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Handbook in the Preparation and Management of Investigatory Project Proposals for Secondary School Science Teachers

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Abstract
Aim: The study focused on the development and validation of a handbook in the preparation and management of science investigatory project (SIP) proposals. Specifically, it looked into the profile of science teachers, their level of competence, and the problems they encountered in conducting SIPs.
Methodology: This study used the descriptive research and the Research and Development (R&D) Methodology. Data on the secondary science teachers' profile and their level of competence in the preparation of a Science Investigatory Project were gathered using a survey questionnaire adapted from Cudapas (2020) and was processed to come up with an SIP Handbook for Teachers. A questionnaire adapted from Mopera (2011) was also used to validate the teacher-made handbook. A panel of experts evaluated the handbook, gave their comments and suggestions for its improvement and data gathered were analyzed and interpreted to determine the validity of the handbook.
Results: The study revealed that most of the science teachers are considered young with experience ranging from 1-10 years, and only a few have attended to any SIP training program. It was also found out that teachers are slightly competent in the preparation of research plan, research paper, research abstract, and research logbook. Further, it was also identified that there is deficiency in the availability and adequacy of instructional resources like handbook, and as a result, there is limited number of SIPs conducted; hence, there is a need to develop a handbook in SIP for teachers.
Conclusion: The developed handbook was subjected to the scrutiny of experts and teachers in SIP in terms of content quality, clarity, usability, adequacy, and language and style, and the SIP was assessed to be very highly valid. It was recommended that the developed Science Investigatory Project Handbook for Teachers be used by teachers in the preparation and management of science investigatory projects.

Keywords: Handbook, management, preparation, Science Investigatory Project, Teachers

INTRODUCTION

Science Investigatory Projects (SIPs) are considered instruments that contribute to the upgrading of Science and Technology (S&T); however, the need for improving science education has been reflected on the lack of quality in basic science education. First, not all students are given the opportunity to develop their scientific investigatory skills because only a few number of schools offer research as part of their curriculum. Only the special science classes in selected high schools are offering research and there is limit to the number of students who enroll in the program due to their high qualification standards for admission. With this setup, public national high schools can only teach and do investigatory projects as an entry in joining competitions in science fairs (Gomez, 2013).

Second, teacher-centered classrooms still dominate the education landscape. Science teachers fail to provide engaging and challenging activities like doing investigatory projects as they are centered to traditional lecture method. DOST-SEI & UP-NISMED (2011) found out that many schools assign teachers to teach science subjects despite their limited background. As a result, teachers tend to focus on competencies they are familiar with and neglect the difficult ones. Arguably, science education in schools is greatly influenced by the quality of science teacher. The learning interactions provided and the quality of teaching are associated with student's interest. Students are greatly inspired by science teachers who engage them in tasks that enable them to inquire and find solutions to problems.

Third, learning resources are also limited that is why teachers fail to engage the students to conduct investigatory projects. With the many overlapping activities and other tasks assigned to them, doing research remains a challenge.

On the other hand, the lack of quality on the basic science education has been reflected on the low performance of students in international and national assessment studies. The results of the 2018 Program for International

Student Assessment (PISA) of the Organization for Economic Cooperation and Development (OECD) where Philippines ranked second-lowest among participating countries in science assessment, with a low average score of 357 points, significantly lower than the average score of OECD, which is 489 points (DepEd, 2019). This shows that, on average, Filipino students have a poor grasp of scientific concepts and methods and can do structured scientific inquiries with at most two variables only with additional guidance.

Another disturbing situation is the result of the 2018 National Achievement Test which measured the 21st Century Skills of students, under the sub-skills Problem solving (PS), Information Literacy (IL), and Critical Thinking (CT) in five (5) subject areas for Grade 6 and Grade 10, while seven (7) subject areas for Grade 12, revealed a dismal result due to the very low performance in the test and the Critical Thinking Skills registered the lowest mean. Although there had been increase in the performance of students, the national mean percent score is still below mastery level (Albano, 2019).

