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THE ROLE OF PEER TUTORING IN STRENGTHENING MATHEMATICS PERFORMANCE OF STUDENTS WITH HEARING IMPAIRMENT

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KEYWORDS	ABSTRACT
Peer Tutoring, Hearing Impairment, Mathematics, Academic Achievements, Primary Level Education	The study examined the effect of peer tutoring on mathematics performance of primary students with disability of hearing impairments. The major aim of the research was to examine the impact of peer tutoring on students with both a defined and an undefined zone of proximal development. Due to the experimental nature of the study, multigroup pretest-posttest design was used. A total of three classes of 4th grade were chosen from District Mardan. Selected sample was classified into three groups. Students with a defined zone of proximal development were placed in Experimental group-1, while the students with an undefined zone of proximal development were placed in Experimental group-2. A control group was also added to compare the effectiveness of treatment. Class-wide peer tutoring was used, and Unit 4, which was about Decimals, was taught from the KP textbook board. Pre-test and post-test were administered before and after treatment, respectively. Treatment session was continued for five weeks. After treatment, collected results were interpreted. Study found that peer tutoring is active strategy for refining mathematics for students with hearing impairment. Peer tutoring was found to be effective for both tutors and tutees in enhancing their scores in mathematics.
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INTRODUCTION

According to Jackson, Varner, Denecke and Namara (2013), the individual differences played an important role in the learning of the students at classroom level. Some students need extra academic help, making it dynamic for teachers to report their exact needs to ensure the supportive learning environment (Elliott, 2018; Fitriani & Turmudi, 2022). The teaching strategies such as group work,

discussion, tuition expert mentoring, counselling, and peer tutoring are usually used to address the learning needs of diverse nature (Ali, Anwer, & Abbas, 2015; Prastowo, Surya & Syahputra, 2023). The research acknowledged that peer tutoring is an effective strategy for addressing the needs of individual differences (Shamir & Tzuriel, 2004). The peer tutoring is a well-organized approach in which an intelligent student assists another student of the similar age, academic, or grade level in the academic activities (Tiwari, 2014; Gaustad, 1993). Thus, the school administration manages this relationship to share knowledge and ideas among students (Duran, 2002). Tutors do not need to be so highly expert; they just need to be proficient than their tutees (Kunsch, Jiteendra, & Sood, 2007; Topping, 2000).

There are three main types of peer tutoring: Class-Wide Peer Tutoring (CWPT), where both tutors and tutees belong to the same class, Cross-Age Peer Tutoring (CAPT), where the tutor is older than the tutee, and Peer-Assisted Learning Strategy (PALS), in which the role of the tutor and tutee is alternated and based upon the student's needs. Every type of peer tutoring successfully meets the individual needs and also fosters educational and social growth. Empirical studies confirmed that the peer tutoring played an important role in the academic development of the students and the motivation development (Khattak, 2012; Mushtaq, 2010; Austin, 2008; Ullah, Kaleem, & Amir, 2020). It develops confidence, self-efficacy, and social engagement (Spencer, 2006). Peer tutoring also develops spelling, numerical skills and reading ability (Alegre, Miravet, Lorenzo & Maroto, 2018; Gamlem, 2019). Alegre, Moliner, Maroto and Valentin (2020) state that peer tutoring in the mathematics is beneficial both at the elementary as well as secondary levels as compared to the conventional method. Peer tutoring was found effective for students with disabilities, especially for those students who are hearing impaired, both in special education and inclusive settings (Chinaka & Osisanya, 2020).

The cooperative learning and peer tutoring improved motivation, academic achievement, social interactions and peer relationships amid students with hearing impairments (Chinaka & Osisanya, 2020; Fuchs, Fuchs, & Burnish, 2005). Rajalakshmi (2020) used various models of peer tutoring and found them highly effective for deaf students in inclusive setups. Mehra and Mondal, (2005); Haider, and Yasmin, (2015) demonstrated that students taught in the zone of proximal development performed better as compared to conventional development. Rizve (2012) achieved better results by teaching English through peer tutoring to the students in the zone of proximal development. The concept of peer tutoring is rarely used in Pakistan, while there is always a shortage of teachers and a very high teacher-student ratio (44:1) in primary schools (World Bank, 2018) and 41:1 in Khyber Pakhtunkhwa general education, while it is 44:1 in the institutes of special education (EMIS, 2018; MIS, 2017). The use of peer tutoring is a practical solution to overcome teachers' shortage, and can also reduce classroom overcrowding, and can also reduce the workload on the teachers (Ajani & Akinyele, 2014).

