Causative agents of science learning among elementary students

ABSTRACT

The study analyzed the causative agents as determinants that enhance or hinder the learning process to lessen difficulties in science instruction, therefore, overall student academic achievement must be diagnosed. Several determinants were extracted from reports affecting learning in science; this study points out the intrinsic and extrinsic determinants that affect science learning among elementary students. Determinants were identified using descriptive-correlational research employing Cohen's Kappa Index (CKI) = 0.70 among 250 student respondents. Analysis showed that four determinants are causative agents that significantly affected their learning in science: previous grades in science, parents' education, combined monthly income, and availability of books. A supportive academic-laden environment orientation and other motivational influences can help unprepared and less knowledgeable students understand the complex nature of science subjects. Therefore, the researcher who is a science educator in a higher education institution would like to initiate linkage with the primary schools through extension projects wherein students will be mentored and capacitated to engage in a science educational set-up to improve academic learning in science.

Keywords: causative agents, science learning, elementary students.

1. INTRODUCTION

The prevalent impact that science education has had on human society is one of the by-products of globalization brought during the progression of the teaching-learning process in academic institutions. Science education has been integral to various educational programs in every society, from basic to higher education. The science curriculum differentiates the role of science and technology in everyday human activities (Mork et al.[1]). Researchers have emphasized the severe challenges in science education in many countries, resulting in poor academic achievements (Cho & Baek[2], Erath & Şahin[3], Musengimana et al.[4], Sibomana et al.[5]). The same situation is happening in the Philippines; science education in the country, specifically at the basic education level, lags behind other countries (Aggabao et al.[6], Sadera et al.[7]) Numerous primary education students are exposed to the complexities of concepts and ideas in science education, leading to low retention, insufficient cognitive and critical skills, inability to apply perceptions to real-life problem-solving circumstances nor generate an analysis to describe a problem and Filipino students' performance in Trends in International Mathematics and Science Study (Banilower[8], Banilower et al.[9]) The National Achievement Test is constantly low (Salloum et al.[10]).

The recurring scenario illustrates that science education in the country is at its edge, which needs immediate response. From one of the top Asian countries, nowadays, academic conditions in the Philippines when it comes to science education are presently identified to be far behind other countries in the Southeast Asian region, such as Thailand, Malaysia, and Singapore, in terms of academic excellence (Shine[11], Shine[12], Shine & Rogers[13]).

The 21st-century teaching and learning illustrates challenges, issues, and concerns in science education. Moreover, science and technology are not accessible to most of the population. Based on previous studies, some of society's recurring problems today are associated with the depletion of natural resources, unending poverty, hunger, and illiteracy in many nations worldwide (Toma et al.[14]). It was also noted that several challenges are interrelated to the need for more infrastructure and resources for teaching science. Issues and concerns interrelated to students' backgrounds, the language of instruction, and the dearth of parental support are also notable. These challenges negatively affect learning, which should be addressed immediately (Tom & Greca[15], Wallace & Coffey[16]). (Skamp[17]), states that accessibility to resources and academic efficiency among students are strictly connected. The need for more resources could lead to unproductivity among learners. Students in institutions with scarce instruction and learning amenities performed lower, unlike their counterparts in schools with enough facilities. Researchers worldwide have observed a widespread collection of issues and problems in education faced by students today.

Additionally, Dwivedi et al.[18] noted that the quick advancement in science and technology, newly recognized societal and cultural norms and values, and changes in the climate and environment, as well as the depletion of natural

resources all significantly impact the lives of children and youths, and hence their ways of learning, viewing the world, experiencing phenomena around them and interacting with others. These changes challenge science educators to rethink the epistemology and pedagogy in science classrooms today as the practice of science education needs to be proactive and relevant to students and prepare them for life in the present and the future.

The present study highlighted various intrinsic and extrinsic determinants affecting students' science education learning. This study generated a model as a point of reference for improvement in creating a long-term development plan for excellent academic achievement of elementary students. The result of the study is significant to students as elementary years must have the concrete foundation of essential knowledge and skills in science that are needed to upgrade to a higher level of education. Teachers are also guided by the status quo of students learning in science. The result is baseline information for adapting and evolving new teaching and learning science education trends. An awareness among administrators is needed to make an improvement plan and strategies for the academic needs of the students; therefore, implementing new science learning pedagogies is required to improve excellent student performance.

