Asia Pacific Journal of Contemporary Education and Communication Technology
ISBN (eBook): 978 0 9943656 8 2 | ISSN : 2205-6181
Year: 2018 , Volume: 4, Issue: 2

MENTORING, SELF-EFFICACY AND PERFORMANCE IN CONDUCTING INVESTIGATORY PROJECTS: A MIXED-METHOD ANALYSIS

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Abstract

This study investigated the effects of mentoring assistance and students' self-efficacy beliefs on the performance in conducting investigatory projects. Specifically, its aim is to: ascertain the students' level of performance in the conduct of investigate or projects; identify the level of mentoring assistance that prevails in the conduct of investigatory projects in terms of identifying the research problem, formulating the research problem, formulating the hypothesis, writing the review of literature, constructing the research design, gathering of data, data analysis, presentation, and interpretation of results/findings, formulating conclusions and recommendations, and general practices; identify the students' level of self-efficacy beliefs, correlate mentoring assistance, self-efficacy beliefs and students' performance; find out which variable best predicts students' performance; and determine students' experiences in the conduct of investigatory projects.

Mixed-method analysis using descriptive-correlational methods were used to collect data. Data were analyzed using frequency counts, percentage, means, standard deviation, correlation and multiple linear regression analysis. Findings revealed that majority of the grade-10 students have low performance in the science process skills of conducting investigatory projects. Teachers were satisfactory in mentoring students in the following science processes: identifying the research problem; formulating the research problem; formulating the hypothesis; writing the review of literature; constructing the research design; collecting or gathering of data; analysis, presentation, and interpretation of data; formulating conclusions and recommendations; and the general practices in the conduct of science investigatory projects.

Students have moderate self-efficacy beliefs on their ability to conduct science investigatory projects and research tasks. The mentoring assistance in terms of formulating the research problems, formulating the hypothesis, writing the review of related literature, constructing the research design, and analysis of data, presentation and interpretation of results have significant relationship to students' performance. In addition, regression analysis shows that mentoring students in writing literature reviews is a predictor of their performance. The findings of the study indicate that mentoring students in the conduct of investigatory projects has an impact to their performance. Also, students' perceptions and experiences in the conduct of their science research projects are both positive and negative. Teachers are encouraged to promote understanding of science research processes through effective mentoring relationship. Recommendations for future studies and research are provided.

Keywords: Mentoring, Self-Efficacy, Performance and Investigatory Projects.

 DOI : 10.25275/apjcectv4i2edu7

1. Introduction

The development of scientific literacy is the principal purpose of science education today. Students should develop knowledge, skills, attitudes and values that reinforce creative, critical and constructive thinking. An approach to improve science teaching and learning is the use of student-led scientific investigations which emphasizes the importance of scientific thinking and discovery.

The science investigatory project is an undertaking for science students which need an application of certain scientific principles and ideas. One of its aims is to develop one's capacity in order to actively and effectively participate in the solution of problems being faced by the community (Tobias, 2015) through the investigation of real examples of the application of science, where students gain insight into the tensions and dependencies between science and societal, environmental and ethical factors (dela Cruz, 2014).

The Philippine government recognizing the importance of science and technology capability for the development of the country, in partnership with the Department of Education has programs and projects aimed at improving science education. The framework for K-12 science curriculum strives to create changes in the classroom to teach students scientific practices; including understanding and applying scientific knowledge, performing scientific processes and skills, and developing scientific attitudes and values. Students are also exposed to scientific investigations related to real life(Department of Education, Philippines, 2013).

Involving high school students in research has been shown to be beneficial for the student. It contributes to student understanding and confidence in scientific material, fosters interest in pursuing science-related careers, and promotes understanding of scientific method and process (Harley, 2013).

