American Journal of Educational Research, 2022, Vol. 10, No. 12, 697-701
Available online at http://pubs.sciepub.com/education/10/12/6
Published by Science and Education Publishing
DOI:10.12691/education-10-12-6

Science Process Skills Survey as Input to Instructional Materials Development

Glenn Reuben Roa, Maria Teresa M. Fajardo*

Department of Science Education, University of Science and Technology of Southern Philippines, Cagayan de Oro City, Philippines
*Corresponding author: mariateresa.fajardo@ustp.edu.ph

Received November 09, 2022; Revised December 13, 2022; Accepted December 22, 2022

Abstract The COVID pandemic had made science educators realized the dearth of effective learning resources for distance education. There is a need to produce materials that promote the acquisition of science process skills in remote learning situations. This study is a phase 1 of the design and development of a science module research to address the effective acquisition of science process skills in distance education mode. The objective of this study is to determine the knowledge of science teachers on science process skills, their frequency and ease of science process skills integration as an input to the design of the learning material intended for distance education mode. An instrument adopted from the study of Miles (2010) was used to measure the science teachers' basic science process skills. Another survey instrument was validated and used to gather the data from 64 respondents to know their integration practice in terms of frequency, challenges and ease of integration. Findings indicated that the Grade 9 science teachers did well in most science process skills except in observe and communicate. Among the science process skills, science teachers declared that making prediction is the most challenging skill to develop. There is a need to provide professional development to improve the science teachers' efficacy and skills in promoting science process skills acquisition.

Keywords: *science process skills, scientific literacy, students' achievement, science pedagogies*

Cite This Article: Glenn Reuben Roa, and Maria Teresa M. Fajardo, "Science Process Skills Survey as Input to Instructional Materials Development." *American Journal of Educational Research*, vol. 10, no. 12 (2022): 697-701. doi: 10.12691/education-10-12-6.

1. Introduction

1.1. Background of the Study

Science literacy has become a common vision of today's science education. As emphasized by American Association for the Advancement of Science (1993) and NRC (1996) its primary goals as an improvement of thinking skills including computation, prediction, manipulation, observation, communication and critical response skills and the ability to engage in research activity including making observations, asking questions, planning research studies, reviewing what is known in the light of experimental evidence, using data collection tools, analyzing data, interpreting data, suggesting answers, and explaining, predicting and communicating results. These skills, which are the primary goals of science literacy, are among the Science Process Skills (SPS) dimensions, and the SPS dimensions and the primary goals of science literacy intersect.

In the Philippines, one of the aims of the Philippine Science Curriculum is to develop scientific literacy among learners through science process skills (DepEd, 2016). It is expressed in the literature that data processing skills have a central role in reasoning [1]. In the context of 21st-century learning, SPS cannot be separated from the teaching of science. It was asserted that a student should possess a mastery of the necessary science process skills to succeed in science inquiry and hands-on science activities [2]. As such, a well-developed SPS has the potential to contribute to the success of science teaching. A number of previous studies have confirmed the correlation between science process skills and formal reasoning ability, learning achievement, scientific literacy, and scientific attitude. In essence, efficient science teaching can be done by simultaneously integrating science process skills [3].

However, with the current health crisis worldwide due to COVID 19, teaching Science Process Skills has faced another set of challenges and difficulties. The "new normal" presents a unique challenge to every educational leader's decision-making process. One of the challenges is the integration of science process in the curriculum materials. This study seeks to establish the basic design elements of a science instructional materials for distance education mode. This is help provide curriculum material for flexible or hybrid set-up.

1.2. Theoretical Framework

The present research focuses on the following frameworks and design models as they are deemed most

relevant in explaining concepts in this study: Constructivism and Moore Transactional Distance Theory.

