THE IMPACT OF CREATING A SCIENCE ELITE CLUB AND ACTIVELY ADOPTING STUDENT-LED LEARNING METHOD ON MIDDLE SCHOOL ESL STUDENTS' ACADEMIC ACHIEVEMENT IN SCIENCE

by

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TABLE OF CONTENTS

1. INTRODUCTION……...1

2. CONCEPTUAL FRAMEWORK…….……...4

3. METHODOLOGY……..7

4. DATA AND ANALYSIS……..13

5. INTERPRETATION……..17

6. CONCLUSION……..19

7. VALUE……..22

REFERENCES CITED……24

APPENDICES…….26

APPENDIX A Invitation Letter to Science Elite Club……..27
APPENDIX B Screenshots of The Name List on Website……29
APPENDIX C Science Elite Club Promotion System……...31
APPENDIX D Photos of Science Elite Club Extracurricular Activities……...33
APPENDIX E Microsoft Form Questionnaire……..35
APPENDIX F Questionnaire Respondents Name List……..39
APPENDIX G Part of The Science Competition Results……..41
APPENDIX H Part of The Videos Made by Science Elite Club……...43

LIST OF TABLES

1. Science Elite Club Establishment Timeline.....8

2. Responses for Questions 6 and 7……...15

LIST OF FIGURES

1. Responses to Question 2: Role Distribution of Respondents……..14

2. Responses to Questions 3 and 4: Overall Evaluation.…….14

3. Responses to Question 5: Learning Materials Usage…….…….17

INTRODUCTION

I was the Head of Science at Nanwai King's College School Wuxi from 2018 to 2021. Wuxi, a city located about 130km west of Shanghai, is home to around eight million people. The school officially opened in September 2018, consisting of four divisions, a kindergarten for kids aged 3 to 5, an international division for students aged 6 to 13 with overseas passports, a bilingual division serving Chinese students aged 6 to 13, and an international curriculum center for students age 14 to 17. The school was founded by two world-class schools, Nanjing Foreign Language School (Nanwai) and King's College School, Wimbledon, England, along with Dipont, a leading educational organization, the Ministry of Education, and the local government.

I joined the school as part of the founding team and was responsible for curriculum development and the establishment of science labs. Our school offers students a world-class education, preparing young men and women for university study throughout the world and developing the qualities needed for leadership in the 21st century. The school has grown rapidly, with 800 students joining us in the first year, increasing to 1200 in the second year, and over 1500 in the third year. Within three years, it has become one of the most popular schools in the region, attracting many students from other cities.

The bilingual division had over 800 Chinese students and the majority of the students came from upper-middle-class backgrounds. Most of the students studied in public schools before joining this school and were English as a Second Language (ESL) learners. We deliver a unique bilingual curriculum, which combines the Chinese national

standard curriculum with Cambridge Lower Secondary Framework from 6th to 8th grade. The school also offers the International General Certificate of Secondary Education (IGCSE) for 9th to 10th grade and Cambridge A-level for 11th to 12th grade.

The result of English education in most public schools in China is not satisfactory since they focus on how to do English exam questions instead of using English in learning other subjects. Most students enter our school with a low level of English while parents expect their children to be fluent in English in a short period of time and be able to participate in international standard examinations. All science classes and exams in our school use English as the medium language. Science could be very challenging for ESL students because of the large number of professional vocabulary and abstract concepts. Science classes in public primary schools are not taken seriously, resulting in weak subject knowledge and a lack of effective learning methods. Many students who were new to our school found science to be the hardest subject.

In addition, our school was not streamed which means students in each classroom may have significant differences in English levels. High-level students want more challenges, while weaker students are not used to taking the initiative to ask for help. Parents hope the school can provide them with more support, such as basic learning materials, extra tuition time, etc. On the one hand, teachers need to prepare their own courses, and on the other hand, they need to take into account the needs of different students. With limited time and energy, they cannot do everything by themselves. These issues must be addressed through innovative and differentiated teaching methods that leverage the power of outstanding students and create multi-dimensional learning

pathways that will help maintain and encourage a positive learning environment.

I hold a Master's Degree in International Education and am enrolled in the Master's of Science in Science Education program at Montana State University. I have been involved in bilingual education since 2009 and have always believed that every child has their own unique learning path. My classroom presents a positive and encouraging atmosphere, and it is my goal to make learning a fun and meaningful thing. I also believe that true elite education is giving outstanding students the opportunity to demonstrate leadership, and to be able to improve themselves while influencing those around them.

My primary action research question was *What is the impact of creating a Science Elite Club and actively adopting student-led learning method on middle school ESL students' academic achievement in science?* Science Elite Club was made up of a group of people who love exploring science and enjoy helping others to learn science and academic achievement was defined by students' grades in science. I will detail the selection process and requirements in the treatment section.

My sub-questions were as follows:

1. What is the impact of creating a Science Elite Club and actively adopting student-led learning method on science academic achievement and learning attitudes of Science Elite Club members?

2. What is the impact of creating a Science Elite Club and actively adopting student-led learning method on science academic achievement and learning attitudes of other students who are not in the Science Elite Club?

3. How does sharing teaching resources created by members of the Science Elite Club affect the learning community, including parents, other teachers, and students from other schools?

CONCEPTUAL FRAMEWORK

From the very beginning, I chose to teach as a profession mainly because I wanted to be a lifelong learner. I feel that being a teacher can satisfy my desire to learn. I am a firm believer that teaching and learning are integrated, not divisive opposites. The Roman philosopher Seneca was a proponent of this very idea, declaring that "docendo discimus" ("by teaching, we learn"). For students, I also encourage them to see teaching others as one of the best ways to learn. When a person teaches others what he knows, he truly internalizes and absorbs the knowledge applied. The result of passive learning is that very little is really mastered, and it is often forgotten quickly because it does not reflect the value of what you have learned. While active learning is a teaching method that engages students in collaborative activities, enabling students to take more responsibility for their own learning (Hacisalihoglu, G., Stephens, D., Johnson, L., & Edington, M., 2018). In addition to the cognitive and academic benefits, active learning methods can also provide social-emotional support, especially for students who may feel uncomfortable or unsupported in traditional passive learning (Wible, B., 2021).

