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Analysis of Science Investigatory Projects (SIP) Conducted by Caraga Regional Science High School Students

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Abstract*: This study investigates the Science Investigatory Projects (SIPs) conducted at Caraga Regional Science High School from 2009 to 2020. SIPs serve as a crucial educational tool, fostering scientific research skills among students and preparing them for participation in various science fairs and competitions. The primary objectives are to profile the SIP advisers and assess the types and achievement levels of these projects over 12 years.*

The demographic profile of the advisers indicates a majority are young and female, with various specializations predominantly in Biological Science, Chemistry, and Physics. Their academic qualifications range from baccalaureate degrees to PhD units, with a notable number of them having substantial teaching experience and having attended relevant research training.

The study employs a descriptive, comparative, and correlational research design to analyze the data. The descriptive approach profiles SIP titles, types, proponents, advisers, and awards received, while the correlational method investigates the association between SIP types and their achievement levels. The comparative design examines differences in achievement levels based on advisers' profiles.

Results show a diverse range of SIP types, with a notable concentration in Life Sciences, including fields like Botany, Zoology, and Microbiology. Achievements are categorized into regional, national, and international levels, providing insights into the effectiveness of SIPs based on adviser profiles.

The study highlights the significant role of SIP advisers and emphasizes the need for continuous training and resource support to enhance students' research capabilities. It underscores the importance of SIPs in contributing to scientific knowledge, technological advancements, and socio-economic development.

In conclusion, this research serves as a baseline for future evaluations and improvements in SIPs, aiming to boost scientific inquiry and educational achievements at Caraga Regional Science High School.

Keywords: Science Investigatory Projects, Secondary Education, Research Competitions, Adviser Influence, Student Research

I. INTRODUCTION

SIPs, or Science Investigatory Projects, are activities that substantially assist and challenge teachers and students in applying the process skills required in the scientific method of inquiry. To investigate, a SIP requires the use of basic procedural abilities. Annually, science fairs or research congresses are organized by various bodies at various levels - Division, Regional, National, and International. These activities serve as contest venues and allow young science enthusiasts to exhibit initiatives to solve current challenges.

According to Cobern (2011), for students to actively create meaningful Science knowledge, they should be widely advocated by Science researchers, especially those working on investigative projects. A Science Investigatory Project (SIP) is a must-do activity for students to improve their ability to use and practice the scientific research method. Teachers and students have a lot of options when it comes to studying physical and life sciences.

Competitions serve to promote the ongoing development of School Innovation Projects (SIPs), which helps to sustain and refresh the culture of scientific inquiry in both public and private schools across the division. Drawing from empirical observations and discussions with colleagues, the researcher is motivated to evaluate the student SIPs

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implemented at Caraga Regional Science High School over the past 16 years (2005–2021). This assessment aims to provide insights into the progress and impact of these projects during that period.

The researcher has chosen to conduct this study to create a comprehensive database for recognizing and evaluating previous projects. While annual competition results are compiled to identify winning schools in science contests, no effort has been made to assess the achievements of School Innovation Projects (SIPs). This study aims to examine the historical baseline of research at Caraga Regional Science High School, starting from the time the school first participated in the research contest. Additionally, the researcher seeks to analyze trends in the school's research performance over time, determining whether it has improved or declined, particularly considering the absence of records for past winning projects.

Advantages of Science Investigatory Projects (SIPs)

Science investigatory project (SIP), according to Cuartero (2016), enhances students' interest and process skills (observing, comparing, classifying, measuring, gathering and organizing, predicting, inferring, assessing, synthesizing, and interpreting data). The proponent went on to say that learning Science by conducting Science investigative projects allows all students (male and female) to think, learn, and develop an interest and curiosity about the world around them through exploratory and investigative experiences and activities.