The deaf students communicate very well in sign language among themselves, but less so with the teacher (Noor, 2017). In this connection, based on this natural communication, the implementation of peer tutoring among deaf students is highly advantageous, as they can clarify the concepts very well. Through this collaborative learning arrangement, students with the hearing impairment gain

opportunities to revisit difficult concepts, practice problem-solving more frequently, and receive immediate feedback in ways that traditional teacher-led instruction may not always provide. Most current studies have focused on hearing children as peer tutors, which leaves a substantial gap with respect to deaf students acting as tutors in special education institutions and a positive attitude toward challenging mathematical tasks. In the series of studies, the present research study wanted to explore the benefits of peer tutoring for the tutor and the tutee (deaf) and to assess whether peer tutoring within Zone of Proximal Development shows greater academic outcomes than traditional teaching methods.

Research Objectives

1. To explore achievements in mathematics of Hearing-Impaired students with defined ZPD, under the effects of peer tutoring in comparison with traditional teaching.
2. To explore achievement in mathematics of Hearing-Impaired students with undefined ZPD, under the effects of peer tutoring in comparison with traditional teaching.
3. To compare the consequences of tutoring on the achievement in mathematics of Hearing-Impaired students with defined and undefined ZPD in particular context.

LITERATURE REVIEW

The current investigation aimed to explore the effects of peer tutoring on the students occurring in the Zone of Proximal Development (ZPD) as compared to those in the traditional teaching, learning environments, and those with undefined ZPD levels. The past research has shown that peer-assisted learning develops cognitive, academic, and social competence, critical thinking, and motivational levels (Ullah, Iqbal, & Kaleem, 2025). Rajalakshmi (2020) acknowledged that peer tutors are also helpful in physical education for enhancing the engagement of students with disability. In this continuation, Ghalley, Tobgay, Penjor, Rai, Oli and Tenlo (2020) proved that significant academic development was observed among students who participated in peer tutoring session to use sign language, visual aids & peer-explained strategies to understand mathematical ideas more deeply. Olson (2019) noted that cooperative & peer-learning strategies improved academic achievement & peer relationships in chemistry, particularly for students with disabilities. Alzahrani and Leko (2018) proved that peer tutoring is effective for children with LD, enhancing reading comprehension and engagement.

Bakare and Orji (2018) confirmed that the reciprocal peer tutoring (RPT) performed better than traditional teaching in the development of academic achievement and motivation in learning the computer fundamentals, while mentioning the gender differences that underscored the equitable potential of interactive learning. Academic improvement observed across other subjects, like Ullah (2018), proved that peer tutoring enhanced academic achievement in biology across all cognitive levels of Bloom's taxonomy and recommended its inclusion in teacher training programs. Alegre et al. (2020) noted significant improvement in mathematics performance, while Moliner and Alegre (2020) explored that peer tutoring reduced math anxiety and developed the students' confidence level. All these studies admit same-age & reciprocal tutoring for best engagement and performance improvements. Apart from cognitive benefits, peer tutoring is helpful to emotional & motivational growth. Song, Loewenstein, and Shi (2017) noted that peer tutoring in rural areas of China improved

students' social behaviour and attitude but also enhanced learning stress, highlighting the need for careful operation.

[Nawaz and Rehman \(2017\)](#) also reported that structured peer tutoring has improved mathematics performance among both average and weak students, highlighting necessity for teacher training to maintain the effectiveness of the program. Meta-analyses further confirm the strength of these findings. [Alegre et al. \(2017\)](#), analyzed about fifty studies, and reported that about 88% of peer tutoring programs are effective with respect to academic performance irrespective of ability, age, or session type while [Farrell \(2019\)](#) implemented class-wide peer tutoring (CWPT) for the physical fitness and skill performance among children with different disabilities in inclusive settings and showed high levels of satisfaction. Among the cooperative learning research, [Thurston, Cockerill, and Chiang \(2011\)](#) showed controlled trial with 295 students from low-socioeconomic backgrounds in England and noted substantial improvement in reading comprehension, particularly among tutors. [Tirado, Martin, and Torres \(2019\)](#) achieved the similar academic effects by incorporating structured peer tutoring among first-year students in university, demonstrating its admissibility to higher education.

