the tutees weekly, at approximately the same time of the school day when future tutoring sessions would be implemented. A special education paraprofessional (for the special education setting) and the general education teacher (for the inclusion setting) completed the tutors' CICO point sheets. This allowed for behavioral ratings to be obtained from teachers who were blind or semi-blind to the study.

Intervention Phase

Tutor training. Prior to the starting tutoring sessions, each tutor was individually trained on tutoring procedures by the investigator during a 1:1, 45-min training session, which was also observed by the special educator. The tutor training sessions included introducing the number line board game materials, modeling, guided practice, corrective feedback, role-playing tutoring sessions, and evaluating the following skills: (1) instructional techniques and number line board game procedures, (2) corrective feedback methods, and (3) positive behavioral reinforcement strategies. Instructional techniques included: how to greet their tutee, reviewing the previous session (i.e., what went well, what they will focus on improving during the current session), starting the game, keeping their tutee on task, and the number line board game rules and procedures. Training on the number line board game procedures and corrective feedback methods were based upon the training manual developed by Ramani, Siegler, and Hitti (2012) to train paraprofessional for an earlier study. Some of the language used in the training manual was adapted, with the authors' permission, to meet the needs of the elementary student tutors. The corrective feedback method included a two-step process. When the tutee was observed making a counting error, for example, if the tutee's game piece sat on number six and they spun a three on the spinner and they then

1 moved their game piece by counting the number of spaces they earned (e.g., “1, 2, 3”)
2
3
4 instead of counting-on from the number their game piece was currently sitting on (e.g., “7, 8,
5
6 9”), the tutor would first verbally prompt the tutee to count the numbers on the board game,
7
8 giving them another practice opportunity. If the tutee again made an error by counting from
9
10 ‘one’, or made an error in counting the consecutive numbers correctly, the tutor would model
11
12 how to count-on correctly, followed by providing another practice opportunity. Positive
13
14 behavioral reinforcement strategies included providing specific feedback on tutees’ counting
15
16 skills and verbal statements of praise for on-task behaviors.
17
18

19
20 Fidelity of implementation of tutor training sessions was assessed through a
21
22 procedural checklist containing the training components aligned with the scripted training
23
24 manual. A second researcher was trained on the observational measure and IOA was
25
26 established at greater than 95% on practice administrations of the training prior to
27
28 implementation. The second researcher observed 40% of the tutor training sessions and
29
30 found the mean quality of implementation to be 96.5% across sessions.
31
32
33

34 **Tutoring intervention.** Tutees attended three tutoring sessions per week in an
35
36 unoccupied classroom for 10 weeks. Sessions were 25-30 min and supplemental to the
37
38 tutees’ 45 min BAU daily instructional time in mathematics. None of the tutees received
39
40 additional mathematics beyond the previously stated 45 min of mathematics instruction.
41
42 Tutees participated in the number line board game with the tutor, one-on-one, with the tutor
43
44 providing the game procedures, modeling, corrective feedback, and positive reinforcement.
45
46 After the last tutoring session each the week, tutees were administered a paper-based TEMI-
47
48 AC.
49
50
51

52 **Maintenance.** The maintenance phase occurred for four weeks following the
53
54 conclusion of the last tutoring session. No further tutoring sessions took place between the
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1
2 end of the intervention phase and the administration of maintenance measures. To assess
3
4 maintenance, the TEMI-AC was administered to each of tutees during the typically
5
6 scheduled tutoring time at 2- and 4-weeks after the final tutoring session. To assess the
7
8 maintenance of outcomes for the tutors, teachers of the tutors were asked to continue scoring
9
10 CICO point sheets after each instructional period.
11
12

