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The Impact of After School Science Club on the Learning Progress and Attainment of Students

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This study reports the measured impact of attendance at after school science club (ASSC) on the progress and attainment of Key stages 3 and 4 students in a co-education academy in the UK. The research was experimental in design and collected data from both a control and an experimental group of participants, 17 and 140 respectively. Data were collected through observation, questionnaires, focus groups and test performance scores. The data were subjected to various statistical analyses using SPSS. The means of performance scores for students in both control and experimental groups were tested for significance at different time points using Welch's T-test, and the effect of the ASSC on science performance scores across the different time points for both groups was tested (pre and post-tests) using the Kruskal Wallis test. The questionnaire was analyzed using thematic analysis with recurrent themes identified following a process of coding to establish the skills that students can gain from attending and participating in an ASSC. The study found that the experimental group, who attended ASSC showed improvements in their academic attainment although most participants identified the acquisition of non-academic skills as the more significant outcome of their engagement. These skills included collaboration and teamwork, leadership and communication skills, and confidence in learning. Drawing on the findings, the study provides evidence that discipline-specific after-school clubs can facilitate learning and recommends that discipline-informed extra-curricular activities should be promoted in facilitating learning in STEM subjects.

Keywords: after school science club, extra-curricular activity, attainment in science, STEM, learning progress, attainment of students

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INTRODUCTION

Extra-curricular activities (ECA) outside normal classroom hours can help schools to promote learning and overcome barriers to learning (Cadwallader, Garza & Wagner, 2002). Various terms describing out-of-classroom support are used interchangeably in the UK education setting (Department for Education and Skills (DFES), 2006; Donnelly et al., 2019). As such, the term extra-curricular activity (ECA) is similarly used in this study to include study support and after school science club (ASSC) which is the focus of this study (Im, Hughes, Cao & Kwok, 2016; Nuffield Foundation, 2016; Donnelly et al., 2019). ASSC in the context of this study is framed as an after-school activity designed to provide extra support to students by promoting their interests in learning to enhance their social, emotional, moral, cultural, and academic development (Tseng et al., 2020). ASSC aligns with the UK Government's agenda on Every Child Matters (DFES, 2002) and is centered on promoting extra-curricular activities to enable students to stay safe and healthy, enjoy and achieve, make a positive contribution to their learning, and achieve economic well-being so that students can realize their full potentials (Cheminais, 2007). ECA can provide improvements in various aspects of the educational experience including fun and healthy activities, personal attributes, skills development, confidence, self-reliance, self-esteem, initiative, resourcefulness, loyalty, and academic performance (Im et al., 2016; Nuffield Foundation, 2016; Behtoui, 2019). These outcomes are attributed to its inherent social capital (Behtoui, 2017).

Many discipline-specific ECAs have a specific positive impact on students' learning such as sports and music and can lead to academic achievements and encourage students to remain in education after compulsory schooling (Donnelly et al., 2019). However, Denault & Poulin (2009) reported that participation in performing arts and academic clubs can be linked to higher academic grades than participation in sports while Villarreal (2013) reported that participation in sports accords students a sense of school belonging and social interactions among students, parents and school. This is corroborated by Bekomson et al. (2020) who suggest that taking part in interesting physical activities as part of an ECA can promote the mental alertness of students and lead to academic attainment. Regarding the attainment of students, Chan et al. (2020) reported that math-focused out-of-school time support can have a positive impact on students' attainment than ASSC. While these studies have demonstrated improvement based on various discipline-specific ECAs, there is little evidence of investigating the impact of science clubs as a discipline-specific ECA. One exception is Assaraf (2011), who found a mixed pattern of the impact of the ASSC on the science learning of students. Whilst there was evidence of improvements in the science attainment of some students, there is evidence of the reverse in some of the other students in the study. The lack of progress is attributed to the students' refusal to take responsibility for their learning, a lack of motivation and teachers' pedagogy. It is conceivable, therefore, that the students' inconsistent involvement in the learning process may have affected the lack of success in developing and maintaining a process of constructing scientific knowledge.

It can be argued that a structured ASSC can make STEM or science interesting to students as it can develop non-academic skills and attitudes towards the subject, application to real-life situations and help shape students' views of science (Gonsalves, 2014). Unfortunately, the lack of pedagogical knowledge of teachers in running ASSC may continue to hinder students' engagement, interests, and performance. The provision of training for teachers running ASSC and incentives to other experienced teachers may attract further teacher participation. Although ASSC may present evidence of mixed academic gains among students, the additional benefits including students' performances and the non-academic skills such as collaboration and teamwork, leadership and communication skills, and confidence in learning that contributes to the improved performance may be the case for its promotion. The conflicting outcomes to the various studies in ECAs depend on the structure and focus. This, therefore, necessitates the need to look at ECAs, not as a homogenous structure, but in typologies. Unpacking impact in this context should not only be limited to test scores but should also include perceptions of practitioners and beneficiaries to ascertain their views on a more coherent and holistic approach to designing activities that would promote and support students' learning. It is against this backdrop that this study sets out to answer the following research questions:

- What is the impact of ASSC on science students' attainment?
- What are students' views on how ASSC impacts their attainment?
- What are the skills acquired by students attending ASSCs that promote their learning and progress?

Theoretically framing the literature on Extra-curricular activities

Studies on ECAs and their impact on learners have been theoretically framed using a myriad of structures (Shulruf, 2010). Such theoretical framings have informed several studies including the examination of ECA within school-sponsored contexts (Tseng et al., 2020), organized and non-organized activities for high school students (Chambers & Schreiber 2004) as well as social behaviors and high-risk activities. Other studies have constructed their frameworks around the ownership of the various ECAs and the implications for perceived gains of ECA. This includes the impact of ECAs on self-efficacy (Attarwala, 2015; Raffo & Forbes, 2020; Bekomson et al., 2020), academic and learning outcomes (Storey, 2010; GEC, 2018; Behtoui, 2019; Donnelly et al., 2019), impact on peer interaction, social capital, and friendships (Fredricks & Simpkins, 2012; Simpkins, Vest, Delgado, & Price, 2012), teamwork, social skills, managing emotions (Braund & Reiss, 2006; Siddiqui, Gorard & See, 2019; Buckley & Lee, 2021) and resilience (Raffo & Forbes, 2020).