[Chinaka and Osisanaya \(2020\)](#) noted that the students with hearing impairment who were taught through peer tutoring achieved higher scores in biology, compared to those in traditional settings, with self-efficacy moderating these outcomes. Also, [Kalaivani and Kowsika \(2019\)](#) pointed out that peer tutoring enhanced self-confidence, understanding, and moral development, enabling the tutees and tutors alike to practice academic and interpersonal development. Moreover, the peer tutoring supports differentiated learning by allowing instruction to proceed at a pace suited to students with the hearing impairment. Vygotsky's sociocultural theoretical framework provides a convincing theoretical lens for understanding the power of peer tutoring. By promoting learning within a social setting and the ZPD, peer tutoring converts education into a collaborative process that develops cognitive and socio-emotional faces and creating an inclusive learning atmosphere where learners feel empowered to succeed. Past research consistently shows that all types of peer tutoring boost academic achievement, self-efficacy, and motivational level, especially for students with disabilities.

Research Hypotheses

- H01: There is no considerable difference in the mean scores of post-tests in mathematics between HI students with a defined ZPD, those with an undefined ZPD, and those taught through the conventional method.
- H02: There is no distinguishable difference in test scores before & after treatment in mathematics for HI students taught using the conventional method.
- H03: There is no distinguishable difference in the test scores before and after treatment in the mathematics for the HI students with the defined ZPD.
- H04: There is no distinguishable difference in the test scores before and after treatment in the mathematics for HI students with an undefined ZPD.
- H05: There is no distinguishable difference in the mean posttest scores in mathematics of tutees with a defined undefined ZPD in particular context.

RESEARCH METHODOLOGY

The current study falls within domain of experimental research, and a multigroup pretest-posttest design was used. All the students of class 4th studying in government institutes for students with hearing impairment, working under Directorate of Social Welfare and Special Education in KP, formed the study population. Using convenient sampling, all students in grade 4 at government Institutes for children with hearing & speech impairment in District Mardan were selected as study sample. The 4th-grade classes in each school were assigned to the selected groups by using random selection method.

Instruments of Study

The one test was randomly selected as a pre-test, and other served as a post-test. An anticipation guide was prepared to identify students in the zone of proximal development (ZPD), only among low achievers of the experimental-1 group ([Belolan, 2013](#)). This evaluation was conducted using a 5-point Likert scale. KWL (Know, want to know, and what they learned). A three-column chart was developed for students, listing what they already know, what they want to know, and what they have learned. KWL was administered only to low achievers in the experimental-1 group. The last column, "what they learned," was filled after the experiment ([Belolan, 2013](#)). The anticipation guide was administered again after the treatment phase to assess the students' learning outcomes in the mathematics.

Research Experiment

The experiment was conducted for five weeks, five days a week. Control group: They followed the usual routine and were taught by the relevant class teacher, adhering to the same schedule, exact timetable, and the same number of the mathematics classes, with the same number and duration of periods per week in the current research study. This group was not exposed to peer tutoring at all. Experimental Group 1: The students in this group received peer tutoring. The zone of proximal development of low achievers in this group was identified before the experiment. Experimental-2 group: This group was also exposed to the peer tutoring; however, students' ZPDs were not identified in this context.

The peer tutoring was provided in the same setting (same classroom environment) to avoid the disturbance during the last 15 minutes of the mathematics period. The classroom environment was made comfortable for the peer tutoring in experimental groups for attaining the desired leading outcomes in research. The researcher ensured regular interaction with the children in experimental groups, meeting once a week to monitor and guide the tutors and tutees as needed. Immediately after the experiment was completed, achievement tests were administered to the students of both experimental groups and control group as a post-test. For this purpose, the scores were calculated and organized.

Data Collection

1. The pre-tests were given to all three groups before treatment phase, and data thus collected were analyzed. Pre-tests were administered by the respective mathematics teachers in their classrooms. The pre-test lasted approximately 3 hours.

