Received: 20 August 2022 | Revised: 11 December 2022 | Accepted: 15 January 2023

DOI: 10.1002/pits.22866

RESEARCH ARTICLE

WILEY

Effect of Jigsaw and Team Pair-Solo cooperative learning strategies on interest in Basic Science of primary school children with visual impairment

Ogechi Nnamani[1] | **Blanche Ntombizodwa Hadebe-Ndlovu**[2] | **Chinedu I. Okeke**[3] | **Moses Onyemaechi Ede**[3]

[1]Department of Educational Foundations, Faculty of Education, University of Nigeria, Nsukka, Nigeria

[2]Department of Childhood Education, Faculty of Education, University of the Free State, Bloemfontein, South Africa

[3]Department of Education Foundations, Faculty of Education, University of the Free State, Bloemfontein, South Africa

Correspondence
Moses Onyemaechi Ede, Department of Education Foundations, University of the Free State, South Africa
Email: onyemaechi.moses@gmail.com and edeh.mo@ufs.ac.za

Abstract

This study investigated the effect of the Jigsaw and Team-Pair Solo cooperative learning strategies on interest in Basic Science of primary school children with visual impairment. This is a pretest–posttest control group with a follow-up design study. A total of 56 students in Enugu State of Nigeria were randomized into one of two groups, $n = 27$ (male: $n = 18$; female: $n = 9$) for the treatment group and $n = 29$ for the control group (male: $n = 20$; female: $n = 9$). A Learner's Interest Rating Scale was used as an outcome measure. The results showed that there was a significant difference in the interest of students with visual impairment exposed to intervention strategies and those exposed to conventional-lecture strategy in favor of those exposed to intervention strategies. This concluded that Jigsaw and Team Pair-Solo cooperative learning strategies are effective treatment strategies that enhance the interest of students with visual impairment in Basic Science.

KEYWORDS

Basic Science, cooperative learning strategy, interest, Jigsaw, Team-Pair Solo, visual impairment

1 | INTRODUCTION

Basic Science is a subject of study that draws its content and concepts from all the major disciplines in science such as Life Science (Biology), Physical Sciences (Chemistry and Physics), and Earth Sciences (Geography and Agricultural Science) (Nigeria Educational Research and Development Council (NERDC), 2007). The Nigeria Educational Research and Development Council maintained that the general objective of Basic Science is to enable students to observe and explore their environment using their senses. Basic Science formerly known as Integrated Science is the form of science a child encounters at the primary and junior secondary school level.

Basic Science has been made one of the compulsory subjects for all pupils both at primary and junior secondary school levels. It is based on this that learning Basic Science by all students, including students with visual impairment, became inevitable.

Visual impairment is defined as presenting acuity of less than 6/12 in the better eye. The term visual impairment involves mild, moderate, and severe vision impairment. Blindness is used for complete or nearly complete vision loss (World Health Organization, 2021). World Health Organization (2021) classifies vision impairment into two: Distance and near-presenting vision impairment. Vision impairment can be mild, moderate, or severe

Mild—visual acuity worse than 6/12–6/18;
Moderate—visual acuity worse than 6/18–6/60;
Severe—visual acuity worse than 6/60–3/60.

The learners in this category have no light perception and have an acuity worse than 6/60–3/60.

These visually impaired learners (the blind) encountered a lot of challenges in learning Basic Science such as the inability to observe, experiment, and write down necessary information needed during teaching and learning processes, lower rates of workplace participation, social isolation, low self-esteem, anxiety, fear, low academic achievement, inferiority complex, greater likelihood of falls and fractures, depression, and so on which eventually results in their lack of interest in Basic Science (Bunkonola & Idowu, 2012).

Interest has been viewed as an emotional trait that determines a student's urge and vigor to tackle educational programs or other activities (Chukwu, 2002). Murphey and Beggs (2003) maintained that there is a positive relationship between students' interest and the development of knowledge, and skills in Basic Science. In engaging in real-life activities, both interesting and challenging learning activities are always of great interest to students. Hidi and Renninger (2006) observed activities that will promote interest to include cooperative learning groups, team projects, one-on-one tutoring, and interactive problem-solving with or without a teacher.