2. LITERATURE REVIEW

Significant Changes in Science Education

Science education has changed in terms of its placement in the curriculum. In the Netherlands (Avraamidou[19]), science is compulsory in primary education. The action led to significant modifications in the curriculum, especially in the period allotted to every subject. The change led to significant problems in adaptation to the science curriculum; in this sense, the teachers competed in the time constraints because they covered the old curriculum sequence about half the time. In response, they opposed the deletions and were disappointed with the shortened time for the subject.

The science curriculum in China prioritized systematic mastery as the dominant instructional aim, indicating that various forces had driven the globalization of science curricula (Lee[20]). Contemporary science instruction development congregations represent the country's response to comprehensive economic reform and the necessity of global institutions for quality science instruction (Rousell & Cutter-Mackenzie-Knowles[21]). The national curriculum expansion series density draws full responsiveness from experts with the guidance and influences from technologically advanced countries that made China produce an authentic, contextual, and affordable science curriculum (Ball[22]).

In Arab states Rashed[23] like Saudi Arabia, Algeria, Jordan, Kuwait, Palestine, Egypt, and Syria, science implementation is influenced by the comprehensive utilization of different textbooks. Contents are very traditional and irrelevant, with minimal influences on the learning interests of new chemistry users. It established a negative relationship between the envisioned science curriculum and expected learning outcomes. (Leikin[24]) pronounced that a lesser percentage of Arabic primary education institutions are bombarded with concerns about and trials of sustainable science instruction. In emerging states like Nigeria, Ghana, Cameroon and the Gambia, stakeholders and school administrators are prominent personalities taking responsibility in school Kanjam[25] in which any form of development and curriculum operation in the schools is enacted to influence policy-making (Opoku et al.[26]). On the other hand, government initiatives in taking over schools from principals on free education, academic undertakings depend solely on the government to acquire resources (Mufalo et al.[27]). The action led to a higher number of students enrolment Yakohene & Appiah[28] which caused pressing problems in the instruction plan, specifically in science and related areas, resulting in inadequate instructional equipment due to population outbursts.

The status quo of the educational structure in the Philippines takes many challenges. It partakes in a series of changes and transformations relevant to the current global market demands amidst numerous setbacks and complications. Revisions were made due to the thorough reflection of the existing content of the educational mission, classroom supervision, instruction approaches, and the financial provision needed to deliver worthwhile science instruction to students (Reimers & Chung[29]). The Philippine education system can be labeled as an old style that is open-minded to conventional education (Jenkins[30]). To sum up, teachers who are the forefront runners of education may explore the causative agents in learning science to devise a solution to maximize teaching-learning engagement. Thus, this study is conceptualized to explain the underlying reasons for the low academic performance of elementary learners in science. The variables covered in the study are only limited to intrinsic and extrinsic factors because they are the most relevant matters to the current study.

3. METHODOLOGY

This study utilized a descriptive-correlational research design to identify the determinants of learning science among elementary students. The study emphasized the students from Grades 5-6 in the District of Tuburan, Cebu, Philippines, who had

science subjects as one of the subjects embedded in the primary education curriculum.

3.1. Participants and research setting

Two hundred fifty students from different schools participated in this study. Various factors affecting students' science learning, explicitly emphasizing the intrinsic and extrinsic factors only, were considered in this study and taken from previous studies. The respondents were chosen based on their population characteristics and the study's research objectives.

3.2. Data collection instruments

The research instrument Mangubat & Picardal[31] is adapted and modified according to the context of the study and is composed of two parts. The first part is a list of the intrinsic determinants such as sex, grades in previous science subjects, number of study hours, and motivation in learning the science subject. The second part of the instrument is also a list of the extrinsic factors, including parents' education, number of siblings, parents' monthly income, and assistance in learning the science subjects. The instrument underwent face validity using Cohen's Kappa Index (CKI) with a Kappa of 0.70 for inter-rater agreement.

Consent was obtained from the school heads and the student respondents. The researcher informed the respondents about the study's purpose and protocol. The questionnaire was distributed face-to-face, and instructions were explained to guide the respondents in answering it.

