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Effectiveness of Reggio Emilia Approach on Academic Achievement of Pupils in Basic Science

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Abstract--- Teachers, parents, and stakeholders in the Nigerian education sector are becoming increasingly concerned about low achievement levels in basic science, but little is known about how teaching approaches play crucial roles in pupils' achievement in the subject. The objective of the study was to investigate the effectiveness of the Reggio Emilia instructional approach among pupils in Basic science. In an explanatory sequential mixed-methods study, 50 pupils and four teachers were purposefully drawn from intact classes in two schools in Nsukka, a city in eastern Nigeria, and divided into a control and an experimental group. We conducted a six-week teaching intervention programme using the Reggio Emilia instructional approach with the teachers from the experimental group. We collected qualitative data from teachers in both groups via structured individual interviews with open-ended questions. Responses to the open-ended questions were transcribed and analyzed thematically. We collected quantitative data using an achievement test in three stages: pretest, posttest, and follow up. For quantitative analysis we used repeated measures analysis of variance-ANOVA. Findings from the experiments showed that the Reggio Emilia approach improved the achievement of the pupils at posttest. After the intervention, the teacher-participants also reported that the pupils' achievement in basic science had improved significantly. We concluded that Reggio Emilia is effective for teaching of basic science teaching.

Keywords--- Reggio Emilia Approach, Basic Science Achievement, Primary School Pupils.

I. Introduction

The 21st century is characterized by volatility, uncertainty, complexity, and ambiguity, referred to as the VUCA world (Adnan et al, 2021). Success in a VUCA world requires increasing development in a nation's technological, industrial, and scientific spheres (Hadar et al, 2020). It is imperative that children are prepared to participate in this fast-changing world (Omoera, 2011; Smidt, 2013) and, with science and technology viewed as the drivers of this, there is increasing attention worldwide on strengthening both the content and the teaching of these subjects in schools (Guzey et al, 2009; Widiyatmoko et al, 2013 & Cajas, 2001).

Effective science education needs to begin in the child's early and formative years. Several studies suggest that exposing children to basic science concepts and experiences early in life could help them develop curiosity, critical thinking, and problem-solving skills, skills deemed key to succeeding in a fast-changing world (e.g., Jacob, 2010; Cobo, 2013). In addition, introducing children to science education in the early years stimulates intrinsic motivation for science learning later in life (Gordon, 2007). This is crucial as students' interest in science tends to decline as they progress to higher grades (Potvin & Hasni, 2014) due to the very abstract nature of key concepts taught (Leden et al, 2015) and teachers' inability to make learning real and relevant (Sticht, 2005; Tayor, et al, 2003).

In Nigerian primary schools basic science is taught as a core subject that lays the foundation for science in secondary and tertiary schools (Nigerian National Policy on Education, FRN, 2013). Basic science involves teaching and learning science to develop individuals' creativity and skills for critical thinking and problem-solving in order that they are able to use scientific knowledge to solve societal problems (Ayua and Jato, 2012; Leden et al, 2015; Mohd-Saat, 2004). Considering the importance of basic science in the

development of individuals and the nation, science instruction at all levels of the Nigerian educational system is now being emphasized, beginning from the basic education level (Omoera, 2011; Federal Republic of Nigeria, 2014.). In 2007 the Nigerian Educational Research and Development Council (NERDC) developed a curriculum on basic science for lower basic education that focuses on developing an indepth science knowledge in students (Ayua & Danjuma, 2019). Students were introduced to this revised aspect of new basic science curriculum in September 2014 in order to equip them with the skills they need to address challenges, make decisions, develop survival strategies, and live effectively within the global community (Ayua & Danjuma, 2019; Smidt, 2013).