Consequently, there has been a pronounced lack of interest concerning students with visual impairment in Basic Science in the Junior Secondary Certificate Examination (JSSCE), and this has created a lot of concern in the minds of the parents, teachers, and other stakeholders in the education sector. The poor results are evident in 2013, 2014, and 2015 JSSCE results. The statistics showed that in 2013, out of 10 students with visual impairment who sat for the examination in Basic Science in Enugu State, Nigeria, none had distinctions or credits, and 10 (100%) had pass levels. In 2014, 13 students sat for the same examination, and out of the 13, none had distinction or credit, 10 (77%) had pass level, and 3 (23%) failed. In 2015, 15 students sat for the examination, and out of the 15, none had distinction or credit, 10 (67%) had pass level, and 5 (33%) failed (Results of 2013, 2014, and 2015 Junior Secondary School Certificate of students with visual impairment in Enugu State). In the Nigerian examination system, different grades are assigned to students which range from distinction, credit, pass as well as fail. For a learner to get distinction the scores should range from 70 marks and above. Credit level ranges from 69 to 60, 59–40 marks are all graded as passes while 39 marks downwards are regarded as fails. The statistics also show that though the students with visual impairment who sat for the examination in the above-mentioned years could not get distinctions in

other subjects they sat for but some of the learners had credit levels in some other subjects such as English, Igbo, Social Studies and Religion, to mention but a few.

Researchers have shown that it is not the only vision that can be a hindrance to the study of Basic Science but also an inappropriate teaching strategy (Fatokun & Inti, 2007). These authors attributed students' poor results in Basic Science to a lack of interest and poor instructional approaches. Based on the interview the researchers had with Basic Science teachers, the Director of Education for the learners with visual impairment, as well as learners with visual impairment themselves; it is evident that learners with visual impairment who receive instructions in Basic Science through a conventional-lecture strategy encounter a lot of challenges. These challenges include not giving them room for active involvement during teaching and learning processes, and not using activity-oriented strategies that will help learners possess in-depth knowledge of Basic Science. Learners with visual impairment are also challenged by a lack of training and awareness from the staff and peers. Their social inclusion in the classroom when learning Basic Science is not cordial, learners with visual impairment usually isolate themselves due to their visual impairment predicament. These learners exhibit low self-esteem and lack of social acceptance which hinders their interest in learning Basic Science. According to Harris and Lord (2016), learners with visual impairment prefer to spend most of their time in solitary and parallel play and do not usually engage in imaginative play or social interactions with their sighted classmates. Research evidence indicates that children with visual impairment are at greater risk of emotional difficulties such as anxiety, fear, inferiority complex, and depression to mention but a few (Augestad, 2017). The author observed that the above problems may stem from several factors such as neurological impairment associated with their vision, limited participation in leisure-time activities, increased dependency on others, and increased parental control (Augestad, 2017), which invariably distract the learners and results in their lack of interest in learning Basic Science.

The situation, therefore, calls for a search for appropriate teaching and learning strategies that will give students with visual impairment room for active participation, exchange of ideas, opportunities to ask questions, and being in charge of their learning and decision-making. The use of Jigsaw and Team Pair Solo cooperative learning strategies will equally make teaching and learning learner-centered, helps learners to work in teams, and changes teachers' role to facilitating, monitoring, and mentoring to mention but a few. It also reduces learners' dependence on their school teachers as well as their parents. All these were expected to encourage learners with visual impairment to learn maximally. Based on this premise, the researchers were motivated to investigate the effect of a cooperative learning strategy as an activity-oriented strategy concerning the interest of students with visual impairment in Basic Science.

Cooperative learning is an educational approach that aims to organize classroom activities, and academic and social learning experiences (Sharan, 2010). To the researchers, cooperative learning is an organized and structured strategy that involves learners working together in small groups of two–six people tackling a common learning task to achieve a set goal. There was substantial evidence that cooperative learning is a promising intervention for the improvement of students' interests. For example, the past finding showed that school children exposed to the Jigsaw strategy did better than those in the control group (Chiakwelu & Okigbo, 2020). According to Bukunola and Idowu (2012), the Jigsaw was far more effective than traditional lecture methods. Students taught physics using computer-assisted Jigsaw II performed better compared with those taught using personalized computer teaching, according to Isiaka and Mudasiru (2016). Another study found a substantial difference in the performance and interest scores of science students in the experimental and control groups (Ojekwu & Ogunleye, 2020).

Two cooperative learning strategies identified by Schul (2012) were used in this study. These include Jigsaw and Team-Pair Solo. The Jigsaw Strategy is a multifunctional structure of cooperative learning. Jigsaw can be used in a variety of ways for a variety of goals, but it is primarily used for the acquisition and presentation of new material, review, or informed debate. The use of this structure creates interdependence and status equalization (Kagan, 2001). There are steps involved in carrying out the Jigsaw Cooperative Learning Strategy (JCLS). These steps include: first, materials are divided into sections and each of the expert groups is assigned a section to learn, explore, and then report to their home groups; second, the class shares common learning experiences and the

expert groups take different approaches in analyzing or responding to these experiences, for instance, presenting an experiment or other scientific activities in Basic Science, posing a problem and presenting a possible solution for home group discussion; finally, all the learners will come together as a class to share ideas on their various tasks which will be followed by assessment of learners' performance in the learning tasks (Kagan, 2001).

