

Collaborative Instructional Strategy and Academic Achievement of Senior Secondary School Students in Mathematics in Calabar Education Zone, Cross River State, Nigeria

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Abstract

The main purpose of this study was to examine the effect of Collaborative Instructional Strategy on Students' Academic Achievement in Mathematics in Calabar Education Zone of Cross River State. The study was guided by three research questions and three null hypotheses. The study adopted a quasi-experimental research using pre-test and post-test control group design involving intact classes. A total sample of eighty-five (85) students was used for the study. The study made use of two instruments; first was non-cognitive which involved the design of two instructional strategy packages which are Collaborative Instructional Strategy (CIS) and Conventional Traditional Method (CTM) and the second was a Mathematics Achievement Test (MAT) made up of 25 essay questions designed specifically to measure the achievement of students in some units of instructions in Mathematics. Data collected were subjected to statistical analysis using ANCOVA, independent t-test, mean and standard deviation. The findings of the study show, among others, that collaborative Instructional Strategy has significant effect on students' academic achievement in Mathematics. Based on the findings of the study, it was recommended that Mathematics teachers in schools should always use CIS which will yield good results when carrying out their teaching instructions in Mathematics.

Keywords: Collaborative, instruction, strategy, achievement, mathematics

Introduction

The importance of the knowledge of Mathematics to all individuals in order to live effective and active life in the society in which they find themselves is not in doubt. Mathematics is one of the compulsory disciplines in the Nigerian education system. Mathematics is a very vital subject in human lives and it impacts almost everything one does for survival in the society. Akusoba and Okeke (2009) affirmed that the importance

of Mathematics in human endeavours cannot be over-emphasized, pointing at the fact that people use Mathematics consciously or unconsciously in different aspects of life. Anaduaka and Okafor (2013) opined that an individual can get on sometimes without knowing how to read and write, but he/she will know how to count, measure, add and subtract. Huemen (2003) asserted that a good foundation in Mathematics is an essential step for the study of science and other science disciplines. Usman (2006) explained that for any nation to aspire to be competitive on the global market and in this technological era, that nation must first be scientifically and technologically outstanding.

Mathematics is the foundation of other subjects (Musa & David, 2015). As important as Mathematics is, there is persistent prevalence of poor academic achievement among senior secondary school students in Nigeria. In looking for the ways of enhancing the teaching and learning of Mathematics, there is need to foster innovative teaching strategy and improve students' academic achievement in Mathematics for secondary school students to be accustomed to the relevance and to develop authentic foundation in the knowledge of Mathematics. There is need for practical, hands and minds on activities in Mathematics lessons. Saunders (2014) opined that "the pedagogical pattern of the teacher is very important to the students' academic achievement, and it can greatly impact on the way a student views a particular subject and even education as a whole". Furthermore, he observed that teachers represent their subject anytime and anywhere, and so, the way they teach would encourage or discourage the students from studying the subject. Anaduaka and Okafor (2013) observed that a dedicated Mathematics teacher should be able to lift his or her students to the level they would begin to appreciate Mathematics, its beauty and its application so that Students attitude towards the subject would begin to change positively.

Gokhale (2011) sees collaborative learning as an instructional method in which students work together in small groups toward a common goal. Students who engage in collaborative learning are responsible for each other's learning as well as individual, and as a result, the success of one student assists other students to succeed. Thus, collaborative learning entails the formation of an informal setting, whereby students work collaboratively on a particular task, to analyze, synthesize and evaluate problems together, facilitate discussion and interaction. Collaborative strategy could be summarized as a form of learning, an approach that is active both physically and mentally. Learners of all ages learn together and people of different abilities learn together. The collaborative strategy is learner-centered, project-based and learning strategy that integrates learning while learning mathematics. Moreover, it ensures that everyone is a learner and everyone is a teacher. Despite the importance of collaborative teaching strategy, low ability basic science students are not being carried along, in which Bani (2012) stated that there is an increase in the number of low ability basic science students. Most of the Science teachers adopt the use of traditional method of teaching like lecture method, which brings about the total negligence of low ability learners (Usman, 2006).