Studies on ECA have also been anchored on a framework that explores the typology of ECA including internship, multicultural events, career activities, creative arts, leadership, and service (Storey, 2010), study-related activities, tutoring support or private classes, and mixed activities (Moriana et al., 2006). These examples typify the complexity, on the one hand, and the potential inconsistency, on the other hand, that can manifest with the use of various theoretical frameworks. For example, while Raffo & Forbes (2020) offer a framework of ECAs that can go beyond the mainstream school curriculum, other studies present ECAs that are aligned with the curriculum and labeled as co-curricular (GEC, 2018). It is viable to argue, therefore, that ECA activities are complex and may be designed to have varying foci.

In the context of this study, we suggest that none of the frameworks explored above is sufficiently suitable for carrying out a valid impact analysis of ECAs. Central to this rejection is the potential these frameworks have for generating a non-finite list of variables. Because of this, it becomes difficult to identify with any serious conviction, the actual impact. Because of these limitations, this study draws on elements of a more current alternative framework for evaluating the impact of the ASSC intervention implemented. In our view, a more suitable framework for this study would need to offer elements that are represented across several existing frameworks. Such a framework is founded on a fruitful amalgamation of some of the elements of existing frameworks which makes it a more comprehensive and robust framework for evaluating the impact of an ASSC intervention in a much more straightforward way. To achieve this, we draw on the theoretical framework proposed by Seow & Pan (2014) which offers the opportunity to identify some of the crucial elements of existing frameworks.

In a comprehensive literature review of ECAs, Seow & Pan (2014) identify three frameworks that embody the simplicity we advocate. We suggest that they can be merged to present a single comprehensive framework. The first posits that engagement with ECAs can have a negative effect on academic achievement and is called the 'zero-sum framework'. This framework is often acknowledged with the understanding that the negative impact is often caused by the additional time that extra-curricular activities demand and could result in negative effects (zero-sum framework) (See e.g. Buckley & Lee, 2021). The second posits that ECAs can have a 'positive effect on academic performance indirectly because of the non-academic skills and this is the developmental framework', while the third has a 'positive effect on academic performance up to a certain point beyond which participation leads to negative academic outcomes' (threshold) (p. 364). We suggest that by combining these frameworks, we can account for the impact of ASSC on students' attainment and the non-academic skills that may have influenced their achievements.

Various studies have employed frameworks that align with the individual elements of Seow & Pan's (2014) framework, and this shows their viability as evaluative instruments in this context. For example, Im et al. (2016) utilized a framework that enabled them to measure the impact of ECA on the academic attainment of students but with a focus on how the non-academic attributes could result in this progress. Denault & Poulin's (2009) framework mirrors the threshold component of the framework, as it shows a positive effect on academic performance from early to mid-adolescence with a positive developmental trajectory throughout adolescence but with a decline in impact subsequently. Although Buckley & Lee's (2021) framework helps to track the impact of ECA on students' learning at the outset, it highlights the potential for a zero-sum or threshold outcome if a balance is not struck between extra-curricular activities and study and other forms of academic work. Essentially, therefore, the literature provides evidence of the viability of Seow & Pan's framework and its effectiveness in measuring the impact of ECAs on the academic and non-academic achievements of learners.

Because of the functionality of these three elements as illustrated above, we feel confident that a framework that combines all three, although transient, will help us to fully interpret and justify students' performances and any relationships that can be drawn from them.

The impact of ASSC on students' learning

ASSC provides the opportunity for students to develop skills that can have a positive impact on their academic achievements. Bekomson et al. (2020) conclude that participating in such activity promotes social, academic, language, and moral efficacies as a collective gain, and encourages teachers and school leaders to create the opportunity for students to engage in activities that will promote such skills. It can also promote curiosity and an enjoyable learning environment (Tseng et al., 2020). In the same vein, Wade-Jaimes, Cohen & Calandra (2019) assert that ASSC can promote inclusive learning, STEM skills, using scientific equipment, and help make connections between science and students' interests by influencing their views of science. This can promote students' attitudes towards learning in the ASSC activities, but at the same time, it leaves open questions about the effect that the absence of formal assessments may have on students' attainment. Congruently, Raffo & Forbes (2020) assert that the attainment of students can be promoted through these non-cognitive skills mentioned and can be transferred into the mainstream classroom for cognitive capabilities. This resonates with the views of Donnelly et al (2019), who argue that by their very nature, these activities encourage academic achievement even though this might not be the original objective. Their argument is centered on the premise that activities in ASSC develop students' attitudes that are more predisposed to academic study and promote their long-term goal and opportunity to develop a network with others, as it influences their educational aspirations.

The nature of the skills identified as a product of ASSC underscores their potential for encouraging educational achievements. For example, although developing networks with students, teachers, and other people involved in ASSC has also been considered as a strong element in promoting socialization and connecting with the larger community of learning (Ginosyan, Tuzlukova & Hendrix, 2019; Tseng et al., 2020; Buckley & Lee, 2021), these skills are also seen as having the potential to help students transition from secondary to university education especially for navigating issues of social and cultural imbalances. A more direct link between ASSC achievements and academic development is provided by McVee et al. (2017) who found that an after-school engineering club created the opportunity for a hands-on activity for children who are English language learners and supports the children in constructing knowledge, bridging the gap on language, culture, or gender, and especially promoting social interactions. The outcomes of ASSC are, therefore, not solely academic but can be a mixture of academic and non-academic skills.