2. Purpose

This study is intended to examine the effects of mentoring assistance and students' self-efficacy beliefs on performance in conducting investigatory projects. Specifically, this study aimed to:

1. ascertain the students' level of performance in the conduct of investigatory projects;
2. identify the level of mentoring assistance that prevails in the conduct of investigatory projects in terms of:

    a. identifying the research problem,
    b. formulating the research problem,
    c. formulating the hypothesis,
    d. writing the review of literature,
    e. constructing the research design,
    f. collecting/gathering of data,
    g data analysis, presentation, and interpretation of results/findings,
    h. formulating conclusions and recommendations, and
    i. overall conduct of investigatory project;

3. identify the level of self-efficacy beliefs in the conduct of investigatory projects;
4. correlate mentoring assistance, self-efficacy beliefs, and students' performance in conducting investigatory projects;
5. find out which variable, singly or in combination, best predict students' performance in the conduct of investigatory projects; and
6. determine students' experiences in the conduct of investigatory projects.

Conceptual Framework

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This study is anchored on many learning theories and concepts about science education and the conduct of scientific investigations as well as the different learning approaches in factors such as motivation, mentoring and self-efficacy.

The constructivist view of learning is reflected in the developmental theories of Piaget, Dewey, Bruner, and Vygotsky. The constructivist view of learning argues that students do not come to the science classroom empty-headed, but arrive with lots of strongly formed ideas about how the natural world works. Learning is a process of acquiring new knowledge, which is active and complex. It is also an active interaction between teachers and learners, and learners try to make sense of what is taught by trying to fit these with their own experience (Wing-Mui, 2002). Constructivist views also emphasize generative learning, questioning or inquiry strategies, discovery, experimentation, open-ended problems, and hands-on inquiry-oriented instruction to promote children's conceptual knowledge by building on prior understanding, active engagement with the subject content, and applications to real world situations in science lessons.

Bandura's social cognitive theory posited that self-efficacy beliefs refer to beliefs in one's capabilities to organize and execute the courses of action required to manage prospective situations. Self-efficacy is what an individual believes he or she can accomplish using his or her skills under certain circumstances (Bandura, 1997).

This study is also based on inquiry-based learning which aims to enhance learning based on (1) increased student involvement, (2) multiple ways of knowing and (3) sequential phases of cognition (Their, 2000). By using student derived investigations knowledge is more relevant and meaningful. This investment in the curriculum and learning process leads to active construction of meaningful knowledge, rather than passive acquisition of facts transmitted from a lecturer. Inquiry-based learning has been shown to develop independent and critical thinking skills, positive attitudes and curiosity toward science and increased achievement in biological content.

The mentoring relationship concerned with teaching and learning is also supported by learning models and theories. According to Kram's mentor role theory (1985), mentors can provide two broad categories of mentor functions: career/cognitive development functions – enhance cognitive and skills of mentee; and psychosocial functions – enhance the mentee's sense of competence, self-efficacy, engagement and personal development. In collaborative learning, it includes approaches involving joint intellectual and active effort, where social and intellectual engagement and mutual responsibility are emphasized between student and teacher(Turkish, et al., 2014).

The researcher recognizes the importance of self-efficacy beliefs and mentoring assistance in the performance of students in conducting science investigatory projects. Figure 1 shows the research paradigm of the study highlighting the influence of mentoring assistance in the science process skills provided by science research teachers and students' self-efficacy beliefs in connection with their performance in the conduct of science investigatory projects.