Ishaq (2015) examined effects of collaborative learning strategy on performance among low ability junior secondary school basic science students in Kano, Nigeria. The study investigated the effects of collaborative learning strategy on performance among low ability junior secondary school basic science students in Kano, Nigeria. Quasi Experimental pretest and posttest control group research design was adopted for data collection. Pretest was conducted on the two groups. After treatment, posttest was administered. The experimental groups were given treatment for six weeks, using collaborative learning while the control group was exposed to teaching for six weeks using lecture method. The population consists of 6,715 students. A sample of 120 subjects of both experimental and control groups was selected. The instrument used for data collection was Basic Science Achievement Test. Simple random sampling using balloting method involving a pick from a hat, was used. The Basic Science Achievement Test has reliability coefficient of 0.78. Four null hypotheses were stated in line with the research questions. Data collected were analyzed using t-test statistics at 0.05 level of significance. The findings revealed that: there was a significant difference in the mean scores of experimental groups, with experimental group performing better. And there was a significant difference in the mean scores of female students. Both the male and female low ability students exposed to collaborative learning strategy performed better when compared to their counterparts who are low ability students exposed to lecture method. It was recommended that curriculum planners and basic science teachers should consider its suitability and incorporate collaborative teaching strategy for the teaching of Basic Science concepts among low ability students.

Evrim (2016) carried out a study on the effect of guided-inquiry laboratory experiments on science education students' chemistry laboratory attitudes, anxiety and achievement. The study aimed at determining the effect of guided inquiry laboratory experiments on Chemistry students' academic achievement and attitudes. The population of the study was made up of the third-year undergraduate science education students at Imam University in Turkey. The sample for the study was thirty seven students of year three science education students. Traditional laboratory method and guided inquiry laboratory experiments were used in teaching the science education laboratory Applications I and II courses respectively. The study was carried out using a single group pre-test and post-test research design. The duration for the course was 6 hours per week i.e. 2 hours of theoretical study and 4 hours of laboratory work. A semi-structured interview questionnaire of 5 point Likert scale was also developed. Its content was made up of open ended question to elicit students' views as it relates to the guided inquiry laboratory experiments. The instrument was titled Chemistry Laboratory Attitude scale (CLA). The author adopted the scale developed by Yeslyurt (2003) to determine students' attitude towards physics. This was used by Ercan (2014) to identify student attitude towards Chemistry laboratories. It has 33 statements with sixteen (16) positive and seventeen (17) negative statements. The Cronbach Alpha reliability Coefficient was determined to be 0.85. Similarly, a Chemistry Laboratory Anxiety scale (CLA) constructed and translated into Turkish was also used to determine students' anxiety level. The questionnaire was a five point Likert scale type made up of twenty (20) questions, five

(5) of the statements were those that do not support anxiety (negative statement) while fifteen (15) statements supported anxiety (i.e. positive statement). This has four divisions or dimensions of items ranging from the ability to use laboratory tools and implement experimental procedures, data collection, ability to use laboratory time effectively and the ability to work in group with others. The Cronbach Alpha reliability coefficient was established as 0.88, 0.86, 0.87 and 0.87 respectively for each division. The CLA and chemistry laboratory without treatment (CLAx), was administered to the students at the beginning of the academic year as pre-test. The fall semester academic achievement of the students was evaluated as pretest using the students' quiz average of the traditional laboratory equipment while the spring semester was evaluated as post-test using the students' quiz average of the guided inquiry experiments. To determine the difference between the pre-test and post-test results of the CLA, CLAx and Academic Achievement (AA), a paired sample t-test was used. The results revealed that there is a significant difference between the scores of the pre-test and post-test of the CLA with the post- test result having a higher score. It also shows a decrease in Chemistry students' anxiety towards the laboratory activities. In addition to this, the t-test also revealed that as a result of the guided inquiry laboratory experiments, there is a positive increase of students' attitude towards Chemistry laboratory. Furthermore, comparing the students' academic achievement in the fall and spring semester, using the paired sample t-test results, the grades of the students of the spring semester in which guided inquiry experiment was applied was higher. The findings quantitatively revealed that the use of guided inquiry laboratory experiments led to the development of positive attitudes towards chemistry laboratory and invariably decreased the laboratory anxiety of Chemistry students. The structured interview also revealed that students have positive perception and thinking about guided inquiry laboratory teaching approach. This they preferred because the application of the inquiry laboratory method promotes meaningful learning. The study therefore suggested that in teaching of science education, students should participate actively in the experimental process in order to develop their laboratory skills and in turn reduce their anxiety about Chemistry as well develop positive attitudes towards Chemistry laboratory.