In traditional education, we tend to divide students or put them on opposite sides. This is particularly evident in Chinese public schools. Because of the fierce competition for higher education, every student wants to be the best in class. As a result, they only focus on their own studies and grades and even think that helping their classmates to

improve will lead to their own failure. I think it's just a very unhealthy and harmful idea because, in a real society, success mostly depends on cooperation to create a win-win situation. From the very beginning of establishing the Science Elite Club, I carefully communicated my beliefs with every student. Just having excellent academic results does not meet the conditions for joining us. It must be that they agree that we want to create the progress of the team, and they believe that this process will allow themselves to grow as well. Several benefits of peer tutoring for both tutors and tutees are documented in the literature. From an academic point of view, most studies report significant improvements in student achievement. The social impact of peer tutoring is also valuable because it promotes student inclusion and improves classroom climate (Moliner, L., & Alegre, F., 2020).

On the other hand, each student has different interests and preferred learning styles. Traditional classroom education often only provides learning paths from one or two dimensions, such as listening to teachers or completing classwork. What if we can provide multi-dimensional learning resources, from visual, auditory, to one-on-one communication, group competition, hands-on practice, etc? New information technologies also enable new types of communication and interpersonal interaction, which in turn reshape both traditional face-to-face and distance education (Dede, 1996). Students can feel more empowered to choose the learning approach, thus stimulating the initiative of learning. Most teachers will say they don't have the time to prepare so much material, but in fact, they ignore the power of the students themselves. It is completely possible to involve some students in the class to assist in completing these things, then a

classroom with only one teacher may become with seven or eight teachers, which inadvertently increases the teacher-student ratio.

Why do I sometimes find it hard to take advice from my parents and elders while it's easier to open up with close friends? This may be the influence of peers, which we tend to ignore in education. Peer learning is a teaching practice that affects not only learning but the overall mental health of students (Hanson, J. M., Trolian, T. L., Paulsen, M. B., & Pascarella, E. T., 2016). There are differences in age and experience between teachers and students. We teach them what we have experienced, but their future may not be like that. In traditional education, teachers are often positioned high, and mistakes are not allowed. The sense of distance created by this causes students to dare not take the initiative to communicate even if they do not understand or think that what the teacher said was wrong.

However, if another classmate made a mistake during the recording, peers are more likely to point it out. It is also easier to ask your classmates for advice when you can't finish the assignment. Self-directed learning means that learners are actively involved in shaping their own learning process, collaborative learning means working together on tasks, and peer learning aligns with these new goals (Zundert, M., Sluijsmans, D., & Merriënboer, J., 2010). The premise of all this is that teachers first set an example in the classroom and encourage this atmosphere of peer-teaching and common progress. In a classroom like this, finding mistakes is a good thing, not an embarrassment. After all, the development of science itself is to continue to move forward in all the people who are fascinated by it, constantly making mistakes and looking for answers.

METHODOLOGY

This study is a descriptive study where I describe the impact of a Scientific Elite Club mainly operated in the Bilingual Junior High division. The Bilingual Junior High division consists of three grades, grades 6-8, with more than 400 students aged 11-14. Each class has a maximum of 24 students, with an even ratio of males and females. Almost all of the students are Chinese citizens from upper-middle-class backgrounds. Most parents value education and have the financial means to support their children. The school also aims for an elite education, with good facilities and a generous budget for the science department. All science classes are held in the laboratory, each teacher has a fixed laboratory, and students only come to the laboratory during science class time.

In my lab, there are eight student tables, one teacher's desk, five sinks, a fume hood, emergency showers, several cabinets, an interactive whiteboard, and three ordinary whiteboards. Each student table is approximately two meters by one meter in size and can seat four students. Students bring their own laptops and can use the power supply on the desk. There is a laboratory preparation room connected to the laboratory, which stores some experimental supplies. There are eight laboratory preparation rooms in the whole school. The items in them are managed by specialized laboratory technicians for the use of science teachers in the whole school.

The establishment of the Scientific Elite Club is a continuous process from inside the classroom to outside the classroom. As I get to know more about my students, I'm constantly thinking about better ways to organize and motivate them. At first, it was just my personal idea, and then other teachers joined me. Table 1 is a simple timeline

describing the step-by-step setting up and history of the Science Elite Club.

Table 1
Science Elite Club Establishment Timeline

Time	Description
September to October 2018	Rewarded stickers for students who perform well in group study.
November 2018	Confirmed the requirement to join the Science Elite Club and issued the first invitation letter. Designed the logo.
December 2018	Started recording science books on the website www.ximalaya.com. In the beginning, I asked different teachers to help with the recording, and then the students joined.
January 2019	Officially launched Science Elite Club website reedscience.sxl.cn. Confirmed the names of the four levels: Junior Member, Senior Member, Science Tutor, and Science Mentor.
February 2019	Every Thursday club members have lunch with science teachers in the school cafeteria and discuss cutting-edge topics. This tradition has continued since then.
March 2019	Run Science Video Making extracurricular activity for club members and started uploading experiment videos made by students to v.qq.com.
June 2019	11 students won awards in the Australian Big Science Competition. Since then, members of the Science Elite Club have continued to achieve good results in various science competitions.
September 2019	First trip outside of school for the Science Elite Club. We took an enlightenment class on the theory of relativity at the Shanghai World Expo Museum, and also had fun in the Museum of Illusions

Time	Description
October 2019	The student-made promotional video for the Science Elite Club was completed and posted to various websites.
December 2019	Eight members of the Science Elite Club went to Beijing Jiaotong University to participate in the XLab advanced experimental course as the youngest students.
January to February 2020	With the outbreak of the epidemic, all schools in China had online classes, our club produced a large number of videos and learning materials for students to study at home.
March 2020	Wuxi Education Channel reported on a member's introductory stop motion animation of the COVID-19 virus and introduced Science Elite Club in the TV news.
September 2020	One science mentor runs a lunchtime tutoring session to answer questions and provide reviews for fellow students in the same grade.
November 2020	Online media EnsightEdu published a report on our science department, which detailed how the Science Elite Club operates and interviewed several members.
December 2020	Ties with club logos were customized so that science mentors could get ties and wear them in and out of school.
February 2021	The Science Elite Club was extended to the primary division, and some fourth and fifth-grade students also began to organize activities under the leadership of their science teachers.
March 2021	Organized chemical experiments and biological experiments extracurricular activities for club.
July 2021	Seven club members join the London International Youth Science Forum in Shanghai. One was invited to the stage for the opening ceremony as a student representative.

In the beginning, I needed to find suitable potential club members from each class. A semester course is divided into four units, each lasting approximately four to five weeks. We will rearrange study groups before the start of each unit. A study group shares a student table and consists of a group leader and two or three group members. The task of the group leader is to help and support the group members in their learning process. Any student can nominate themselves or recommend others to become the group leader, but in general, students with excellent academic performance in science or those who are willing to help other students will be more likely to serve.