2. The anticipation guide was administered to the experimental-1 group to find out the zone of proximal development of low achievers before the pairing process by the researcher himself. An anticipation guide was administered again after the treatment phase to assess students' improvement in mathematics.
3. After the identification of low achievers in experimental-1 group, KWL was administered, and areas of "want to know" were identified by researcher. For the "What Students Learned" section, the KWL was administered again by the researcher after the experiment.
4. Post-tests were administered to all three groups in their respective classrooms by concerned mathematics teacher. The post-test lasted 3 hours. Finally, achievement scores of students of all three groups were collected, organized, and finally analyzed.

Data analysis

The pre- and post-test scores were analyzed to obtain mean, median, and standard deviation. The significant difference in mean scores was calculated using ANOVA and a t-test. The researcher analyzed the anticipation guide, identifying areas where students had limited knowledge and needed further practice, and evaluating students' improved areas after the posttest. Through KWL, the researcher identified areas of interest, or "want to know" questions, before the experiment. The "what students learned" section of the KWL was also given to students after the experiment and data analysis, to identify areas for improvement. Both descriptive and inferential statistics were used for data analysis.

RESULTS OF STUDY

Table 1 ANOVA about Significant Differences among Posttest Scores of E1, E2, & C

	Sum of squares	Df	Mean square	F	Sig
Between the groups	10630.4	2	5316.7	18.9	.000
Within the groups	9248.1	33	280.2		
Total	19881.6	35			

Based on P-value mentioned in table, is less than 0.05, leading to the rejection of null hypothesis, and its alternate hypothesis was accepted, which stated that There is no considerable difference in the mean scores of post-tests amid HI students with a defined ZPD, those with undefined ZPD, and those taught through conventional method. It was concluded that all groups were distinct after the treatment phase.

Table 2 Significant difference (mean pretest & posttest scores) of Control Group.

Groups	N	Mean	SD	SED	P-value	t-value
Control (pretest)	14	39.71	21.34	8.17	0.95	0.061
Control (posttest)	14	40.21	21.93			

df = 26

Table value at 0.05 = 2.056

Based on P-value and t-value as mentioned in table, Null hypothesis H_{02} stand true, meaning that control group showed same results on both pretest and posttest, indicating that students in group made no progress.

Table 3 Significant Difference (Mean Pretest & Posttest) Scores of E1

Groups	N	Mean	SD	SED	P-value	t-value
Experimental-1(pretest)	12	36.67	21.34	7.33	0.03	5.554
Experimental-1(posttest)	12	80.42	21.93			

df=22

Table value at 0.05 = 2.074

It is evident that P-value (0.03) is lower than 0.05, and the calculated t-value (5.554) is greater than table value which confirms the rejection of null hypothesis, H_{03} , & approves alternate hypothesis. It is therefore interpreted that the experimental group showed significant progress after receiving peer tutoring.

Table 4 Significant difference (Mean Scores of Pretest & Posttests) Experimental-2 Group.

Groups	N	Mean	SD	SED	P-value	t-value
Experimental-2(pretest)	10	59.5	21.65	7.95	0.006	3.094
Experimental-2(posttest)	10	63.9	12.77			

Df = 18

Table value at 0.05 = 2.101

In above table, it is evident that both the P-value and t-value fall within the criteria for rejecting the null hypothesis and accepting the alternate hypothesis, indicating a significant difference between the pre-test and post-test scores in mathematics for the HI students with an undefined ZPD. In this connection, it was concluded that, after treatment, the difference in pre-test and post-test scores that was significant, thereby indicating that the treatment had a positive impact on the students' achievement.

Table 5 Significant Difference Mean Posttest Mathematical Scores of E1 and E2.

Groups	N	Mean	SD	SED	P-value	t-value
Experimental-1	12	80.4	11.78	5.2	0.005	3.128
Experimental-2	10	63.9	12.7			

df=19

Table value at 0.05 = 2.093

In the above table, it is evident that both P-value and t-value fall within criteria for rejecting the null hypothesis and accepting the alternative hypothesis. It was found that there was a significant difference in mean posttest scores in mathematics amid HI students with defined & undefined ZPD. It was construed from this that the experimental-1 groups showed better results than experimental-2 groups.

