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Enhancing self-esteem of students with special needs in solving algebraic word problems using peer assessment

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Abstract

Understanding self-esteem among students with special needs (SSNs) is essential for identifying factors contributing to learning gaps and designing effective interventions. This study examined the impact of a learner-centered approach—peer assessment strategy (PAS)—on the self-esteem of SSNs in solving algebraic word problems. Quasi-experimental design was adopted. The sample comprised 22 SSNs in upper basic one, drawn from a population of 77 students across six special secondary schools. Data were collected using a questionnaire with a reliability coefficient of 0.77 (Cronbach's alpha). Descriptive statistics (mean and standard deviation) addressed the research questions, while analysis of covariance tested the null hypotheses. Findings revealed significant difference in mean self-esteem ratings between students taught algebra using PAS and those taught with conventional assessment strategies (CAS). However, no significant gender difference was observed in mean self-esteem ratings among SSNs taught algebra using PAS. Hence, PAS is more effective than CAS in enhancing SSNs' self-esteem in algebra.

Keywords: peer assessment strategy, self-esteem, academic performance, algebra, special needs students

INTRODUCTION

Algebraic word problems require both conceptual understanding and encourages collaboration in addressing its problems. Areas such as algebra in mathematics provide powerful tools for modelling and solving problems across diverse contexts, including data analysis, budgeting, and decision-making. In solving algebraic word problems, there is need for teachers to use learner-centered pedagogies that can encourage students to enthusiastically interact with each other, share knowledge and in the process develop self-esteem. Self-esteem is a critical factor influencing students' academic motivation, engagement, and achievement, a positive self-esteem serves as a buffer against the negative effects of stigma, labelling, and low expectations. Conversely, students with low esteem can be encouraged and motivated to learn by fostering self-confidence and engaging them in interactive, collaborative learning strategies (Keziah et al., 2023).

Students can be motivated to learn and show confidence in solving mathematical problems when a learning strategy that can boost their self-esteem such as peer assessment strategy (PAS) is used. PAS, an activity-based and cooperative learning approach, has the potential to foster confidence, self-esteem, motivation, and engagement. This strategy entails students interacting and learning from each other. PAS involves students evaluating each other's work through structured assessment forms designed by teachers, with clear objectives aligned to the learning content (Topping, 2021). It's unfortunate that most mathematics teachers use conventional assessment strategy (CAS) in teaching and assessing their students, where the teacher assesses the students without allowing interaction between the students or allowing the students to assess themselves.

In recent years, the education of students with special needs (SSNs) has undergone significant transformation, with emphases being on inclusive education and individualized support. These students go through

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Contribution to the literature

- The study improves algebraic problem-solving skills through interactive, and collaborative strategy. It presents support strategies for students with special needs in mathematics classroom.
- The study gives insights on the role of peer assessment in enabling self-esteem of students with special needs.
- This study provides empirical findings that promote student-centered learning.

special needs education, which is a customized program that addresses the unique learning requirements of individuals who may not benefit fully from the general education system. The classification of SSNs is in three broad categories:

(1) learners with physical and sensory impairments,

(2) at-risk children and youth, and

(3) gifted and talented learners (Aligba & Nyihemba, 2022).

The first category is made up of learners who are visually impaired, hearing impaired, physically challenged, or living with chronic health conditions such as asthma and sickle cell anemia. This study focuses on students who are deaf and mute, and who rely on sign language for learning. Despite efforts towards inclusive learning, SSNs often face significant barriers in solving word problems, experience low self-esteem in mathematics classrooms, and this limits their participation and affects their achievement. Many SSNs struggle with mathematics, particularly algebraic word problems, experiencing difficulties in mastering and retaining arithmetic operations and algebraic skills, as well as in applying these skills to real-life situations. This academic struggle frequently undermines their self-esteem.

Students struggle can be largely attributed to educators' reliance on teacher-centered methods rather than learner-centered approaches which can boost self-esteem. The PAS is a learner-centered assessment strategy where students learn from each other, it has the potential to enhance students' understanding of mathematical concepts and fosters self-esteem (Sinusoid, 2022). In this light, McGuire (2024) emphasized that elements of mathematics competence, identity, and self-esteem are often formed in classroom practices of inclusive learning using learner-centered strategies. This emphasizes the need for an inclusive learning environment that can enable self-esteem of SSNs.

Recent international research on inclusive mathematics education and its role in social-emotional learning such as self-esteem emphasize the use of learner-centered pedagogy to enable students interact, and engage, during learning. Siregar et al. (2022) opines that using strategies that are interactive, in learning mathematics can boost student's self-esteem and problem-solving confidence. It is crucial to help students overcome difficulties in solving word problems by using innovative teaching and assessment strategies that enhance their self-esteem. Wani (2021) supports the discussion on the use of interaction in learning; by emphasizing the need for collaboration in learning mathematics, this motivates the students to learn and enthusiastically apply mathematics reasoning in real-world problem-solving. This is in line with Singh and Jethwani (2023) they emphasized that students who are anxious about mathematics lose confidence and self-esteem when addressing problems with numbers, hence, the need for an interactive, mathematics class.

This study makes a distinct and valuable contribution to literature in the educational field of inclusive mathematics education by addressing both cognitive and affective dimensions of learning for SSNs. Most studies focus on achievement, but its unique focus on self-esteem is a key predictor of persistence and motivation. The use of PAS here is innovative, as it shifts focus from teacher-centered teaching to learner-centered learning. This study provides empirical evidence on how students can learn from each other and the students' reflections on how self-esteem influences their ability to learn. It expands scholarship by demonstrating that the intervention for SSNs should not only target achievement, but other aspects such as the student's affective domain areas, hence, addressing a critical gap in the literature and offering practical, evidence-based strategies for inclusive education.

Statement of the Problem

Despite the importance of algebra and the need for students to have self-esteem while solving mathematics, many SSNs find algebraic word problems particularly challenging. They often struggle with low self-esteem and reduced motivation, which paralyze their active engagement with mathematics. Low self-esteem, compounded by repeated academic failure and social stigma, hinders their ability to learn algebra effectively and to apply it in solving real-world problems. A great gap exists in leveraging PAS to enhance self-esteem of SSNs in the context of algebraic solving word problems. Existing studies on mathematics interventions focus largely on mathematics skills, neglecting the affective domains such as self-esteem. Targeted interventions should address both cognitive and affective domains in an inclusive learning environment. A few studies explore learner-centered learning strategies such as PAS.