Considering the huge impact, Investigatory Projects (IPs) play in the holistic development of a student and the society at large. United Nations Educational Scientific and Cultural Organization (UNESCO, 2014) encourages schools to improve instruction and make Science and Mathematics more appealing to ignite the interest of more learners to venture in these fields. Likewise, the Schools Division of Ilocos Norte is anchored in transforming learners to possess skills, thus, students are involved in doing SIPs to cultivate their interest and strengthen their attitude towards learning science and technology.

Consequently, due to lack of available resources in IP preparation and management, students are denied of a life-long skill and are robbed of the opportunity to learn the basic process of conducting investigations (Prouty, 2012). The researcher having analyzed the problem has come up with the idea of developing a handbook in writing investigatory projects through a step by step procedure to follow that may help teachers and students develop, guide and stimulate their interest in scientific inquiry. The conduct of a science investigatory project is a widely practiced teaching and learning method; however, it requires proper planning and management to yield optimum results (Gomez, 2013). In addition, science teachers' strategies and techniques in the SIP instruction and assessment are instrumental for the students to conduct SIPs and join science fairs (Mascarelli, 2011). It is in this light that a handbook explicitly specifying the goals and limitations for the conduct of Science Investigatory Project is necessary.

Objective

The study was conducted to determine the level of competence of science teachers in preparing an investigatory project and to properly manage its implementation which will serve as basis in the development of a handbook for teachers.

Precisely, to identify the profile of teachers in terms of their sociodemographic characteristics and professional qualifications; determine the level of competence of science teachers and find out the problems and challenges they encounter in the preparation and management of investigatory projects. Also, to find out the validity of the handbook based on the panel of expert's evaluation.

METHODS

Research Design

This study used the descriptive research and the Research and Development (R&D) Methodology. Data on the secondary science teachers' profile and their level of competence in the preparation of a Science Investigatory Project were gathered using a survey questionnaire and was processed to come up with a SIP Handbook for Teachers.

The study underwent three stages to come up with the Investigatory Project Handbook.

(1) **Planning Stage**. A survey questionnaire was adapted from Cudapas (2020) to gather data on the teacher-respondents' socio-demographic profile, professional characteristics and their level of competence in the preparation and management of Investigatory Projects. Some parts of the questionnaire, however, were contextualized to suit the local needs based on the guidelines of the NSTF-SRC as stipulated in DepEd Order No. 113, s. 2019. This stage includes the identification of the format and principle involved in the conceptualization of an IP Handbook as well as the problems encountered by teachers.

(2) **Development Stage**. A handbook on the preparation and implementation of an investigatory project was prepared based on the results obtained from the survey on the teacher respondents' socio-demographic and professional characteristics and their level of competence in the preparation and management of an investigatory project proposal.

(3) **Validation Stage.** This stage includes the assessment of the Investigatory Project Guidebook by a chosen panel of experts. Revisions on the handbook were done based on their evaluation, comments, and suggestions to further improve the material.

Locale of the Study.

This study was conducted in the fifty-four (54) public secondary schools and integrated schools of the Schools Division of Ilocos Norte (SDOIN) for the School Year 2020-2021.

Population and Sampling.

To satisfy the target number of teacher-respondents, purposive sampling was used in the selection of samples. This was used because the units selected have similar characteristics which are of great interest to the researcher (http://dissertation.laerd.com/purposive-sampling.php). Teacher respondents include all permanent Science teachers in the Junior and Senior High Schools in the Schools Division of Ilocos Norte as they manifest the same job descriptions, duties and responsibilities. Total enumeration was employed to cover all 247 target science teacher-respondents considering their involvement and role in SIP preparation and management in the school level.