METHOD

This research is a mixed-method experimental study (Creswell, 2012). It enabled us to harness a richer and more comprehensive data corpus which translated to a more credible and in-depth understanding of the phenomenon being investigated. The study employed observation, questionnaires, focus groups and test performance scores. which also furthered the course of triangulation (Robson, 2011).

The Research Participants

The study took place in a co-education secondary school Academy in London. The experimental group of 17 students, consistently participated in an ASSC and are in Key stages 3 (year 7 and 8, first and second year of secondary education) and 4 (year 9 and 10, third and fourth year of secondary education) in the British Educational system. We limited the experimental group to 17 participants because only this number participated fully in the ASSC program for two years thus meeting the threshold for measuring the impact of ASSC (Bohnert, Fredricks & Randall, 2010; Siddiqui, Gorard & See; 2019). Therefore, the group was self-selective, and we recognize that this might be reflective of a commitment to study which could have an impact on the outcomes of the study. This possibility was however ameliorated by the similar level of performance between the control and experimental group at baseline (table 1). Further, because of the small number of participants in the experimental group, we consciously subjected the quantitative data to additional statistical tests to enhance the data's validity and reliability. The control group is made up of 140 participants from the same year groups but did not attend ASSC. The third group was made up of the teacher for the ASSC and the teaching assistant (TA), who contributed to the ASSC. These participants might help further the course of triangulation, as they offer structures and insights that can be compared with what is found with our experimental group.

The Research Design

The research was experimental with both control and experimental groups. Using a control group enabled us to discount any alternative explanations for the effect of treatment (Ary, Jacobs & Sorensen, 2010). Performance data were collected at different stages over the two-year duration of the study starting with pre-intervention data (baseline) and a post-intervention dataset which were collected four times to track the progress of students. The quantitative data generated from the tests and surveys were analyzed.

Intervention

The intervention was an ASSC that was offered to students for two years. The ASSC took place weekly after school for 1 hour. It offered students the opportunity to informally engage in experimenting in the areas of engineering, chemical production, and biological analysis. The experiments included building structures, acids, and alkali, making slime and bouncy balls, cosmetics (e.g., shampoo and body cream), making ice cream, paint production, making fire extinguishers, rocket designs, parachute, plants, and animal practical, field surveys, problem solving and other relevant practical work.

Students were encouraged to work collaboratively and discuss their findings, design experiments and explore scientific phenomena. This promoted the scientific inquiry process such as problem-solving, generating and applying knowledge, discussing ideas, and critical thinking (Capps & Crawford, 2013; Irwanto et al., 2018; Syarifudin et al., 2019). Others include hypothesizing, analyzing questions, evaluating, and making an informed decision (Syarifudin et al., 2019), but importantly relating their everyday life experiences to science and their community.

The practical work and activities were selected from the national curriculum topics covered in the school to give students the opportunity for extra support and develop transferrable knowledge to the mainstream classroom. The national curriculum in England stipulates topics that schools need to teach throughout the academic year. The activities were partly student-led, as they had the independence to decide what to engage with, how to engage and the time spent on the activities. This involves students suggesting topics and practical activities that they would like to take part in, and this may be informed by practicals they may have completed or not completed in the mainstream classroom. In some cases, students were required to search for topics listed in the national curriculum contents or any area of interest. However, the teacher is also involved in choosing activities that relate to topics that the students were engaged in as reflected in their current schemes of work. These activities were, therefore considered high impact activities based on their relevance to the students' curriculum and because of students' interest. For the former, the expectation is that activities relating to the curriculum content will necessarily align to the planned outcomes while for the latter, it is assumed that interest will result in motivation.

Data Collection

Data were collected using observation, questionnaires, focus groups and test performance scores.

Observation

Observing the teacher and TA during the ASSC was useful in helping us to frame relevant questions during the focus group discussions. The questions centered on the teacher and TA's experiences of running the ASSC, their views on the effect on students' learning and the nature of the skills students can develop from participating in ASSC. The observation took place fortnightly for 1 hour and over two years. This allowed us to ask relevant questions where necessary. During the sessions observed, students were involved in practical work, problem-solving, and discussing their findings collaboratively. The observer, one of the researchers, took field notes. These notes informed the structure of the focus group and in some cases, provided the framework for understanding the data collected through questionnaires.

Questionnaire

The questionnaire was essentially informed by a preliminary observation of students and teachers during ASSC. The focus of observation was on how students learn and the support they received from teachers and TAs working with them. The questionnaire was piloted with similar students attending ASSC. Examples of questions generated for the questionnaire include 'what is the impact of ASSC on your communication and participation in class and other school activities?' and 'how has attending ASSC encourage or support your self-confidence and self-esteem?'. In designing the questionnaire, we recognized that we could adopt a student questionnaire for measuring satisfaction and engagement (See Andrew & Ronald, 2009). However, we decided not to use this but created our questionnaire to get a true dimension of both qualitative and quantitative impact of ASSC on students' learning mainly because we intend to explore some findings from our preliminary observations and, therefore, required specific questions.

Focus Group

The focus group discussion took place once every term at 6 weeks intervals and lasts for 30 minutes over the two years of this study. It centered on the teacher and TAs experiences of running the ASSC. During the discussions, both the teacher and TA were asked to provide the researchers with other relevant information that we may not have considered. The feedback received highlighted the understanding of terminology as a potential issue and in response, technical terms were simplified into ordinary language use. Comments from the focus groups were collected from the teacher and teaching assistant and these provided pathways to triangulation with the findings from students' questionnaires.

Test Performance Scores

The science test performance scores of both groups over two years were collected and analyzed. Students' performance scores in science tests were graded using the progress 8 and attainment 8 grading systems in the English National Curriculum (Department for Education (DFE), 2020) ranging from 1 (grade U) to 9 (grade A*). Progress 8 and attainment 8 are based on a calculation of students' performance across 8 different subjects of which science is one. The standardized tests were used to track performances throughout the study and the grades each student requires to achieve a positive Progress 8 score set by the school. Each student's results are compared to other students with the same prior attainment within the same cohort. 'The greater the progress 8 scores, the greater the progress made by the student compared to the average for students with similar prior attainment' (DFE, 2020, p 9). Test results indicate whether, as a group, students in the school made above or below average progress compared to similar students in other schools.