On a bigger scale, Sanchez &Rosaroso (2019) asserted that SIPs are instruments through which students can contribute to the country's S&T [Science and Technology], as seen by the content of these initiatives. These projects are scientific knowledge creations and new knowledge generation; they are socioeconomically relevant to livelihood development. They contribute to the advancement of science and technology as well as community improvement. Indeed, the Department of Science and Technology established a coordinated national R&D plan to benefit Filipinos economically and socially (Department of Science and Technology, 2018). Knowing how vital scientific investigation projects are for students, schools, and society, there must be ways to encourage all students to participate in investigation projects (Butron, 2018). Education organizations host scientific fairs as platforms for academic competition in primary education to motivate students to create high-quality SIPs (Ndlovu, 2014).

Challenges in Conducting/Advising SIPs

On the educator side, Sanchez &Rosaroso (2019) suggested that science teachers teach students how to source problems, identify the validity and reliability of reading literature, and ensure the ethical adaptation of validated and published experimental methods and data analysis interpretation. In this regard, training and capacity-building seminars are required to improve the capacity of Science teachers, particularly those who are new to the subject. Teachers involved in SIP-making improved their personal and professional growth by learning new things and developing career values (Wilson, Schweingruber, & Nielsen, 2015).

Both SIP advisers and student researchers are now addressing issues in the conduct of SIPs. According to Butron (2018), not all students in the Philippines have the opportunity to develop their scientific investigative skills because only a few schools are chosen to offer research as part of the curriculum. Furthermore, the author claims that as a result, ordinary public national high schools may only teach investigative projects to students who participate in scientific fair contests.Again, Jugar (2013) found that, due to a lack of laboratory resources in schools, Science teachers spend their funds to conduct experiments and analyses at commercial laboratories. He continued, "The practice of students having their IP data examined and analyzed through commercial laboratories is regarded invalid yet acceptable by the majority of teacher-coaches respondents."

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II. METHODOLOGY

Participants and Procedure

The study used the descriptive, comparative, and correlational research designs. The descriptive design profiled the SIPS from 2009 to 2020 as to title, type, and year conducted by proponents, advisers, and awards received at the

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division, regional, and national levels. The correlation method determined the association between the type and achievement level of the SIPS. Comparative design was employed to determine the significant difference in the achievement level of SIPs in competition when the respondents are grouped according to their profile.

Data Collection and Analysis

The study used two (2) survey forms (Appendix A) to collect the data. Form 1 gathered data on the Science Investigatory Projects (SIPs) from 2009-2020. Form 1 has six (6) significant columns filled out by School Science/Research Coordinators. These columns are complete title of the SIP, year conducted, type of SIP, name of student-researchers, name of adviser(s), and level of achievement of SIP. Form 2 gathered data on the profile of the advisers with six (6) significant columns. These are name, age, sex, years in service at the time the SIP was conducted, highest educational attainment at the time the SIP was conducted, and number of trainings attended.

The following statistical tools were used to analyze the data collected in the study.

Frequency Count and Percent. These were used to determine the school with the greatest number of winning SIPs, the frequency of life and physical sciences, and the achievement level of SIPs in competitions.

Chi-Squared Test. This was used to determine the association between the type of SIPs and the achievement level.

Kruskal-Wallis ANOVA. This was used to determine the difference in the achievement level of SIPs in competition when the respondents are grouped according to their profile.

III. RESULTS AND DISCUSSIONS

Profile of Teachers/Advisers-Respondents

Table 1 presented the demographic profile of the teachers/advisers in terms of age, sex, field of specialization, highest educational attainment, length of experience and number of relevant trainings attended.

Table 1: Profile of SIP Advisers

Profile		f(n=12)	Percent
Age	20-29	5	41.67
	30-39	5	41.67
	40 and above	2	16.67
Sex	Male	3	25.00
	Female	9	75.00
Field of Specialization	Biological Science/Biology	3	25.00
	Chemistry	3	25.00
	Electronics	1	8.33
	General Science	2	16.67
	Physics	3	25.00
Highest Educational Attainment	Baccalaureate Degree	5	41.67
	MA Units	4	33.33
	MA Degree	2	16.67
	PhD Units	1	8.33
Length of Experience	1-5	5	41.67
	6-10	3	25.00
	11-15	2	16.67
	16-20	2	16.67
Number of Relevant Trainings Attended	None	2	16.67
	1-5	7	58.33
	6-10	3	25.00
Resourcefulness	Developing	4	33.33
	Proficient	5	41.67
	Exemplary	3	25.00

Distribution of SIP's from 2009-2020

The distribution of Science Investigatory Projects (SIPs) conducted in the Life Sciences at CRSHS from 2009 to 2020 is shown in Table 2.