3.3. Data analysis

To achieve the research objectives, quantitative analysis was carried out on the data for this study, including the sociodemographic profile of the respondents. It emphasized intrinsic variables such as sex, grades in a previous science subject, number of study hours, motivation in learning, and extrinsic variables such as parents' education, number of siblings, parent's income, and monthly income of the parents. SPSS software was employed to examine the correlational analysis among intrinsic and extrinsic factors.

4. FINDINGS AND DISCUSSION

4.1. Profile of the student respondents – intrinsic factors.

The analysis of the intrinsic determinants affecting students learning in science is summarized in Table 1.

Table 1. Profile of the student respondents in terms of intrinsic factors.

Determinant	Frequency	%
Sex		
Male	98	39.0
Female	152	61.0
Grade in Previous Science Subject		
71 - 75	11	4.0
76 - 80	44	18.0
81 - 85	171	68.0
86 - 90	16	7.0
91 - 95	5	2.0
96 - 100	3	1.0
Number of Study Hours		
1 - 2	134	54.0
3 - 4	80	32.0
5 and above	36	14.0
Motivation		
Parents	50	20.0
Siblings	7	3.0
Relatives	13	5.0
Friends	7	3.0
Personal choice	173	69.0

Table 1 illustrates the breakdown of the intrinsic determinants' distribution of the students' respondents according to sex, grade in the previous science subject, number of study hours and motivation in learning the science subject. As highlighted in Table 1, the result of the analysis of the sex distribution of the respondents shows that almost twice as many females than males are in Grades 5 and 6 in this given set of respondents. The sample did not attain a near gender disparity in the population sample due to the low population of male students who responded to the survey instrument.

The study affirms Muhammad et al.[32] that girls possessed constructive behaviors concerning science learning. (Otani[33]) illustrated that females' achievements are way better than males.

On the contrary, (Schäfer[34]) pointed out significant issues that caused fewer girls to get low scores in science because girls consistently display less interest in studying, demonstrate less self-confidence, and categorize science subjects as boys' things. Based on the study's findings, females dominate science classes, implying that girls perform better and will naturally pursue STEM-related degree programs. This means that they may intensify their modes and delivery in terms of the teaching-learning process to encourage male students to attain excellent academic performance in science irrespective of the sexes of the students.

As to grades in previous science subjects, data indicates that 171 (68 %) of the respondents obtained a grade between 81-85 and only 11 (4 %) obtained the lowest grade, 71-75. The result reveals that many students are average science achievers, 15 times higher than poor performers. Thereby, students had an excellent academic performance entry and a sound underpinning for leveling up to advanced science subjects. Al Husaini & Shukor[35] found that GPA was one determinant in forecasting student academic achievement and retention. Similarly, Francis[36] established that GPA showed a 29% difference among the students in the United States of America. Therefore, schools may conduct remedial measures like consultation, peer mentoring and coaching, buzz sessions and informal creative groups to attain an excellent GPA, a critical success indicator for positive student academic performance. It would be designed for students with difficulty learning chemistry subjects to work with the teacher and their classmates to understand science lessons best.

On the number of study hours, most students, 134 (54%), had the least number of study hours in science subjects being 1-2 hours only; it is noticeable that only 36 (14%) spent five and the above number of hours every day studying the subject. It is evident that three times as many respondents spent little time studying science lessons. Abdallah & Mohammed[37] suggested that study time provision matters for education as regards the varied forms of time routine considered here; time dedicated to studying lessons affects educational attainment for all students. (Bozkurt et al,[38]) found that the duration of study hours strongly correlates with many students' educational achievement. The result implies that elementary students, on average, would only spend 1-2 hours studying their science lessons, which may result in low academic performance. Time spent studying and long hours of self-study using different learning resources and media largely determine students' academic performance. The student who spends specific schoolwork periods performs differently from a student with fewer hours of study time.

Regarding the motivation in learning science subjects, findings reveal that it is a personal choice 173 (69%), while siblings and friends 7 (3%) are the least motivational determinants in learning science. The study results disaffirm Walck-Shannon et al. [39], who argued that Asian students have a parental impact on their motivation towards learning science subjects. It is a prerogative that students will level up to secondary after completing the elementary coursework. They primarily decide which track they will pursue. To help aspiring future STEM professionals, schools may intensify the implementation of inclusive, updated science education curricula.