3. Research Paradigm

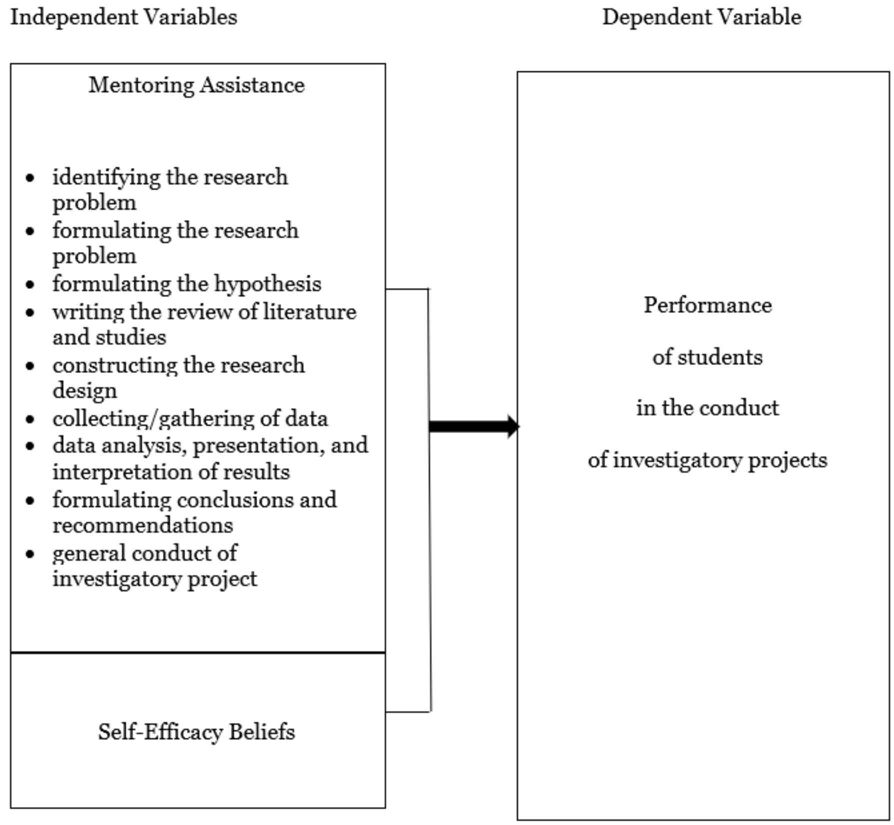

Figure 1: Schematic diagram showing the independent and dependent variables of the study.

4. Methodology

This chapter presents the methods that were used in this study which include the research design, locale and participants of the study, sampling procedures, data-gathering procedure, research instruments, and statistical techniques.

4.1 Research Design

A mixed-method research analysis was used to collect pertinent data of this study through quantitative and qualitative research. For quantitative research, this study incorporated the descriptive-correlational research methods. This used descriptive research as it attempted to describe the levels of mentoring assistance in the different science process skills, self-efficacy beliefs, and performance in conducting science investigatory projects. Also, the correlational research design was used to explore and determine the degree of relationship that exists between the independent and dependent variables of the study.

In qualitative research, structured interview was used that answers several questions that pertain to students' experience during the conduct of investigatory projects.

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4.2 Locale of the Study

The study was conducted among secondary schools in selected divisions of Region X, Northern Mindanao specifically, Division of Cagayan de Oro City, Division of Misamis Oriental, Division of Bukidnon, Division of Malaybalay City, and Division of Valencia City. These schools are under the provinces of Bukidnon and Misamis Oriental located in the Northern Mindanao Region.

The Divisions of Bukidnon, Malaybalay City, and Valencia City are under the province of Bukidnon, which is a landlocked province of the Northern Mindanao, Philippines. It is bounded on the north by Misamis Oriental and Cagayan de Oro City; on the south by North Cotabato, General Santos City and Davao City; on the east by Agusan del Sur and Davao del Norte; and west by Lanao del Sur. It lies between parallels 7°25' and 8°38' North latitude and meridians 124°03' and 125°16' East longitude. Malaybalay City, the capital town, is about 850 km by air from Manila and 91 km by road from Cagayan de Oro City.

The Divisions of Misamis Oriental and Cagayan de Oro City are part of the Province of Misamis Oriental, which is along the northern coast of the island of Mindanao. It is bounded on the north of Macajalar Bay, on the west by Iligan Bay, on the south and southwest by the Province of Bukidnon and Lanao del Norte and on the east by the Province of Agusan del Norte. It has an estimated total land area of 357,010 hectares making it the 2nd largest province in the region. It is subdivided into 24 municipalities and 3 cities of Cagayan de Oro, Gingoog and El Salvador.

Figure 2: Map of Region X, Northern Mindanao showing the locale of the study

4.3 Participants of the Study

The participants of the study were the selected grade-10 students of Region X, Northern Mindanao, particularly the Division of Misamis Oriental, Division of Cagayan de Oro City and the divisions of Bukidnon Province: Division of Bukidnon, Division of Malaybalay City, and Division of Valencia City. Specifically, these were the grade-10 students enrolled in the Special

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Science curriculum with research science subject for the School Year 2015-2016. Table 1 shows the schools of each division and its actual participants.