Team-Pair Solo is a learning strategy where students solve problems first as a team, then with a partner, and finally on their own (individually). Team-Pair Solo is designed to motivate the students or learners to tackle and succeed in solving problems that initially were beyond their ability (Ogunleye, 2011). The choice of these strategies was because the strategies are activity-oriented, involve an increased level of reasoning, and create new ideas and solutions in learning Basic Science tasks. Researchers have shown that when learners are actively involved in the teaching and learning process and necessary feedback is received in their small groups, the learners' interest will be enhanced. Trends in research and evidence from literature tend to suggest that cooperative learning strategies such as the above-discussed strategies enhance learners' interest (Bukunola & Idowu, 2012).

Some studies have found significant differences in the interests of male and female learners. Motani et al. found a significant difference in interests of male and female students in favor of male learners. Nonetheless, Obot (2011), in his study found no significant difference in the interest of male and female learners in Basic Science. This difference in research reports indicates that the issue of interest and gender of students in school subjects is still inconclusive. However, the above studies were conducted with learners with normal vision. This situation, therefore, motivated the researchers to carry out this study to investigate the effect of cooperative learning strategies on the interest of learners with visual impairment in Basic Science using gender as one of the independent variables. This loss of interest in this subject was a result of their peculiarities. It then became pertinent to investigate the effect of cooperative learning strategies specifically on the interest of learners with visual impairment in Basic Science.

Thus, the main purpose of this study was to investigate the effect of cooperative learning strategies (Jigsaw and Team Pair-Solo) on the interest of students with visual impairment in Basic Science. In this study, it was hypothesized that there is a significant difference in the mean interest scores of learners with visual impairment in Basic Science exposed to Jigsaw and Team Pair-Solo cooperative learning strategy and those exposed to a conventional-lecture strategy as measured by the Learners' Interest Rating Scale (LIRS). Further, there will be a significant difference in the mean interest scores of male and female students with visual impairment in Basic Science exposed to (Jigsaw and Team Pair-Solo) cooperative learning strategies and those exposed to a conventional-lecture strategy.

2 | RESEARCH METHODS

2.1 | Ethical approval

The Department of Educational Foundations, University of Nigeria, approved this study. In addition, the researchers adhered to research ethics as in American Psychological Association (2013).

2.2 | Participants

The study participants were 56 students ($n = 25$ males and $n = 31$ females) with visual impairment (blind) in the Enugu State of Nigeria. See Table 2 for additional details about the demographic information of the participants. The eligibility conditions included: (1) learners with visual impairment (blind) in accordance with World Health Organization (WHO) diagnostic criteria/classification, (2) must have Braille. All participants were within the categories of light perception, no light perception, and other thresholds. These were used to identify eligible

participants. However, those who were considered ineligible for this study were: (1) students that were receiving treatment from pharmacologist, psychologist counselors, and their related professionals, (2) students whose parents did not complete and submit written form consent, and (3) any student who is not in secondary school regularly not in regular secondary schools.

2.3 | Procedure

The first stage was an initial visitation to the secondary schools where students with visual impairment study in large numbers together with those with normal vision, in Enugu State of Nigeria, from January 2018 to March 2019. During the visitation, the principals took us around the schools to see the students in their various classrooms. The principals mobilized the students at school halls where the researchers recruited 56 participants out of 62 students with visual impairment using word of mouth. Further, during the recruitment, the researchers took into account of WHO classification of visual impairment. The researchers generated and used random sampling techniques with plastic containers with (slips of paper) during the random assignments of the recruited participants into intervention groups (n = 28 participants) and no intervention (n = 28 participants).

The participants were exposed to a container with slips of paper written: A, 19 slips, 19 slips written B, and 18 slips written C. The papers were folded and properly mixed in the plastic container for the participants to pick. Those who picked As were grouped into intervention treatment 1 (Jigsaw Strategy) while those who picked Bs were grouped into intervention treatment group 2 (Team-Pair Solo Strategy), and those who picked Cs received no intervention, they were grouped as a control group and received instructions on conventional-lecture strategy. This was carried out in the Enugu State of Nigeria. During the first meeting (session), the participants familiarized themselves with the research assistants and the participants, rules, and regulations, objectives of the study, name of each participant, and challenges of the participants were presented.