As to the validation of the material, nine experts served as validators. The nine validators along content are the following: one education program supervisor in science, two school principals, two head teachers and four permanent teachers who are experts in the field of Science in the Junior and Senior High Schools. The experts have competed in science fair competitions and have garnered special certificates of awards and recognition. The developed handbook was assessed in terms of content quality, clarity, usability, adequacy, and language and style.

Data Gathering Instrument

The study made use of the following instruments:

Socio-Demographic Characteristics and Professional Qualifications of Science Teachers and their Competencies in SIP Preparation and Management.

This instrument is a survey questionnaire, with an attached letter indicating provision for the teacher respondents' full consent in the study and informing them that all disclosed information will be kept confidential.

The first part of the survey questionnaire is the Secondary School Science Teacher's Personal Profile. It is in a checklist form which includes the teacher-respondents' socio-demographic characteristics (age, gender and civil status) and professional characteristics (degree completed, training programs on investigatory project proposal preparation and implementation, investigatory project proposal generated and conducted and award-winning investigatory projects/ research studies conducted).

The second part is the survey questionnaire checklist which was adapted to determine the level of competence of the teachers in preparing the research plan, research paper, research abstract and research logbook. Some parts of the survey were contextualized to suit local needs based on the guidelines of the NSTF-SRC as stipulated in DepEd Order No. 113, s. 2019. Performance indicators were set to determine whether they are very highly competent, highly competent, slightly competent, and not competent teachers in preparing and managing investigatory project plans.

In describing the teacher-respondents' level of competence in investigatory project preparation and management, the following scale was used:

Numerical Rating	Descriptive Interpretation
4	Very Highly Competent
3	Highly Competent
2	Slightly Competent
1	Not Competent

The last part of the survey questionnaire adopted from Mbowane, et.al (2017) is about teachers' problems and challenges in the preparation and management of SIP. The gathered responses were used to explain further details to the problems of teachers in conducting investigatory projects.

Content Validation Instrument for the Handbook in the Preparation and Management of Investigatory Project for High School Science Teachers.

The second instrument is a questionnaire adapted from Mopera (2011). It was slightly modified by the researcher to suit it to the developed instructional material; however, no major changes were done in the instrument. A validation of the revised questionnaire checklist was done by the panel members of the current study as well as experts who validated the developed handbook. The instrument is composed of two parts. Part I elicits some basic information about each evaluator such as name, position, name and address of the school, number of years in the service as Science Teacher, and highest educational attainment. Part II is a rating scale where the evaluators could assess the SIP handbook along its basic features.

The following scale was used in evaluating the validity of the handbook:

Numerical rating	Descriptive Interpretation
4	Very Strongly Agree
3	Strongly Agree
2	Slightly Agree
1	Disagree

Treatment of Data

Data obtained from the teachers' profile were analyzed and interpreted using mean, frequency count, and percentage. Weighted mean was used to describe the teachers' responses to the survey questionnaire along the four major parts of the research paper format of the National Science and Technology Fair - Scientific Review Committee (NSTF-SRC) and to determine the content validity of the handbook.

The following statistical ranges were used to describe the teacher-respondents' competence in SIP preparation and management.

Range Interval of Mean Scores	Descriptive Interpretation
3.51 - 4.00	Very Highly Competent
2.51 - 3.50	Highly Competent
1.51 - 2.50	Slightly Competent
1.00 - 1.50	Not Competent

The evaluation of the panel of experts as to the content validity of the handbook was analyzed and interpreted using the following statistical ranges:

Range Interval of Mean Scores	Descriptive Interpretation
3.51 - 4.00	Very Strongly Agree / Very Highly Valid
2.51 - 3.50	Strongly Agree / Highly Valid
1.51 - 2.50	Slightly Agree / Slightly Valid
1.00 - 1.50	Disagree / Not Valid

RESULTS and DISCUSSION

Demographic Profile of Science Teachers

Teachers are instrumental in the conduct of Science Investigatory Projects (SIP) as they instill basic research skills to students; thus, their background and competencies matter a lot. Their expertise leads the students in the planning and implementation of the whole SIP process.