Despite the increased emphasis on science education, pupils in Enugu state and Nigeria in general continue to perform poorly in basic science (Ayua & Jato, 2012). Based on the data from the Examination Development Centre, Enugu, Nigeria, the percentage pass rate between 2015 and 2020 in basic science in the state has remained low, ranging from 35% to 49% (EDC Enugu, 2020). This low level of performance in the subject relates specifically to the areas of problem solving, analytical skills, evaluation, and mastery of key concepts (McCormick & Chao, 2018).

Among the leading causes of this poor performance may be the teaching approach used. In a study conducted in Abuja, Nigeria, it has was reported that the poor quality of teaching method used contributes to poor performance by students in basic science (Hamdallah et al., 2014; Naz & Murad, 2017). The research of Ayua (2012) indicates that approximately 35% of basic science topics are difficult to teach using conventional teaching methods, especially for teachers in lower and middle UBE classes (i.e., Grades 1 - 3 and 4 – 6, respecively). In this study, conventional teaching methods are considered to be those that involve rote learning and a direct instruction by the teacher, whose primary role is to pass knowledge to students and conduct testing and assessments. This method does not permit pupil activity-centered learning since it is teacher-centered (Ajayi et al, 2017).

Most basic science teachers in Nigeria tend to utilize the conventional lecture method (Peter et al, 2010). Unfortunatey, the majority of science teachers in Nigeria lack the knowledge and skills to teach differently because they are not adequately qualified (Jirgba et al., 2018). According to Ayua (2011), only 25% of basic science teachers in Nigeria possessed the requisite skills for improvisation and impactful teaching. Thus, rather than employing the more desirable experimental methods of science teaching, Nigerian teachers emphasize the theoretical component of primary science (Naz & Murad, 2017). Although we argue that conventional teaching methods have a place in the classroom, they should not be the dominant method of basic science teaching.

II. Reggio Emilia: A Critical Instructional Approach

In the classroom, multiple factors impact science teaching and learning, including students' beliefs and teachers' orientations, prior knowledge, and experience, all of which influence students' outcomes (Caleon et al., 2018; Tufail & Mahmood, 2020). Science teachers' teaching methodologies also play a crucial role in classroom practices. Science teachers are recommended to use various research-based teaching methods in order to develop a conceptual understanding of science concepts (Tufail & Mahmood, 2020). An example is the Reggio Emilia Approach, which uses experiential learning and places pupils at the center of teaching and learning.

The Reggio Emilia approach is a philosophy that originated in the Italian city of Reggio Emilia and was developed by Loris Malaguzzi after World War II. It is a methodology centered on observing and appreciating children in their routines, ideas, and skills (Santn & Torruella, 2017). The core tenets of the approach are: (a) the view of the child as an active constructor of knowledge, as a social being, and as having rights; (b) an integrated, emergent curriculum and project work; (c) the teacher–child learning relationship (d) the documentation of children's thinking processes and the products thereof (Edwards, Gandini, & Forman, 1998; Hendrick, 1997; Stegelin, 2001). This approach is rooted in constructivism and was developed according to Dewey, Gardner, Piaget, and Vygotsky's ideas (Nan, Kantor, & Trundle, 2010). Although it shares some similarities with other techniques, it also has distinctive features. Such features include allowing children to initiate their own classroom activities. This is because the children's curiosity motivates them to learn, and as a result, they are highly individualized in their understanding of how to structure their own learning.

The approach focuses on learning through collaboration and communication, the aim of which is discovery with the teacher acting as facilitator. Essentially, the Reggio Emilia methodology utilizes a unique approach to school pedagogy. Children's education, both at the preschool and early elementary levels, is based on by connecting them to culture, community, and the natural world (Hewett, 2001; Kelemen, 2013). Reggio-inspired classrooms use real objects, recyclable materials, and artistic displays created by children (McCormick Smith & Chao, 2018). They emphasize documentation by teachers of learner' activities, as documenting children's learning and making it visible to their families and the community provides concrete evidence of children's learning through hands-on experiences (Kaufman, 2014). With a Reggio approach, children are considered both capable and creative, and it is recognized that each child can express themself in a multitude of ways.