Table 2: Distribution of SIP's Conducted in CRSHS under Life Sciences from 2009-2020

Category	**f**	**Percent**	
		Life Science	**All**
Anatomy	6	4.35	2.05
Botany	29	21.01	9.93
Zoology	11	7.97	3.77
Marine Biology	11	7.97	3.77
Pharmacology	4	2.90	1.37
Ecology	25	18.12	8.56
Microbiology	50	36.23	17.12
Cell Biology	2	1.45	0.68
Total	**138**	**100.00**	**47.26**

Students prefer microbiology as their research topic due to the intriguing nature of microbiology, with its focus on microorganisms that are often invisible to the naked eye, which sparks curiosity and engagement, making it a compelling field of study. Additionally, the hands-on research opportunities in microbiology, which often involve practical laboratory work, allow students to gain valuable skills and experience, further enhancing their interest in this area over other life sciences (Hasruddin, 2019).

Table 3: Distribution of SIP's Conducted in CRSHS under Physical Sciences from 2009-2020

Category	**f**	**Percent**	
		Physical Science	**All**
Robotics	19	12.34	6.51
Mechanics	19	12.34	6.51
Electromagnetics	4	2.60	1.37
Thermodynamics	4	2.60	1.37
Kinetics	1	0.65	0.34
Inorganic Chemistry	10	6.49	3.42
Electrochemistry	9	5.84	3.08
Analytical Chemistry	82	53.25	28.08
Biochemistry	6	3.90	2.05
Total	**154**	**100.00**	**52.74**

The study indicates a slight preference for Physical Sciences SIPs over Life Sciences SIPs at CRSHS, largely due to the practical applications found in fields such as Analytical Chemistry. This branch of chemistry is essential for tackling local and regional socio-economic challenges, including the monitoring of soil and water quality, promoting sustainable agricultural practices, and reducing environmental impacts. As noted by Savary et al. (2021), Analytical Chemistry is integral to agrochemistry, supplying data that aids in sustainable farming and environmental protection. The prominence of this field may also be influenced by institutional priorities, the availability of laboratory facilities, and the presence of mentorship in chemistry-related research.

Achievement Level of SIPs

The achievement levels of Science Investigatory Projects (SIPs) conducted at CRSHS from 2009 to 2020 in regional competitions is shown in the next Table.

Table 4: Achievement Level of SIP's in CRSHS from 2009-2020 in Regional Competitions

Achievement	**f**	**Percent**	
		Entries	**All SIPs**
Participation	15	24.59	5.14

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1st Prize	22	36.07	7.53
2nd Prize	11	18.03	3.77
3rd Prize	10	16.39	3.42
4th Prize	3	4.92	1.03
Total Entry	**61**	**100**	**20.89**

The achievement levels of Science Investigatory Projects (SIPs) conducted at CRSHS from 2009 to 2020 in national competitions are shown below.

Table 5: Achievement Level of SIPs in CRSHS from 2009-2020 in National Competitions

Achievement	f	Percent	
		Entries	All SIP's
Participation	10	35.71	3.42
1st Prize	5	17.86	1.71
2nd Prize	4	14.29	1.37
3rd Prize	7	25.00	2.40
4th Prize	2	7.14	0.68
Total Entry	**28**	**100**	**9.59**

Table 6: Achievement Level of SIP's in CRSHS from 2009-2020 in International Competitions

Achievement	f	Percent	
		Entries	All SIP's
Participation	8	61.54	2.74
1st Prize	4	30.77	1.37
2nd Prize	1	7.69	0.34
Total Entry	**13**	**100**	**4.45**

It can be gleaned from the Table that eight (8) out of 13 projects of 61.54% were accepted in the international competition but did not win. Moreover, the 1st Prize was secured by 4 projects, accounting for 30.77%, emphasizing the caliber of research being conducted. Such recognition underscores the students' ability to compete effectively and gain acknowledgment on a world stage. Meanwhile, the 2nd Prize, represented by a solitary entry at 7.69%, signifies that while fewer projects reached this level of success, it still reflects positively on the competitive spirit of the participants.