Table 1: List of schools and number of participants

DIVISIONS	SCHOOLS	NUMBER OF PARTICIPANTS
Division of Malaybalay City	Bukidnon National High School	61
Division of Bukidnon	Manolo Fortich National HS	43
Division of Valencia City	Valencia City National HS	53
Division of Cagayan de Oro City	Cagayan de Oro National HS	60
	Gusa Regional Science HS	135
Division of Misamis Oriental	Misamis Oriental General Comprehensive HS (MOGCHS)	55
TOTAL		407

4.4 Sampling Procedure

Sampling was made through complete enumeration as it was conducted among students enrolled in the special science curriculum in selected schools of Region X. Purposive sampling was also used to identify the schools selected in the study. Also, students in these schools who have received awards or distinctions in their investigatory projects were particularly chosen as participants of the study.

4.5 Data-Gathering Procedure

A written letter of permission was addressed respectively to the Regional Director, Schools Division Superintendent, Schools District Supervisor, and to the school principals of the select high schools asking permission to conduct the study. Consent letter to the respondents was also sent. Upon approval, the questionnaires were administered by the researcher and structured interviews were conducted among the student-participants. Approximately three months was spent to collect the necessary information needed for the study. Afterwards, data were tabulated, computed and statistically analyzed, discussed and interpreted.

4.6 Research Instruments

This study used four instruments to collect the necessary data for statistical analysis to measure the following categories: students' performance, mentoring assistance, and self-efficacy beliefs. The instruments were pilot-tested to ensure their validity and reliability among grade-10 students of Central Mindanao University Laboratory High School (CMULHS), Musuan, Bukidnon.

4.7 Performance

Measuring performance in the conduct of investigatory projects through science process skills is important as these are procedures of investigation fundamental in understanding scientific concepts and experiments in order to gain knowledge and develop ones critical thinking skills. Thus, in this study, a 30-item research-validated instrument on science process skills test developed by Kazeni (2005) was used to determine the performance of students in the science process skills. This contained the following science process skills: identifying and controlling variables, stating and identifying hypotheses, experimental/research design, graphing and interpreting data, inferring and operational definitions.

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The test is meant for grades 9-12 students. It is content independent, gender and race biased, and school type and location neutral. For this study, some proper nouns were changed to local family names to make the test more culturally valid. It has a Cronbach's alpha of 0.725 which means that it is reliable. The following equivalent and descriptive rating were used to interpret the data:

Percentage Grade Equivalent	Descriptive Rating
90 – 100	Advance proficiency
85 – 89	Proficient
80 – 84	Approaching Proficiency
75 – 79	Developing
74 and below	Beginning

4.8 Mentoring Assistance

In determining the level of mentoring assistance as perceived by students, a questionnaire was developed by the researcher which underwent validation before administration to establish validity and reliability of the research instrument. The instrument is highly reliable with a Cronbach's alpha of 0.931. The questionnaire is a 5-point Likert scale instrument with a total of 90 statements all about the mentoring assistance provided by science research teachers among the science processes in conducting investigatory projects. The following limits and qualitative description were used to interpret the data:

Scale	Range	Descriptive Rating	Qualitative Interpretation
5	4.51 – 5.00	Strongly agree	Excellent
4	3.51 – 4.50	Agree	Very Satisfactory
3	2.51 – 3.50	Neutral	Satisfactory
2	1.51 – 2.50	Disagree	Fairly Satisfactory
1	1.00 – 1.50	Strongly Disagree	Did not meet expectations

4.9 Self-Efficacy Beliefs

The instrument that was utilized in determining the self-efficacy beliefs of students in the conduct of science research and investigatory projects were modified and patterned after the studies of Glynn and Koballa (2006) and Witt-Rose (2003). The instrument undergone pilot testing for reliability and received a Cronbach's alpha of 0.889 indicating that it is highly reliable. The questionnaire includes twenty-five (25) statements which were construed with the following 5-point Likert scale, range, qualitative descriptions:

Scale	Range	Descriptive Rating	Qualitative Interpretation
5	4.51 – 5.00	Strongly agree	Very high self-efficacy
4	3.51 – 4.50	Agree	High self-efficacy
3	2.51 – 3.50	Neutral	Moderate self-efficacy
2	1.51 – 2.50	Disagree	Low self-efficacy
1	1.00 –1.50	Strongly Disagree	Very low self-efficacy

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4.10 Structured Survey Interview

Three (3) students from each school were invited to answer the questions from the structured survey interview. This was done to evaluate their experiences in conducting their investigatory projects. Students were asked to answer by way of printed surveys or direct interview. The structured survey consisted of seven (7) questions and was evaluated by experts to ensure content validity.

4.11Statistical Treatment and Analysis of Data

Descriptive statistics such as mean, standard deviation, frequency and percentages were used to determine the level of students' performance, motivation, mentoring relationship, and self-efficacy beliefs in the conduct of investigatory projects. In addition, Pearson product moment correlation was used to analyze the relationship between the independent and dependent variables of the study. Multiple linear regression analysis was also employed to find out the predictors of students' performance.

In analyzing qualitative data, cross-case analysis was used to describe and/or explain the experiences of students when conducting their investigatory projects. The data were gathered, examined, presented and interpreted.

Table 1: Students' level of performance

RANGE	**FREQUENCY**	**FREQ PERCENT**	**QUALITATIVE DESCRIPTION**
90 and above	2	0.49	Advance Proficiency
85 – 89	4	0.98	Proficient
80 - 84	20	4.91	Approaching Proficiency
75 - 79	29	7.13	Developing
74 and Below	353	86.73	Beginning
Average:58.07			Beginning

Legend:

Percentage Grade Equivalent	Descriptive Rating
90 – 100	Advance proficiency
85 – 89	Proficient
80 – 84	Approaching Proficiency
75 – 79	Developing
74 and below	Beginning

The result shows that most of the student-participants (86.50%) got grade scores of 74 and below described as "beginning", followed by grade scores of 75-79 and 80-84 described respectively as "developing" and "approaching proficiency". Only 6 students have reached either

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proficient or advanced proficiency level. The average score is 17.42 with a percentage equivalent of 58% described as “beginning” proficiency.

According to the Department of Education (DepEd Order No. 73, s. 2012), student at the “beginning” level struggles with his/her understanding; prerequisite and fundamental knowledge and/or skills have not been acquired or developed adequately to aid understanding. The student with “developing” proficiency possesses the minimum knowledge and skills and core understandings, but need help throughout the performance of authentic tasks. “Approaching proficiency” means that the student has developed the fundamental knowledge and skills and core understandings and, with little guidance from the teacher and/or with some assistance from peers, can transfer these understandings through authentic performance tasks. “Proficient” and “advanced” students have developed and/or exceeded the fundamental knowledge and skills and core understandings, and can transfer them independently, automatically and/or flexibly through authentic performance tasks.

The results imply that although there are students who can perform competently in the research process, majority of the students have low performance and still need to improve their knowledge and skills in the science processes involved in conducting scientific investigations and may especially require support and assistance from their teachers in performing science research tasks.

In addition, their low performance may also account for their experiences as novice investigators; they are yet to integrate and apply their knowledge on the science processes involved in doing research projects. Science process skills are important skills for solving problems, undertaking research projects, and doing experiments. Various factors may cause low performance which may come from the teachers, school environment, family background, or the students itself.

This is supported by the findings of the study of Demirbas and Tanriverdi (2011) and Shaibu and Mai (2003) that many students have either low, tolerable and/or moderately satisfactory performance in the science process skills. Likewise, Duggan, Johnson and Gott as cited by Myers (2006) construed that students have difficulty understanding science content information and trouble transferring process skills between experiments. Myers further recommended that teachers should overtly teach and model all the science process skills to improve their students’ aptitude proficiently. Becoming skilled users of science process skills help students gain perspectives on science, and also support the development of language fluency and contribute to the development of a coherent classroom community (Settlage & Southerland, 2012).