13 **Tutors' fidelity of implementation.** The kindergarten teacher assessed fidelity of
14
15 implementation of tutoring procedures by the cross-age tutors with EBD during each tutoring
16
17 session. The teacher, trained on the fidelity checklist of tutoring procedures (i.e., modeling,
18
19 providing practice opportunities, corrective feedback procedures, positive behavioral
20
21 reinforcement techniques), observed using momentary time-sampling procedures, rotating
22
23 among each tutor every 30 s. The teacher used a timer, which buzzed, to notify a change to
24
25 the next interval. IOA was assessed through a second, independent observation of the same
26
27 tutoring sessions by a trained researcher for more than 30% of the total fidelity observations
28
29 conducted during the study. When a tutor's fidelity of implementation of tutoring procedures
30
31 was observed to fall below an 80% mean score across a given week, a retraining session on
32
33 tutoring procedures was provided to the tutor by the investigator immediately prior to the
34
35 first tutoring session the following week.
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40

41 **Data Analysis**

42
43 Results were interpreted based on visual analysis guidelines by the What Works
44
45 Clearinghouse (WWC) guidelines (Institute of Educational Sciences [IES], 2017) and the
46
47 Council for Exceptional Children (CEC) Standards for Evidence-Practices in Special
48
49 Education guidelines (Cook et al., 2014). Both the WWC (IES, 2017) and the CEC (Cook et
50
51 al., 2014) guidelines recommend visual analysis to identify functional relationships. In visual
52
53 analysis, three within phase and two between adjacent phase variables determined the
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1
2 presence and direction of a functional relationship. The within phase variables included the
3
4 level (i.e., central tendency; means and standard deviations), the trend or slope, and the range
5
6 or standard deviation of the data from the trend line. Between adjacent phase variables
7
8 included immediacy of effect (i.e., following a change in the independent variable how
9
10 quickly a change in the pattern of the dependent variable occurs) and the degree of overlap
11
12 (i.e., a proportion of overlap of data points between phases). To measure the degree of
13
14 overlap, we utilized the percentage of nonoverlapping data (PND) points with a higher
15
16 percentage indicating a greater effect (Horner, Swaminathan, Sugai, & Smolkowski, 2012).
17
18 Each case was individually assessed according to these guidelines.
19
20
21

22 **Study findings.** Outcomes were also categorized as *strong-*, *moderate-*, or *no-*
23
24 *evidence* of a causal relationship based on the quantity of the demonstrations of effect and
25
26 non-effect (i.e., level, trend, variability, immediacy of effect, PND; IES, 2017). Studies with
27
28 three or more demonstrations of effect and no non-effect were categorized as *strong*
29
30 *evidence*. Studies with three or more demonstrations of effect *and* one demonstration of non-
31
32 effect were categorized as *moderate effect*. Studies with less than three demonstrations of
33
34 effect were categorized as *no evidence*.
35
36
37

38 **Results**

39
40
41 Figure 1 displays tutee weekly TEMI-AC math fluency total scores. Worth noting is
42
43 that the intervention phase was introduced prior to an identified, stable baseline for some of
44
45 the later dyads due to time constraints of the study.
46
47

48 **RQ1: Mathematics Performance of Tutees**

49
50 Figure 1 displays the tutees weekly mathematics fluency outcomes as the total
51
52 number of items correctly completed across the four, two min subtests. Note, due to the
53
54 attrition of Tutee 3, Tutor 3 was reverted to baseline phase after the third week of
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1
2 intervention (i.e., removed tutoring program attendance/responsibilities). From baseline to
3
4 intervention phases, all five tutees demonstrated an increase (demonstrating a positive effect)
5
6 in level and a slight (see tutee 1) to large (see tutees 2, 3, and 4) increase in a positive trend.
7
8 All tutees had low variability around the trend line in the intervention phase, with tutees 1, 2,
9
10 and 4 showing no change in variability from baseline to intervention and tutees 3 and 5
11
12 showing a decrease in variability from the baseline to intervention phases. Immediacy of
13
14 effect was not present. Table 3 presents the PND across phases for each participant. The
15
16 mean PND for intervention phase, compared to the baseline, was 68% ($SD = 34.9$, range: 10-
17
18 100%). The mean PND for maintenance, compared to the baseline, was 100% ($SD = 0\%$).
19
20 For the tutee math fluency outcome, there were more than three demonstrations of effect and
21
22 no non-effects, suggesting strong evidence of a causal relationship. Additionally, the TEMA-
23
24 3 was administered as a post-test (see Table 4). TEMA-3 pre-test standard scores ranged
25
26 from 72 to 80 ($M = 76.2$, $SD = 2.9$). At post-test, tutees scores ranges from 89 to 90, with a
27
28 mean score of 93 ($SD = 4.2$). The mean change in score was 17.8 ($SD = 4.0$, range = 12-21).
29
30
31
32
33