4.2. Profile of the student respondents – extrinsic factors.

Table 2 shows the following entry of the questionnaire, pertaining to the extrinsic determinants affecting students' learning in science.

Table 2. Profile of the student respondents in terms of extrinsic factors.

Determinant	Frequency	%
Parents Education		
Elementary level	11	4.0
Elementary graduate	19	8.0
High school level	28	11.0
High school	87	35.0
graduate	2	1.0
Vocational graduate	25	10.0
College level	63	24.0
College Graduate	10	4.0
Masters level	3	2.0
Masters graduate	2	1.0
Doctorate level	0	0.0
Doctorate graduate		
Number of siblings		
1 - 2	63	25.0
3 - 4	131	52.0
5 - 6	36	14.0
7 and above	20	9.0

Parents monthly income						
Poor						
(less than 11, 690)	44				18.0	
Low-income but not poor						
(11, 691 – 23, 381)	86				34.0	
Lower – middle income						
(23, 382 – 46, 761)	45				18.0	
Middle – middle income						
(46, 762 – 81, 832)	45				18.0	
Upper – middle income						
(81, 833 – 140, 284)	13				5.0	
Upper–income but not rich						
(140, 285 – 233, 806)	15				6.0	
Rich						
(at least 233, 807)	2				1.0	
Assistance in learning (weekly basis)	None	1-2	3-4	5-6	Everyday	Mode
Parents	111	57	21	11	50	none at all
Peer	28	82	66	25	49	1-2 times
Relatives	146	60	20	11	13	none at all
Tutor	191	29	20	4	6	none at all
Books	106	4	63	19	58	none at all
Journals	74	120	33	7	16	1-2 times
Laptop/ computer	104	56	47	19	24	none at all
Smartphone	152	36	33	22	7	none at all
Tablet	129	46	29	12	34	none at all
Science TV Program	134	39	27	10	40	none at all

Table 2 shows the distribution of extrinsic determinants of the students' respondents according to parents' education, number of siblings, parents' monthly income, and assistance in learning the science subject. Based on the table, the respondents' parents were primarily high school graduates, at 87 (35%), while the lowest number of parents were doctorate level, at 2 (1%). The result shows that most parents who send their children to school attained a marginal education status. They wanted their children to become highly educated individuals to surpass their education level. The result supports Filgona[40], who illustrated that parents with a marginal level of education are most likely to have children with good academic performance. Therefore, to obtain an excellent academic performance in science, it is imperative to establish a strong linkage and collaboration between parents and schools. PTA meetings may be facilitated to get parents' feedback on how their education attainment significantly affects their children's academic performance in science subjects.

On the number of siblings, it is figured out that most of the students had medium-sized family members, ranging from 3-4, with 131 (52%), and the least comprised 20 (9%) of the respondents with seven or more siblings in the family. The data illustrates that as much as five times the preferred smaller families. The result corresponds with the survey conducted by the Commission on Population in 2019, which stated that Filipino parents nowadays want a smaller number of children for a manageable flow of expenditures, especially in terms of education. This entails more attention parents can have to their children and enough support to provide their children's education. The result of the study is further elaborated Assari et al.[41] wherein they posited that a sizeable family would prospectively enjoy the ease and comfort of life with the prime to meet the expenses and enjoy discernible luxuries of life with family members.

Regarding the parents' combined monthly income, the result displays that most of the student respondents' families belong to low-income families but not poor, with 86 (34%) whose combined income is between 11, 691 – 23, 381. In comparison, only 2 (1%) belong to the rich with a corresponding combined monthly income of at least 233 807 respectively. The data ascertain that most students' parents are of low financial status. The result agrees Mante et al.[42] that children from low-income families lacked such resources, resulting in an unsmooth life journey or hindered academic achievement. The result of the study clearly illustrates that schools can link to other institutions and agencies for learning assistance to help children narrow the wealth and knowledge gaps among other societal groups in a bigger picture.