Participants were also encouraged to exchange pleasantries which will be followed by an assessment of the chosen plan. Before the commencement of the treatment, students in the control group and the experimental groups were given the pretest. The first session focused on familiarization with participants, rules and regulations, the establishment of rapport with the participants, and plans for executing the learning strategies properly. Sessions 2–4 focused on pretests on the participants to identify their level of interest in Basic Science. In each, intact streams received the appropriate instructional programs during the usual Basic Science periods in the regular school timetable of classes which lasted for 3 weeks. Experimental groups were taught using the JCLS and Team-Pair Solo Cooperative Learning Strategy (TCLS). These learners in JCLS and TCLS were taught by research assistants while those in the control group were taught using conventional-lecture strategy procedure by their regular Basic Science teachers. These learners who are known as the control group were taught by class teachers because there was no new intervention introduced unlike in JCLS and TCLS. Thereafter, the researchers met the participants 3 months later for a follow-up evaluation.

2.4 | Measures

The LIRS was developed by Aiken and was adapted and modified by researchers from measures of interests and attitudes in mathematics. We used 10 items out of 24 items originally developed by Aiken. The measure assesses the interest of students with visual impairment in Basic Science when studying with JCLS and TCLS as well as conventional-lecture strategies. LIRS was built on a four Likert-types scale ranging from 1 = *Strongly Agree* (SA), 2 = *Agree* (A), 3 = *Disagree* (D), 4 = *Strongly Disagree* (SD). The study also tested the reliability of the LIRS in the Nigeria context and found its internal consistency at 0.79, indicating that LIRS is a reliable instrument. LIRS has a 10-item questionnaire that was used to investigate the interest of students with visual impairment in Basic Science.

LIRS consists of four response options from a range including Basic Science helps me to develop the mind and teaches a person to think; I like to acquire further knowledge on Basic Science; Trying to understand concepts in Basic Science does not make me anxious; I do not get upset when solving problems in Basic Science; I like participating in Basic Science experiments that require a sense of touch; I enjoy studying Basic Science; I want to develop more skills studying Basic Science; I cannot be motivated to study Basic Science; I do not want to take part in Basic Science lesson.

2.5 | Research assistants

In this study four research assistants were used, two male and two female Basic Science teachers. The age range of these research assistants was between 35 and 45 years old. They were professionally licensed teachers. These research assistants were briefed and guided on how to use JCLS and TCLS by the researchers. The briefing and guidance lasted for 2 weeks. Each meeting with the researchers and research assistants lasted for 45 min each week until there was evidence of mastery by the research assistants.

2.6 | Treatment manuals

The JCLS program developed by the researchers is a set of lesson notes used to instruct students with visual impairment in Basic Science to learn how to work in teams, grouping the students according to tasks using the Jigsaw strategy. These students were taught using JCLS. The groups were arranged by experts to examine aspects of text or discussion topics. Learners in their home group pick areas of discussion such as defining and giving examples of a lever. Another home group follows the same pattern. The duty of the research assistant here was to organize, monitor, and facilities the learners. At last, the expert group emerged, where all the group members sat together and received the learning outcome as presented by experts from each group. Learners asked questions and responded to them. In addition, the home group is the individual sub-group composed by the researchers and each group is assigned specific tasks by the researchers. The individual group performed their independent tasks within the time specified for such an assignment. Information was combined to get a full picture of the problems, text, topic, or tasks. Steps involved in carrying out JCLS: first, materials are divided into sections and each of the expert groups was assigned sections to learn, explore, and then report to the home group; second, the class shares a common learning experience and the expert groups take different approaches in analyzing or responding to the experiences, for example, by experimentation or other activities in Basic Science; finally, JCLS involves tests and assessment. The strategies were designed to last for 3 months.

2.7 | Summary of the JCLS program

Sessions/ weeks	Material	Topics	Instructional objectives	Activities	Instructional strategies
1 per 40 min		Introduction of research assistants and students	To establish rapport, explain the purpose, and state the guiding rules	The research assistant introduces themselves to the students with visual impairment and equally requested them to do the same.	Cognitive rapport and set induction

Sessions/ weeks	Material	Topics	Instructional objectives	Activities	Instructional strategies
2 per 40 min	Real objects (Braille), typewriter, relevant textbooks	Explanation of cooperative learning strategies (Jigsaw)	To explain cooperative learning strategies (Jigsaw) Discuss the benefits of cooperative learning strategies (Jigsaw)	They explained to them that Cooperative learning involves a situation where the students are organized in small groups of three; four, or five members to work jointly to achieve a given task or assignment to achieve a specific objective(s). The Jigsaw strategy on the other hand is where students are grouped from 2 to 5 per group and each member of a group is assigned some unique materials to learn. Different groups will get together to decide what is important and how to teach it. They explained the benefits of cooperative learning strategies. Performance Assessment	Explanation, questioning, demonstration, illustration, and examples.
3	3	Living things habitat	To explain habitat, mention at least three habitats of living things and discuss them.	The research assistant shares the selected braille copies of the tasks assigned to the visually impaired students. She presents the learning outcome and explains to the visually impaired students what they are expected to do. The research assistant then arranges them in groups each group sitting in circular form. The research assistant then distributes the assigned tasks thus. Group 1—Define habitats. Group 2—Mention three different habitats you know. Group 3—Say two organisms are	Explanation, questioning, set induction, and closure Questioning reinforcement and closure