34 **RQ2: Tutors' Fidelity of Implementation**

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36 Across tutors, the fidelity of implementation mean was 90.5%. Weekly means, across
37
38 tutors, were above 90% in seven of ten intervention weeks, and above 80% in nine of ten
39
40 intervention weeks. Across tutors, a steady increasing trend was exhibited in weekly fidelity
41
42 means from Week 1 through Week 5, and then stabilizing above 95% for each of the
43
44 remaining weeks of the intervention. Retraining sessions were required for four of five tutors,
45
46 and all retraining sessions took place within the first 3 weeks of implementation. None of the
47
48 tutors required a retraining session after the third week of intervention. The interobserver
49
50 agreement across tutor observations ranged from 88% to 100% ($M = 92.8\%$).
51
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53

54 **RQ3: Behavioral Outcomes for Tutors**

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1
2 Figure 2 displays the tutors weekly percentage of points earned on their CICO. For
3
4 the within phase demonstration of effects, from baseline to intervention phases, all five tutors
5
6 demonstrated a slight increase (demonstrating a positive effect) in level, with a negative (see
7
8 tutor 3) to no change (see tutors, 1, 2, 3, and 4) in trend. Tutors had similar variability across
9
10 phases, with the exception of tutor 2 having greater variability in the intervention phase than
11
12 the baseline phase. Immediacy of effect was not present. The mean PND for the intervention
13
14 phase was 65.3% ($SD = 21.8$, range: 30-90%). The mean PND for maintenance was 40% (SD
15
16 = 54.8, range: 0-100%). For the tutor CICO outcome, there were less than three
17
18 demonstrations of effect and more than one non effects, suggesting no evidence of a causal
19
20 relationship.
21
22
23

24 All five tutors' post-intervention SRSS-IE scores showed decreased risk-status on
25
26 both externalizing and internalizing subtests (SRSS-E7 and SRSS-I5). Table 5 displays
27
28 tutors' pre-/post-test scores and EBD risk-status. Across tutors, externalizing behavior scores
29
30 showed the greatest improvement, with a mean score decrease from 13.2 ($SD = 2.6$) to 9.8
31
32 ($SD = 3.5$), while internalizing risk scores decreased at lower rates or remained at
33
34 approximately the same levels. An improvement in risk-categorization was exhibited for two
35
36 tutors, with a change from high- to moderate-risk status for externalizing behaviors.
37
38
39

40 Social Validity

41
42 All participants reported high favorability towards the benefit and effectiveness of the
43
44 intervention ($M = 5.0$). Tutors perceived themselves to have the skills necessary to be
45
46 effective tutors ($M = 4.4$). Teachers perceived the tutoring program to be successful in
47
48 increasing tutors' positive behaviors ($M = 4.0$) and decreasing negative/challenging
49
50 behaviors ($M = 4.0$). Tutors scored themselves similarly in these areas ($M = 4.0$) but their
51
52 self-ratings in decreasing challenging behaviors were slightly lower ($M = 3.8$). The highest
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1 ratings, across tutors, tutees, and teachers were in the perception of the intervention's impact
2 on tutees' mathematics skills ($M = 4.0$; 4.75; 4.0, respectively). Additionally, all tutors and
3
4 tutees reported high agreement regarding their understanding of responsibilities ($M = 4.55$),
5
6 ease of implementation ($M = 4.43$), and desire to participate in future incarnations of the
7
8 program ($M = 5.0$). Both teachers reported neutral ratings ($M = 3.0$) for the ease of
9
10 implementation due to challenges in scheduling tutoring sessions across differing grade level
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12 schedules, but high ratings for the program's perceived benefits for all students ($M = 5.0$).
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18 Discussion