Regarding assistance in learning science subjects, peers and books signified the highest responses being utilized 1-2 times a week. Based on the study's outcome, the information points out that students have limited access to assistance in learning. Indeed, the students are not exposed to different forms of assistance that give them supplementary graphical illustrations of learning material, which directly discourses the needs of the students. Science is a subject that needs an experiential method for teaching; the guided discovering process is resource-based (Thomas-Price[43]).

4.3. Correlational analysis of the intrinsic factors affecting students' learning in science

The following section represents the correlational analysis of the intrinsic variables in students' learning using Cramer's v-value. The quantitative data for this question is presented in Table 3.

Table 3. Correlational analysis of the intrinsic factors affecting students' learning in chemistry

Determinant	Cramer's V-value	p-value
Sex	0.210	.095
Grade in Previous Science Subject	0.244	.000
Number of Study Hours	0.085	.728
Motivation in learning	0.210	.095

As elaborated in Table 3, it is noticeable that the correlational analysis pointed to grades in previous science subjects significantly affecting science learning based on Cramer's V-value (0.244) and p-value (000). However, sex, number of study hours, and motivation to learn are not significant determinants affecting students' learning in any science subject. The result means that the previous grades are substantial aspects that serve as a reference point for having an excellent rating in higher science lessons. An outstanding performance of a student during previous years denotes a higher chance of getting an excellent future science achievement. The present study affirms Olatunde-Aiyedun & Ogunode[44], Huang & Kuo[44] that grades in previous science subjects are a consistent educational success determinant among students. Numerous researches show that grades are associated with all measures of academic achievement encompassing standardized assessment results Carpenter et al.[46]; time grade and school competition Camacho-Morles et al.[47]; admission, performance and determination to advance learning in science subjects Zimmerman[48]; and lifetime academic attainment. Therefore, schools must strengthen the teaching and learning process to leverage academic performance in science subjects.

4.4. Correlational analysis of the extrinsic factors affecting students' learning in chemistry

Teachers' self-description of their existing error feedback practices

This section represents the correlational analysis of the extrinsic variables in students' learning using Cramer's v-value. The quantitative data for this question is presented in Table 4.

Table 4. Correlational analysis of the intrinsic factors affecting students' learning in chemistry

Determinant	Cramer's V- value	p-value
Parents education	0.258	.011
Number of siblings	0.145	.067
Combined monthly income	0.215	.009
Assistance in learning		
Parents	0.159	.087
Peer	0.154	.114
Relatives	0.105	.760
Tutor	0.136	.295
Books	0.171	.036
Journals	0.130	.388
Laptop/ computer	0.121	.516
Smartphone	0.136	.302
Tablet	0.119	.548
Science TV Program	0.165	.055

Table 4 summarizes the extrinsic determinants in learning science learning. Correlational analysis shows that parents' education (0.258; .011) significantly impacts students' learning in science subjects. The combined monthly income is also a significant (0.215; .009) determinant in science learning among students. Moreover, the result emphasized that books (0.171; .036) are a significant determinant as assistance in learning science. All other extrinsic factors are not correlated (>.05) with science learning.

The present study affirms Howard et al.[49] that the recent investigation also highlights the positive effects of using books beyond parents' education and combined monthly income. Furthermore, List et al.[50] (claim that parents with high socioeconomic status connect through concerted cultivation as a way of rearing. With close monitoring and strict parenting, families of high socioeconomic status assume higher education accomplishments and career anticipations Mangubat[51], cumulatively decipher into excellent academic performance.

5. CONCLUSION

The study's results stated a positive correlation involving intrinsic determinants, such as grades in previous science subjects, and extrinsic determinants, including parents' education, combined monthly family income, and books, as

significant determinants to assist students in learning science. This study draws insights into areas where science learning can be fully supported and intervention programs can be developed to ensure excellent science learning.

Based on the preceding results, this study recommends encouraging positive reinforcement of science teaching and learning opportunities to motivate students to thrive in their science subjects to attain better academic performance in preparation for more complex science subjects as they step up for another year of learning. Therefore, this can be done through an initiative by means of linkage and collaboration with other agencies, such as implementing extension projects to address the learning difficulty of the different lessons and contents to assist students in learning science subjects.

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