(Continues)

Sessions/ weeks	Material	Topics	Instructional objectives	Activities	Instructional strategies
				found in different habitats. As the groups solve their problems, the research assistant goes around monitoring, supporting, and assisting the students in their group work. Performance Assessment	
4 Per 40 min	4	Changes in nonliving matter	Describe different ways nonliving matters change, identify the changes as temporary or permanent, and Finally state the causes of such changes.	Explains the topic and demonstrate how changes in nonliving matter occur, for example, changing from liquid to solid and from liquid to solid again and vice versa. Identify the types of changes and explains the difference between temporary and permanent changes using ice block and firewood. Allows the students to mention the causes of changes in nonliving matters.	Explanations, discussions, reinforcement, examples, questioning, and closure.
5	5	Simple machine (levers)	Define and give examples of a lever, state the three types of lever, mention classes of a lever and discuss them and identify levers according to their classes.	Writes the topic on the chalkboard and ask the students to read the same from their braille. Distributes the braille copies of the materials to the visually impaired students. The teacher asks the visually impaired students to define the lever, as they make efforts, she writes the important points on the chalkboard and encourages them. Defines lever as the simplest form of machine. A simple machine on the other hand is any instrument that makes our work easy. Asks the students to give examples of a lever. As they say it, the	Discussion, brainstorming, reinforcement, questioning, and closure.

Sessions/ weeks	Material	Topics	Instructional objectives	Activities	Instructional strategies
				Teacher writes it on the chalkboard thus pliers, scissors, spoons, and bottle openers. Gives more examples like a wheelbarrow, clips, blacksmith tongs, grinding machines, and broom among others.	

The TCLS program developed by the researchers, is also a set of lesson notes focused on starting to solve problems as a team, then with a partner, and finally on their own (individually). The focus of this strategy is solely designed to motivate the learners to tackle and succeed at problems that initially are beyond the student's ability (Mediated Learning). In this treatment TCLS, it involved three steps: students were first arranged in teams of five students each up to three teams and one team of four students, the second step was to pair the students to handle learning activities, and the last was to assign learning content to an individual to learn on his or her own.

2.8 | Summary Team Pair-Solo teaching strategy

Sessions/ weeks	Material	Topics	Instructional objectives	Activities	Instructional strategies
1 Per 40 min		Introduction of research assistants and students	To establish rapport, explain the purpose, and state the guiding rules	The research assistant introduces themselves and asks the learners with visual impairment to do the same.	Introduction and set-induction.
2 Per 40 min	Real objects (Braille), typewriter, relevant textbooks	Explanation of cooperative learning strategy (Team Pair-Solo)	To explain the cooperative learning strategy (Team Pair-Solo) Discuss the benefits of cooperative learning strategies (Team Pair-Solo)	Defines Team Pair-Solo strategy and the way it is being organized thus starting with a team of three to four learners, then pairing the learners, and finally, the learner handles a task as an individual. Mentions the benefits of Team Pair-Solo to students.	Explanation, demonstration, discussion, and reinforcement.

(Continues)

Sessions/ weeks	Material	Topics	Instructional objectives	Activities	Instructional strategies
3 Per 40 min	Real objects (Braille), typewriter	Living things habitat	To explain habitat, mention at least three habitats of living things and discuss them.	Asks students to mention different organisms they know and their habitat ie land, water, and arboreal explains specifically arboreal habitat to them.	Discussion, explanation, questioning, answers, and closure.
4 Per 40 min	Real objects (Braille), typewriter, relevant textbooks	Changes in nonliving matter	Describe different ways nonliving matters change, identify the changes as temporary or permanent, and finally state the causes of such changes.	Asks some questions such as how many of you have touched ice block before? What will happen to firewood after burning? Explain temporary and permanent changes. Explain to the students the changes in an ice block. Asks them to say the causes of changes in nonliving matters. Asks them to handle the tasks in their teams first, paired, and finally as individuals.	Set induction, questioning, explanation, experimenta-tion, examples, and closure.
5 Per 40 min	Real objects (Braille), typewriter, relevant textbooks	Simple machine (levers)	Define and give examples of a lever, state the three types of lever, mention classes of a lever and discuss them and identify levers according to their classes	Asks the following questions; say the simple instruments we use in our homes to ease our tasks. From their responses, the teacher introduces the topic and defines lever as the simplest form of machine. Displays simple machines such as openers, knives,	Set-induction explanation, discussion, and closure.