19 Mathematics Performance of Tutees

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21
22 Previous reviews of cross-age instructional models with tutors with EBD have shown
23 consistent, positive effects on mathematics performance of both tutees and tutors (Ryan,
24 Reid, & Epstein, 2004). Two studies focusing on tutoring early numeracy knowledge and
25 skills showed moderate to large effects in tutee outcomes and large effects in tutor outcomes
26 (Watts, Bryant, & Carroll, 2019). Similarly, the at-risk kindergarten students in this study
27 showed moderate improvements in early numeracy knowledge and skills, such as counting,
28 number comparison, and number magnitude. In regards to effectiveness, this study's findings
29 are consistent with the literature base showing number line board games as a promising
30 intervention for young children with mathematics difficulties (Ramani, Siegler, & Hitti,
31 2012). Additionally, the findings related to tutees' improved mathematics performance add to
32 the evidence-base suggesting number line board games to be an effective instructional tool
33 for promoting early numeracy knowledge and skills for students with at-risk backgrounds
34 (Ramani & Siegler, 2008; Siegler & Ramani, 2009).
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52 Previous studies utilizing cross-age tutors with EBD as the interventionists, in
53 delivering mathematics instruction to students at-risk or with disabilities, have shown
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1 moderate to large effects in improving mathematics performance for tutees when compared
2 to studies utilizing cross-age tutoring for instruction in other content or skill areas (e.g.,
3 reading fluency, spelling; Lazerson, 2005; Ryan, Reid, & Epstein, 2004). One possible
4 explanation may be the structured, procedural steps for some mathematics skills may be more
5 conducive to the cross-age tutoring model than, for example, reading fluency or
6 comprehension skills.
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15 **Students with EBD as Cross-age Tutors**

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18 Across the small number of previous studies measuring and reporting fidelity of
19 cross-age tutors with EBD, findings show high implementation rates, ranging from 88% to
20 97% (Blake, Wang, Cartledge, & Gardner, 2000; Hamelberg, 1987). Additionally, when
21 fidelity is measured for cross-age tutors with EBD, the related outcomes for tutees is
22 typically substantial in academic and behavioral skill improvements. The study at hand found
23 similar results regarding tutors' fidelity of implementation, which was greater than 90%
24 across tutors. Tutees' mathematics scores on proximal and distal measures exhibited
25 moderate to substantial improvements. These findings add to an evidence-base suggesting
26 students with EBD to be capable and effective cross-age tutors when provided with the
27 appropriate training and supervision.
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41 In regards to training, some improvements may be necessary for future iterations of
42 instructional models requiring the training of students with EBD as cross-age tutors. Fidelity
43 of implementation means were high across tutors during the 10-weeks of intervention. These
44 results demonstrated tutors' ability to effectively implement the tutoring procedures, but
45 areas for improvement can be identified when fidelity rates are disaggregated by weekly
46 means. Re-training sessions were required and provided for four of five tutors within the first
47 3-weeks of the intervention phase. There are multiple explanations for these initial, variable
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2 levels of implementation. First, the initial tutor training session may have been insufficient in
3
4 some component. Findings related to increased fidelity rates after re-training sessions
5
6 suggests basic modifications to the training protocol may facilitate higher, initial rates of
7
8 implementation. One recommendation would be to provide more practice opportunities with
9
10 instructional procedures within training sessions. Tutors may also benefit from additional
11
12 practice/role-playing with other students (e.g., peers being trained as tutors) during tutor
13
14 training. This feature could be provided in addition to initial practice/role-play opportunities
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16 with the teacher-trainer, where corrective feedback and reinforcement is provided to the
17
18 tutor. Additionally, an overall increase in frequency and/or duration of initial tutor-training
19
20 sessions may support the development and maintenance of required tutoring procedures and
21
22 strategies.
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26 27 **Behavioral Outcomes for Tutors with EBD**