Bhowmik (2017) carried out a study on the impact of collaborative learning on academic achievement in mathematics of secondary school students in the school hostel in rural area in India. According to the author, collaborative learning is basically known as a teaching arrangement such that small, heterogeneous groups of students work jointly to achieve a certain goal. Students or peers encourage and support themselves; mentally they are aware that the responsibilities are theirs; they employ group related social skills and evaluate their own progress. The common things are positive interdependence, equal opportunities and individual accountability. So, it implies that collaborative learning groups in schools would be used as a logical teaching method. The main objective of the paper was to determine the effect of collaborative learning towards achievement in mathematics and also the attitude towards collaborative learning of mathematics among the hostel students of class nine in secondary school. The eighteen (18) hostel students took part in the 8-week studies. In the first 4-weeks, they

studied in their usual traditional way, and for the next 4-weeks, they studied in collaborative style. The result showed that they had significant difference in their academic achievement. Also from survey and field notes, it can be concluded that collaborative learning had an effective positive attitude on students' academic achievement in the classroom. Collaborative learning is a teaching and learning strategy in which students come together as a team, to discuss an important topic, solve a particular task, provide answers to specific questions and come up with a meaningful project. In education, collaboration involves an effective method of contributing and comparing "know how" among researchers to create and sustain competitive advantage (Bedwell, Wildman, DiazGranath, Salazar, Kramer & Salas, 2012). Collaboration in the academia is when two or more academics, departments, faculties, colleges, institutes or institutions do group work together through idea sharing and thinking to accomplish a common goal. It is simply teamwork taken to a higher level (Bedwell et al., 2012).

Shuaibu and Ogunsola (2002) examined the achievement of mathematic students. They were interested in finding out whether there is a relationship between students' achievement and their teaching methods. Their results indicated that Nigerian students showed higher achievement to collaborative teaching strategy. The high achievement is a confirmation of the study of Shuaibu (2002). In another study about the social outcome for students in collaborative classroom, Vaughn, Elbaum, Schumm and Hughes (2006), used a sample of 185 third through sixth grade students distributed between low achievement, average achievement and high achievement. The participants were distributed between two different settings; co-teaching setting and collaborative teaching setting. According to the results, the students on the collaborative teaching setting demonstrated a more positive outcome than their peers on the co-teaching setting.

Iji, Ochu, Adikwu, and Atamonika (2017) evaluated the effect of collaborative instructional strategy on male and female students' achievement in secondary school chemistry in Benue State, Nigeria. The study investigated effect of collaborative instructional strategy (CIS) on students' achievement in secondary school chemistry in Benue State, Nigeria. Its design was quasi-experimental. Its population was 6,400 senior secondary school two students of 301 government-approved co-educational schools in Benue State. Study sample was 216 students of 4 schools within the three Educational Zones of the state. Purposive sampling was used to select 4 out of 6 schools. Random sampling, by tossing a coin, was used to sample 2 schools for experimental group while the remaining 2 served as control group. Two research questions and two hypotheses guided the study. Instrument for data collection was Chemistry Achievement Test. It was developed and validated by 3 experts; its reliability coefficient, Kuder-Richardson, K-R 21, was 0.85. Mean scores were used to answer research questions while ANCOVA was used to test hypotheses. Students of CIS had significantly greater mean achievement score than those of Traditional Lecture Method (TLM) and there was no significant difference in mean achievement scores due to gender of CIS. Thus, CIS was more effective in enhancing students' achievement than TLM, and was gender friendly. It was

recommended that trainings be organized on use of CIS for Secondary School Chemistry teachers.