A Reggio Emilia teacher is a teacher who creates an environment and opportunities that allow each child to develop independence, structure knowledge, and act independently (Kelemen, 2013). They enjoy sharing their discoveries with students, seeing themselves as participants in the learning process (Arseven, 2014). Educators give learners ample opportunities to explore their creativity and solve problems, and value children's social and personal experiences (Fernández-Santín & Feliu-Torruella, 2020). Unlike the conventional teaching approach, Reggio classes are not assigned to a single teacher. Rather, the teachers work together in planning lessons and jointly strive to stimulate the learners by sharing teaching responsibilities (Rinaldi, 2021). In addition to observing their learners' ways of manipulating and using materials, teachers pay attention to where their learners' interests lie (McCormick, Smith & Chao, 2018). Within this context, the role of the teacher is that of an observer, listener, learner, nurturer, partner, and provocateur (Rinaldi, 2021). Children benefit when teachers take an active role in listening, observing, and researching (Ghirotto & Mazzoni, 2013). As facilitators, collaborators, and researchers, teachers thus play an essential role in the development of children (Hewett, 2001).

Research has demonstrated that Reggio Emilia-inspired schools create a science-rich environment that prompts and supports learners' inquiries while engaging their hands, minds, and hearts with science (Amus, 2013). Findings suggest that the Reggio pedagogy, which is inquiry-based, is compatible with science education's goals (Inan, 2007). Notwithstanding that the Reggio Emilia philosophy is compatible with basic science education from a content and skills point of view, very few studies have been conducted in the use of Reggio Emilia in science classrooms in Nigeria and beyond. To the best of our knowledge, no empirical study has been conducted in Nigeria to examine the effect of the Reggio Emilia approach on pupils' achievement in Basic Science. Therefore, the primary purpose of this study was to investigate the effect of the Reggio Emilia approach to teaching on the achievement of pupils in Basic Science in Nigeria. To guide the study, we hypothesized that the Reggio Emilia approach would improve puplis' achievement in Basic science when compared to their counterparts in the control group.

III. Design

In the study an explanatory sequential mixed method design was used. According to Creswell and Plano-Clark (2011), an explanatory sequential design entails first collecting quantitative data to provide a general answer to the research problem, and then collecting qualitative data to refine, explain, or elaborate on the quantitative data. In this study, the aim of the quantitative phase of data collection was to determine the impact of the Reggio instructional method on pupils' basic science knowledge, while in the qualitative phase teachers' views, perspectives, and experiences of using the Reggio method were explored. The quantitative phase of the study specifically adopted quasi-experimental design with intervention and control groups using pretest, posttest and follow up. The findings of each phase were analyzed separately and then combined for a deeper understanding of and broader insight into the research questions and phenomena (Johnson & Onwuegbuzie, 2007). Using this design, the researchers collected data through standardized achievement tests and interviews.

IV. Participants

All Grade 5 pupils in Nsukka Education Zone of Enugu State, Nigeria, made up the study population. The sample comprised of Grade 5 pupils (n=50) in public primary schools (n=2) in Enugu State, Nigeria. A multi-stage sampling procedure was used. The two schools were purposively selected based on the availability of a well-equipped science laboratory and an existing school garden for outdoor science exploration, which were non-existent in the rest of the schools in the zone. The two schools were assigned

to an experimental or control groups. The experimental group (school 1; n=25) was taught with the Reggio Emilia Approach, while the control group (school 2; n=25) was taught with the conventional approach. Because it was challenging to randomize every participant in a school, the researchers used intact classes from which to collect quantitative data. For the qualitative phase of the study, four basic science teachers were selected from the two schools used for the study. Teachers from the experimental group responded to questions relating to the pupils performance in basic science both at the pretest and posttest stages as well as on the efficacy of the the teaching intervention approach. On the other hand, teachers from the control group only responded to questions relating to the pupils performance in basic science both at the pretest and posttest stages.