Reports from the Benue State Basic Education Certification Examinations (2017-2024) indicate consistently low performance in mathematics, with average scores ranging between 40-55% in algebra for SSNs. Persistent struggles with algebraic instruction among SSNs not only widen learning gaps but also diminish their opportunities for post-secondary education and career advancement in STEM-related areas.

Significance of the Study

This study seeks to investigate the effect of peer assessment on the self-esteem of SSNs in learning algebraic word problems.

Research on self-esteem in SSNs in algebra provides valuable insights into teacher preparation programs by equipping educators with the knowledge, skills, and strategies necessary to support students' social-emotional development and enhance learning outcomes. This study can also inform policymakers and educational stakeholders in designing initiatives aimed at improving student performance, reducing achievement gaps, and promoting the overall well-being of SSNs. Additionally, the findings can guide educators in adopting and adapting instructional strategies, such as the PAS, to support both the academic and social-emotional growth of SSNs.

Purpose of the Study

The primary purpose of this study was to investigate the effectiveness of PAS in enhancing the self-esteem of SSNs in the learning of algebra in Benue State. Specifically, the study sought to

(1) examine the effect of PAS compared to CAS on the self-esteem of SSNs in the learning of algebra and

(2) determine whether there is a difference in self-esteem in the learning of algebra between male and female SSNs when PAS is used.

The study answered the following research questions (RQs):

RQ1. Is there a difference between PAS and CAS in the mean self-esteem ratings of SSNs in algebra?

RQ2. Is there a difference in mean self-esteem ratings in the learning of algebra between male and female SSNs when PAS is used?

The following null hypotheses (Hs) were formulated and tested at the 0.05 level of significance:

H01. There is no significant difference between the mean self-esteem ratings of SSNs taught algebra using PAS and those taught using CAS.

H02. There is no significant difference in mean self-esteem ratings between male and female SSNs when PAS is used in learning algebra.

LITERATURE REVIEW

Education is a fundamental right of every child, and governments are obliged to ensure equal access for all learners (Oyundoyin & Oyefeso, 2019). To achieve meaningful inclusion, stakeholders must ensure that schools are equipped with facilities and resources that accommodate SSNs. Special education, therefore, is not merely about integration but about promoting self-realization, self-development, and societal participation for students with exceptionalities (Abaver et al., 2024).

National Policy on Special Needs Education in Nigeria (2015) outlines objectives aimed at addressing the physical, mental, and emotional needs of children with disabilities in diverse settings, including schools, homes, and hospitals. These objectives promote interaction, inclusion in mainstream classrooms, and equal learning opportunities. For students with physical or cognitive challenges, such initiatives are central to building positive self-esteem and enabling them to succeed in mathematics. Specifically, mastering algebraic word problems has the potential to boost learners' competence and confidence, thereby strengthening their ability to solve real-life problems.

Singh and Jethwani (2023) explains that self-esteem has been widely recognized as a critical determinant of learners' motivation. Research indicates that students with higher self-esteem are better equipped with coping skills, confidence, and feelings of worthiness. This implies that low self-esteem often leads to disengagement and poor achievement (Singh & Jethwani 2023). Studies in Nigeria further highlight that both special and mainstream schools use the same mathematics curriculum and participate in the same examinations, yet SSNs often remain disadvantaged due to inadequate facilities and insufficiently trained teachers (Fakolade & Bamidele, 2017). This underscores the need for learner-centered, interactive, and collaborative instructional approaches that embrace diversity and promote inclusion.

Mathematics is intended to be inclusive, not reserved for the academically gifted or those without disabilities (Sabaruddin et al., 2020). Strategies that foster peer collaboration have been found to enhance both learning outcomes and self-esteem. For instance, Adene et al. (2021) study examined effectiveness of peer collaborative learning strategy on the self-esteem of pupils with behavior problems. Quasi-experimental research design was adopted for the study, with participants who exhibited oppositional defiant disorder (ODD) from the basic five classes drawn from four schools. This study demonstrated that peer-based learning strategies improved the self-esteem of pupils

with behavioral challenges. In this context, PAS emerges as a promising approach.

It was discovered that the effect of peer learning by collaboration strategy was significant on the self-esteem of pupils with behavior problems. However, gender had no significant influence on the self-esteem of pupils with ODD. In contrast to the similarity of Adene et al. (2021) study in examining the self-esteem of pupils using a collaborative learning strategy, the present study uses PAS strategy in learning algebraic word problems where students learn and assess each other, enabling collaborative, interactive learning, and assessment. The present study also uses SSNs such as hearing impaired, the speech impaired, and the handicapped instead of students without physical disability, nor ODD; who can be debated upon to be or not be a category of SSNs.

Empirical evidence suggests that PAS promotes inclusiveness, interaction, and cooperation. Kumar et al. (2023) report that PAS enhances collaboration, enabling weaker students to learn from stronger peers, which improves both mathematical ability and self-esteem. Similarly, Meskauskiene and Guoba (2016) found that PAS motivates students by strengthening their confidence and eagerness to learn. Omar et al. (2018) further highlight that PAS influences not only cognition and metacognition but also affective, social, and transferable skills. Senousy (2020) investigated peer assessment interactive and effective measures. A quasi-experimental research design was used in the study, using an implementation guide, checklists, and evaluation of performance as instruments, which were modified to meet the criteria for each topic. Hs were tested using the mean (M), standard deviation (SD), and t-value of the students' scores for the GSWG for the experimental and control groups. Data analysis revealed that an interactive PAS was effective in improving individual skills, teamwork skills, and practical performance Senousy (2020) supports these findings, recommending PAS as an effective strategy to enhance academic skills and curriculum understanding, though in contrast, it does not examine the self-esteem of SSNs, and its tasks are not in the learning of algebra.

In addition to academic benefits, PAS cultivates lifelong and transferable skills such as critical thinking, analytical reasoning, and logical evaluation of peer work (Mohammed, 2022). For SSNs, this approach may be particularly valuable in building both competence and self-esteem in learning algebraic word problems. Collectively, the literature indicates that peer assessment, when effectively implemented, can foster learner-centered, classrooms that support inclusion and empower SSNs to achieve academically and socially.