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29 Allen and Feldman (1973) proposed that when students with or at-risk for disabilities
30
31 undertake the role of a cross-age tutor, the large discrepancy between that role and their
32
33 typical student identity requires a transformation that produces “spillover” effects seen in the
34
35 form of increases in academic skills, time on-task, classroom behavior, and positive attitudes
36
37 towards school. This explanation connects to *role theory*, which proposes that the behavior of
38
39 the individual is influenced by the role they inhabit or play (Thomas & Biddle, 1966). In the
40
41 context of this study, the theory proposes that when students undertake a given role (e.g.,
42
43 cross-age tutor, teacher), they adopt the attitudes or behaviors associated with the assumed
44
45 role/identity (Turner, 2002). Thus, this theory provides a possible explanation for some
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47 behavioral improvement during the intervention phase and decreases in those same behaviors
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49 after the responsibility/role of being a tutor was removed (i.e., during maintenance phase).
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55 Although the data, across tutors, was variable during the maintenance phase, distal
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1 effects were found in improvements in externalizing risk status for two tutors. In these
2 instances, the findings related to generalized behavioral improvements and decrease risk-
3 status for EBD align with previous research showing potential benefits of cross-age tutoring
4 on students' non-academic skill areas such as general classroom behavior, on-task behavior,
5 social skills, and peer relationships (Blake, Wang, Cartledge, & Gardner, 2000). Considering
6 the limited literature base, it is currently unclear if this intervention shows promise as a peer-
7 mediated instructional model, or if potential benefits are available for students with specific,
8 challenging behaviors/disabilities. Thus, further research in this area is suggested,
9 specifically in the measurement of distal outcomes for tutors (both academically and
10 behaviorally), which has been infrequently addressed in previous studies. Additionally, there
11 are needs for research methodologies designed to directly assess the potential impact of tutor
12 training and tutor implementation on tutors' academic, social, and behavioral skills in
13 generalized settings (i.e., outside of the tutoring environment; Watts, Bryant, & Carroll,
14 2019).

34 **Limitations**

35
36 Caution must be used in generalizing the results of brief interventions due to their low
37 external validity (Slavin, 2008). Two main limitations need to be considered when
38 interpreting the results of this study. First, the uniqueness of the design implemented to
39 evaluate outcomes for two distinct populations of students with disabilities poses limitations.
40 One challenge in utilizing a co-occurring multiple baseline design across two sets of
41 participant groups is the intertwined intervention schedule, that is, when the independent
42 variable (i.e., tutoring program) is introduced to the tutee, it must also be introduced to the
43 tutor (i.e., tutoring sessions are attended by the dyad). Therefore, a decision must be made as
44 to which of the participant's baseline data (i.e., tutees or tutors) will be utilized in
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1
2 determining when the intervention will be introduced. For this study, a rationale was
3
4 provided for utilizing the tutees' TEMI-AC total scores as the primary data set for evaluating
5
6 the stability of the baseline phase, and therefore, determining when each dyad would be
7
8 provided the intervention (i.e., provided tutor training and begin attending tutoring sessions).
9
10 One potential issue with this arrangement occurs when tutee's baseline data quickly stabilizes
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12 in trend and level, providing inadequate time for the tutors' baseline data to stabilize before
13
14 the intervention is introduced, therefore, making the interpretation of results more
15
16 challenging.
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20 Second, due to the components, structure, and delivery of the intervention (e.g.,
21
22 training tutors, implementation of number line board games, peer-mediated instruction), it is
23
24 difficult to assess which component(s) was/were the primary mechanism(s) of change. For
25
26 example, during tutoring sessions, the tutees were exposed to modeling, multiple practice
27
28 opportunities, explicit feedback, number line board game materials/procedures, positive
29
30 reinforcement, and attention from, and interactions with an older peer. Each of these
31
32 components has evidence of supporting effective instruction and could have potentially
33
34 assisted the development of early numeracy knowledge and skills. Therefore, although the
35
36 intervention resulted in positive participant outcomes, the mechanism of change cannot be
37
38 readily determined.
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42 43 **Future Research** 44