Adolphus and Omeodu (2015) carried out a research on the effects of gender and collaborative learning approach on students' conceptual understanding of electromagnetic induction in secondary schools in Nigeria. The research design adopted for the study was a quasi-experimental design. The population of the study comprised of 323 senior secondary three (SS 3) students in all 6 public co-educational schools in Port Harcourt while the sample consisted of 90 students (60 males and 30 females). A 50-item performance test on electromagnetic induction was used for data collection. Statistical mean, standard deviation, t-test and Analysis of Variance (ANOVA) were the statistical tools used for data analysis. The results of data analysis revealed that collaborative instructional strategy affects students' understanding of magnetic induction; however, there was no significant difference in gender in the understanding of electromagnetic induction when taught with collaborative strategy. Some of the recommendations made based on the findings included that teachers should receive adequate training in the use of collaborative instructional strategy; teachers need to understand various aspects of physics curriculum that students can learn better by collaborative learning strategy and be able to use all the available resources to support and facilitate student's participation; teachers should device appropriate approaches that encourage the interaction of boys and girls in the learning processes so as to drastically reduce or remove gender gap in performance in science subjects. The study relates to the present study because it examined the effects of gender and collaborative learning approach on students' academic performance in physics while the present study is examining gender and collaborative instruction in Mathematics.

Bingham (2011) examined the effects of using parallel, station and alternative collaborative teaching structures in a sixth-grade Mathematics classroom. This research was guided by three focus questions on how to implement the structures, student learning outcomes, and teachers and students' appreciation of and ability to adapt to working in a classroom that uses the three structures. The treatment group did not show significant academic gains when compared to the control groups but rather displayed an improved outlook toward learning in a collaborative classroom. The study is related to the present study because it deals with the effects of collaborative instruction and learning on students' performance.

Statement of the problem

The importance of Mathematics for Sustainable Development Goals (SDG) and growth of any nation is not in doubt. People use Mathematics knowingly and unknowingly in solving their day to day problems. It is true that Mathematics is a model of thinking and a very crucial tool in both Science and Arts. The abysmal lack of understanding and poor academic achievement of senior secondary school Mathematics students in Nigeria have become of great concern to all stakeholders in education. From interview and questions, it was discovered that teachers centered approach has dominated the teaching of Mathematics in Nigerian educational system particularly in Calabar education zone of

Cross River State. There is a need to bring an innovative teaching strategy which may have the capacity of increasing the mindset of students and enhance the academic achievement of senior secondary school Mathematics students. The study seeks to find out the effect of collaborative instructional strategy on students' academic achievement in Mathematics.

Purpose of the study

The purpose of this study is to investigate the effects of collaborative instructional strategy on students' academic achievement in Mathematics. Specifically, the study sought to:

1. Examine the effects of collaborative classroom instructional strategy on students' academic achievement in Mathematics.
2. Determine to what extent achievements of students taught with classroom collaborative instruction strategy differ from those taught with conventional method.
3. Investigate the interactive effect of gender in collaborative instructional strategy on students' academic achievement in Mathematics.

Research questions

1. What is the effect of collaborative instructional strategy on students' academic achievement in Mathematics?
2. To what extent do achievements of students taught with collaborative instructional strategy differ from students taught with conventional approach?
3. What is the interaction effect of gender on students' academic achievement in Mathematics?

Hypotheses

Ho1: There is no significant effect of collaborative instructional strategy on students' academic achievement in Mathematics.

Ho2: There is no significant interaction effect of gender on students' Academic Achievement in Mathematics.

Significance of the study

This study would be significant to various groups and consequently contributes to the field of mathematical knowledge to enhance the Nigerian educational system. On the part of the students, findings of the study would help the students to understand the need for active participation in class which is in line with the global practices in teaching and learning. Also, the teacher would benefit because if collaborative strategy is adopted as an alternative strategy in this innovative strategy, it will fast-track scientific and technological skills in teaching. The teachers will also realize that their roles have changed from being dispenser of knowledge to guiding learning.

Methodology

The design of this study is quasi-experimental design. This design was considered appropriate because it is applied to a situation which is not purely experimental in nature

involving human beings especially when all the threat to validity cannot be controlled. As a result, since the study was conducted under quasi-experimental conditions that do not permit total control, manipulation of variables or random selection of participants, the intact groups or classes were used to define the effect of collaborative classroom strategy on students' achievement in Mathematics. Also, senior secondary school (SS2) students who participated in the study received treatment in their usual classes and were used as control in their classes without re-arranging the class setting. Participant in the control group receive no treatment while the treatment group (E) received instruction with collaborative classroom strategy. Hence, two groups were involved in the study, the treatment group and the control group. The treatment group was one group and the control group one.