The tests were standardized tests from the scheme of work used by schools in England to measure the attainment of students. We have relied on the tests rather than using a neutral instrument to measure attainment because it allows us to measure students' progress scores over the academic year in comparison with other students at a similar stage of learning in England (DFE, 2020). This test was preferred in this study because it is an integral part of curriculum delivery and offers the element of consistency in terms of curriculum exposure and testing conditions. This provided a reasonable reassurance of the limited impact that other factors could have had if a different testing tool were utilized. The science tests were generally administered at 3 months, 7 months, 15 months, and 19 months. It is comprised of different tests that have been used for several years to assess students and consistently reviewed and improved. Therefore, it is a consistent instrument that is used by all schools and for all students.

Data Analysis

The effect of ASSC on students' attainment in science was analyzed using SPSS. The performance scores in science tests were measured at four points 3 months, 7 months, 15 months, and 19 months. The study had an experimental group (n=17) who took part in ASSC, and a control group (n=140) not involved in the ASSC (table 1). Shapiro-Wilk's test was performed to test the normality of the data (Razali & Wah, 2011). The means of performance scores for students in both control and experimental groups were tested for significance at different time points using Welch's t-test (Delacre et al., 2017). The effect of the ASSC on science performance scores across different time points for both groups was tested (pre and post-tests) using the Kruskal Wallis test (Hoffman, 2019).

Data from questionnaires were analyzed using thematic analysis (Braun & Clarke, 2006) with recurrent themes identified following a process of coding. The principle of semantic association helped to merge the emerging terms after each researcher went through the codes to ensure the reliability and validity of the outcome and discrepancies were resolved. The emergent themes were then discussed in the context of existing theoretical frameworks. Comments from the focus group discussions with the teacher and TA was used as supporting evidence of the outcome from the students' questionnaire.

FINDINGS

The study sample was tested for normality and the dependent variable for performance scores of students in the control group was not normally distributed at the 4 measurement points (Shapiro- Wilk, $P < 0.05$). The level of skewness and kurtosis was measured at every measurement point but did not differ significantly from normality (Celikoglu & Tirnakli, 2015). Skewness ranged from −0.169 to −0.347 (SE= .205) and kurtosis ranged from −0.121 to −0.438 (SE= .407) across the 4 measurement points. Shapiro-Wilk test confirmed the dependent variable for performance scores was not normally distributed in the experimental group across the 4 measurement points ($P < 0.05$). Skewness ranged from −0.051 to 0.399 (SE= .550) and kurtosis ranged from -0.580 to 0.382 (SE= 1.063) across the 4 measurement points and did not differ significantly from normality. These findings were expected, and alternative statistical tests were performed to reach accurate statistical findings.

Kruskal Wallis test revealed statistically significant differences in performance scores of students in the experimental group at the 4 measurement points compared to the control group. Significant differences after 3 months, $\chi^2 (2) = 32.01$, $p < 0.001$, 7 months, $\chi^2 (2) = 48.95$, $p < 0.001$, 15 months, $\chi^2 (2) = 50.96$, $p < 0.001$, and 19 months, $\chi^2 (2) = 51.33$, $p < 0.001$. Welch's t-test was conducted as the assumption of homogeneity of variance was not met. We hypothesized that the ASSC would increase the performance scores of students. Performance scores between the two groups differed significantly according to Welch's t-test after 3 months t(18.071) = 6.527, $p < .05$, 7 months t(17.534) = 10.217, $p < .05$, 15 months t(17.728) = 12.341, $p < .05$ and 19 months t(19.062) = 16.689, $p < .05$ (table 1). The mean increase in performance scores for the experimental group ranged between 2.82 and 6.59 while the control group ranged between 2.91 and 3.06. The 95% confidence interval of the effect of ASSC is between 1.111 and 4.143 points and this supports our hypothesis that students who participated in the ASSC performed significantly higher. The effect size (Hedges' g) (Lakens, 2013) was calculated to determine the more practical significance of the difference detected between the experimental and control groups looking at the difference in standard deviations. It revealed after 3 months = 1.625, 7 months = 2.525, 15 months = 3.063, and 19 months = 4.209. The positive value indicates that the ASSC has an impact on the performance of the experimental group compared to the control.

Table 1
Performance scores and statistics for the control and experimental groups

	Mean of the control group (n=140)	Mean of the experimental group (n=17)	SD	Mean difference	95% CI of the difference Lower	95% CI of the difference Upper	t	df	P-value	Hedges' g
Baseline	2.95	2.82	0.809	-0.13	-0.556	0.303	-0.616	19.141	0.497	-0.159
Postint1 (3 months)	2.95	**4.59**	1.004	1.64	1.111	2.165	6.527	18.071	<0.05	1.625
Postint2 (7 months)	3.06	**5.88**	1.111	2.82	2.237	3.399	10.217	17.534	<0.05	2.525
Postint3 (15 months)	3.06	**6.24**	1.033	3.18	2.631	3.711	12.341	17.728	<0.05	3.063
Postint4 (19 months)	2.91	**6.59**	0.870	4.04	3.220	4.143	16.689	19.062	<0.05	4.209

Bold; indicates comparative significant results and/ or P-value

Findings from the Analysis of Students' Questionnaires

Findings from students' questionnaires contribute answers to our research questions two and three: 'What are students' views on how ASSC impacts their attainment?' and 'What are the skills acquired by students attending ASSC that promote their learning and progress?'. Several skills associated with the learning process were developed because of participants' involvement with the ASSC. The survey highlights three dominant themes. For each theme, there were different synonyms, but we used the principle of semantic association to merge some of the emerging terms. Also, comments from focus group discussions with the teacher and teaching assistant that ran the ASSC will be used as part of supporting evidence in the outcome from students' questionnaires where applicable.