Effects of Peer Assessment Strategies on Students' Self-Esteem

Adediwura (2015) investigated the impact of PAS on students' mathematical retention and attitudes toward mathematics learning. The research instruments collected information about students' study habit, mathematics self-efficacy, information on students' attitude towards self- and peer-assessment, it used descriptive statistics, z-test, chi-square, and t-test statistics to analyze the data collected. This study does not address self-esteem of SSNs, learning of algebra, nor does it use analysis of covariance (ANCOVA) in its analysis to determine the effect of the use of PAS. The study established a significant positive relationship between peer assessment practices and students' retention ability, as well as a notable improvement in their attitudes toward learning mathematics. The present study in contrast to students' retention ability will focus on self-esteem and how the use of PAS enhances it.

In a related study, Fakolade and Bamidele (2017) examined self-esteem and peer influence as predictors of learning outcomes in mathematics among high-ability students in Ibadan, Oyo State, Nigeria. Their findings revealed a strong positive relationship between students' mathematics performance and their levels of self-esteem, suggesting that academic outcomes enhance self-esteem. This finding does not address the self-esteem of SSNs in the learning of algebra using PAS, rather it examines self-esteem and peer influence as a predictor of learning outcomes without presenting an intervention such as PAS with scores to justify the academic outcomes.

Similarly, Madaber and Far (2017) explored the effects of cooperative learning on students' self-esteem across five subjects religious life, social studies, English, science, and mathematics. Their results indicated that cooperative learning significantly enhanced students' self-esteem, with a marked difference observed between groups exposed to cooperative learning strategies and those that were not. Though this study presents cooperative learning, and self-esteem, it does not address the issue of SSNs self-esteem when taught algebra using PAS as set out by the present research.

Expanding this perspective, Adene et al. (2021) investigated the effectiveness of peer collaborative learning strategies on the self-esteem of pupils with behavioral problems in Nsukka, Nigeria. The study reported significant gains in self-esteem among pupils exposed to peer collaboration, although gender differences were found to have no significant influence on the outcomes of students with ODD. This study has similarities with the present study in terms of a collaborative learning strategy effect on self-esteem of students, but it does not use PAS which is also an assessment strategy on SSNs.

In another context, Siregar et al. (2022) examined ways of improving students' self-esteem in learning mathematics through realistic mathematics education in Indonesia. Motivated by persistently low levels of self-esteem among students, the study confirmed that self-esteem can be significantly improved through engaging, context-based mathematics learning approaches, which in turn enhanced students' learning experiences and outcomes. Algebraic word problems can be considered engaging like other mathematics concepts and there is need to use learning strategies such as PAS in improving the self-esteem of students as they engage in its tasks. In contrast to the study, the present study addressed SSNs self-esteem when taught algebra using PAS.

Collectively, these studies demonstrate that peer assessment and other collaborative or learner-centered strategies can positively influence students' self-esteem, which serves as a foundation for improved academic engagement, attitudes, and performance in mathematics.

Interaction of Strategies and Gender in Self-Esteem

For many years, mathematics has been traditionally regarded as a male-dominated subject because of its technical, creative, and analytical nature. Research has yet to provide explicit clarity on whether males are more confident in their mathematical ability than females, partly due to lower anxiety levels. This confidence gap may be more pronounced in mathematical tasks that require advanced reasoning skills (Wang, 2020, as cited in McMurran et al., 2023). Consequently, mathematics self-esteem varies across different contexts, including gender, and students' physical or cognitive abilities. Contini et al. (2017) highlight non-cognitive abilities such as self-esteem and motivation are crucial predictors of academic and life success. From this perspective, females' relatively lower self-esteem in mathematics could contribute to their weaker performance in STEM fields, influencing future educational and occupational outcomes.

Empirical evidence supports these claims. Warner and Budd (2018) found a significant main effect of gender in their study of peer-to-peer coaching, with females reporting lower self-esteem than males, regardless of training. However, other studies suggest that learner-centered approaches can minimize such differences. For example, Ajogbeje and Aladesaye (2020) reported no significant difference in the self-esteem of male and female students, while Smitter (2018) as cited in Obilor and Adegbeye (2021) argued that PAS can equip students with the skills to self-assess and improve flexibility in the learning environment, particularly for SSNs.

Additional studies also provide mixed results. Adediwura (2015) found that self-assessment strategies and PAS enhanced students' self-efficacy and learner autonomy in mathematics, though gender had no significant effect on self-efficacy. Interestingly, gender did influence learner autonomy, but attitudes toward mathematics improved regardless of gender. Similarly, Seroussai et al. (2023) reported no significant gender differences in students' willingness to provide peer feedback, indicating that males and females demonstrated homogeneous behaviors in self-esteem when engaged in peer learning. In contrast, McMurran et al. (2023) established a significant interaction between gender and problem difficulty, with males exhibiting higher confidence in solving complex mathematics problems than females.

Taken together, the literature reveals mixed findings: while some studies show gender-related differences in mathematics self-esteem, others suggest parity when interactive, learner-centered strategies are employed. This study therefore investigates whether PAS can improve the self-esteem of male and female SSNs in Benue State when solving algebraic word problems.

Theoretical Framework

This study is underpinned by Vygotsky's (1978) sociocultural theory of cognitive development, and Branden's (1969) psychology of self-esteem. These theories collectively support a shift from teacher-centered to learner-centered approaches, which aligns with the use of PAS as a collaborative, activity-based teaching and learning approach. In contrast, CAS is teacher-centered and does not foster peer interaction or collaborative learning.

Vygotsky's (1978) social constructivist theory emphasizes the role of social interaction and mediated learning in cognitive development. Central to this theory is the concept of the zone of proximal development, which refers to the gap between what learners can achieve independently and what they can achieve with guidance. This framework is relevant to the present study as it highlights how instructional support, and collaborative engagement can enhance SSNs self-esteem when PAS is used in learning algebra.

Vygotsky's (1978) sociocultural theory emphasizes that learning occurs through interaction, collaboration, and cooperative learning and assessing of each other's work, particularly when learners engage with peers who possess greater skills in each area. Applied to this study, SSNs (physically challenged) can successfully perform algebraic tasks by interacting with and assessing each other. In practice, students pair up to exchange notebooks and assess their peers' work using a structured PAS assessment format. This process allows learners to check problem-solving steps, score work, and provide constructive feedback. Through such interactions, learners are actively engaged in their learning, enhancing competence, understanding, and self-esteem.

Branden's (1969) psychology of self-esteem frames self-esteem as the sense of personal worthiness and confidence in one's ability to perform specific tasks. In the context of this study, self-esteem enables students with physical challenges to verify their understanding and capabilities through peer interaction. By participating actively in peer assessment—a learner-centered, activity-based learning and assessment strategy—students not only engage with algebraic concepts but also build confidence in their ability to solve problems.