45
46 There is still much to be evaluated for this instructional model in terms of
47
48 replication/external validity, component analysis/dosage, measurement of tutor outcomes,
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50 implementers, methodological rigor, and potential benefits for other at-risk populations. Due
51
52 to the innovative nature of this study, and considering the limited research, there is a need for
53
54 replication of these methods and procedures to assess external validity. Furthermore,
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1
2 conducting a component analysis may assist in identifying the mechanisms of change within
3
4 the model. Considerations for evaluating components of the cross-age tutoring model should
5
6 include identifying the number of tutees effectively served one tutor, as well as the effect of
7
8 dosage (i.e., frequency and duration) on participant outcomes. Determining the minimum
9
10 dosage required to improve target skills would also assist in the standardization of the
11
12 intervention's procedures as well as identify the model's utility for specific student needs.
13
14 Considering the cross-age model's utility in providing supplemental instruction, identifying
15
16 the effects of the intervention's duration on student outcomes may be beneficial for
17
18 supporting its use as a booster/supplemental instructional practice for students at-risk.
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22 **Implications for Practice**

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25 Special education classrooms show a continuing demand for effective instructional
26
27 techniques and arrangements that meet the needs of students with disabilities. Barriers to
28
29 certain instructional models and interventions become compounded when cost(s) and/or
30
31 feasibility are issues (e.g., staff/personnel requirements, necessary training; Bettini,
32
33 Kimerling, Park, & Murphy, 2015). Cross-age tutoring has shown promise of effectiveness
34
35 and feasibility for practitioner implementation, and may be suitable for addressing the
36
37 intensive needs of students with/at-risk for mathematics difficulties, while also providing
38
39 tutors with EBD opportunities to practice and develop social and behavioral skills in an
40
41 academic context (Watts, Bryant, & Carroll, 2019).
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45
46 Considering the evidence showing teachers and students are more likely to continue
47
48 using the practice with fidelity when they perceive it to be effective or beneficial, the
49
50 implications of this study's social validity findings are promising (Hawkins, Kroeger,
51
52 Musti-Rao, Barnett, & Ward, 2008). Furthermore, this intervention aligns with the
53
54 development of special educator preparation programming that teaches and supports
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CROSS-AGE TUTORS FOR KINDERGARTENERS AT-RISK

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1
2 proactive, instead of reactive practices (e.g., timeout/isolation, removal/exclusion from
3
4 general education setting) when working with students with EBD (Oliver & Reschly, 2010).
5

6 This study adds to the groundwork for a future line of research in studying the effectiveness,
7
8 feasibility, social validity, and related outcomes of an academic cross-age tutoring
9
10 intervention delivered by students with EBD.
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Table 1

Tutees' Demographic and Pre-test Information.

	Tutee 1	Tutee 2	Tutee 3	Tutee 4	Tutee 5
Age (years-months)	5-3	5-2	5-5	5-3	5-0
Grade	K	K	K	K	K
Gender	M	M	M	M	M
Race/Ethnicity	African-American	Hispanic	Caucasian	Caucasian	Caucasian
IEP/ Disability status	None/ At-risk	None/ At-risk	None/ At-risk	None/ At-risk	None/ At-risk
Free/Reduced lunch	Y	Y	Y	Y	N
<i>Pre-test</i> TEMA-3	77	77	80	75	72

Note. K = kindergarten; M = male; IEP = Individualized Education Program; Y = yes; N = no; TEMA-3 = Test of Early Mathematics Ability-3: Standard Scores (Ginsburg & Baroody, 2003)

Table 2

Tutors' Demographic and Pre-test Information.