Each class is forty-five minutes, and I usually set up fifteen minutes of group study time when planning the class. The fifteen minutes may be separated into several time blocks or a single time block. For example, after finishing teaching a section, I give the group five minutes to discuss what they just learned and work on a task together. The group leader has the responsibility to understand the situation of each group member. If a group member is found to have doubts about what has just been learned, the group leader can explain according to his or her own understanding. If the problem cannot be solved within the group, they can seek help from other group leaders or teachers. Besides, the language of instruction was English when I taught, but they were allowed to use Chinese during group study time. The advantage of this is that students who are not fluent in English will not feel lost throughout the class. Their group leader and group members will do their best to ensure that they also understand the content and progress of the class.

At the end of the group study time, I deliberately select some group members to answer questions or make summaries. When a group member completes a task, both the

member and the leader will be rewarded. I would choose some rare stickers such as a chameleon as a bonus to stick on their notebooks. Since each sticker is different, many students are also keen to collect them. By doing this, it encourages an atmosphere of actively peer-teaching within the class. At the end of a unit, a group review time will also be arranged, and some team leaders will even come up with their own questions to test the team members. After the assessments, the group with the greatest improvement in the total score of the whole group will be rewarded with sticker points. When I see a group leader being proud of the progress made by his or her members, I know we're moving in the right direction.

The next step is that during the mid-term or final assessment, students whose personal scores reach 90% and whose sticker points have accumulated 30 points will receive an invitation letter to join the Science Elite Club (See Appendix A). Outstanding individual assessment results demonstrate their own solid foundation in the subject area, while high sticker scores indicate a willingness to participate in group activities and help others. The invitation letter introduces the purpose of the Science Elite Club, why the child receives the invitation, and we must obtain the consent of the parents to use the teaching materials created by the child, including audio recordings, photos, videos, and written materials. Basically, all the students who received the invitation felt it was a great honor, and parents were happy to sign and agree for their children to join. After signing the invitation, their name will appear on the Science Elite Club website (See Appendix B) and school display board, get a custom sticker of the club logo, and start the next journey.

Members who have just joined the Science Elite Club are listed as junior members, and they can strive for upgrades by creating additional teaching aids. Teachers will distribute task sheets according to their own needs, such as Chinese and English word lists, audio recordings of textbooks, translation of textbooks, experimental demonstration videos, review questions, extra tutoring time, etc. Tasks are divided into easy, intermediate, and advanced tasks according to difficulty and complexity. Complete five simple tasks and you will be upgraded to a senior member, continue to complete five intermediate tasks and you will be promoted to science tutor, finally, complete specific advanced tasks, and you will be promoted to science mentor. Each time students upgrade, they will get different souvenirs, and their names will move on the display board. The entire promotion system and requirements are listed in Appendix C.

In addition to this, members of the Science Elite Club have a weekly lunchtime with science teachers. Members of different classes get together with the science teachers to chat about science topics of interest, and they can ask any science-related questions they want. Teachers may not be able to answer, but everyone shared their own information and ideas, and the atmosphere was very harmonious. Such informal meeting help deepen the bond between students and teachers and help teachers learn about topics of interest to students. Another benefit of being part of the Science Elite Club is the choice of our extracurricular activities. Every semester, teachers offer advanced science extracurricular activities for club members. For example, we did forensic science, university physics introduction, chemistry in real life, biology experiments, science video production, etc. (See Appendix D).

The point I want to emphasize here is that it took us three years to gradually mature the system, step by step. Both teachers and students are slowly exploring and learning in the process. On the one hand, we encourage students who have joined the club to continue to create more learning materials and explore what they are interested in. On the other hand, we also encouraged students who were not club members to actively use various learning materials to improve their science academic results. Eventually, Science Elite Club had a strong impact in middle school, with many children making it their goal to receive invitations or get upgraded.

DATA AND ANALYSIS

One year after I left Nanwai King's College School, I made a questionnaire with 15 questions using Microsoft Form (See Appendix E). It was shared with the students and parents of the previous school, and they forwarded it to their own class groups and parent groups to invite everyone to fill in. A total of 85 valid responses were collected within three days, with an average completion time of 16 minutes. It can be seen that most of the respondents filled out the questionnaire carefully. The list of respondents included students and parents, of whom 41 were Science Elite Club members, 21 were non-member students, 16 were member's parents and 7 were non-member's parents. See Appendix F for the specific name list and Figure 1 for the role distribution. Here I sincerely thank them for their support and dedication. Ninety-eight percent of all respondents said they had heard of the Science Elite Club, and two percent of those who had not heard of it were parents of other schools. On a scale of 5 stars, the sum of all

votes gave Science Elite Club an average score of 4.84 stars. Figure 2 shows the details of questions 3 and 4.

Figure 1 - Responses to Question 2: Role Distribution of Respondents (*N=85*)