Table 6 Significant difference (Mean Posttest Mathematical Scores) of tutors of E1 and E2.

Groups	N	Mean	SD	SED	P-value	t-value
Experimental-1	6	88.16	7.9	4.006	0.003	4.142
Experimental-2	5	72.4	4.5			

df 8

Table value at 0.05 = 2.306

In the above table, it is evident that both the P-value and t-value fall within criteria for rejecting the null hypothesis and accepting alternative hypothesis. It was clear that there was a significant

difference in mean posttest scores of tutors amid experimental-1 and experimental-2 groups. It was interpreted that the peer tutors in experimental-1 group showed better results than those in the experimental-2 group.

Table 7 Difference (Mean Posttest Scores) of Tutees of E1 and E2

Groups	N	Mean	SD	SED	P-value	t-value
Experimental-1	6	72.66	9.9	6.8	0.042	2.449
Experimental-2	5	55.4	12.8			

df 8

Table value at 0.05 = 2.306

In the above table, it is evident that both P-value and t-value fall within the criteria for rejecting the null hypothesis and accepting the alternate hypothesis, which stated that there is a significant difference in the mean post-test scores of mathematics for tutees with a defined ZPD and those with an undefined ZPD. It was concluded that the tutees in experimental-1 group achieved better results than those in the experimental-2 group. It was confirmed that peer tutoring in the zone of proximal development yielded better results than peer tutoring administered to students undefined zone of proximal development.

Table 8 Difference (Mean Pretest & Posttest) Mathematical Scores of Tutors of E1

Groups	N	Mean	SD	SED	P-value	t-value
Tutors of E1(pretest)	6	59.5	8.8	4.8	0.000	5.908
Tutors of E1(posttest)	6	88.1	7.9			

df 10

Table value at 0.05 = 2.228

In the above table, it is evident that P-value and t-value fall within criteria for rejecting the null hypothesis and accepting alternative hypothesis. It was concluded that tutors in experimental-1 group improved mathematics scores on posttest, and difference between pretest and posttest scores was significant.

Table 9 Difference (Mean Pretest & Posttest Scores) of the Tutees of E1

Groups	N	Mean	SD	SED	P-value	t-value
Tutees of E1(pretest)	6	19.8	9.6	5.6	0.000	9.349
Tutees of E1(posttest)	6	72.6	9.9			

df 10

Table value at 0.05 = 2.228

In the above table, it is evident that both P-value and t-value fall within the criteria for rejecting the null hypothesis and accepting the alternative hypothesis. It was thus demonstrated that the tutees in the experimental-1 group improved their mathematics performance in the posttest. It was concluded that the difference between the pretest and posttest means was statistically significant. It was also reported that peer tutoring had improved the mathematical scores of the tutees in the experimental-1 group.

Table 10 Difference (Mean Pretest & Posttest Scores) of Tutors of E2

Groups	N	Mean	SD	SED	P-value	t-value
Tutors of E2 (pretest)	5	59.4	4.8	3	0.002	13.4
Tutors of E2 (posttest)	5	19.2	4.6			

df 8 , table value at 0.05 = 2.306

In the above table, it is evident that P-value and t-value fall within criteria for rejecting the null hypothesis and accepting the alternative hypothesis. It was concluded that tutors in experimental-2 group improved mathematics scores on post-test & difference amid pre-test and post-test scores was significant.

Table 11 Difference (Mean Pretest & Posttest Scores) of Tutees of E2

Groups	N	Mean	SD	SED	P-value	t-value
Tutees of E2 (pretest)	5	19.2	4.6	6.1	0.000	5.904
Tutees of E2 (posttest)	5	55.4	12.8			

df 8 Table value at 0.05 = 2.306

In above table, it is evident that both the P-value and t-value fall within the criteria for rejecting the null hypothesis and accepting the alternative hypothesis in the current research study. It was interpreted that the tutees in the experimental-2 group improved their mathematics scores in the posttest. Consequently, it was concluded that difference between the pretest and posttest means was significant.