	Tutor 1	Tutor 2	Tutor 3	Tutor 4	Tutor 5
Age (years-months)	10-9	11-6	10-5	12-2	11-0
Grade	5	6	5	6	5
Gender	M	M	M	M	M
Race/Ethnicity	Caucasian	Caucasian	Caucasian	Caucasian	Caucasian
IEP disability category	EBD	LD & at-risk for EBD	EBD	LD & at-risk for EBD	EBD
Free/Reduced lunch	Y	N	Y	Y	Y
<i>Pre-test</i> SRSS-E7:	10 (High)	11 (High)	17 (High)	13 (High)	15 (High)
SRSS-IE Scores (Risk-status)	4 (High)	8 (High)	13 (High)	13 (High)	11 (High)
SRSS-I5:					

Note. M = male; IEP = Individualized Education Program; EBD = Emotional-behavioral disorder; LD = learning disability; Y = yes; N = no; SRSS-IE = Student Risk Screening Scale-Internalizing and Externalizing (Drummond, 1994; Lane & Menzies, 2009); SRSS-E7 = externalizing subtest; SRSS-I5 = internalizing subtest; Cut scores = high-risk (E7: 9-21; I5: 4-15); moderate-risk (E7: 4-8; I5: 2-3)

Table 3

Effects by Student and Phase.

Tutees	Phase compared to baseline	PND % (TEMI-AC)	Tutors	Phase compared to baseline	PND % (CICO)
Tutee 1	Intervention	70	Tutor 1	Intervention	90
	Maintenance	100		Maintenance	100
Tutee 2	Intervention	70	Tutor 2	Intervention	70
	Maintenance	100		Maintenance	100
Tutee 3	Intervention	100	Tutor 3	Intervention	66.7
	Maintenance	N/A		Maintenance	0
Tutee 4	Intervention	90	Tutor 4	Intervention	30
	Maintenance	100		Maintenance	0
Tutee 5	Intervention	10	Tutor 5	Intervention	70
	Maintenance	100		Maintenance	0
Intervention Mean (SD)		68 (34.9)	Intervention Mean (SD)		65.3 (21.8)
Maintenance Mean (SD)		100 (0)	Maintenance Mean (SD)		40 (54.8)

Note. PND = percentage of nonoverlapping data; SD = standard deviation

Table 4

Tutees' Pre-/Post-Test TEMA-3 Scores

Tutees	TEMA-3 <i>Pre</i>	TEMA-3 <i>Post</i>	<i>Pre-/Post- Change</i>
Tutee 1	77	98	+21
Tutee 2	77	89	+12
Tutee 3	80	N/A	N/A
Tutee 4	75	95	+20
Tutee 5	72	90	+18
Mean (SD)	76.2 (2.9)	93 (4.2)	+17.8 (4.0)

Note. TEMA-3 = Test of Early Mathematics Ability-3: Standard Scores (Ginsburg & Baroody, 2003); SD = standard deviation

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Table 5

Tutors' Pre-/Post-Intervention SRSS-IE Scores and Risk Status.

Tutors	SRSS-IE <i>Pre</i>		SRSS-IE <i>Post</i>		Risk Status <i>Pre</i>		Risk Status <i>Post</i>	
	E7 (Extrn.)	I5 (Intrn.)	E7 (Extrn.)	I5 (Intrn.)	E7 (Extrn.)	I5 (Intrn.)	E7 (Extrn.)	I5 (Intrn.)
Tutor 1	10	4	8	6	H	H	M	H
Tutor 2	11	8	7	8	H	H	M	H
Tutor 3	17	13	15	12	H	H	H	H
Tutor 4	13	13	6	12	H	H	H	H
Tutor 5	15	11	13	9	H	H	H	H
Mean	13.2	9.8	9.8	9.4				
(SD)	(2.6)	(3.4)	(3.5)	(2.3)				

Note. SRSS-IE = Student Risk Screening Scale-Internalizing and Externalizing (Drummond, 1994; Lane & Menzies, 2009); E7 = externalizing subtest; I5 = internalizing subtest; SD = standard deviation; Cut scores: H = high-risk (E7: 9-21; I5: 4-15); M = moderate-risk (E7: 4-8; I5: 2-3)

Figure 1

Tutees' TEMI-AC Total Scores by Week.