Table 7: Summary of Achievement Level of SIP's in CRSHS from 2009-2020

Achievement	f	Percent
Regional	61	20.89
National	28	9.59
International	13	4.45
Total	**102**	**47.00**

Results show that only 102 of the 217 SIPs from 2009 to 2020 were acknowledged, with the remaining 115 SIPs being recognized at the school level. A total of 61 projects, or 20.89%, reached the regional level, signifying that a significant portion of the school's research projects were recognized and qualified for regional competitions. At the national level, 28 projects, representing 9.59%, progressed to higher recognition, reflecting a more selective group that was able to meet the stringent requirements of national competitions. On the international stage, 13 projects, or 4.45%, achieved recognition, showcasing the highest level of accomplishment for a small but elite group of students whose research met global standards. The data highlights a gradual decrease in the number of projects as the competition level advances, emphasizing the increasing selectivity and competitiveness of national and international platforms.

Table 8: Difference on the Achievement Level of SIPs from 2009-2020 based on Profile of Advisers

Profile	Level	Nature of Achievement	H	p	D	I
Age	Reg'l	Total Entry	2.32	0.31	NR	NS
		With Awards	0.44	0.80	NR	NS
	Nat'l	Total Entry	0.55	0.76	NR	NS
		With Awards	3.05	0.22	NR	NS
	Int'l	Total Entry	0.22	0.90	NR	NS
		With Awards	3.05	0.22	NR	NS
Sex	Reg'l	Total Entry	1.96	0.16	NR	NS
		With Awards	3.17	0.08	NR	NS
	Nat'l	Total Entry	2.39	0.12	NR	NS
		With Awards	0.73	0.39	NR	NS
	Int'l	Total Entry	1.18	0.28	NR	NS
		With Awards	0.73	0.39	NR	NS
Field of Specialization	Reg'l	Total Entry	1.66	0.80	NR	NS
		With Awards	4.24	0.37	NR	NS
	Nat'l	Total Entry	3.60	0.46	NR	NS
		With Awards	6.55	0.16	NR	NS
	Int'l	Total Entry	1.46	0.83	NR	NS
		With Awards	6.55	0.16	NR	NS
Highest Educational Attainment	Reg'l	Total Entry	4.40	0.22	NR	NS
		With Awards	1.36	0.71	NR	NS
	Nat'l	Total Entry	2.47	0.48	NR	NS
		With Awards	0.73	0.87	NR	NS
	Int'l	Total Entry	3.00	0.39	NR	NS
		With Awards	0.84	0.84	NR	NS
Length of Experience	Reg'l	Total Entry	1.43	0.70	NR	NS
		With Awards	0.47	0.92	NR	NS
	Nat'l	Total Entry	0.55	0.91	NR	NS
		With Awards	3.13	0.37	NR	NS
	Int'l	Total Entry	1.51	0.68	NR	NS
		With Awards	3.49	0.32	NR	NS
Number of Relevant Trainings Attended	Reg'l	Total Entry	1.08	0.30	NR	NS
		With Awards	2.37	0.12	NR	NS
	Nat'l	Total Entry	2.37	0.12	NR	NS
		With Awards	0.95	0.33	NR	NS
	Int'l	Total Entry	0.37	0.54	NR	NS
		With Awards	0.95	0.33	NR	NS
Resourcefulness	Reg'l	Total Entry	6.44	0.04	R	S
		With Awards	7.01	0.03	R	S
	Nat'l	Total Entry	6.44	0.04	R	S
		With Awards	7.82	0.02	R	S
	Int'l	Total Entry	7.01	0.03	R	S
		With Awards	7.82	0.02	R	S

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Table 8 shows that there is no significant difference on the achievement level of SIP's in CRSHS when grouped according to the profile of the advisers except on resourcefulness. The p-values obtained when comparing the achievement level of the SIP's with respect to age, sex, specialization, highest educational attainment, and the length of service of the adviser are greater than 0.05 level of significance. This brought the nonrejection of the null hypotheses.