These three theories collectively suggest that the academic performance and self-esteem of SSNs can be enhanced through PAS. Teacher guidance, coupled with structured peer assessment, can help SSNs overcome difficulties in mathematics, particularly in solving algebraic word problems, while promoting their psychological well-being. For SSNs, low self-esteem often arises from frustration, anxiety, and perceived limitations in interacting with the world. PAS provides a supportive learning environment that fosters confidence, competence, and active participation.

Given the centrality of self-esteem to academic engagement, decision-making, and goal setting, it is worthwhile to investigate how PAS can reinforce the self-esteem of SSNs in learning algebra in Benue State.

MATERIALS AND METHODS

This study adopted quasi-experimental design, a non-equivalent pre- and post-test control. This design was appropriate because the schools did not allow disruption of their schedules or reorganization of classes during the study; hence, intact classes were used. According to Emaikwu (2015), the non-equivalent control group design is suitable for identifying causal effects in educational interventions. This design enabled the researcher to determine the effect of a PAS on the self-esteem of SSNs in algebra.

Population and Sampling

The population of the study comprised 77 upper-basic one student with special needs from six special secondary schools in Benue State during the 2024/2025 academic session. The sample consisted of 22 students (15 males and 7 females) from two intact classes. A sample size < 30 is small, while n = 22 is small, it is due to the population constraints in special education schools. Such students present a heterogeneous subgroup, and accessing large samples of SSNs is difficult to obtain (Praharaj & Amen, 2024). In some critical cases, many studies in special education involve single-case designs or small-group interventions and little population sizes, hence for high quality special education research involving interventions, small sample sizes can be used.

A multi-stage sampling procedure was employed to select the sample. Stratified random sampling was first used to divide the population into two strata to ensure each subgroup (urban and rural) are represented in the sample, to ensured balance in the representation, precision and control of the population for reliable results. In the second stage, simple random sampling was used to select from each stratum. One school was selected each from the two strata.

In each of the two schools, a junior high class, two intact classes were used. The research was conducted in intact classes with students of similar performance levels and cognitive ability. This was because there is only one upper-basic one in each of the special education schools. In the third stage, a simple random sampling technique of the 'bucket and draw' method without a replacement technique was used. The researcher wrote out the names of the two sampled schools on paper, folded them, and dropped them in a bucket. The first school drawn without replacement was randomly assigned to the experimental group (taught and assessed using PAS), while the one remaining in the bucket was drawn and recorded as the control group (CAS).

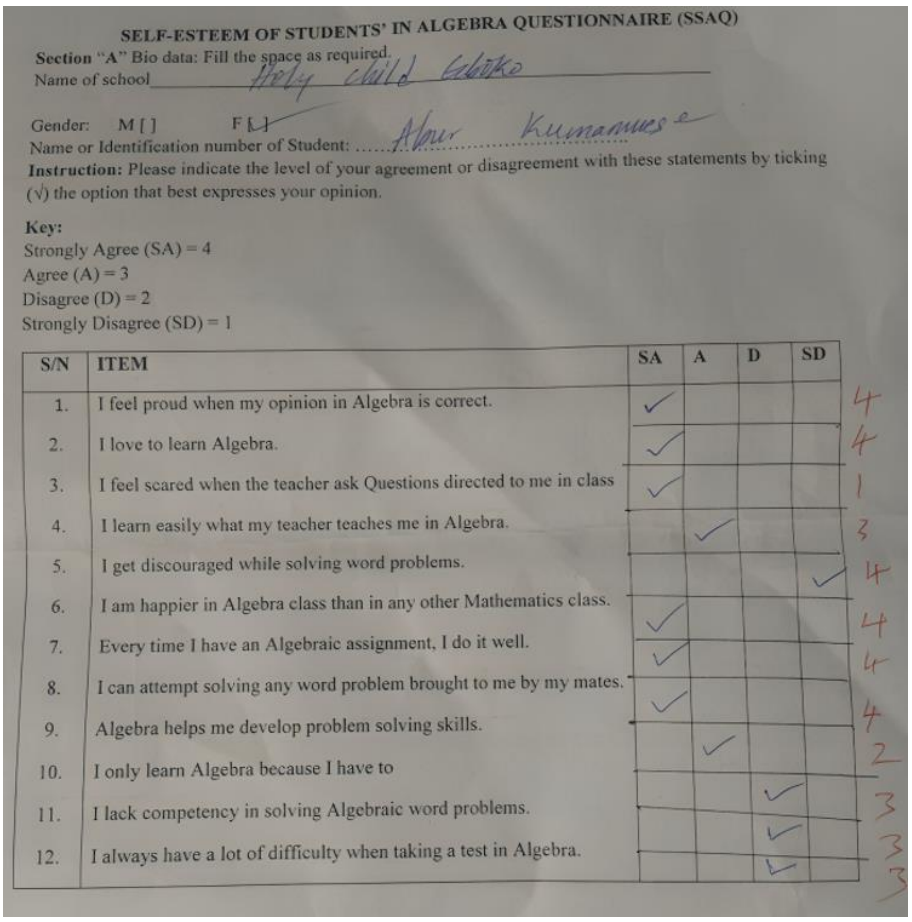
Upper-basic one students were chosen because this is the first secondary school level where algebraic word problems are introduced, providing the foundation for conceptual understanding, interpretation, and problem-solving in algebra. The participants used in the research are those with hearing impairment, who rely on sign language for learning, and those with speech impairment.

Instrumentation

The self-esteem of students in algebra questionnaire (SSAQ) was used to measure students' self-esteem (**Appendix A** and **Appendix B**). It was validated by three experts in mathematics education from Benue State University. To ensure the content validity of SSAQ, experts' advice was required in terms of scope of coverage, language level appropriate for the students' clarity, ambiguity, and vagueness of expression, as well as the suitability of items for the upper-basic one algebraic word problem topics specified. SSAQ is a four-point Likert scale questionnaire consisting of 12 items: 7 positively worded (items 1, 2, 4, 6, 7, 8, and 9) and 5 negatively worded (items 3, 5, 10, 11, and 12)), which requires SSNs to choose between strongly agree (4), agree (3), disagree (2), and strongly disagree (1) options.