Table 1: Shows quasi-experiment design

Design	Groups	Pre-Test	Treatment	Post-Test
Non-equivalent	E	O_1	X_1	O_2
Control group	C	O_1	X_0	O_2

Where E: Experimental group

C: Control group

X_0 : No treatment

X_1 : Treatment

O_1 : Pre-test

O_2 : Post- test

The total population of this study comprised all senior secondary II (SS2) Mathematics students in Calabar education zone. Two senior secondary schools were purposively selected for participation based on the two criteria listed below:

a. The school must have registered students for the senior secondary certificate examination for at least 10 years.

b. The senior secondary schools should be co-educational schools.

Only one arm of Senior Secondary School (SS2) class was randomly selected for participation in each of the two schools. The students in the selected arms of SS2 classes in one of the schools were randomly assigned to the experimental groups, while the control group was assigned to the second school. A pre-test was administered to establish the homogeneity of the groups. A total of eighty-five (85) subjects (38 males and 47 females) from the two co-educational schools were selected for the study. Also a total of forty-one (41) subjects (18 males and 23 females) for the collaborative classroom strategy and a total of 44 subjects (20 males and 24 females) participated for the conventional method. The population and sample of the study are shown below on table 2.

Table 2: Population and sample distribution table

Schools	Population	Sample		Total
		Male	Female	
A	63	18	23	41
B	56	20	24	44
Total	119	38	47	85

The study used two instruments. The first was non-cognitive which involved the design of one instructional package on collaborative strategy and the second instrument for data collection in this study was Mathematics Achievement Test (MAT). The development of MAT which was used for this study involved the following stages:

- a. Content base Mathematics.
- b. Instrument Strategy Objectives.
- c. Table of specification.

Table 3: A blueprint for a-25 item Mathematics achievement test (MAT)

Content	Knowledge	Comprehension	Application	Total
Numeration & trigonometry	4	6	1	11
Statistics and probability	3	3	1	7
Simultaneous equation	2	1	1	4
Geometry	1	1	1	3
Total	10	11	4	25

The 25 items on Mathematics achievement test passed the faced validation by other experts in Test and Measurement in Faculty of Education, University of Calabar. To determine the reliability of the Mathematics Achievement Test on students' academic achievement, a trial test was conducted with 30 secondary schools students who were not part of the study sample. The reliability co-efficient of the MAT was determined with the use of Kuder Richardson formula KR-21 reliability method. The scores obtained from the administration of the instrument were analyzed using KR-21 to obtain an index of reliability of the instrument which was 0.65. The data gathered were analyzed using mean, standard deviation, ANCOVA and t-test. The hypotheses were tested at .05 level of confidence.

Presentation of results

Research questions 1: What is the effect of collaborative instructional strategy on students' academic achievement in Mathematics?

Ho1: There is no significant effect of collaborative instructional strategy on students' academic achievement in Mathematics.

Table 4: t-test on collaborative instructional strategy

Test	N	\bar{x}	SD	Mean Diff	DF	t-cal	p-value
Post-Test		11.18	3.36				
	39			3.88	38	4.85	0.000
Pre-Test		8.20	4.16				

From the table 4, Mathematics mean scores of students exposed to collaborative instructional strategy are 11.18 (with standard deviation of 3.36) and 8.20 (with standard deviation of 4.16) for post-test and pre-test respectively. The gain mean score of 3.88 obtained shows that collaborative instructional strategy (CIS) improved students' achievement in Mathematics. Where the pre-test and the post-test mean scores were subjected to t-test, a t-value of 4.85 was obtained at a degree of freedom (df) 38 with a p-value of 0.000. Since the p-value obtained is lower than .05, then the null hypothesis is rejected and this implies that collaborative instructional strategy has significant effect on the Mathematics achievement of students.

Research question 2: To what extent do achievements of students taught with collaborative instructional strategy differ from students taught with conventional approach?

Table 5: Students' mean and standard deviation and difference in mathematics achievement when taught using collaborative instructional strategy (CIS) and conventional method

Group	N	Post-test			Post-Test Mean Diff		
		\bar{x}	SD	N	\bar{x}	SD	
CIS	39	80.45	8.45	39	84.56	7.25	2.84
CTM	40	79.98	9.16	40	81.41	7.57	

Table 5 shows post-test mean scores of 80.45 with standard deviation of 8.44 for students on CIS group and 79.98 and a standard deviation of 9.16 for students on CTM group. The results showed a difference of 2.84 in the post-test mean scores of the 2 groups in favour of the group taught with CIS.