DISCUSSION

The primary aim of the present study was to explore the effects of peer tutoring on the performance in mathematics of the primary school students with hearing impairment. The study focused on the effectiveness of peer tutoring administered within the zone of the proximal development (ZPD) as compared to traditional teaching and with the peer tutoring implemented outside the ZPD. It was noted that peer tutoring significantly improved mathematics performance among students with disability of hearing impairments in both experimental groups. These findings matched with past previous studies like [Alegre et al. \(2020\)](#); [Leung, \(2019\)](#); [Shin et al., \(2019\)](#); [Alzahrani, \(2018\)](#); [Olson, \(2019\)](#); [Rajalakshmi, \(2020\)](#); [Nawaz, \(2017\)](#); [Ullah, Tabassum, and Kaleem \(2018\)](#); [Rizve, \(2012\)](#), all of which confirmed that peer tutoring enhances academic achievements of students. Peer tutoring proved effective regardless of whether the Zone of the proximal development was identified. In this regard, experimental groups showed notable improvements between the means of pre- and post-test scores, align with past findings mentioned by [Nawaz \(2017\)](#), [Alegre et al. \(2020\)](#), and [Moliner \(2017\)](#). However, the experimental group with a defined Zone of Proximal Development outdid the group without one, supporting [Vygotsky's \(1978\)](#) theory that learning is most effective within the learner's ZPD.

This finding of study further reconfirmed by [Rizve \(2012\)](#) and [Mehra and Mondal \(2005\)](#), and [Ullah, Kaleem Amir \(2020\)](#), who emphasized that the peer tutoring within the ZPD adopts greater gains in academic achievements, social aptitude, confidence and self-concept? Another finding of study

pointed out that peer tutoring aids both tutors and tutees, as pointed out by [Ullah, Kaleem Amir \(2020\)](#), [Rizve \(2012\)](#), [Mackiewicz et al. \(2016\)](#), [Thurston \(2021\)](#), and [Song et al. \(2018\)](#). Tutors develop their own knowledge over preparation for study & mentoring that in turn improves communication skills & self-efficacy. Also, tutees of both groups exhibited improved mathematical achievements. The findings matched with the findings of [Hott \(2014\)](#), [Thurston \(2021\)](#), [Ghalley et al. \(2019\)](#), [Arco and Ternado \(2019\)](#), [Kalaivani and Kowsika \(2019\)](#), and [Ullah \(2018\)](#), all of whom validated the utility of the peer tutoring in developing the academic achievements for the students with hearing impairment. At all, the peer tutoring appeared as an effective learning strategy, providing better results than traditional instruction. When peer tutoring was implemented within the ZPD, peer tutoring displayed stronger results. While conventional teaching methods face many challenges and have limited effectiveness in enhancing academic performances of students with disability of hearing impairments.

CONCLUSION

As mentioned above it is now evident that the peer tutoring showed good results. Students in both groups under investigation showed significantly better result under the influence of peer tutoring. The peer tutoring strengthens mathematics performance among students with hearing impairment by offering personalized support, improving sympathetic over visual, peer-mediated explanations, increasing confidence, engagement, & creating inclusive learning atmosphere where learners feel empowered to succeed. Still, experimental group No. 1 performed better than experimental group No.2 as shown by post-test. It was confirmed that peer tutoring is more effective when administered in the zone of the proximal development. The conventional teaching method was less effective and showed slight improvement in students' understanding of mathematics. Moreover, tutors from both experimental groups improved their performance; though, those in experimental-1 group achieved better results.

Recommendation

1. As peer tutoring proved to be an effective way to enhance the performance of students with hearing impairment, it is recommended that all teachers administer peer tutoring in their classrooms. As the traditional method of teaching was found to be less effective, it should be added to peer tutoring.
2. It was proven that peer tutoring showed better results when administered in zone of proximal development, so it is recommended that, before administering peer tutoring, zone of proximal development of students must be pointed out.
3. Peer tutoring is a well-organized method of instruction and requires much expertise. It is therefore recommended that teachers receive specific training on peer tutoring during their teaching training programs.
4. Peer tutoring as technique of teaching will be more productive when used by teachers, so it is recommended that it be considered a technique that adds to other teaching techniques. As studies regarding effectiveness of peer tutoring on deaf students are scarce, further studies are recommended in this area.
5. It was proved that students with hearing impairment can learn from peers more easily than from their teachers, so it is recommended that collaborative teaching strategies should be

followed. The best-performing students with hearing impairments be paired with weaker students to enhance their skills and support their academic growth.

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