Validity and Reliability

The study adopted quasi-experimental design it compared two groups: experimental (students taught using PAS) and control groups (students taught using CAS), external variables such as prior differences between the schools was controlled by using the same class; upper-basic one, and use of ANCOVA to control



SELF-ESTEEM OF STUDENTS' IN ALGEBRA QUESTIONNAIRE (SSAQ)

Section "A" Bio data: Fill the space as required.
Name of school Holy Child Eclotko

Gender: M [ ] F [✓]
Name or Identification number of Student: Abur Kumanuse

Instruction: Please indicate the level of your agreement or disagreement with these statements by ticking (√) the option that best expresses your opinion.

Key:
Strongly Agree (SA) = 4
Agree (A) = 3
Disagree (D) = 2
Strongly Disagree (SD) = 1

S/N	ITEM	SA	A	D	SD	
1.	I feel proud when my opinion in Algebra is correct.	✓				4
2.	I love to learn Algebra.	✓				4
3.	I feel scared when the teacher ask Questions directed to me in class	✓				1
4.	I learn easily what my teacher teaches me in Algebra.		✓			3
5.	I get discouraged while solving word problems.				✓	4
6.	I am happier in Algebra class than in any other Mathematics class.	✓				4
7.	Every time I have an Algebraic assignment, I do it well.	✓				4
8.	I can attempt solving any word problem brought to me by my mates.	✓				4
9.	Algebra helps me develop problem solving skills.		✓			2
10.	I only learn Algebra because I have to			✓		3
11.	I lack competency in solving Algebraic word problems.			✓		3
12.	I always have a lot of difficulty when taking a test in Algebra.			✓		3

Figure 1. SSAQ example-1 (Source: Field study)

pre-existing differences while testing the intervention effect using post-test scores. Teacher quality was also controlled by provision of training on PAS to minimize teacher effects. And ensure that the teachers have at least two years of teaching experience.

Other extraneous variables, such as group interaction effects and initial differences due to intact class selection, were controlled using distant locations and homogeneity tests. Both pre- and post-test administrations were conducted under standard examination conditions.

Cronbach's alpha was employed to assess the reliability of the instrument, yielding a coefficient of 0.77, since the sample size is small, the value of $\alpha \geq 60.0$, with 0.77 this indicates acceptable internal consistency (Emaikwu, 2015). This demonstrates that the instrument reliably measures the same characteristics across its items.

Data Collection

The questionnaire was administered as a pre-test to determine students' self-esteem in the learning of algebra before treatment. The PAS intervention was then conducted over a six-week period. At the end of the sixth week, the questionnaire was re-administered as a post-test to assess changes in self-esteem. During the peer assessment sessions, students paired up to assess each other's classwork using the educator's structured PAS assessment format, checking steps in problem-solving and providing scores and feedback. **Figure 1** and **Figure 2** shows the evidence of fieldwork data collected from participants.

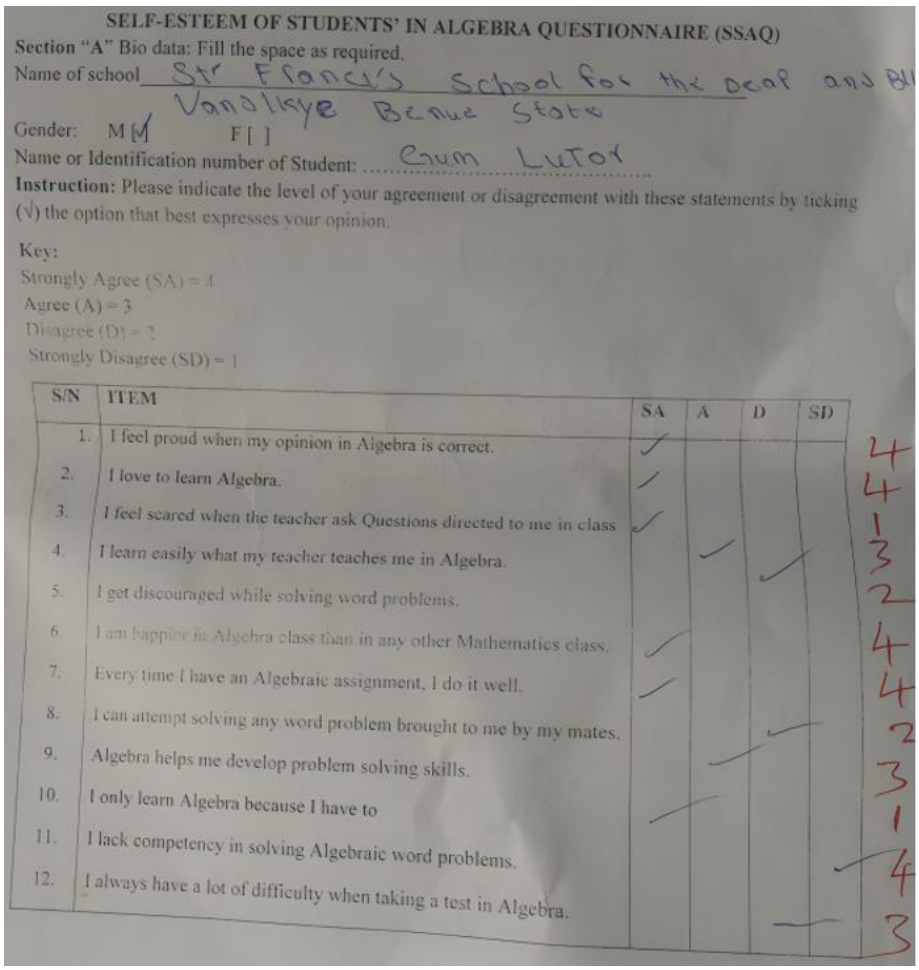
Data Analysis

Data were analyzed using the statistical package for the social sciences version 26. Data were analyzed using M and SD to answer the RQs. Hs were tested at the 0.05 level of significance using ANCOVA, which is appropriate for comparing means of intact classes in quasi-experimental designs while controlling for initial differences.

The assumptions for ANCOVA randomness of selection, homogeneity of variance, normality of distribution, measurement at interval scale, and independence of samples were satisfied, ensuring the robustness of the statistical analysis.

Ethical Considerations

Ethical standards were strictly observed throughout the study. Institutional approval was obtained from participating schools before data collection. Informed consent was secured from the school authorities on behalf of the participants, and confidentiality was maintained by anonymizing the names of the students



SELF-ESTEEM OF STUDENTS' IN ALGEBRA QUESTIONNAIRE (SSAQ)

Section "A" Bio data: Fill the space as required.