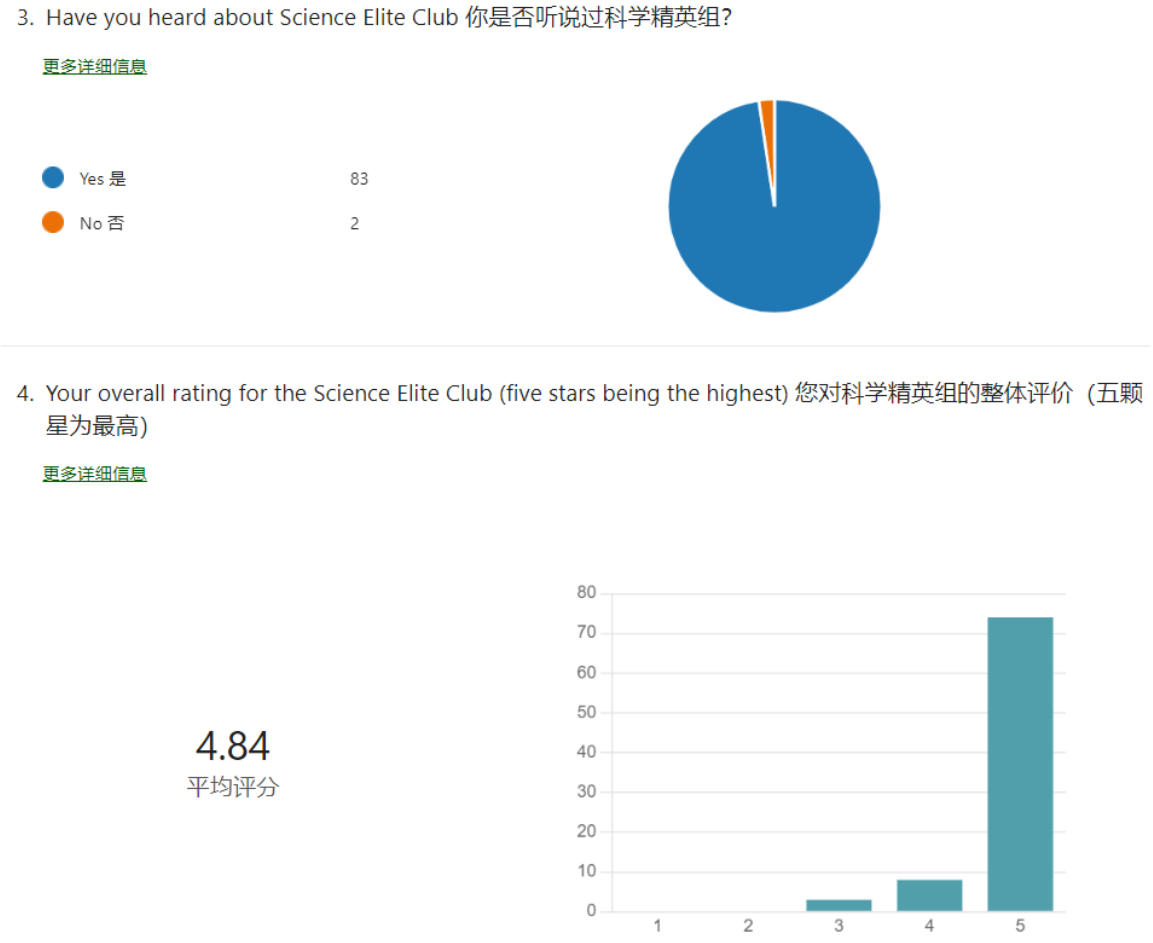


Figure 2 - Responses to Questions 3 and 4: Overall Evaluation (*N=85*).

For questions 6 and 7, I count the responses of members and parents of members as one set of data, and the responses of non-members and parents of non-members as another set of data. For the members and parents of members, in response to the question "Science Elite Club had a positive impact on your/your child's academic performance in science", 75 percent strongly agreed and 23 percent agreed. 79 percent of the respondents strongly agreed, and 18 percent agreed when they answered "The Science Elite Club had a positive impact on your/your child's attitude toward science learning." For the non-members and parents of non-members, in response to the question "Science Elite Club had a positive impact on your/your child's academic performance in science", 50 percent strongly agreed and 21 percent agreed. 61 percent of the respondents strongly agreed, and 14 percent agreed when they answered "The Science Elite Club had a positive impact on your/your child's attitude toward science learning." Table 2 compared the two sets of data.

Table 2
Responses for Questions 6 and 7

	6. Science Elite Club had a positive impact on your/your child's academic performance in science	7. Science Elite Club had a positive impact on your/your child's attitude toward science learning
members and parents of members	75 percent strongly agreed and 23 percent agreed	79 percent strongly agreed, and 18 percent agreed
non-members and parents of non-members	50 percent strongly agreed and 21 percent agreed	61 percent strongly agreed, and 14 percent agreed

Of the 41 club members, 71 percent said they had received and completed between 1 and 10 mission slips. Another 24 percent said they had received and completed more than 11 mission slips. Most members are happy to receive a mission slip as it is an

opportunity for them to level up, and they usually meet the deadline to complete tasks assigned by their teachers. 80 percent of members said they had participated in a lunch meeting with a science teacher, and 83 percent said they had attended an extracurricular or live lesson provided by the Science Elite Club. These are additional opportunities for teachers to explore more esoteric and interesting science topics to encourage club members. In the freelance answer to the question "What aspects of the Science Elite Club impress you the most?", many mentioned being able to do interesting experiments during extracurricular activities and talk about interesting extracurricular topics at lunch meetings.

An interesting phenomenon is that among all the members of the elite science club who participated in the survey, 20% are science mentors, which greatly exceeds the real proportion in our club. The reason is that all mentors completed the questionnaire, while only a small percentage of members of other ranks did. Once upgraded to science mentors, they will get ties specially made by me for them. The school requires students to wear school uniforms, and the ties of the science elite club are the only different styles allowed except for school uniform ties. They usually wear this tie as a symbol of honor on important occasions. I have developed strong friendships with all of my science mentors and their parents, and I promised to write letters of recommendation for them whenever they need me in their life.

Among the various study materials provided by the Science Elite Club, the most used is the Quizlet word list, followed by science videos made by students and review questions or review outlines provided by students. Figure 3 shows the response details of

question 5 about the usage of learning materials created by the Science Elite Club.

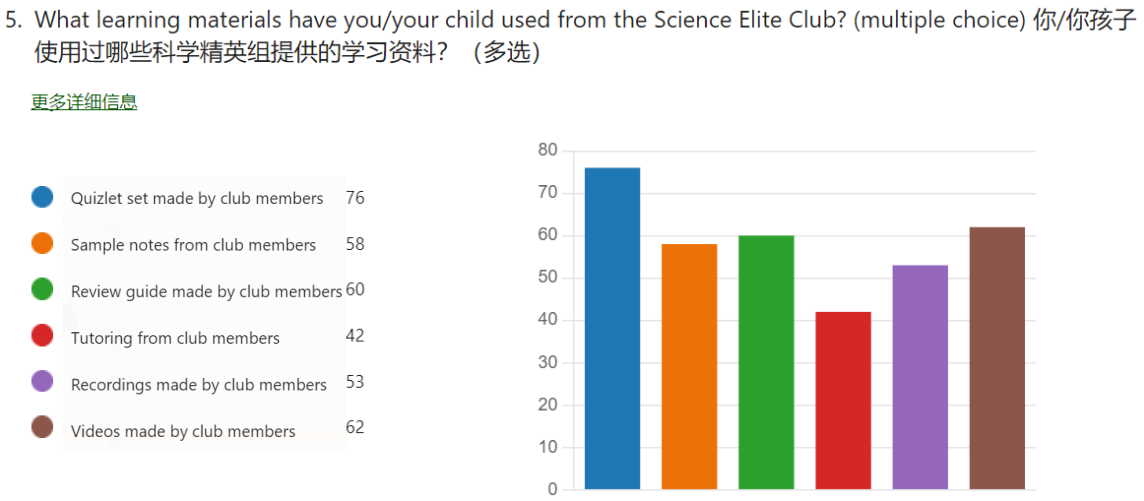


Figure 3 - Responses to Question 5: Learning Materials Usage (*N=85*).