V. Instrumentation

The Basic Science Achievement Test (BSAT) was used to collect quantitative data from the pupils. The BSAT, comprising of a 20 item multiple-choice questionnaire, is a standardized test developed and administered by the Examination Development Center, Enugu (2020). Pretest, posttest (week two of intervention, and shuffled), and follow-up (two week after posstest) data were collected using the BSAT. The reliability co-efficient of BSAT was determined by using Kuder-Richardson 21(K-21) statistics which yielded a reliability score of 0.75.

Four open-ended questions were used to elicit data from the basic science teachers to collect the qualitative data. The teachers were interviewed individually in two intervals, before the pretest and after the posttest stages of the study. The two teachers who were part of the intervention were asked a series of questions based on their perspectives on the pupils performance and the Reggio Emilia approach, while the two teachers in the control group only responded to questions relating to the performance of the pupils. Examples of such questions are: i) What is your opinion about Reggio Emilia Approach? ii) What is your current assessment of your pupils in basic science? iii) Do you think that Reggio Emilia Approach can be useful in basic science teaching and learning? (iv) What do you find most challenging or discouraging when teaching basic science? Further follow-up questions were asked to help the interviewer better understand the perspectives. The written and audio responses to these questions were meticulously recorded. While the intervention took place, researchers also visited the schools to supervise and observe.

VI. Intervention Procedure

Two regular Grade 5 basic science teachers taught the pupils in the school used for experimental group with Reggio Emilia principles. Similarly, at the second school used for control group, two regular Grade 5 basic science teachers also taught the pupils using the conventional teaching method. One week before the study began the researchers trained the teachers in the experimental group, who served as the research assistants. During the training, we discussed the purpose of the study, topics to be taught, lesson plans to be used, use of BSATs, and general study procedures. During the first week of the study, the pupils were taught about the theme: *Living and non-living things,* in particular, *reproduction in plants I.* During the second week, the pupils learned about *Reproduction in Plants II* - specifically, they learned about *insect and wind-pollinated plants, fertilization, and fruit development*, as well as the *differences between fertilization and pollination*. The third week was dedicated to teaching the pupils about the *Water Cycle and Rain Formation*. These topics are from the Basic Science syllabus for primary 5 which are taught during the second term (see FRN, 2014). The teachers used the same amount of time (35 minutes) to teach the topics to both groups.

For the control group, conventional classroom instruction was used. The experimental group was taught using the Reggio Emilia approach. In this study, the Reggio Emilia approach entailed exploring the school environment during basic science classes, especially the gardens and school laboratory; for example, in the first unit, pupils were taken to the school garden where they identified the parts of a flower and learned how pollination occurs. Pupils in the experimental group were also provided with materials, objects, and diagrams and were encouraged to be motivated through conscious inquiry-guided pedagogy continually. During the lesson periods, no specific seats were assigned to pupils because they were allowed to move around for observation and manipulation of the learning materials.

VII. Ethical Approval

Ethics clearance was obtained from the Faculty of Education Research Committee at the University of Johannesburg (Ethical Clearance Number: SEM 1-2022-016). The Board Secretary, Enugu State Universal Basic Education Board, granted permission for the study to be conducted, and the participants consented in writing.

VIII. Data Analysis

Quantitative data were analyzed using mean and standard deviation, and hypothesis testing was performed using analysis of variance (ANOVA) with SPSS. For the qualitative data, a thematic content analysis approach was employed. Inductive coding was used to identify teachers' views about Reggio Emilia and the teaching approach's perceived effectiveness. To cluster codes and form consistent themes from the interviews, we identified patterns across the codes and reflected on the underlying meaning. This was done to draw attention to the most critical issues and similarities and differences between participants' perspectives. Throughout the thematic data analysis, all data were presented and analyzed in six phases in accordance with Nowell, Norris, White, and Moules (2017) prescriptions for establishing trustworthiness, which are familiarizing yourself with your data, generating initial codes, searching for themes, reviewing themes, defining and naming themes, and producing the report.