Name of school St Francis School for the Deaf and Bl Vandikya Benue State

Gender: M [✓] F [ ]

Name or Identification number of Student: Esum Luter

Instruction: Please indicate the level of your agreement or disagreement with these statements by ticking (√) the option that best expresses your opinion.

Key:

Strongly Agree (SA) = 4

Agree (A) = 3

Disagree (D) = 2

Strongly Disagree (SD) = 1

S/N	ITEM	SA	A	D	SD	
1.	I feel proud when my opinion in Algebra is correct.	✓				4
2.	I love to learn Algebra.	✓				4
3.	I feel scared when the teacher ask Questions directed to me in class	✓				1
4.	I learn easily what my teacher teaches me in Algebra.		✓			3
5.	I get discouraged while solving word problems.			✓		2
6.	I am happier in Algebra class than in any other Mathematics class.	✓				4
7.	Every time I have an Algebraic assignment, I do it well.	✓				4
8.	I can attempt solving any word problem brought to me by my mates.			✓		2
9.	Algebra helps me develop problem solving skills.		✓			3
10.	I only learn Algebra because I have to	✓				1
11.	I lack competency in solving Algebraic word problems.				✓	4
12.	I always have a lot of difficulty when taking a test in Algebra.			✓		3

Figure 2. SSAQ example-2 (Source: Field study)

Table 1. Descriptive statistics for self-esteem ratings of students with special needs taught algebra using PAS and CAS

Group	N	Pre-SSAQ mean	Pre-SSAQ SD	Post-SSAQ mean	Post-SSAQ SD	Mean gain
PAS	17	2.35	0.77	3.23	0.41	0.88
CAS	5	2.15	0.16	2.62	0.42	0.47
M/SD difference		0.20	0.61	0.61	0.01	0.41

Note. N: Number of participants

participants were assured that their responses would be used solely for academic purposes and would not affect their professional or academic standing.

In place of an approval from an ethical committee, a letter of permission and letter of introduction were given to the researcher by her institution (Benue State University, Makurdi) to carry out this research. this research came from the researchers PhD thesis work.

RESULTS

RQ1. Is There a Difference Between PAS and CAS on Mean Self-Esteem Ratings in the Learning of Algebra for SSNs?

Data **Table 1** shows the results of students taught algebra using PAS and those taught using CAS pre-test self-esteem ratings, with Ms of 2.35 and 2.15, and SDs of 0.77 and 0.16, respectively. However, after the intervention, students in the PAS group had a post-test mean of 3.23 (SD = 0.41), compared to 2.62 (SD = 0.42) for the CAS group.

The mean gain in self-esteem was 0.88 for students taught using PAS, while the CAS group had a mean gain of only 0.47, this gives a difference in mean gain of 0.41, this indicates that PAS is more effective in improving self-esteem The difference in mean gains (0.41) indicates that students in the PAS group experienced a substantially higher increase in self-esteem compared to the CAS group.

Although the PAS group had a slightly lower SD (0.41) in the post-test compared to the CAS group (0.42), this small difference (0.01) suggests that variability in self-esteem gains was slightly higher in the CAS group. Overall, the data indicate that the PAS is more effective than CAS in enhancing self-esteem among SSNs in the learning of algebra.

Table 2. M and SD of self-esteem ratings of male and female students with special needs taught algebra using PAS

Group	Gender	N	Pre-SSAQ mean	Pre-SSAQ SD	Post-SSAQ mean	Post-SSAQ SD	Mean gain
PAS	Male	10	2.20	0.77	3.31	0.46	1.01
	Female	7	2.56	0.77	3.25	0.37	0.69
Mean difference			0.36	0.00	0.06	0.09	0.32

Note. N: Number of participants

Table 3. Summary of ANCOVA results of post-self-esteem ratings in algebra word problems for SSNs taught using PAS and CAS

Source	Type III sum of squares	df	Mean square	F	Significance	Partial eta squared
Corrected model	2.467[a]	2	1.233	9.990	0.001	0.513
Intercept	8.032	1	8.032	65.058	0.000	0.774
SE-PRE	1.034	1	1.034	8.380	0.009	0.306
Strategy	1.125	1	1.125	9.109	0.007	0.324
Error	2.346	19	0.123			
Total	214.479	22				
Corrected total	4.812	21				

RQ2. Is There a Difference in Mean Self-Esteem Ratings in Algebra Between Male and Female SSNs When PAS Is Used?

Data in **Table 2** shows that male SSNs had pre-test self-esteem ratings of 2.20 (SD = 0.77), while female students had ratings of 2.56 (SD = 0.77). After the intervention, the post-test mean self-esteem ratings were 3.31 (SD = 0.46) for males and 3.25 (SD = 0.37) for females. This result indicates that both males and females showed improvement in self-esteem from pre- to post-test.

The mean gain in self-esteem was 1.01 for males and 0.69 for females, indicating a mean gain difference of 0.32 in favor of male students. This suggests that PAS had a slightly greater impact on the self-esteem of male students, likely due to their higher engagement and interaction during peer assessment activities. This difference can be due to the small and unequal sample sizes (10 males, 7 females). With small sample size, the use of non-parametric tests (Mann-Whitney U and qualitative insights using interviews to understand males and females experience using PAS) would have given a better comparison of mean gains. Furthermore, females had a higher pre-test M (2.56) than males (2.20), this might have lest less room for improvement, the factor of how females and males engage in mathematics learning also affect their self-esteem.

Regarding variability, the female group demonstrated homogeneous self-esteem ratings with SDs of 0.77 (pre-test) and 0.37 (post-test). In contrast, male students exhibited higher variability, with SDs of 0.77 (pre-test) and 0.46 (post-test). The post-test SD difference between males and females was 0.09, indicating that male students' self-esteem ratings were more varied compared to females. Overall, these results indicate that while PAS positively influenced the self-esteem of both male and female students, male students experienced a slightly greater gain, though with more variability in their ratings.

H01. There Is No Significant Difference Between the Mean Self-Esteem Ratings of SSNs Taught Algebra Using PAS and CAS

The ANCOVA results in **Table 3** shows that the effect of teaching strategy on the post-test self-esteem ratings of SSNs was statistically significant, $F(1, 19) = 9.109$, $p = 0.007 < 0.05$. This indicates that the null H is rejected. In other words, there is a significant difference in the self-esteem of SSNs taught algebra using PAS compared to those taught using CAS. The results suggest that PAS has a positive effect on enhancing self-esteem in algebra among SSNs. Partial eta squared value of 0.324 indicates that approximately 32% of the variance in students' self-esteem ratings can be attributed to the teaching strategy employed. This highlights the practical importance of adopting PAS in teaching algebra to SSNs, as it contributes meaningfully to improving their self-esteem.