Results show that about 78.53% fall within the 22 to 42 years' age-bracket, and majority are married (63.56%). These results imply that majority of the science teachers are in their momentum of gaining experiences and are active in participating various professional development activities. More female teachers (68.82%) than male teachers (31.17%) comprise the Science teaching force in the division of Ilocos Norte.

There are 150 respondents (60.72%) who have earned some master's degree units; 10 respondents (4.04%) are graduates of a master's degree; 8 respondents (3.23) have earned doctoral units (3.23%); and two respondents (0.80%) are doctoral degree graduates. This is a manifestation that science teachers are determined to further hone their craft for professional growth, to step up to a higher level of competence and experience, and to apply for possible promotion. A closer look in the field of specialization reveals that 232 teachers are BS Education graduates whose majors are Biology/ Biological Science (46.96%), Physics (19.02%), Physical Science (12.05%), Chemistry (8.90%), and General Science (6.07%). This implies that most of them are capable of SIP instruction as they have both the pedagogy and content in their respective fields.

It can also be noted that most of the teachers (57.07%) have teaching experience ranging from one to 10 years, which implies that most of the respondents are relatively young in the profession.

Data further reveal that out of 247 teacher-respondents, only seven have attended any training program on science investigatory project development and implementation. This is alarming as the need to improve teachers professionally via trainings is very crucial in their development (Sanchez & Sarmiento, 2020). Moreover, 10 teacher respondents have admitted in preparing and conducting an SIP and six teacher-respondents have an award-winning SIP. This reveals that most of them have not been given the chance to attend training programs in SIP and at the same time they are not used to conducting science researches that hinder them from joining Science Fairs. These data validate the claim of UNESCO Office Jakarta and Regional Bureau for Science in Asia and the Pacific (2018) that the Philippines remains one of the lowest in ASEAN in investment in both education and research. The lack of investment is seen in the low number of researchers per million inhabitants in a country.

Level of Competence of Science Teachers in Science Investigatory Project Preparation and Management

The role of science teachers in the SIP instruction and assessment is critical as their strategies and techniques provide the medium for the students to conduct SIPs and join science fairs (Mascarelli, 2011). Strategies further improve students' engagement in the classroom setting (Dizon & Sanchez, 2020). As such, it is very

significant to consider their strategies and competencies in developing the research skills of the students, helping them refine their projects, and training them to become problem-solvers, critical thinkers, and creative thinkers as they reveal the answer of their investigations (DOST-SEI & UPNISMED, 2011).

Table 1 presents the competencies of Science teachers in preparing the research plan.

Table 1. Competencies of Science Teachers in the Preparation of Science Investigatory Project.

Criteria	Mean	Descriptive Interpretation
1. Research Plan	2.41	SC
2. Research Paper	2.47	SC
3. Research Abstract	2.44	SC
4. Research Logbook	2.29	SC
Composite Mean	***2.41***	***SC***

Legend:

Range of Means	**Descriptive Interpretation**
3.51 - 4.00	Very Highly Competent
2.51 - 3.50	Highly Competent
1.51 - 2.50	Slightly Competent
1.00 - 1.50	Not Competent

The composite mean of the ratings as evaluated by teachers in their preparation of the research plan is 2.41 which is interpreted as slightly competent. This reveals that science teachers have problems on the setting up of a research project in logical and concise manner.

In addition, it was found out that research question has a big impact on the design of a research plan and that it is a must to establish relevant objectives because these will determine the methodology that will be employed once the research plan is implemented. However, these competencies could still be improved to detail the investigation that will be performed.