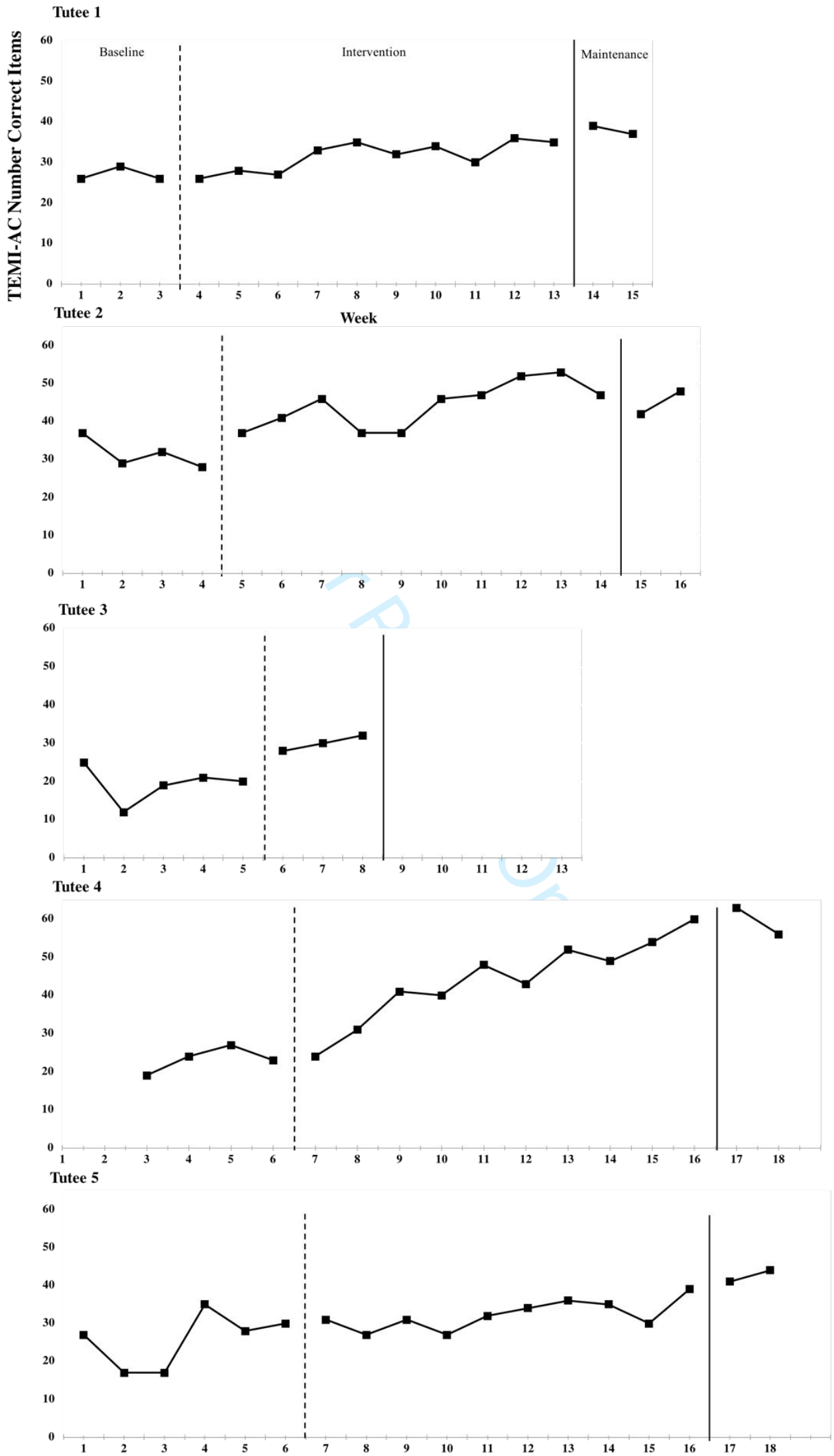


Figure 2

Tutors' CICO Behavioral Points by Week.