H02: There Is No Significant Difference in Mean Self-Esteem Ratings Between Male and Female SSNs When a PAS Is Used in Learning Algebra

The ANCOVA results in **Table 4** shows that $F(1, 14) = 0.298$, $p = 0.594 > 0.05$, indicating that the probability level is greater than the alpha level of 0.05. Therefore, the null H is not rejected. This implies that there is no significant difference in the self-esteem ratings of male and female SSNs when PAS is used in algebra word problems. The partial Eta squared value of 0.021 indicates that only 2.1% of the variance in self-esteem can be attributed to gender, suggesting that PAS affects male and female SSNs similarly. While differentiating by gender, the effect of changing from CAS to PAS, the p-value (0.594) indicates no statistically significant interaction between CAS vs PAS, and gender on self-esteem. In other words, while PAS positively impacts the self-esteem of SSNs overall, it does not favor one gender over the other, showing that the strategy supports inclusivity and equitable engagement in algebra learning.

Table 4. Summary of ANCOVA results of post-self-esteem ratings for male and female SSNs taught using PAS in algebra word problems

Source	Type III sum of squares	df	Mean square	F	Significance	Partial eta squared
Corrected model	1.208[a]	2	0.604	5.705	0.015	0.449
Intercept	8.005	1	8.005	75.587	0.000	0.844
SE-PRE	1.201	1	1.201	11.343	0.005	0.448
Gender	0.032	1	0.032	0.298	0.594	0.021
Error	1.483	14	0.106			
Total	179.556	17				
Corrected total	2.691	16				

DISCUSSION

Findings from this study reveal a significant effect of PAS compared to CAS on the self-esteem of SSNs in algebra. Specifically, students taught using PAS demonstrated higher mean gains in self-esteem than those taught with CAS, indicating that interactive, learner-centered approaches positively influence how students perceive their mathematical abilities. This implies that the teacher's utilization of CAS in place of PAS lowers students' self-esteem

This finding aligns with Fakolade and Bamidele (2017), who reported a positive relationship between learning outcomes in mathematics, self-esteem, and peer influence, suggesting that peer interactions can predict academic success. Similarly, Adene et al. (2021) observed that peer collaborative learning strategies significantly enhanced the self-esteem of pupils with behavioral problems, such as ODD. This is particularly relevant for SSNs, who may experience emotional or behavioral challenges, as PAS promotes engagement, social interaction, and confidence-building during learning.

The result also corroborates Modaber and Far (2017), who found that cooperative learning methods have a significant impact on students' self-esteem. PAS, as an interactive strategy, facilitates collaboration, allowing students to actively assess and learn from one another, thereby boosting their self-esteem, and sense of competence in solving algebraic word problems.

Furthermore, this finding supports Sinusoid (2022), who emphasized that PAS enhances students' self-esteem by fostering coping skills, confidence, and a sense of worthiness. Through PAS, SSNs engage in interpreting and transforming word problems, applying algebraic operations, and collaboratively finding solutions. This active engagement not only reinforces their mathematical understanding but also improves how they perceive their own abilities and value in the learning process.

Consistent with Siregar et al. (2022), the present study shows that enhanced self-esteem positively influences learning outcomes. Likewise, Adediwura (2015) demonstrated that self-assessment strategies and PAS improve students' self-efficacy, learner autonomy, retention ability, and attitudes towards mathematics. Collectively, these studies reinforce the conclusion that PAS can effectively enhance the self-esteem of SSNs, enabling them to solve algebraic word problems, apply mathematical reasoning to real-life situations, and contribute meaningfully to their communities.

The present study reveals that there is no significant difference in the mean self-esteem ratings between male and female SSNs when the PAS is used in algebra. This finding aligns with Adene et al. (2021), whose study showed that gender had no significant influence on the self-esteem of pupils with ODD. Similarly, Seroussai et al. (2023) found no significant difference in the self-esteem of male and female students, indicating that both genders display homogeneous behaviors in self-esteem when exposed to learner-centered, interactive strategies such as PAS.

The findings also corroborate Adediwura (2015), reported that engagement in self-assessment strategies and PAS enhances students' self-efficacy and promotes positive attitudes toward learning, independent of gender. Likewise, Ajogbeje and Aladesaye (2020) found no significant difference in students' post-test attitude scores according to gender, further supporting the notion that interactive and collaborative strategies can mitigate gender disparities in self-esteem. This clearly shows that the use of PAS boosts both male and female SSNs self-esteem because of improved learning outcomes. The use of interaction, collaboration and learning from each other fosters increase in students' self-esteem. However, these results contrast with Warner and Budd (2018), and Mcmurran et al. (2023) who observed a significant main effect of gender, with females exhibiting lower self-esteem compared to males, and male students showing higher self-esteem in solving complex mathematics problems than females.

The discrepancy between these studies and the present findings may be attributed to contextual factors such as the educational program, nationality, and the physical and cognitive abilities of the students. The use of PAS, with its emphasis on peer interaction, collaborative learning, and mutual feedback, appears to bridge these gaps, enabling both male and female SSNs to display comparable self-esteem levels when learning algebra. This suggests that interactive, learner-centered strategies like PAS can reduce gender-based differences in self-esteem and promote equitable learning experiences for all students.

CONCLUSION

This study investigated enhancing the self-esteem of SSNs using a PAS to improve the learning of algebra in Benue State. The findings suggest that PAS can effectively reinforce the self-esteem of SSNs by enhancing their achievement in algebra, both in Benue State and more broadly in Nigeria. This outcome may be linked to the collaborative nature of peer learning, which allows SSNs to gain confidence and engage actively in solving mathematical problems. Without such interactive strategies, students often experience low achievement and weak results due to a lack of self-confidence in approaching algebra independently. Furthermore, the study revealed that the effect of PAS on self-esteem does not depend on gender, indicating that both male and female SSNs can build self-esteem and improve their problem-solving abilities when engaged in collaborative classroom activities. Therefore, PAS provides a practical approach for teaching, learning, and assessing algebra while simultaneously enhancing the self-esteem of SSNs.

With a small sample size of 22, the study can only detect large effect sizes, if PAS has a moderate or small impact, it may not be statistically significant. With the small sample size, findings may have limited external validity, and the results will not be applied to broader populations or other contexts like other schools. This implies that this result can be best applied on special education for SSNs.