The first theme was collaboration and teamwork. An element of this involves leadership as some students alluded to the development of the ability to lead collaborative activities. This resonated through various terms such as '*work with others'* (student 1), *'participate in discussion with others'* (student 2), '*work with others and making new friends'* (student 3), and '*it made me work with others and participate in discussions and lead a team'* (student 4). These comments all fed into the emergence of the theme of collaboration as they were all considered to subscribe to a similar semantic field in terms of interpretation. Although they initially contributed to the emergence of sub-codes, a further process of synthesization led to the emergence of the overarching theme. Other contributions that help to build up the theme of collaboration and teamwork include: '*it made me think for myself a bit more and work as a team' (student 5), 'it helped me work as a team with others and improve group work'* (student 6) and '*we had the opportunity to improve teamwork, leadership and good participation in the practical'* (student 7). More comprehensive evidence of the emergence of this skill is offered by student 8 who said: '*we do a lot of activities such as experiments and fun stuff, I led my team when we were making cosmetics but someone else led the rocket design and I learned from them'*. The students' comments were echoed by the teacher who said that '*engaging students in ASSC stimulate their interest in science, promotes inquiry learning and collaborative problem solving'*.

The second theme, leadership and communication skills emerged through various synonymous terms**.** Student 1 referred to '*listening and concentrating during ASSC'* while student 2 emphasizes the element of leadership, noting *'it has taught me leadership skills and how to support my learning'*. Other responses that contribute to the development of this theme include comments such as: '*it has improved my interaction with other students and my communication skills'(student 2), 'it supports my learning, meeting other students and people and interacting more with friends'(student 9), 'it supported my learning because I learn more skills such as discussing with people and leading activities in the ASSC' (student 12) and 'I believe in myself, able to lead and respect others' (student 17)*. Student 13 introduces the element of attitudinal change in communication, as; '*I can talk now before I used to be shy'*. Comments from the TA also highlight the emergence of students' leadership quality in taking ownership of their learning. For example, the TA noted: '*attending ASSC benefits the children and supports their learning, socializing with others from different ethnic backgrounds'* while the teacher said that '*it helps in meeting the social and emotional needs of students and cognitive development.* These responses show how the additional impact is generated through the ASSC even though it was not the original goal. More importantly, we can visualize how these additional goals can ultimately contribute to the achievement of academic goals. There was an indication that developing leadership skills was a product of acquiring other skills. Student 7 commented; *'teamwork has helped me in leadership, communication and ability to take part in other activities'* while student 8 noted that; '*it helps me in leading people and their learning and believing in myself'*.

The third dominant theme was confidence in learning which manifested in two different ways. While some relate to the notion of self-worth, others focus on attitude towards learning. The notion of self-worth is used in consonance with Duchesne & McMaugh, (2016) who see it as an element of the self-worth theory of motivation, which describes an individual's tendency to protect their sense of self-worth as the motive of avoiding failure and hence approaching success. As such, comments relating learners' achievements to the achievements of other learners and those relating to self-belief are considered reflective of self-worth. Typifying the notion of self-worth, student 1 said that *'I have a better understanding of my learning and be above other students';* student 5 asserts that *'I am happy with myself because I have improved in my learning and interest in studying'* while student 7 commented *'that it has made me believe in myself because I know things that I did not know before'* and student 12 said '*ASSC has improved my concentration and self-esteem'*. In terms of attitude, the focus is more on the disposition of these students towards their studies and echoes what might be termed the affective domain of learning which includes constructs such as attitudes, beliefs opinions, and interests (Glynn & Koballa, 2006). Responses that indicate progress in the context of learning in the affective domain are represented by student 2, who commented; '*it has improved my skills and confidence',* student 3, who observed *'it has improved my concentration in different tasks',* student 6 who noted*, 'it supports my interest in learning and makes me work harder'* and student 9, who confirmed that it '*allows me to do things that I have interest doing because I have a lot of fun doing them'*. For student 11, the additional dimension of clarity of direction is important**;** **'***it made me know what I want to be in life and decide a career in science'*.

This development is reiterated in the response of the teacher and allows us to triangulate the emergence of this theme. In his response, the teacher confirmed that '*participating in ASSC promotes behavior for learning and builds students' scientific ideas and how they relate it to the real-life situation'*. These are all elements that highlight the affective dimension to learning, as they do not necessarily relate to cognitive development in any way. The teacher further noted: *'we also engage them in scientific inquiry and concepts as well as addressing their misconceptions'*.

DISCUSSIONS

Discussion of the Test-Score Data

Our findings show a steady improvement in students' attainment from year one to two echoing the developmental construct in Seow and Pan (2014). We can, therefore, conclude that a longer-term attendance of ASSCs elicits a statistically significant improvement in the attainment of students but with marked differences in the second year of attendance (Bohnert et al., 2010). This suggests that ASSC tutors' focus must go beyond what is gained to include the disposition to participate. What might be responsible for the progress noticed amongst students in the experimental group? This may be due to the non-academic skills that they have developed such as collaboration and teamwork, leadership and communication skills, and confidence in their learning (Im et al., 2016; Mc Vee et al., 2017). Robinson, Dailey, Hughes & Cotabish (2014) attribute this progress to improvement in students' science process skills, science concepts, and science content knowledge. This is embodied in the scientific inquiry process (Irwanto et al., 2018; Syarifudin et al., 2019) as students solve problems, evaluate their learning and relate their everyday life experiences to science and their community. The findings underscore the developmental framework of Seow & Pan's (2014) constructs and provide evidence for our research question one, that ASSC does contribute to the attainment of science students.