Sessions/ weeks	Material	Topics	Instructional objectives	Activities	Instructional strategies
				spoons, etc. for them to touch for they cannot see them due to their vision challenges. Share the tasks with the students in teams—1. Define and mention simple machines, state three parts of a lever and three classes of levers. As students brainstorm and discuss teacher monitors and reinforces them. After that, the teacher shares the above learning tasks by pairing the students which will be followed by individual tasks.	

2.9 | Data analysis

The data from Time 1 (before treatment), Time 2 (after treatment), and Time 3 (follow-up), were subjected to statistical analysis using SPSS Version 28. Specifically, repeated measures of analysis of variance were used for data analysis. Frequency, percentage, and χ^2 statistics were employed to describe the demographic characteristics of the recruited participants. The Sidak correction was used to correct for multiple comparisons in the post hoc analyses.

3 | RESULTS

Table 1 shows that no significant difference in terms of gender ($\chi^2 = 0.034$, $p = .983$), age ($\chi^2 = 1.704$, $p = .790$), religious affiliation ($\chi^2 = 2.855$, $p = .582$), ethnicity ($\chi^2 = 1.780$, $p = .939$), state of origin ($\chi^2 = 1.667$, $p = .948$), level of parents' education ($\chi^2 = 2.354$, $p = .671$), and family size ($\chi^2 = 4.548$, $p = .337$) was observed among the study participants.

Table 2 suggests that gender is not statistically significant in increasing school children with visual impairment interest in Basic Science, F (1, 50) = 0.335, $p = .566$, $\eta^2_p = 0.007$, and no significant groups × gender interaction effect, F (2, 50) = 0.018, $p = .983$, $\eta^2_p = 0.001$. The results also suggest a statistically significant effect of time on the interest of school children with visual impairment as measured with the LIRS, F (1.949, 97.433) = 730.697, $p < .001$,

$\eta^2_p = 0.936$. The results also indicate that LIRS scores as rated by school children were influenced significantly by group and time interaction effect, F (3.897, 97.433) = 16.099, $p < .001$, $\eta^2_p = 0.392$. The results also indicate that LIRS scores as rated by school children were not influenced by time, group, and gender interaction effects, F (3.897, 97.433) = 2.483, $p = .050$, $\eta^2_p = 0.090$. For the main effect, there was a significant effect of the treatment group in improving school children with visual impairment interest in Basic Science as measured by LIRS, F (2, 50) = 18.607, $p < .001$, $\eta^2_p = 0.427$.

In Table 3, Sidak's post hoc analysis by group shows that the students in the Jigsaw and Think pair Solo intervention groups had significantly improved LIRS compared to the control group (Mean difference = 1.2456, standard error = 0.69088, $p = .215$; Mean difference = −1.2456, standard error = 0.69088, $p = .215$).

The post hoc comparison of the interaction Effect of group × Gender × Time for the LIRS shows that there is no interaction Effect of group × Gender × Time as observed from the Jigsaw and Think pair Solo for male and female participants at Time 2 and sustained over time.

4 | DISCUSSION

The findings of this study revealed that there was a significant effect of the treatment group in improving the interest of school children with visual impairment in Basic Science. Gender is not statistically significant in increasing interest in Basic Science, and no significant groups and gender interaction effects. The results also suggest a statistically significant effect of time on the interest of school children with visual impairment. The results also indicated that LIRS scores as rated by school children were influenced significantly by group and time interaction effects. The results suggest that LIRS scores as rated by school children were not influenced by time, group, and gender interaction effects. This finding is in line with the findings of Bukunola and Idowu (2012) who posited that effective cooperative learning strategies promote interest and motivate students in learning tasks.

Similarly, this finding confirms the findings of Hung et al. (2014) which indicated that the Game-Based learning approach enhances students' interest and motivation in learning mathematics more than the traditional instructional model and conventional technology-enhanced model. From the discussion above, it can be concluded that the interest of students with visual impairment in Basic Science was enhanced by the use of JCLS and TCLS. The above findings have confirmed the earlier study (Njoku, 2002) which posited that, exposing students to learning strategies that are participatory and involving enhances the students' interest to learn and achieve better.

The finding further indicates that gender does not significantly influence the interest of students with visual impairment in Basic Science. Implying that there was no significant difference in interest between male and female students with visual impairment in Basic Science. In consonance with this finding, Obot (2011) in his study indicated that there is no significant difference between the interest of male and female learners in learning activities. However, this finding negates the finding of Opara whose findings revealed a significant effect of gender on secondary school learners' interest in qualitative chemistry analysis.