Research questions 3: What is the interaction effect of gender on students' academic achievement in Mathematics?

Ho2: There is no significant interaction effect of gender on students' Academic Achievement in Mathematics.

Table 6: Summary of 2-way ANCOVA on the interactive effect of gender on CIS and CTM instructional strategy

Source of variation	Sum of square	df	Mean square	F	p-value
Pre test MAT	286.338	1	285.338	21.211	.000
Group (teaching strategy)	8.133	1	8.133	0.611	0.644
Gender	21.111	1	21.101	1.038	0.291
Error	1803.211	81	16.811		
Total	1824.322	84			

Sig at p <.05

The results from the table 6 showed F-value of 1.038 at degree of freedom 1 and 81 and p-value 0.291 with respect to the difference in Mathematics achievement based on gender. Since the p-value (0.291) is greater than the p-value of .05, the null hypothesis is accepted meaning that indeed there is no significant difference in the academic achievement in Mathematics of the students taught using CIS and students taught using CTM based on gender.

Discussion of findings

From hypothesis one, the findings revealed that there was a significant effect of collaborative instructional strategy on students' academic achievement in Mathematics. The finding of hypothesis one is in line with the view of Gokhale (2011) who sees collaborative strategy as an instructional strategy in which students work together in small groups towards a common goal. Ishaq (2015) examined effects of collaborative learning strategy on performance among low ability Junior Secondary School Basic Science students in Kano, Nigeria. The study investigated the effects of collaborative learning strategy on performance among low ability Junior Secondary School Basic Science students in Kano. Quasi-experimental pre-test and post-test control group research design was adopted for data collection. The findings revealed that there was significant difference in the mean scores of experimental group. Also, Babalola (2000) studied the relationship between scientific inquiry with students' achievement in Mathematics. The study revealed a significantly superior achievement for collaborative students. In the same vein, Babalola suggested that it would seem reasonable and prudent to encourage students with collaborative strategy of learning in Nigerian Secondary Schools.

Also, the present study on the influence of collaborative instructional strategy on students' achievement in Mathematics is in agreement with the study of Shuaibu and Ogunsola (2002) who examined the achievement of Mathematics students using heath's

type of instrument. They were interested in finding out whether there is a relationship between students' achievement on their training method. Their results indicated that Nigerian students showed high achievement to collaborative teaching strategy. The study also confirmed the study of Vaughn, Elbaum, Schumm and Hughes (2006), on the social outcome for students in collaborative classroom, which they obtained a positive outcome. In the study, the sample consisted of 185 sixth grade students distributed between low achievement, average achievement and high achievement. The participants were distributed between two different settings; co-teaching and collaborative teaching strategy. From the result, the students on the collaborative teaching strategy demonstrated a more positive outcome than their peers on the co-teaching setting. Further, it was demonstrated that there was an increase in the number of reciprocal friendship formed. The superiority of collaborative guided strategy over other strategies of teaching enhanced adequate achievement and performance in Mathematics. This is because teacher-to-students and students-to-students communication is very effective and functional since some students reason and think much faster than some of their mates in the class and this also stimulates students' interest since group work is allowed and open freely to every sample respondents in the school.

Conclusion

On the basis of the findings of this study, it can be concluded that instructional strategy applied by a teacher is one of the factors that influence students' achievement in Mathematics. It was also said that students who were taught Mathematics by using Collaborative Instructional Strategy (CIS) do better than those ones taught with CTM.

Recommendations

Based on the results of the study, the following recommendations are made:

1. Mathematics teachers in schools should always use strategy they deem good which will yield good results when carrying out their teaching instruction. This would help to lay a good foundation for the students learning Mathematics and also enhance the use of collaborative strategy.
2. Mathematics teachers, parents, government, NGOs and other private organizations should encourage all students in schools, male and female irrespective of their gender to get actively involved in Mathematics lessons since both would all do well in the subject given the right opportunity and equal learning environment for all in the use of instructional strategy.
3. Principals and school administrators should always ensure that classrooms are not over-crowded for effective use of instructional strategy by teachers so that effective teaching and learning as well as quality performance and achievement are retained and achieved in the schools.

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