Combined with the data on related websites, more than 100 Quizlet sets have been produced by club members on quizlet.com, with a total of more than 2,000 scientific words. On ximalaya.com, the Science Elite Club has uploaded more than 400 scientific recordings and received more than 50,000 listens. On bilibili.com and v.qq.com, two well-known video websites in China, the Science Elite Club has uploaded more than 100 scientific videos, which have been viewed more than 10,000 times in total. Among them, the introduction video of the Science Elite Club got 2689 views before the writing of this paper. These data do not include websites outside of China such as YouTube, or accounts created by students themselves, and some students upload their own videos to their personal accounts.

INTERPRETATION

Based on the feedback received, almost all members of the Science Elite Club find it to be an attractive team, and they are proud of the efforts and struggles they have been involved in. They all agreed that while helping others and creating learning

resources, their own academic performance and learning attitudes improved. In the context of China's competitive education, it is favorable proof of cooperative learning. The more resources are created by students within the club, the more they agree with this approach. They are satisfied with the excellent team and excellent learning results, deeply miss the good memories of those years, and continue to consciously follow the principle of the Scientific Elite Club in their future studies.

For non-club members, they remembered the help they had received and the teaching resources they had used. They no longer feel embarrassed when they seek help from their peers, and their academic performance and attitude toward learning have also changed for the better. From the original passive learning, thinking that I can't do it, to starting to consciously learn actively, thinking that I can also. Some students also form deep friendships with club members because of the help they receive. They also took this opportunity to express their gratitude and share their feelings of wanting to be better and help their fellows. This is undoubtedly a challenge for a utilitarian society.

For parents, they also see another possibility. Most Chinese parents focus only on their children's academics at school, but they know in their hearts that life is not that simple. The emergence of the Science Elite Club has allowed them to see that not only learning knowledge in school but also cultivating children's sense of responsibility and creativity. What impresses me the most is that many parents have begun to pay attention to science and even study science because of their children. For example, they will listen to the recordings of their own children, and inadvertently become a learner. Videos produced by us are also shared by parents, who also become our untitled advocates.

While we only started with the impact on our students and teachers, the reality is that the impact eventually extends to the entire community and beyond. The outstanding performance of the students in various science competitions began to attract the attention of our school's science program (See Appendix G). Science videos produced by our members serve as open learning resources for all educators in China (See Appendix H). Our sister school King's College School UK, after visiting our school, was particularly interested in the operation of the Science Elite Club and established its own Science Club. Their students communicated with our members through Emails. When I interview students applying for admission, someone says, "I heard this school has a great science organization, so I want to join." At the beginning of 2020, when the epidemic started, a stop-motion animation of the Covid-19 virus made by a member of the scientific elite club was reported by the local TV channel, and they also interviewed me and promoted the Science Elite Club, which made more people learn about this school because of the science program. At the end of 2020, EnsightEdu, an online media focusing on education in China, conducted a detailed interview with the Science Elite Club and released a long report. They filmed our science classes and described the operation of the club in detail. It was shared with parents and educators in different cities about the endless possibilities of peer teaching and student leadership.

CONCLUSION

If teaching is only regarded as a job, then the teacher will try to choose the simplest and most direct method. Most of the time our own education does not encourage the development of our creativity, and we continue to unconsciously pass this on to our

students. No one person's brain can be compared with what dozens of people can understand and imagine, and teachers should not limit different students to their own minds. I'm glad I enjoyed my teaching process during those three years. It has almost become my interest and hobby to work with the students of the Science Elite Club to improve the learning motivation and outcomes of our entire department. It turns out that when teachers give students trust and encouragement, then guide them to be creative in their areas of expertise, students are no longer just passive learners. Those discipline problems in the classroom, the problem of insufficient learning motivation, can be improved to some extent.

To be honest, I didn’t expect that I could get so many students and parents to support me when I wrote this paper a year after I left the school. Every comment they wrote to me made me feel deeply trusted. During the year, although I did not have much direct contact with the students of the Science Elite Club, I still heard from them frequently. Some students also call and ask me about difficult problems in science class. If they receive a transcript or an award, they will share it with me. There are also people who come to visit me in the city where I live during the holidays. It feels to me that our connection has gone beyond classrooms and textbooks, more like a life connection.

The establishment of the Science Elite Club initially affected a few classrooms and gradually affected the entire grade, the entire division, the entire school, and even students and parents outside the school. This also shows that our ideas are not so special and can easily resonate. It's just that most of the time people are afraid of giving, afraid of making mistakes, and afraid of others being better than themselves. What I am most

proud of is not that the members of the club continue to excel academically, but that they have confidence in themselves, knowing that they can give to the world and that they can pursue what interests them. While helping the world become better and making the people around you progress, your own meaning and value will be better reflected. It sounds like a humanities topic, but we push it into the natural sciences.

In response to my first question “What is the impact of creating a Science Elite Club and actively adopting student-led learning method on science academic achievement and learning attitudes of Science Elite Club members? ”, it was found joining the club not only strengthened their academic achievements, but also stimulates interest in learning science. Members developed team spirits and held a sense of belong and identity. They used their strengths to create different learning materials and learn new skills during the leveling up process. The higher level a student reached, the more he or she agreed with our philosophy of creating a learning community.

In response to my second question “What is the impact of creating a Science Elite Club and actively adopting student-led learning method on science academic achievement and learning attitudes of other students who are not in the Science Elite Club? ”, it was found that many non-member students actively use various learning materials produced by the club members. General academic achievement improved and the overall science learning atmosphere of the class got better. What's more valuable is the fact non-members show gratitude and respect to club members for the help they got.

In response to my third question “How does sharing teaching resources created by members of the Science Elite Club affect the learning community, including parents,

other teachers, and students from other schools?", it was found that almost all the parents agreed with the idea of peer teaching and supported their children to join the Science Elite Club. Our school's science department got more praise and recognition because of the club. Resources created on different websites are used by various educators and students in and out of school. Outstanding competition results not only built confidence of the students but also made our school stand out among similar schools in China. Community media coverage drew more attention to the club and people were surprised to see what a student club can do for promoting science education in China.

VALUES

For all educators, the success of the Science Elite Club makes us think about what is truly elite education. What kind of students can become true leaders? Are we cultivating individual victories or collective victories? By sharing our practices and results, it may be possible to open up some teachers' minds. Elite education does not necessarily only focus on top students, but can also influence others, including difficult students. Teachers can also refer to this model and apply it to their own subjects and settings. Make the classroom with only one teacher into an organic learning community.