5 | CONCLUSION

From this study, it was concluded that:

There is no statistically significant group and gender interaction effect, and gender does not influence the interest in Basic Science among school children with visual impairment. The findings revealed that time has a statistically significant impact on how interested school children with visual impairment are. The findings also show that group and time interaction effects had a substantial impact on school children's evaluations of LIRS scores. The

TABLE 1 Demographic characteristics of the participants.

Characteristics	Jigsaw group, *n* (%)	Think pair solo group, *n* (%)	Control group	Statistic χ^2	Sig.
Gender					
Male	9 (47.4)	9 (47.4)	9 (50.0)	0.034	0.983
Female	10 (52.6)	10 (52.6)	9 (50.0)		
Age					
11 years and below	7 (36.8)	9 (47.4)	7 (38.9)	1.704	0.790
12–14 years	7 (36.8)	4 (21.1)	7 (38.9)		
15 years and above	5 (26.3)	6 (31.6)	4 (22.2)		
Religious affiliation					
Christianity	9 (47.4)	6 (31.6)	9 (50.0)	2.855	0.582
Islam	4 (21.0)	6 (31.6)	6 (33.3)		
Others	6 (31.6)	7 (36.8)	3 (16.7)		
Ethnicity					
Igbo	5 (26.3)	8 (42.1)	6 (33.3)	1.780	0. 939
Hausa	5 (26.3)	4 (21.1)	4 (22.2)		
Yoruba	5 (26.3)	5 (26.3)	4 (22.2)		
Others	4 (21.1)	2 (10.5)	4 (22.2)		
State					
Enugu	5 (26.3)	4 (21.1)	4 (22.2)	1.667	0.948
Imo	5 (26.3)	5 (26.3)	7 (36.9)		
Anambra	4 (21.1)	6 (31.6)	4 (22.2)		
Others	5 (26.3)	3 (16.7)	3 (16.7)		
Parents education					
Primary	8 (42.1)	5 (26.3)	5 (27.8)	2.354	0.671
Secondary	5 (26.3)	8 (42.1)	5 (27.8)		
Tertiary	6 (31.6)	6 (31.6)	8 (44.4)		
Family size					
5 and below	7 (36.8)	4 (21.1)	7 (38.9)	4.548	0.337
6–10	5 (26.3)	9 (47.4)	3 (16.7)		
11 and above	7 (36.8)	6 (31.6)	8 (44.4)		

Abbreviations: *n*, number of participant, Sig, associated probability.

findings also show that time, group, and gender interaction effects had little impact on school children's evaluations of LIRS scores. The intervention significantly increased the interest of school children with visual impairment in Basic Science, which was the main effect. All in all, the student's interests were significantly improved due to Jigsaw and Think pair Solo interventions.

TABLE 2 A repeated measure of analysis of variance for the effect of Jigsaw and Team Pair-Solo cooperative learning strategies on school children with visual impairment interest in Basic Science.

Source	Type III sum of squares	*df*	Mean square	*F*	*p*	η_p^2
Groups × Gender	0.480	2, 50	0.240	0.018	.983	0.001
Time × Groups	254.040	3.897, 97.433	65.183	16.099	<.001	0.392
Time × Gender	8.394	1.949, 97.433	4.308	1.064	.348	0.021
Time × Groups × Gender	39.174	3.897, 97.433	10.051	2.483	.050	0.090
Time	5765.145	1.949, 97.433	2958.507	730.697	<.001	0.936
Groups	506.247	2, 50	253.124	18.607	<.001	0.427
Gender	4.552	1, 50	4.552	0.335	.566	0.007

Abbreviations: *df*, degree of freedom, η_p^2, partial Eta squared (effect size).

TABLE 3 Post hoc of the effect of group.

(I) Groups	(J) Groups	Mean difference (I–J)	Std. error	Sig.	95% CI
Jigsaw	Think pair Solo	1.2456	0.69088	.215	−0.4611, 2.9523
	Control	4.1823[a]	0.70041	<.001	2.4520, 5.9125
Think pair Solo	Jigsaw	−1.2456	0.69088	.215	−2.9523, 0.4611
	Control	2.9366[a]	0.70041	<.001	1.2064, 4.6669
Control	Jigsaw	−4.1823[a]	0.70041	<.001	−5.9125, −2.4520
	Think pair Solo	−2.9366[a]	0.70041	<.001	−4.6669, −1.2064

Note: Based on observed means. The error term is mean square (error) = 4.535.

Abbreviation: CI, confidence interval.

[a]The mean difference is significant at the .05 level.