Table 2: Variables correlated with Performance

Indicators	Correlation Coefficient (r)	Probability
Formulating the Research Problem	.166	.020*
Formulation of Hypothesis	.108	.030*
Writing the Review of Related Literature	.155	.002**
Data Analysis, presentation and Interpretation of Results/findings	.109	.028*
Overall Mentoring	.127	.010**

* - significant at $p < 0.05$ ** - significant at $p < 0.01$

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4.12 Predictor Variable of Performance

Among the variables, only mentoring assistance in terms of writing the review of related literature is the predictor variable of performance. Regression model is $Y = 45.309 + 3.386X$, where Y is the performance and X is the Mentoring assistance in terms of writing the review of related literature

5. Implications

Based on the findings and conclusions of the study, the following recommendations are formulated: To improve the performance of students in conducting science investigatory projects, the teachers are encouraged to provide educational activities that facilitate positive learning, reinforce scientific thinking and emphasize the contributions of scientific investigations in developing students' various thinking and process skills which may help them in future course and careers. Through this, students may also improve their perceptions and attitude towards science learning and research activities.

Students are also advised to find faculty members and/or professional researchers whom are experts on their field of studies that can provide additional assistance on their investigatory projects. They are also encouraged to approach English and Mathematics teachers to guide them on their research writing and data analysis, respectively.

Teachers are further encouraged to enhance their knowledge and skills on science content so they can develop their competencies and better demonstrate the concepts of science processes and research. Additionally, positive interaction between teachers and students helps promote effective mentoring relationships; hence, teachers are encouraged to cultivate approachability and patience, offer collaboration, and create open communication among their students.

The government, school administrators and educators may create programs that will meet the needs of the students (e.g., mentoring programs, research training), provide laboratory facilities and instructional materials, and continue to implement excellent professional development, curriculum assessment, and resource development that promote effective science teaching and learning.

A more comprehensive assessment and evaluation may be established to examine the performance of students not only in their proficiency of the science process skills, but also on their performance in research writing, experimental activities, and oral defense presentations.

Also, in collecting the data for self-efficacy beliefs, it is strongly recommended to conduct the test before the students' start to write or conduct their investigatory projects. A pretest-posttest analysis may also be conducted.

Further studies may be conducted to validate the results of the study as well as to include additional analysis on variables which were not included in this study. Future studies and research are also recommended. These are the following: (1) studies to determine factors influencing students' performance in conducting investigatory projects using experimental analysis; (2) investigation on the relationship between the level of science process skills of teachers and students; and (3) studies on determining the mentoring styles of teachers, perceptions of mentors on their mentees' performance, and qualities of a good mentoring relationship.

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Conclusion

Based on the findings of the study, the following conclusions were drawn:

Students' performance in the science process skills involved in doing investigatory projects is low and still need improvement.

The teachers are effective in mentoring students of the science research process particularly in identifying the research problem, formulating the research problem and hypothesis, writing the literature review, constructing the research design, gathering of data, data analysis, presentation, and interpretation of results, formulating conclusions and recommendations, and general practices of conducting investigatory projects.

Students have moderate positive perceptions on their ability to perform well in their investigatory projects but they also believe that their diligence can help them succeed. Mentoring has an impact to students' performance in the conduct of investigatory projects as it helps develop understanding of the science concepts and processes, most especially in terms of formulating the research problems, writing literature reviews, formulating the hypothesis, constructing the research design, and data analysis, presentation and interpretation of results. Likewise, mentoring in terms of writing literature review is a predictor of students' performance.

Moreover, this study also found that students' perceptions and experiences in conducting their science research projects are both positive and negative. Through conducting investigatory projects, students have gained learning in the different components of the science process, but also encountered some difficulties. They have identified several mentoring needs; most notable includes assistance in selecting the research problem, forming the problem statements, writing literature reviews, selecting appropriate methods, materials and tools to collect data, and analyzing data and interpreting the results. Furthermore, increase understanding of the science processes and skills, and approachable and accessible mentors are advantages of the mentoring relationship.

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