IX. Results for Quantitative Phase of the Study

Presentation of Findings

Table 1: Mean Scores and Standard Deviations of students on Conventional and Reggio Emilia instructional Methods

Method		Pre-test	Post-test	Mean Gain
Conventional	Mean	6.40	11.76	5.36
	Std. Deviation	1.155	1.451	
Reggio Emilia	Mean	6.00	17.04	11.04
	Std. Deviation	.764	1.306	

The data in the above table showed the mean scores and standard deviations of pupils exposed to conventional and experimental (Reggio Emilia) instructional methods. The data showed that pupils exposed to the conventional method had mean scores of 6.40 at pre-test and 11.76 at post-test with a mean gain of 5.36. Additionally, pupils exposed to experimental instructional method (Reggio Emilia) had mean achievement scores of 6.00 at pre-test and 17.04 at post-test with associated mean gain of 11.04. The mean gain score of primary school pupils exposed to Reggio Emilia instructional method is higher than the mean score of those exposed to conventional method. Hence, Reggio Emilia instructional method enhances pupils' achievement score more than conventional method. Similarly, the post-test standard deviation scores of 1.451 for the conventional group and 1.306 for Reggio Emilia indicated a higher dispersion of individual mean scores from their group mean scores for pupils exposed to the conventional method than Reggio Emilia method.

Table 2: Mean and Standard Deviations Scores of pupils at Post-Test and Follow-Up Test on Conventional and Reggio Emilia instructional Methods

Method		**Post-test**	**Follow-Up**	**Mean loss**
Conventional	**Mean**	11.76	10.08	1.68
	Std. Deviation	1.451	1.222	
Reggio Emillia	**Mean**	17.04	14.76	2.28
	Std. Deviation	1.306	1.165	

The data in table 2 showed the mean scores and standard deviations scores at post-test and follow-up test of primary school pupils exposed to Reggio Emilia and conventional instructional methods. The data showed that pupils exposed to conventional method had mean score of 11.76 at post-test and 10.08 at pre-test with associated mean loss of 1.68. Additionally, pupils exposed to the experimental instructional method (Reggio Emilia) had mean achievement score of 17.04 at post-test and 14.76 at follow-up with an associated mean loss of 2.28. The mean score of follow-up test of primary school pupils exposed to Reggio Emilia instructional method is higher than the mean of those exposed to conventional method. Hence,

Reggio Emilia instructional method enhances students' knowledge retention more than conventional method. Similarly, the follow-up standard deviation scores of 1.222 for the conventional group and 1.165 for Reggio Emilia indicated a higher dispersion of individuals' scores from their group mean score for pupils exposed to the conventional method than Reggio Emilia method.

Table 3: Within Subjects Effects Repeated Measures ANOVA of Primary School Pupils Achievement based on method

Cases	Sum of Squares	Df	Mean Square	F	P	η²
Test	1481.047	2	740.524	533.297	< .001	0.697
Test ✻ Method	174.086	2	87.043	62.685	< .001	0.082
Test ✻ Gender	4.648	2	2.324	1.674	0.194	0.002
Test ✻ Age	3.754	4	0.939	0.676	0.611	0.002
Test ✻ Method ✻ Gender	0.360	2	0.180	0.130	0.879	1.693e-4
Test ✻ Method ✻ Age	3.420	4	0.855	0.616	0.653	0.002
Test ✻ Gender ✻ Age	2.540	4	0.635	0.457	0.767	0.001
Test ✻ Method ✻ Gender ✻ Age	8.091	4	2.023	1.457	0.224	0.004
Residuals	105.532	76	1.389			