Research Paper is a piece of academic writing similar to academic essays but are usually longer and more detailed assignment that provides analysis, interpretation, and argument to demonstrate a strong knowledge of the topic. The over-all mean of the composite ratings given by teachers is 2.47 which is interpreted as slightly competent. This means that science teachers in Ilocos Norte have insufficient skills in writing content and format of a science investigatory project. They struggle in organizing the information and arguments presented in the paper. This relates the findings of Sanchez and Rosaro (2019) that teachers should have strengthened their knowledge and skills on research, starting in high school, during their undergraduate studies, and more so in post-baccalaureate studies to have an impact in the implementation of SIP instruction and mentoring. In addition, universities and colleges should strengthen research in science education curriculum since prior experience impacts how teachers teach SIP in the basic education (Sanchez & Rosaro, 2019). However, it can be noted that teachers seem to have the knowledge and skills but cannot fully do it because of the problems they cited in the previous section.

Research abstract on the other hand refers to a brief but comprehensive summary of the research project. It highlights the research question(s), experimental procedures, data, and conclusions that is concise and easy to understand. The preparation of the research abstract as evaluated by science teachers themselves are slightly competent with a composite rating of 2.44. This indicates that teachers fell short in giving an overview of how the investigation was conducted including methods and resources used. In addition, the research process and results should also be reflected, which include conclusive ideas, important applications, and implications of the research.

Meanwhile, research logbook refers to a complete and permanent record of all activities undertaken including step by step procedure in the course of the conduct of experiment or research project. The composite mean of the ratings given by science teachers to the level of competencies they have in preparing the research logbook is 2.29 which is interpreted as slightly competent. This implies that teachers lack skills in examining the logbook section such as schedule, daily notes and ideas, background research, contacts and references, experimental procedure/method, data collection sheets, observations/results in tables and graphs, conclusions. That the teachers have a hard time evaluating even if it seems insignificant at the time because the information may be useful later on. Likewise, they still could not verify well the things described in enough detail to understand researcher's thoughts which may let others understand in the future and repeat exactly the entire experiment.

Problems of Teachers in the Preparation and Management of Science Investigatory Projects

The journey of the teachers in SIP preparation and management has not been explored in literature (Sanchez & Rosaro, 2019); thus, it is significant to explore the challenges they face as they help their students develop their research skills.

The actual set-up of SIP preparation and management in the field was rated as highly serious. This suggests that the experience of science teachers in the preparation and conduct of SIP is not without challenge. This supports the idea of Sanchez & Rosaroso (2019) about the most common problems of teachers in the conduct of SIP.

The criterion "volume of school work-related activities" got the highest mean rating. Teachers attribute also the failure of checking the reliability of electronic sources to the limited time of SIP preparation. This implies that teachers are heavily burdened with tons of work and many activities that hinder them from conducting science investigatory projects.

Teachers' readiness in SIP preparation and implementation is another highly serious problem. This is supported by the findings of the study of Aparecio (2018) that teachers need to enhance their knowledge and skills of science content to improve their competencies in science processes and research. Afterall, teachers' preparations are foundations to better leaning opportunities for their students (Sanchez, et. al, 2022).

Another notable serious problem is the availability or research journals, books, and other learning materials that should be readily available for use by the teachers. While it is true that there is richness of information in the internet, a handbook explicitly specifying all the necessary information to conduct SIP is found nowhere. This implies that in order to increase the competence of teachers in guiding the students to conduct SIP, there is a need to develop a handbook in the preparation and management of SIPs.

Content Validity of the Science Investigatory Project Handbook for Teachers

The handbook was evaluated by a group of experts composed of an Education Program Supervisor, school administrators, head teachers, and teachers who are perennial SIP coaches and winners.

Table 2, as evaluated by the panel of experts, reveals the qualities of the handbook with regard to the different criteria and the specific levels of validity. The handbook is found to be very highly valid with an overall mean of 3.86.