Discussions from Students' Questionnaires

These findings emphasize that students value the opportunity to work with and learn from each other (Nuffield Foundation, 2016). This is probably because of the structure of ASSC activities which involve practical and other problem-solving activities. This may have been further enhanced by the autonomy that comes with it, as students could work within groups composed of consensus. It is conceivable that the implied autonomy inspired participants to work and make meaningful contributions to their learning within a constructivist learning framework, as it engages their epistemological resources (Elby & Hammer, 2010) thus accentuating the distinction between 'constructed and propagated knowledge' (p. 411). It also highlights the effectiveness of ASSC in promoting the scientific inquiry process (Syarifudin et al., 2019) and encourages students to think and act across multiple contexts, making use of ideas and strategies, and reimagining and designing the world around them (Herrenkohl & Bevan, 2017; Wade-Jaimes, Cohen & Calandra, 2019).

Another insight emerges from the fact that students participating in ASSC can be conscious of the impact that one skill might have on the development of others. Participants suggest that acquiring these skills is not an end. For example, they see the improvement in collaboration and teamwork as responsible for the development of leadership and communication skills. This resonates with Vygotsky's notion of social interaction and the development of the learner. It may be that the social dimension of leading their learning facilitated the development of metacognition leading to improvements in academic performance, again validating Seow & Pan's (2014) developmental framework. The significant improvements in science learning (see table 1) resonates with previous studies which found that extra-curricular activities help students to develop skills that impact their academic attainment and progress (Assaraf, 2011; Im et al., 2016; Bekomson et al., 2020) and reiterates the importance of skills that are not directly linked to academic achievements in the context of learning. Further, the concept of transferrable skills is crucial. In the search for promoting a constructivist science classroom, the development of transferrable skills might well be a way forward. Evidence from this study highlights the relationship between listening and concentrating at an ASSC, engagement with others, as well as improved leadership and communication skills. Teachers and facilitators of ASSC must, therefore, take cognizance of this potential causative relationship when designing the structure and outcomes of after school science clubs.

The indication of confidence among students suggests that ASSCs can help students to overcome challenges to their learning. We make this argument in the context of the recognition of the affective domain of learning. There is evidence that learner attitude can sometimes impact their learning. As noted by GL-Assessment, UK (2016) whereas a lot of attention is paid to how students learn, what do we know about what they think of school or their teachers? How well prepared do they think they are to learn? How confident are they and how well do they respond to increased curriculum demands?' (p1). The conclusion we draw in terms of the relationship between attitude, confidence and learning is, therefore, informed by our view of confidence as an indicator of attitude towards learning. This is particularly important for science teaching and learning with students experiencing difficulties in making meaning from abstract concepts. It could be argued that ASSC can prepare students for coping with the perceived challenges inherent in science. Further, because students felt that building confidence could also help their development in other areas, it is important that in planning ASSC, the focus includes both the immediate /direct and potential/ indirect impacts. Therefore, we suggest that the real strength of ASSC lies in the ripple effect it can initiate. Proper measurement of the impact of ASSCs, therefore, should also focus on the associated skills it helps students to develop (Attarwala, 2015). Findings from this study confirm that the associated skills developed in ASSC contribute to the progress of students in their academic work in consonance with Seow and Pan's (2014) developmental framework.

CONCLUSION

Our research questions focused on finding if participation in ASSC could have an impact on students' academic performance, and the identification of the non-academic skills that may promote the learning and progress of students. This is in the context of conflicting arguments about whether ASSCs contribute to students' pedagogical knowledge or not (Assaraf 2011; Chan et. al., 2020). Evidence from this study has shown that all students who attended ASSC made progress in their learning with improved academic attainment (Seow & Pan, 2014). As such, the answer to our first research question is in the affirmative- ASSCs do have a positive impact on students' academic performance. Regarding our second and third research questions, there is evidence that these students achieve other skills and attributes which may have contributed to their improved academic performance. We, therefore, suggest that the real importance of achieving these skills lies in the fact that they help to develop a sense of achievement among students and engender the feeling of belonging to a learning community that values and creates opportunities for them to develop and reach their full potentials. These are echoed by comments from the teacher running the ASSC that:

> *'the students have developed good relationships with others, subject knowledge, practical skills, and problem-solving. I can ask questions and support their learning needs, and I have received feedback from colleagues that these students are now making good progress in their normal science lessons'.*

This is supported by the TA who said that: '*students get a lot of support attending ASSC and they enjoy the experience as it contributes to their learning, they can talk with their peers, share ideas and carry out practical, and they help each other in this process'.*

One other issue emerging from this is the importance of the structure and content of ASSCs. Our findings reveal that for it to be effective, the structure and contents of the ASSC need to be designed to promote those skills and attributes. This may prevent the decline in motivation for learning science among students (Young, Wendel, Esson & Plank, 2018) including difficulty in making meaning from the different abstracts in the science curriculum (Campbell, Schwarz & Windschitl, 2016). The structure needs to combine science content learning with fun and engaging activities to promote learning and progress. This echoes the argument of Braund & Reiss (2006) that ASSC should complement formal schooling and teachers should not ignore its influence on students' knowledge and understanding, attitudes, and motivation to learn. Therefore, there is some positivity associated with the findings of this study, regarding Seow and Pan's (2014) developmental framework. This could serve as a foundation for addressing some of the issues relating to achievement and engagement and opens an opportunity for school leaders and policymakers to consider how ASSC could be made more accessible to students. We can conclude that, just in the same way that ASSC facilitates science learning, it could, act as a catalyst for promoting the science, technology, engineering, and mathematics (STEM) aspirations of schools (Herrenkohl & Bevan, 2017).

LIMITATIONS

An obvious limitation is the small number of students in the experimental group and the teachers involved. While we have used our methodological rigor to address this issue, the study would have benefitted from having more participants in the experimental group. However, concrete evidence emerged from the quantitative data, but we could explore the possibility of interviews in a future study to get participants' views on the impact of ASSC.