Note. Type III Sum of Squares

In table 3 above, repeated measures ANOVA was conducted to compare the mean achievement scores of primary school pupils exposed to Conventional and Reggio Emilia methods designed to enhance pupils' achievement score at time 1 (prior to intervention), time 2 (following the intervention) and time 3 (follow-up). The independent variables were the instructional methods (conventional and Reggio Emilia) while the dependent variable was the test score of pupils after administering the instructional methods. The result showed that there was a significant different on pupils' test, F (2, 39) = 533.297**, p <.001;** however, the effect size was high, (partial eta squared =.697). There was a significant interaction effect of methods and test F (2, 39) = 62.685**, p <.001;** however, the effect size was moderate, (partial eta squared = 0.082. There was no significant interaction effect of test and gender factor F (2, 39) =.1.674**, p =.** 0.194**;** still the effect size was not significant (partial eta squared = 0.002). Similarly**,** there was no significant interaction effect between test and age F (2, 39) = 0.676**, p =** 0.611**;** though the effect size was not significant (partial eta squared = 0.002). The interaction effect among test, method, and gender was not significant F (4, 36) = 0.130, p = 0.879: however, the effect size was high (partial eta squared = 1.693). Furthermore, interaction effect among test, method, and age was not significant F (4, 36) = 0.616, p = 0.653; however, the effect size was high (partial eta squared = 0.002). In addition, the interaction effect among test, gender, and age was not significant F (4, 36) = 0.457, p = 0.767; however, the effect size was not significant (partial eta squared = 0.001). Similarly, the interaction effect among test, method, gender, and age was not significant F (4, 36) = 0.224, p = 0.004; however, the effect size was not significant (partial eta squared = 0.001). Thus, the instructional methods employed were not gender and age bias.

Table 4: Between Subjects Effects Repeated Measures ANOVA of Primary School Pupils' Achievement Based On Method

Cases	Sum of Squares	Df	Mean Square	F	P	η²
Method	258.882	1	258.882	153.155	< .001	0.122
Gender	10.387	1	10.387	6.145	0.018	0.005
Age	1.080	2	0.540	0.320	0.728	5.087e-4
Method ✻ Gender	0.093	1	0.093	0.055	0.816	4.391e-5
Method ✻ Age	1.977	2	0.989	0.585	0.562	9.308e-4
Gender ✻ Age	1.910	2	0.955	0.565	0.573	8.992e-4
Method ✻ Gender ✻ Age	1.916	2	0.958	0.567	0.572	9.020e-4
Residuals	64.233	38	1.690			

Note. Type III Sum of Squares

In table 4 above, repeated-measures ANOVA was conducted to compare the mean achievement scores of primary school pupils exposed to Conventional and Reggio Emilia methods designed to enhance pupils' achievement score. The independent variables were the instructional methods (conventional and Reggio Emilia) while the dependent variable is the test score of pupils after administering the instructional methods. The result showed that there was a significant main effect of instructional method F (2, 48) = 153.155, p <.001; however, the effect size was moderate, (partial eta squared = 0.122). There was a significant influence of gender factor F (2, 48) =.6.145, p = 0.018; still the effect size was not significant (partial eta squared =.005). Similarly, age of the pupils did not significant influence pupils' achievement F (2, 48) = 1.514b, p = 0.728: though the effect size was high (partial eta squared =.5.087).

With respect to interaction effects, there was no significant interaction effects of method and gender on pupils' achievement F (2, 48) = 0.055, p = 4.391: though the effect size was high (partial eta squared =.5.087). Furthermore, there was no significant interaction effects of method and age on pupils' achievement F (2, 48) = 0.585, p = 0.562; though the effect size was high (partial eta squared = 9.308). With regards to interaction effect of gender and age, there was no significant effect F (2, 48) = 0.565, p = 0.573; with associated high effect size (partial eta squared = 8.992). Finally, there was no significant interaction effects of method, gender, and age on pupils' achievement. F (2, 48) = 0.567, p = 0.572; with associated high effect size (partial eta squared = 9.020). Therefore, the instructional methods employed were not gender and age bias.