6 | EDUCATIONAL IMPLICATIONS

The results of this study provided empirical evidence of the effectiveness of Jigsaw and Team-Pair Solo strategies in raising the students' interest in Basic Science. Curriculum developers should adopt JCLS and TCLS in schools because of their inclusiveness in the learning process. It is activity-oriented, participatory, involving, and learner-centered; a process that can give room for all caliber of learners; visual impaired, hearing impaired, gifted learners as well as learners with normal vision, to develop more interest in their subject areas. JCLS and TCLS make it possible for students with visual impairment to be in charge of their own learning by being friendly, skillful decision-makers to mention but a few, their vision challenges notwithstanding. The roles of teachers in the classroom have been changed from a teacher-centered learning process to facilitating, monitoring, mentoring, and organizing in the classroom due to the efficacy of Jigsaw and Team-Pair solo. With both male and female students with visual impairment, interest can be raised significantly in Basic Science when JCLS and TCLS are used in the teaching and learning process. The strategies create equal opportunities for boys and girls.

6.1 | Strengths of this study

The study improved the interest of students with visual impairment, especially the blind who were faced with the challenges of observation, experimentation as well as the recording of information in the classroom during the teaching and learning process. The improvement was accomplished due to the use of JCLS and TCLS that have been proven to be effective for all types of learners including academically gifted and mainstream students. The author is also in support of the efficacy of JCLS and TCLS and maintains that the two strategies promote interest and foster respect and friendship among the diverse group of students.

The study has also raised the interest of students with visual impairment in studying Basic Science which the students previously, through an oral interview, confirmed that they do not have an interest in studying because of their visual challenges and the conventional-lecture strategy used by their teachers. According to Tsay and Brady (2010), JCLS and TCLS had broken down ethnic and physical or mental handicap barriers thereby giving room for positive interaction and friendship among students with visual impairment. Furthermore, the role of the teacher has changed from giving information to facilitating, monitoring and organizing, as well as supporting the learners to work as a team or group, discuss issues concerning their wellbeing, and take their own decisions to survive in a society where they belong and beyond.

This study raised the students with visual impairments' interest to the extent that the learners now believed that their efforts should result in participants striving for mutual benefits so that all group members succeed in Basic Science through the following ways: gain from each other's effort; recognize that group members share a common fact; and, know that one's performance is mutually caused by oneself and one's team members. This study has established that Jigsaw and Team Pair-Solo were effective and consistent across genders which allowed both male and female students to develop more interest in participating actively in Basic Science instructions in the classroom and beyond.

6.2 | Limitations

The general findings of this study were influenced by certain limitations:

JCLS and TCLS constantly change. There is a possibility that a teacher may become confused and lack a complete understanding of the strategies which might have resulted in the wrong use of the strategies by the teacher. We did not provide a factor analysis and comparison of the scales with others that tested the same construct. Therefore, this limitation might have affected the result of this study and by extension its generalizability.

JCLS and TCLS consume a lot of time and the time allotted to Basic Science in the school timetable may not be enough for the teacher to effectively adopt the Jigsaw Team Pair-Solo learning strategies. The teacher may always run short of time during teaching and learning and may not conclude his or her lessons effectively. This limitation, therefore, might have affected the result of this study and by extension its generalizability.

6.3 | Recommendations

Based on the findings, the following recommendations were made:

1. Teachers should always consider the interest of students with visual impairment when teaching and learning are ongoing. This is because research evidence indicated that interest is related to learning in different ways; for instance, interest increases motivation, engagement, and persistence in learning tasks.
2. Students with visual impairment should be encouraged to cooperate and interact among themselves for this will help to raise and sustain their interest in learning Basic Science and other subjects.

3. Schools should be encouraged to adopt JCLS and TCLS for their efficacy. These strategies manifest in learners with visual impairment by making it possible for them to be self-reliant, and decision-makers and to be able to face their day-to-day challenges in their immediate environment and beyond.

4 There is also a need for the provision of essential infrastructural facilities like Braille, the creation of an enabling environment, and other appropriate teaching aids. The above provisions can be possible with the assistance of the federal or state government as well as School Based Management Committee (SBMC) members.

CONFLICTS OF INTEREST STATEMENT

The authors declare no conflicts of interest.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ORCID

Chinedu I. Okeke https://orcid.org/0000-0002-9959-8019
Moses Onyemaechi Ede https://orcid.org/0000-0003-2022-985X

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How to cite this article: Nnamani, O., Hadebe-Ndlovu, B. N., Okeke, C. I., & Ede, M. O. (2023). Effect of Jigsaw and Team Pair-Solo cooperative learning strategies on interest in Basic Science of primary school children with visual impairment. *Psychology in the Schools*, 1–17. https://doi.org/10.1002/pits.22866