REFERENCES

Anderson, G. L., Krathwohl, D. R., Airasian, P.W., Cruikshank, K. A., Mayer, R. E., Pintrich, P. R., Raths, J. & Wittrock, M. C. (2001). *A taxonomy for learning, teaching, and assessing: a revision of Bloom's taxonomy of educational objectives*. (Eds.). New York: Pearson, Allyn & Bacon.

Andrew J. W. & Ronald G. D. (2009) Construct dimensionality of engagement and its relation with satisfaction, *The Journal of Psychology*, *143*(1), 91-112.

Ary, D., Jacobs, L. C. & Sorensen, C. (2010). *Introdcution to research in education*. 8th Ed. USA: Wadsworth Cengage Learning

Assaraf, O. B. Z. (2011). Learning from failure: a case study of where extracurricular science program went wrong. *Journal of Science Educ Technology*, *20*, 592-607

Attarwala, P. (2015) The effects of extracurricular activities on student's academic self-efficacy. *International Journal for Research in Education*, *4*(7), 1-2.

Behtoui, A. (2017). Social capital and the educational expectations of young people. *European Educational Research Journal 16*(4), 487–503.

Behtoui, A. (2019) Swedish young people’s after-school extra-curricular activities: attendance, opportunities and consequences, *British Journal of Sociology of Education*, *40*(3), 340-356.

Bekomson, A. N., Amalu, M. N., Mgban, A. N & Kinsley, A. B. (2020). Interest in extracurricular activities and Self efficacy of senior secondary school students in Cross River State, Nigeria, *International Education Studies, 13*, 8

Bohnert, A., Fredricks, J., & Randall, E. (2010). Capturing unique dimensions of youth organized activity involvement: Theoretical and methodological considerations. *Review of Educational Research*, 80, 576–610.

Braun, V. and Clarke, V. (2006) Using thematic analysis in psychology, *Qualitative Research in Psychology, 3*(2), 77-101.

Braund, M. & Reiss, M. (2006). Towards a more authentic science curriculum: the contribution of out-of-school learning, *International Journal of Science Education 28*(12), 1373-1388.

Buckley, P & Lee, P. (2021). The impact of extra-curricular activity on the student experience, *Active Learning in Higher Education, 22*(1), 37-48.

Cadwallader, T., Garza, N., & Wagner, M. (2002). *Participation in extracurricular activities.* Retrieved 12 October 2020 from: https://nlts2.sri.com/reports/2003_04-2/nlts2_report_2003_04-2_ch4.pdf

Campbell, T., Schwarz, C., & Windschitl, M. (2016). What we call misconceptions may be necessary stepping-stones on a path toward making sense of the world. *The Science Teacher*, *83*(3), 69-74.

Capps, D. K. & Crawford, B. A. (2013) Inquiry-based instruction and teaching about Nature of Science: are they happening? *Journal Science Teacher Education*, *24*, 497–526.

Celikoglu, A., Tirnakli, U. (2015). Comment on universal relation between skewness and kurtosis in complex dynamics. *Physical Review* E 92, 066801 (December).

Chambers, E. A. & Schreiber, J. B. (2004) Girls' academic achievement: varying associations of Extracurricular activities. *Gender and Education*, *16*(3), 327-346

Chan H. Y, Choi H., Hailu M. F., Whitford M. & DeRouen S. D. (2020). Participation in structured STEM-focused out-of-school time programs in secondary school: Linkage to postsecondary STEM aspiration and major. *J Res Sci Teach. 1–31*.

Cheminais, R. (2007) *Extended Schools and Children's centres*. A practical guide (1st Ed.). London: Routledge.

Creswell, J. W. (2012). *Educational research. Planning, conducting, and evaluating quantitative and qualitative research*. 4th edn. Boston: Pearson Education, Inc.

Delacre, M., Lakens, D., & Leys, C. (2017). Why Psychologists should by default use Welch's t-test instead of student's t-test. *International Review of Social Psychology*, *30*(1), 92–101.

Denault A. & Poulin F. (2009). Intensity and breadth of participation in organized activities during the adolescent years: Multiple associations with youth outcomes. *Journal of Youth and Adolescence*, *38*, 1199–1213

Department for Education (DFE) (2020). *Secondary accountability measures. Guide for maintained secondary schools, academies and free schools.* Retrieved 25 October 2020 from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/561003/Progress-8-school-performance-measure-18-Oct.pdf.pdf

Department for Education and Skills (DFES) (2002) *Extended schools providing opportunities and services for all.* Retrieved 10 July 2019 from http://dera.ioe.ac.uk/6326/7/Extended-schools%20prospectus_Redacted.pdf

Department for Education and Skills (DFES) (2006). *Study Support: a national framework for extending learning opportunities*. Retrieved 13 June 2018 from http://dera.ioe.ac.uk/7638/7/study_support_framework_Redacted.pdf

Duchesne, S., & McMaugh A. (2016). *Educational psychology for learning and teaching* (5th ed.). Sydney, Australia: Cengage Learning Australia.

Donnelly, M., Lažetić, P., Sandoval-Hernandez, A., Kumar, K., & Whewall, S. (2019). *An unequal playing field-extra-curricular activities, soft skills and social mobility.* Social Mobility Commission.

Elby, A., & Hammer, D. (2010). Epistemological resources and framing: A cognitive framework for helping teachers interpret and respond to their students' epistemologies. In L. D. Bendixon & F. C. Feucht (Ed.), *Personal epistemology in the classroom: Theory, research, and implications for practice* (pp. 409-434). Cambridge: Cambridge University Press

Fredricks, J. A., & Simpkins, S. D. (2012). Promoting positive youth development through organized after-school activities: Taking a closer look at participation of ethnic minority youth. *Child Development Perspectives*, *6*(3), 280–287.