For me personally, it was a daring attempt in my career, it wasn't exactly planned, and I enjoyed the exploration. I'm glad I followed my original idea, I love learning science, and I want to influence more people to fall in love with science. I'm still thinking about how to modify and continue this model in the future. I am not currently teaching in school, and I deeply feel that it is very difficult to influence the behavior of students

without having face-to-face interactions with them on a day-to-day basis. After all, I don't show up in their everyday lives.

But on the other hand, I also jumped out of the framework of being limited to one school. Currently, I give live online classes to students from many different schools. They are all very interested in science. I am also thinking about how to refer to the practice of Science Elite Club and transfer the impact on them to more people. While the number of students I can teach by myself is limited, the potential of each student is limitless. We can even simulate the model of entrepreneurship, and cooperate with the members of the club to create our own brand and culture with the goal of influencing China's science education on a larger scale. It got me thinking about what my career aspirations were when I was interviewing for a science teacher position for the first time. I replied that I hope to have a good impact on China's science education. I was young and frivolous then, and now I know that I have many, many assistants. One tree can produce many seeds, and many seeds can grow into a forest.

REFERENCES CITED

Dede, C. (1996). The evolution of distance education: Emerging technologies and distributed learning. *American Journal of Distance Education, 10*(2), 4-36.

Hacisalihoglu, G., Stephens, D., Johnson, L., & Edington, M. (2018). The use of an active learning approach in a SCALE-UP learning space improves academic performance in undergraduate General Biology. *PloS One, 13*(5), e0197916–e0197916. https://doi.org/10.1371/journal.pone.0197916

Hanson, J. M., Trolian, T. L., Paulsen, M. B., & Pascarella, E. T. (2016). Evaluating the influence of peer learning on psychological well-being. *Teaching in Higher Education, 21*(2), 191–206. https://doi.org/10.1080/13562517.2015.1136274

Moliner, L., & Alegre, F. (2020). Effects of peer tutoring on middle school students' mathematics self-concepts. *PloS One, 15*(4), e0231410–e0231410. https://doi.org/10.1371/journal.pone.0231410

Wible, B. (2021). Active learning: "Hands-on" meets "minds-on." *Science (American Association for the Advancement of Science), 374*(6563), 26–26. https://doi.org/10.1126/science.abj9957

Zundert, Sluijsmans, D., & Merriënboer, J. (2010). Effective peer assessment processes: Research findings and future directions. *Learning and Instruction, 20*(4), 270–279. https://doi.org/10.1016/j.learninstruc.2009.08.004

APPENDICES

APPENDIX A

INVITATION LETTER TO SCIENCE ELITE CLUB

Dear _____ parents,

I am the Science teacher from Wuxi Nanwai King's College School. Your child participated actively and performed excellently in my class. I am writing to invite your child _____ to join our Science Elite Club. Your child will get some additional science homework and learning tasks. The purpose is to enhance their own learning as well as help other students to improve together. It is completely voluntary to choose whether to join and whether to complete the additional work. Please consult with your child and fill in the receipt below and return it to me. Since the Science Elite Club will produce recordings, videos and other learning materials for other students to refer to, I need your permission to use your child's recordings, photos, videos and publish your child's name to www.reedscience.sxl.cn for non-profit purposes.

Thank you for your support!

Jocelyn Zhang

Date:

I, _____[parent name], the parent or legal guardian of _____ [child name] grant Jocelyn Zhang my permission to use the recordings, photographs, videos of my child legally for non-profit purposes, and publish my child's name to www.reedscience.sxl.cn.