X. Results for the Qualitative Phase of the Study

The two predominant themes that emerged are: 1) The Reggio Emilia pedagogy makes learning real and relevant; and 2) The Reggio Emilia pedagogy improved students' academic performance. We present themes based on the results of both the pre-intervention and post-intervention interviews with teachers.

The Reggio Emilia Pedagogy Makes Learning Real and Relevant

In the pre-intervention interview with the teachers in the experimental group, participant 2 revealed that the Reggio Emilia pedagogy would strengthen teaching and learning in basic science. Participants 1 acknowledged they were not very familiar with the teaching approach *"until it was discussed in the teachers workshop organized by Enugu State Universal Basic Education Board last year".* Participant 2, however, acknowledged being aware of the tenets of the approach thus: "I'm aware that it [Reggio Emilia Approach] involves practical learning and that pupils will be doing the learning on their own". In further converstion, Particpant 2 that "*Reggio Emilia approach is a good teaching approach but it is rarely used in our area (Nsukka, Nigeria)"*. It was appreciated that the method *"grants more rights to learners and fewer rights to teachers" [**P1**].* In the opinion of Paticipant 2, "*it is going to be a nice approach in basic science……. if we are given the opportunity to adopt it".* The data from the post-intervention interview confirm that participants in the experimental group believed that the Reggio Emilia approach improved learners' interest in basic science by keeping them actively engaged. The following excerpt supports these views *"the approach has one thing in common; the kids were fully engaged in the process, and they were given the freedom to move around while learning was taking place"[**P2**].*

In addition, a teacher-participant**[P1]** stated that:

> *"From my observation so far it is clear that the performance and interest of my pupils improved very well. My particular joy is with the pupils who were always slow learners; they become more interested and flow with the others. There is already a wonderful improvement and it is evident in their test scores. I'm also impressed with their retention of some important science concepts in topics like "insect and wind-pollinated plants", "fertilization, and fruit development", as well as the differences between "fertilization and pollination".*

In a further interaction, one of the basic science teachers in the experimental group [**P2**] stated that Reggio Emilia techniques create an active learning process by stimulating learners to become active participants, thus *"it is clear that it is a promising technique…from the beginning of teaching, the pupils find essence in their individual exploratory tasks. They get involved and deeply engrossed in the class activities. Each trying to find the practical interpretation to the content being taught".* In a simiar comment, Participant 1 noted that *"the level of interest and engagement in the learners in the past week, it is clear that there is an improvement in the children. My surprise is that those who were reluctant about learning the subject are*

now becoming really involved in the learning. I think that it is because of the play involved in it. Above all, their performance improved a lot".

On the other hand, at the post-intervention interview, teachers who taught the control group using the conventional approach reported that students lacked motivation and were easily bored. For example, "*the pupils have always shown deplorable attitude in the subject and as you can see, it reflected in their performance. This has been our challenge over time here"[***P3]**. Similarly, Participant 4 expressed displeasure over *"the pupils' inability to retain and demonstrate simple basic science concepts and process".* In the same view, Participant 3 stated thus: "*my worry is that the pupils' performances do not reflect the effort we have put in*".

The Reggio Emilia Pedagogy Improved Students' Academic Performance

In the pre-intervention interview, participants in both the experimental and the control group shared similar views that pupils' academic achievement in basic science was generally poor. This is shown in the words of Participant 2 in the experimental group: "*the pupils' achievement is actually not very encouraging… The worst is when they are taught abstract concepts. They appear lost entirely*". Participant 1 in the experimental group also expressed worry over the pupils' overall achievement. In his opinion, *"it has been the practice that pupils who don't do well in basic science are given complementary assessment tests for them to be able to pass the exam"*. In reaction to the challenges encountered in the process of teaching the subject, a participant in the experimental group emphasized that an intervention programme was timely "*because the teaching basic science as the performance of the pupils in the subject needs urgent improvement"[***P1***].*

At the post-intervention interview, Paticipant 2 in the experimental group attested to the efficacy of the intervention technique. In a reflection below, Participant 2 gave an evaluation of the post-test performance of the pupils thus:

> "*with the test we had in basic science so far. It is impressive and effective. Although it is rigorous, one can be happy that it yielded good results. I don't want to conclude yet but the approach helps the learners to have a direct and unrestricted access to learning materials".*

In a further remark, it was also noted that "*the performance of pupils is very good this time. For me this method works. In the test we conducted last time (Posttest) you can see that it is only 2 pupils who scored less than 60% unlike what was obtainable before*"[**P1**].