GEC. (2018, March). *Thematic review: extra and co-curricular interventions*. Retrieved 29 March 2018 from https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/730863/TR-Extra-Cocurricular-Interventions.pdf

Ginosyan, H., Tuzlukova, V. & Hendrix, T. (2019). Teachers' perspectives on extra-curricular activities to enhance foundation program language learners' academic and social performances, *Journal of Applied Studies in Language, 3*(2), 168-177

GL- Assessment (2016) Pupil attitudes to self and school, report 2016. Retrieved 12 July 2020 from https://www.gl-assessment.co.uk/

Glynn, S. M., & Koballa, T. R. (2006). Motivation to learn in college science. In J. J.Mintzes & W. H. Leonard (Eds.), *Handbook of college science teaching* (pp. 25-32). Arlington, VA: NSTA Press

Gonsalves, A. J. (2014). Science isn't just what we learn in school: Interaction rituals that value youth voice in out-of-school-time science. *Canadian Journal of Education, 37*, 185-208.

Herrenkohl, L. R. & Bevan, B. (2017). What science and for whom? An introduction to our focus on equity and out-of-school learning. *Sci Ed*., 101, 517–519.

Hoekstra, R., Kiers, H. A. L. & Johnson, A. (2012). Are assumptions of well-known statistical tests checked and why (not)? *Front. Psychology*, 3, 137.

Hoffman, J. I.E. (2019). *Analysis of Variance. I. One-Way - Kruskal-Wallis Test in Basic Biostatistics for Medical and Biomedical Practitioners* (2nd ed). Oxford, UK: Academic Press.

Im, M. H., Hughes, J. N., Cao, Q. & Kwok, O. (2016). Effects of extracurricular participation during middle school on academic motivation and achievement at grade 9. *American Educational Research Journal, 53*(5), 1343-1375.

Irwanto, Saputro, A. D., Rohaeti, E., & Prodjosantoso, A. K. (2018). Promoting critical thinking and problem-solving skills of preservice elementary teachers through process-oriented guided-inquiry learning (POGIL). *International Journal of Instruction, 11*(4), 777-794.

Lakens, D. (2013). Calculating and reporting effect sizes to facilitate cumulative science: a practical primer for t-tests and ANOVAs. *Front. Psychol 4*(863), 1-12.

Moriana, J. A., Alós, F., Alcalá, R., Pino, M. J., Herruzo, J. & Ruiz, R. (2006) Extra-curricular activities and academic performance in secondary students *Electronic Journal of Research in Educational Psychology*, *4*(1), 35- 46.

McVee, M., Silvestri, K., Shanahan, L. & English, K. (2017). Productive communication in an afterschool engineering club with girls who are English language learners, *Theory Into Practice, 56*, 246–254

Nuffield Foundation (2016). Out of school activities improves children's educational attainment. Retrieved 19 April 2019 from http://www.nuffieldfoundation.org/news/out-school-activities-improve-children%E2%80%99s-educational-attainment

Raffo, C. & Forbes, C. (2020). A critical examination of the educational policy discourse on/for school extra-curricular activities – a Deweyan perspective, *Oxford Review of Education*, DOI: 10.1080/03054985.2020.1835625

Razali, N. & Wah, Y.B. (2011). Power Comparisons of Shapiro-Wilk, Kolmogorov-Smirnov, Lilliefors and Anderson-Darling Tests. *Journal of Statistical Modelling and Analytics*, *2*(1), 21-33.

Robson, C. (2011). *Real world research. A resource for users of social research methods in applied settings* (3rd ed) West Sussex: Wiley

Robinson, A., Dailey, D., Hughes, G. & Cotabish, A. (2014) The effects of a science-focused STEM intervention on gifted elementary students' science knowledge and skills. *Journal of Advanced Academics*, *25*(3) 189-213.

Seow, P. & Pan, G. (2014) A Literature Review of the Impact of Extracurricular Activities Participation on Students' Academic Performance, *Journal of Education for Business, 89*(7) 361-366

Shulruf, B. (2010) Do extra-curricular activities in schools improve educational outcomes? A critical review and meta-analysis of the literature. *International Review of Education*, *56*(5–6), 591–612.

Siddiqui, N., Gorard, S. & See, B. H. (2019). Can learning beyond the classroom impact on social responsibility and academic attainment? An evaluation of the children's university youth social action programme, *Studies in Educational Evaluation 61*, 74–82.

Simpkins, S. D., Vest, A. E., Delgado, M. Y., & Price, C. D. (2012). Do school friends participate in similar extracurricular activities? Examining the moderating role of race/ethnicity and age. *Journal of Leisure Research*, *44*(3), 332–352.

Storey, K. L (2010). Bridging the gap: linking co-curricular activities to student learning outcomes in community college students (Dissertations, Paper 30). Retrieved 05 May 2020 from: https://digitalcommons.nl.edu/diss/30

Syarifudin, Purwanto, Irawan, E. B., Sulandra, I. M., & Fikriyah, U. (2019). Student verbal interaction in geometry problem-solving through cognitive activities. *International Journal of Instruction, 12*(3), 167-182

Tseng, S., Kang, H., Nguyen, T. S. & Liu, M. (2020). Correlations between the attitudes about learning of after-school club students during school and the teaching quality of elementary school teachers, *Social Sciences, 9*, 125

Villarreal V. (2013). Characteristics and consequences of extracurricular activity participation of Hispanic middle school students (doctoral thesis) Texas A&M University. Retrieved 17 February 2021 from: https://core.ac.uk/download/pdf/13642182.pdf

Wade Jaimes, K., Cohen, J. & Calandra, B. (2019). Mapping the evolution of an after-school STEM club for African American girls using activity theory, *Cultural Studies of Science Education, 14*, 981-1010

Young, A. M., Wendel, P. J., Esson, J. M & Plank, K. M (2018). Motivational decline and recovery in higher education STEM. *International Journal of Science Education*, *40*(9), 1016-1033.