Parent/Guardian's Signature: _____ Date _____

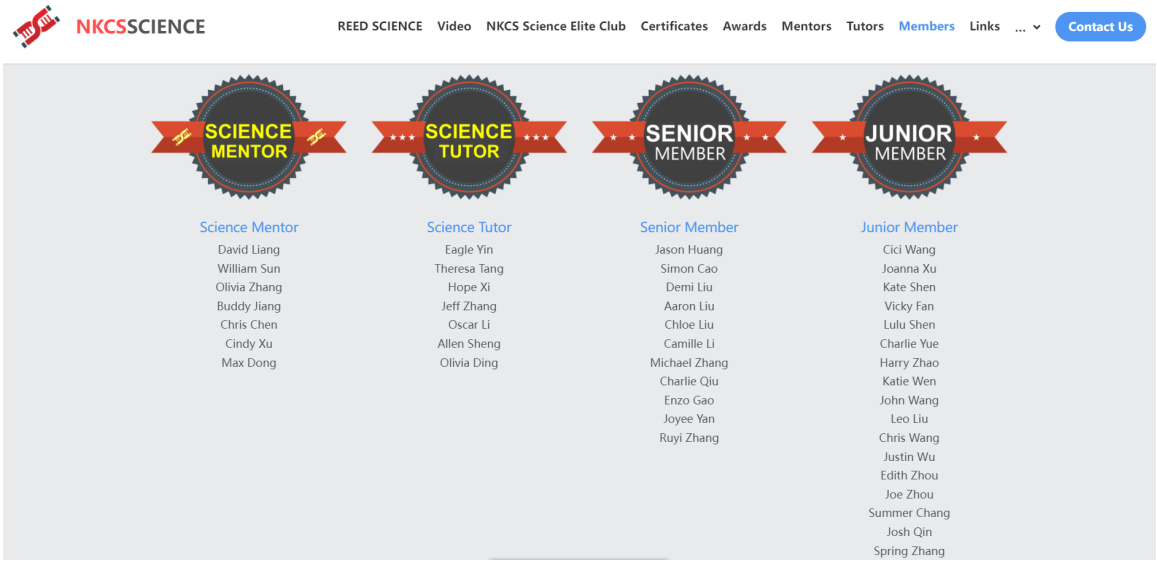
Parent/Guardian's Name: _____

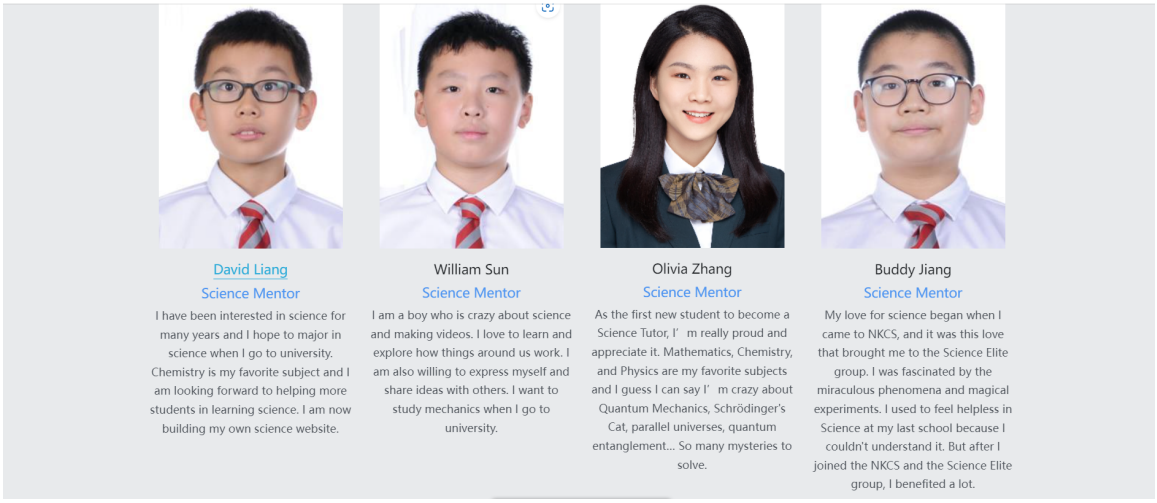
Child's Name: _____

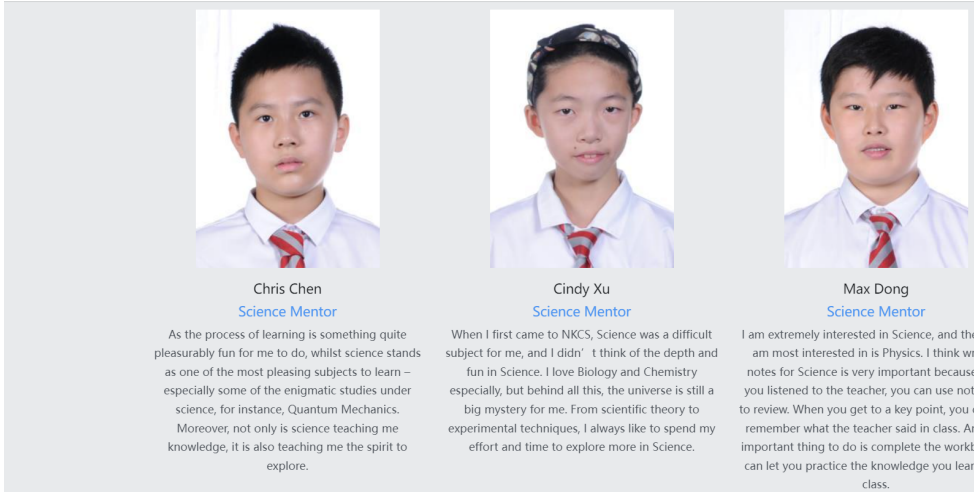
Phone Number: _____

APPENDIX B

SCREENSHOTS OF THE NAMELIST ON SCIENCE ELITE CLUB WEBSITE







*Junior member names are not fully listed here due to limited space

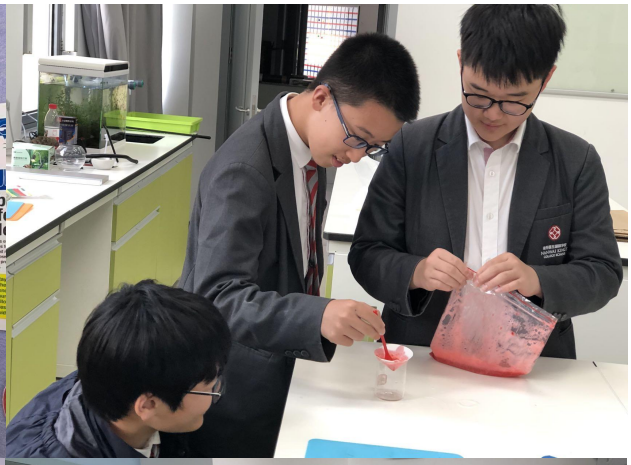
APPENDIX C

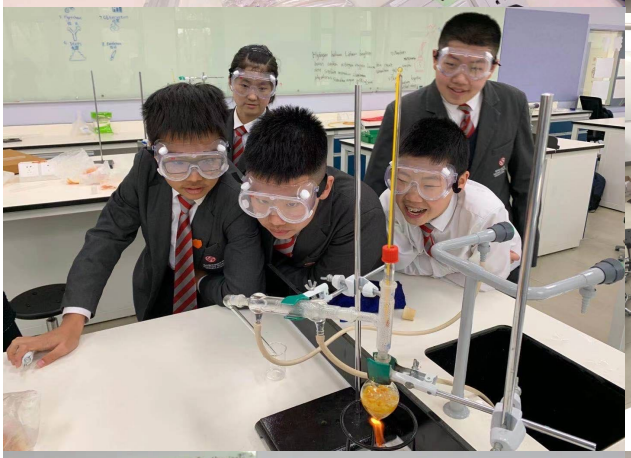
SCIENCE ELITE CLUB PROMOTION SYSTEM

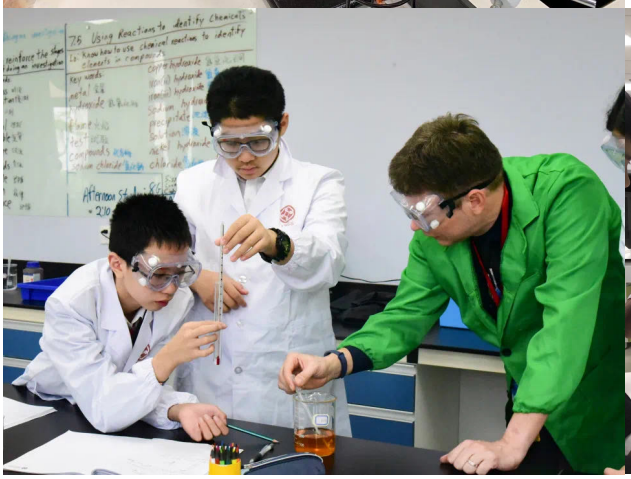
Level	Requirements	Rewards
Junior Member	● Personal scores reach 90% during the mid-term or final assessment ● Personal sticker points have accumulated to 30 points ● Invitation letter signed by guardian	● Club logo sticker ● Name shown on the display board and website under Junior Member section
Senior Member	● Complete five simple tasks, including but not limited to ○ Quizlet set ○ Chapter translation ○ Lab report sample ○ Note sample	● Club logo pencil case ● Name shown on the display board and website under Senior Member section
Science Tutor	● Complete five intermediate tasks, including but not limited to ○ Chapter recording ○ Experiment video ○ Review guide ○ Review quiz	● Club logo badge ● Photo and name shown on the display board and website under Science Tutor section
Science Mentor	● Complete specific advanced task, including but not limited to ○ Provide tutoring sections ○ Build a science website ○ Create a science channel ○ Write a science learning handbook	● Club logo tie ● Photo and name shown on the display board and website under Science Mentor section ● Recommendation letter from the science teacher when needed

APPENDIX D

PHOTOS OF SCIENCE ELITE CLUB EXTRACURRICULAR ACTIVITIES




APPENDIX E

MICROSOFT FORM QUESTIONNAIRE

Science Elite Club Questionnaire (Members, non-members, and parents, all can fill in.)