Table 2. Summary of Validation

Criteria	Mean	Descriptive Interpretation
A. Content Quality	3.94	VHV
B. Clarity	3.86	VHV
C. Usability	3.94	VHV
D. Adequacy	3.78	VHV
E. Language and Style	3.78	VHV
Composite Mean	***3.86***	***SC***

Legend:

Range of Means	Descriptive Interpretation
3.51 - 4.00	Very Highly Valid (VHV)
2.51 - 3.50	Highly Valid (HV)
1.51 - 2.50	Slightly Valid (SV)
1.00 - 1.50	Not Valid (NV)

Content Quality. As shown in Table 2, the composite mean of 3.94 with a descriptive interpretation of very highly valid clearly manifests that as per evaluation of the experts, the content validly serves its purpose in which it delivered value and has met the validators expectations in delivering what they need in a way that it can be applied to their world. This supports the idea of Manurung (2017) that an instructional material like a handbook should be complete, have a thorough explanation, and be simple as possible.

Three of the expert validators commented that "every part is clearly defined, presented and described." However, the following were also suggested:

"Be consistent in writing the scientific names."

"Please provide a sample for research logbook."

"Provide a sample abstract following the format of Intel ISEF/ NSTF."

These suggestions and comments were noted and have been reflected in the handbook.

Clarity. As regards clarity, the assessment of the validators to the handbook is very highly valid with an average of 3.86. This evaluation of the panel of experts indicate that the handbook does not contain any other display features

that may distract or confuse, and is written in a structured, clear and logical progression of topics consistent for the intended readers which are the science teachers. Moreover, with a remarkable high composite mean, the experts highly accept that the concepts and principles discussed can develop further teachers' self-confidence and skills in conducting science investigatory projects.

However, the following were some of the experts' suggestions:

"In the write-up, there must be consistency on the use of tenses of the verb."

"Include the discussion on the operational and conceptual definition of terms."

The above-mentioned suggestions were taken and have already been integrated in the SIP Handbook.

Usability. As per the usability aspect, the table also shows that the handbook as rated by the panel of experts is very highly valid with a composite mean of 3.94. This means that the handbook is useful as it can be used by target users to achieve specified goals. This supports the study of Casper, Myers and Yuen (2015) that usability is important as it minimizes frustration and spending less time finding what they need in other resources.

Adequacy. It is also shown in the table that the handbook along the factor adequacy was rated in general as very highly valid. This indicates the fact that the handbook was well-worth considered by the validators for the presentation of appropriate and updated information in the various topics. This also further implies that the examples provided were appropriate to the topics discussed. The experts also commented that the handbook is very comprehensive which will serve as guide and facilitate the work of researchers in SIP preparation and definitely a great help to all. In consonance also with the findings of Estacio (2015), these instructional materials should emphasize embedding skills and knowledge necessary to generate new knowledge.

Language and Style. With respect to language and style, all the experts agreed that the handbook has good writing style and topic presentation (mean of 3.78). It is also noted that there were some typographical and grammatical errors and words that are difficult to understand. Almost all the experts agreed that the font style and size can be adjusted for its readability, and the spacing is enough. They commented, however, that the handbook needs to be consistent with spacing and use a larger font size to avoid eye strain.

The researcher elicited all the comments and suggestions of the experts in improving the handbook. To address these comments, the researcher simplified the discussions and corrected the errors. Likewise, the font style was changed, and the size was made larger. Also, the researcher adjusted the spacing so that the text is clearer and more even in terms of quality.

In summary, all qualities of the handbook are very highly valid with the criteria "content quality" and "usability" having the highest overall mean score of 3.94, while the criterion "language and style" and "adequacy" has both the lowest mean scores of 3.78. This further implies that the handbook has very good qualities as an instructional material for teachers that can help them prepare and manage science investigatory projects.

Conclusion

Based on the findings of the study, it is concluded that science teachers in Ilocos Norte are relatively young in the profession and have limited exposure to SIP related seminars and training programs. Science teachers are slightly competent in the preparation and management of science investigatory projects. The study concludes that the developed handbook is very highly valid.

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