On the contrary, it was noted that the pupils' performance was not impressive particularly after the posttest. In line with this observation, Participant 4 in the control group, highlighted that " *there is not much gain after the posttest…the pupils were still struggling to to retain simple concepts in the subject. At the end, the pupils still scored below the pass mark"*. The comments from the two teachers who participated in the intervention programme confirm that the Reggio Emilia teaching approach can improve pupils' academic performance in basic science. They commended the programme as it made rapid and tremendous change in the pupils' achievement.

XI. Discussion

The study's findings reveal that the pupils' academic performance improved significantly at posttest [ie after the intervention programme] compared to the control group, confirming the view that the Reggio Emilia method supports deep learning (Bransford, Brown & Cocking, 2000). This approach to teaching focuses on guiding the learners to focus on concepts needed to solve a problem, relating new and previous knowledge, and linking course content to real life (Hewett, 2001). An instance of such an approach to science learning is teachers' belief that Reggio "*makes the learners active and discover and see what they are learning through observation, exploration and manipulation*" [**P2**].

In addition, the finding from the qualitative data that the Reggio Emilia approach is pereceived to be learner centred and in turn deepens science learning accords with the literature on the subject. Reggio Emilia is indeed learner-centered and relies on inquiry in making learning real for pupils, and it can therefore be said to be inquiry-based as any approach to teaching and learning that emphasizes the role of the pupils is known as inquiry-based learning (Kelemen, 2013). In this process, teachers encourage pupils to explore the material, ask questions, and share their ideas, rather than simply telling them what they need to know (Pedaste et al 2015). The Reggio Emilia approach gives a deeper meaning to science learning by

connecting learners to culture, community, and the natural world (Hewett, 2001; Kelemen, 2013), while engaging their hands, minds, and hearts with science (Amus, 2013; Inan, 2007). By promoting deep learning, projects-based learning, peer networking, and collaboration among learners, the Reggio Emilia approach promotes a modernized and renewed approach to teaching and learning (Moss, 2016).

XII. Conclusion and Limitations

This research set out to explore the effectiveness of the Reggio Emilia pedagogy on basic science learning in Grade 5 in Nsukka Urban, Nigeria. Based on related research in childhood education, we tested the effectiveness of the Reggio Emilia approach in the context of basic science pedagogical practices. A limitation is imposed by the sample size which impacts generalisability of the quantitative findings. Further, Reggio is criticized for not being a formal model with clearly defined methods. Teachers without adequate training in Reggio may struggle to implement this model successfully, and classrooms can be unmanageable at times. The strategy cannot simply be transferred from one area to another. To be effective in a typical classroom environment, it must take into consideration the cultures and beliefs of those for whom it is intended (Hewett, 2001). The Reggio approach takes a long time to implement and requires a small classroom size which may not be achievable in a typical primary school setting in Nigeria. Other challenges of implementing this approach in a typically Nigerian school include lack of qualified teachers and instructional resources. Most schools, especially in the rural areas, lack the necessary support system that will enable them to make a paradigm shift in instructional practices.

XIII. Recommendations for Further Research

The researchers urge that more research that includes parents be conducted since they were not able to involve parents in the current study. By including their perspectives, the study will be more complete. It is also suggested that future researchers examine the methods' application in other practical school courses. In addition to this, since the intervention's impact fades with follow-up testing, the researchers recommend extending the intervention period to improve retention.

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