1. What is your name? (Students fill in their own names, parents fill in XXX's father/mother)

2. What is your role?

- Science Elite Club member
- non-member student
- member's parent
- non-member's parent

3. Have you heard about Science Elite Club?

- Yes
- No

4. Your overall rating for the Science Elite Club (five stars being the highest)

☆ ☆ ☆ ☆ ☆

5. What learning materials have you/your child used from the Science Elite Club? (multiple)

- Quizlet set made by club members
- Sample notes from club members
- Review guide made by club members
- Tutoring from club members
- Recordings made by club members
- Videos made by club members

6. The Science Elite Club has a positive impact on your/your child's science academic performance (1 is completely disagree, 3 is neutral, 5 is strongly agree)

1 2 3 4 5

7. The Science Elite Club has a positive impact on your/your child's attitude towards science learning (1 is completely disagree, 3 is neutral, 5 is strongly agree)

1 2 3 4 5

8. What is it about the scientific elite that impresses you? (Free to express ideas)

9. Questions 9-14 are only answered by members of the scientific elite group. What is the highest level you have achieved in the elite group?

- junior member （with logo sticker）
- senior member（with logo pencil case）
- science tutor（with logo badge）
- science mentor（with logo tie）

10. How many misson slips have you received and completed from your science teacher?

- 0
- 1-5
- 6-10
- 11 or more

11. Describe the learning materials you have created: (eg. 2 wordlists, 1 review guide, 1 recording, etc.)

12. How many times have you attended the lunch meetings with Science Elite Club members?

- 0

- 1-2
- 3-4
- 5 or more

13. Have you ever participated in an on-campus extracurricular activity or live online class of the Science Elite Club?

- Yes
- No

14. List the science competitions you have participated in the past four years.

15. The founder Jocelyn Zhang is writing a paper about the Science Elite Club, what do you want to say to her?

APPENDIX F

QUESTIONNAIRE RESPONDENTS NAME LIST

Thanks to the following participants who responded to the questionnaire.

1. "What is your name? (Students fill in their own names, parents fill in X father/mother)

董里昂	梁宸语	陆晨睿	邓子毅 Alpha 爸爸
许天和妈妈	李玥霖妈妈	Charlie 邱天耀	邓小青 妈妈：汪清
Jason Huang	蒋乐晨	陈子浩	华夏
吴鸿彬 Justin	李不染 Karen Li	李墨一 Minnie	Kevin Han 韩健坤
张伟（钰儿爸）	Gino 季锘宇	施文淇 Milly	李悦舟 CamilleLi
孙炜杰妈妈	Joyee 妈妈	周昱彤 Jo	汤雅雯 Wennie
妈妈	黄子一爸爸	缪周洲 George	Edith Zhou
张艺严爸爸	符亦蓝	盛艾朗 Allen	Elaine Fei
沈小芳	Thor 丁浩钦	Sheng	Ivy 任宸瑶
杨琳	丁宇妈妈	Hannah	华夏妈妈
Davina Deng	张钰儿	Zane Cao	孙炜杰
缪贺轩	卞奕铭妈妈	Darren Qian	赵小石 stone
MatthewMiao	李峥赫	张文婧 Joanna	卞奕铭 Andrew
黄子一 Ziyi	张洋 Jeff	程溟浩妈妈	Cindy Tao 陶昕芸
Max 叶栋泱	李奕樘妈妈	俞佑欣 Rebecca	王浩宇 Mike
姜轶轩 Derrick	陈子浩妈妈	虞程杰 Jay Yu	Judy 王昱淇
章茹壹 Ruyi Zhang	潘聿岑妈妈	吕樱珏	高英哲 Enzo
丁宇 Olivia	chris 妈妈	陈果 Jenny	Linda 妈妈
Lareina Li	秦梓恒妈妈	Lucas Changyile	张艺严 Michael
徐清荷 Cindy Xu	Allen 妈妈	Chloe Liu	殷正逸 Eagle
陈泽尘 Chris	范玮城 gary fan	Joyee Yan	
梁宸语妈妈	谈洛菡妈妈	王昱茹	
陈佳璐		Leo Liu	

APPENDIX G

PART OF THE SCIENCE COMPETITION RESULTS OF SCIENCE ELITE CLUB

Junior Physics Challenge 2020

Gold: Pan Pan
Sliver: David Liang, Allen Sheng, Chris Chen, Harly Chen
Bronze: Nicholas Gong, Simon Cao, Gary Fan, Aaron Liu, Max Dong, Enzo Gao, Steven Xie, Buddy Jiang, Leo Liu, Joe Qiao, Josh Qin, Camille Li, William Gu, Anson Zhang, Jack Xu, Richard Zhang, Minnie Li, Frey Wang, Arthur, Zhu, Vincent Shao, John Wang

British Astronomy & Astrophysics Olympiad 2020

Gold: David Liang, Brian Yu, Nicholas Gong
Sliver: Josh Qin, Michael Zhang, Lareina Li
Bronze: Steven Xie, Ina Hou, Emily Hou, Ruyi Zhang

You Be The Chemist Challenge 2020

Top Gold: William Sun, Eagle Yin, Willing Qi, Eric Zhu, Richard Gu, Leo Bao, Tom Shen, Kevin Fang

Big Science Competition 2020

High Distinction: Edward Wang, Eagle Yin, Bunny Wang
Distinction: Pan Pan, Daniel Tan, Chris Chen, Allen Sheng, Vincent Hopkins

British Physics Olympiad Junior 2020

Gold: William Sun
Sliver: Edward Wang, Pan Pan
Bronze: Richard Gu

APPENDIX H

PART OF THE VIDEOS MADE BY SCIENCE ELITE CLUB

Most videos are not accessible outside of China. Here is the link to an introduction video of Science Elite Club on YouTube: [NKCS Science Elite Club Video - YouTube]