The findings of this study have significant implications for educators, policymakers, and researchers committed to supporting SSNs in mathematics education. Teacher preparation programs should emphasize the importance of promoting positive self-esteem among SSNs and equip teachers with the necessary skills to implement learner-centered and inclusive strategies. Educators should adopt instructional practices that foster a growth mindset, provide scaffolding support, and encourage self-reflection among students. Additionally, assessment and feedback processes should not focus solely on academic performance but also consider students' self-esteem and confidence development.

Recommendations

Based on the findings, several recommendations are proposed. Future studies should explore the longitudinal effects of self-esteem on algebra learning outcomes for SSNs to determine how sustained use of strategies like PAS impacts academic achievement over time. Future studies should use Mann-Whitney U and qualitative insights using interviews to understand males and females experience when using small sample sizes.

Educators are encouraged to participate in professional development programs that focus on promoting positive self-esteem and inclusive instructional practices. Policymakers should prioritize initiatives that support inclusive education and allocate resources to teacher preparation and continuous professional development, ensuring that educators are equipped to meet the diverse needs of SSNs effectively.

Limitations

The study had some limitations that should be addressed in future research. A more diverse and larger sample of students and teachers would improve the generalizability of findings related to the self-esteem of SSNs in learning algebra.

Additionally, with small sample size, the methodology has limitations and the use of non-parametric tests (Mann-Whitney U and qualitative insights using interviews to understand males and females experience using PAS) would have given a better comparison of mean gains, and enabled generalization of results for broader contexts.

Future Studies

Future studies should explore the longitudinal effects of self-esteem on algebra learning outcomes for SSNs to determine how sustained use of strategies like PAS impacts academic achievement over time.

Future studies should use Mann-Whitney U and qualitative insights using interviews to understand males and females experience when using small sample sizes.

Future studies could examine the implementation of PAS using digital tools and platforms, exploring how technology-mediated peer assessment might further enhance self-esteem and algebra learning outcomes.

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APPENDIX A: SSAQ

Section "A" bio data: Fill the space as required.

Name of school: _____

Gender: Male [ ] Female [ ]

Name or identity number of student: _____

Instruction: Please indicate the level of your agreement or disagreement with these statements by ticking (√) the option that best expresses your opinion.

Key: Strongly agree (SA) = 4; Agree (A) = 3; Disagree (D) = 2; & Strongly disagree (SD) = 1

Table A1. SSAQ

S/N	Item	SA	A	D	SD
1	I feel proud when my opinion in algebra is correct.				
2	I love to learn algebra.				
3	I feel scared when the teacher ask questions directed to me in class.				
4	I learn easily what my teacher teaches me in algebra.				
5	I get discouraged while solving word problems.				
6	I am happier in algebra class than in any other mathematics class.				
7	Every time I have an algebraic assignment, I do it well.				
8	I can attempt solving any word problem brought to me by my mates.				
9	Algebra helps me develop problem solving skills.				
10	I only learn algebra because I have to.				
11	I lack competency in solving algebraic word problems.				
12	I always have a lot of difficulty when taking a test in algebra.				

APPENDIX B

Table B1. Data for the research (gender: male = 1 & female = 2)

S/N	Gender	Item											
		1	2	3	4	5	6	7	8	9	10	11	12
PAS (pre-test)													
1	2	1	4	3	4	4	4	4	4	1	4	4	2
2	1	2	4	4	4	1	4	4	4	4	4	3	3
3	2	3	3	4	4	3	4	3	3	3	3	2	3
4	1	3	3	2	4	2	3	4	4	4	3	3	3
5	2	3	3	4	2	3	4	2	3	3	3	1	4
6	1	2	3	2	2	3	2	2	2	1	2	4	2
7	1	2	2	2	2	3	2	2	2	1	2	4	2
8	2	2	2	2	2	3	2	2	2	1	2	4	2
9	1	2	1	1	3	1	1	1	1	1	3	1	2
10	1	1	1	1	3	1	1	1	1	1	3	1	2
11	1	1	1	1	3	1	1	1	1	1	3	1	2
12	2	1	1	1	3	1	1	1	1	1	3	1	2
13	1	1	1	1	3	1	1	1	1	1	2	1	2
14	2	2	2	1	3	2	1	1	1	2	3	1	2
15	1	3	4	1	4	1	4	1	4	1	2	1	4
16	2	3	3	3	3	4	3	3	3	4	3	3	4
17	1	1	3	3	4	3	3	1	2	4	3	3	4
PAS (post-test)													
1	2	4	4	1	4	4	4	2	3	3	4	2	4
2	1	4	3	4	2	3	4	4	4	4	4	4	1
3	2	4	4	2	2	3	4	1	4	3	4	2	4
4	1	4	3	2	4	4	4	3	4	4	4	3	2
5	2	4	4	3	4	4	4	4	4	3	4	4	3
6	1	4	4	3	2	4	4	4	3	2	1	3	3
7	1	3	4	4	4	3	4	3	4	4	2	3	3
8	2	3	4	2	1	4	3	1	4	4	3	4	3
9	1	1	2	1	4	4	3	4	3	4	3	2	1
10	1	3	2	1	2	4	1	3	3	4	1	4	2
11	1	4	3	4	2	4	3	1	4	2	1	3	4
12	2	3	3	2	4	3	2	3	1	4	4	1	2
13	1	2	3	3	3	4	4	2	3	4	3	3	2
14	2	4	4	4	4	4	4	3	2	4	1	4	3
15	1	3	4	4	4	4	4	4	4	4	4	4	4
16	2	3	3	4	4	3	3	4	4	4	3	4	4
17	1	3	4	4	4	3	4	4	4	4	4	4	3
CAS (pre-test)													
1	1	3	2	3	2	2	2	2	2	2	2	2	4
2	2	1	2	2	2	2	3	2	2	2	2	2	4
3	1	2	2	2	2	2	3	2	2	2	2	2	4
4	2	1	2	3	2	2	1	2	2	2	2	3	1
5	1	2	2	2	2	2	2	2	2	2	2	3	2
CAS (post-test)													
1	1	3	3	2	3	3	3	3	2	2	3	3	2
2	2	2	2	3	1	2	3	1	3	3	1	3	4
3	1	2	2	2	2	2	3	4	1	2	3	2	1
4	2	4	3	4	4	4	4	3	4	3	3	2	1
5	1	2	3	3	2	3	3	3	3	3	3	3	1