On the other hand, the achievement levels of the SIPs significantly differ when grouped according to the resourcefulness of the adviser since the obtained p-values are less than 0.05 level of significance. At the regional level, the H-value for total entries is 6.44, with a p-value of 0.04, leading to the rejection of the null hypothesis. This indicates that the difference in achievement based on adviser resourcefulness is statistically significant. For SIPs that received awards, the H-value is 7.01, with a p-value of 0.03, further confirming that adviser resourcefulness significantly influences awarded projects. At the national level, the H-values for both total entries (6.44, p = 0.04) and awarded projects (7.82, p = 0.02) show significant differences, indicating that adviser resourcefulness has a significant impact on students' achievements in national competitions. Similarly, at the international level, both total entries (H = 7.01, p = 0.03) and awarded projects (H = 7.82, p = 0.02) demonstrate significant differences. This suggests that resourceful advisers play a critical role in students' success at the international level, both in terms of qualifying and earning awards. These results imply that the SIPs of resourceful advisers tend qualify or get awarded in regional, national, and international competitions than those advised by less resourceful ones.

These results confirm the findings of Mandernach et al. (2018) and Zhang (2021) on the importance of supplemental resources that can significantly enhance student engagement and learning by filling gaps in the instructional materials. Extending personal resources such as internet connection, effort to engage with friends from research presentation organizers to inquire for schedules and guidelines, and even spending their own money for advance presentation fees could make a difference specially for international competitions. This also agrees with the findings of Richman (2020) who pointed out that giving students ample time to develop their projects leads to better outcomes. Spending extra time to advisees for the sake of understanding, revising, and enriching their SIP's could help them improve the chance of having their papers accepted in competitions.

Table 9: Relationship Between Type of SIPs and the Achievement Level from 2009-2020

Award	$\chi 2$	p	Decision on Ho	Interpretation
Regional	5.02	0.41	Not Rejected	Not Significant
National	6.66	0.25	Not Rejected	Not Significant
International	2.44	0.49	Not Rejected	Not Significant

Table 9 shows that there is no significant relationship between the type of SIPs and their success at the regional, national, or international levels. The obtained p-values exceed the 0.05 level of significance, leading to the conclusion that the null hypothesis cannot be rejected.

This suggests that the type of SIP does not significantly impact the participants' achievement levels. Other factors, such as the students' determination to compete, regardless of whether the project is in Life Science or Physical Science, may influence the achievement levels.

The results of Empredo (2021), in contrary, has significant association in national level since there are more SIPs in life science that got awards than those in physical science. Also, in terms of the association between the type of SIPs and the highest award they achieved, more than half of the awards in life sciences are at least at the regional level but only less than half of the awards in physical sciences are regional level or higher.

III. CONCLUSION

The Science Investigatory Project (SIP) advisers at Caraga Regional Science High School are relatively young and early in their careers, with a strong foundation in science-related fields such as Biological Science, Chemistry, and Physics. They are actively enhancing their expertise. They also have commitment in their advising job by being resourceful.

Students of Caraga Regional Science High Schools are more inclined to conduct Science Investigatory Projects in physical sciences than in life sciences.

Less than half of the SIPs in CRHS qualified and won in regional, national, and/or international competitions.

The age, sex, specialization, highest educational attainment, and length of service of the advisers do not determine the number of SIPs that the students can successfully finish. However, SIP's of advised by resourceful teachers tend to qualify or win in regional, national, and/or international competitions.

There is no significant relationship between type of SIP's conducted by CRSHS students and their achievement level in regional, national, and international competitions.

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