1.2.1. Constructivism Theory

Over the past 20 years, science educators recognize the importance of constructivism in science teaching. This study is anchored on Bruner Constructivism theory. Constructivism emphasized the active role of the learner in building understanding and making sense of the information [4]. The constructivist teaching is learner-centered, where students are actively involved in knowledge construction rather than being passive learners. A major theme in the theoretical framework of Bruner is that learning is an active process in which learners construct new ideas or concepts based upon their current and previous knowledge. The learner selects and transforms information, constructs hypotheses, makes decisions, and rely on their own understanding. This is because cognitive structure (schema) provides meaning and organization to experiences and allows the individual to go beyond the information given. In other words, the teacher should encourage the learner to discover principles by themselves. With the use of the SLMs, the learner will be able to process new ideas that they read from the module. Furthermore, the aim to enhance science process skills is also anchored in the constructivist learning theory. It was stated that the acquisition of science process skills is more accessible through a learning strategy geared towards constructivism [5,6].

1.2.2. Moore Transactional Distance Theory

Moore's Transactional Distance theory was considered as a theoretical framework to guide this research. In 1983, Moore developed this theory of distance learning programs to investigate two variables: students' autonomy and the distance between students and teachers [7]. Transitional Distance theory mainly describes the learner and the educator/teacher relationship. According to Moore, transactional distance is essential because the perception is grounded in distance learning within a social structure, not in its traditional form. The second element of Moore's theory involves the student's autonomy, as the distance between him and his teacher means that the student must adopt responsibility for his learning. This kind of situation became very real during the COVID pandemic.

1.3. Conceptual Framework

The acquisition of knowledge and science process skills development is essential to scientific inquiry [8]. Moreover, the inculcation of values, scientific attitudes, appreciation, and critical thinking should be considered in science education, setting objectives as guides for its instructional level.

The conceptual framework, anchored on the theories presented earlier, was framed to address the need for developed SLMs that will foster the acquisition of the Basic SPS in distance learning education. As shown, challenges experienced by the science teachers in the Basic SPS integration in modular distance learning and their Basic Science Process Skills inventory will serve as input in the development of SLMs. The process involves designing and developing the Self-Learning Modules and evaluation of the SLMS for some revisions. The flow of the research framework shows that developed SLMs will serve as the output.

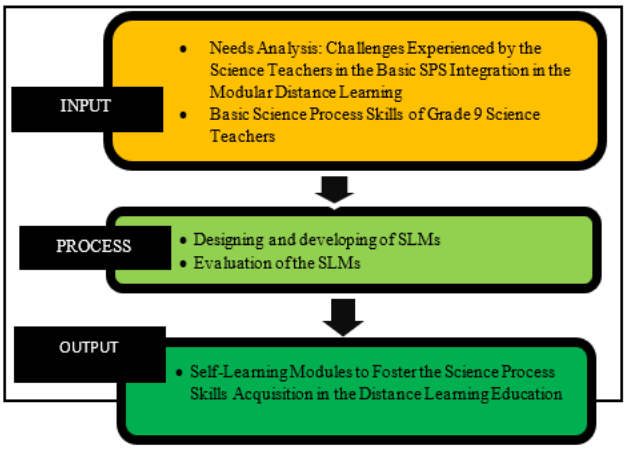

Figure 1. Conceptual Framework of the Research

1.4. Statement of the Problem

Various content standard achievement tests, intervention materials, and modules were developed and utilized to cater to students' needs about acquiring knowledge and skills. The Department of Education released modules on various subjects, especially Science, to meet the newly enhanced spiral curriculum standards. However, with the current situation where face-to-face teaching is not allowed, materials for distance learning education should also foster SPS development. The researcher aims to develop Self-Learning Modules based on the challenges experienced by the science teachers in the Basic SPS integration in the Modular Distance Learning. Specifically, it will seek to answer the following questions:

1. What is the level of performance of Grade 9 Science teachers in the Basic Science Process Skills Test?
2. How often teachers integrate each Basic Science Process Skills?
3. How teachers ranked the Basic Science Process Skills in terms of how easily they can be developed?

2. Material and Methods

The research was guided by the ADDIE (Analysis, Design, Development, Implementation, and Evaluation) Model in developing the Self-Learning Module for Grade 9 Science. This paper covers the Phase I (Needs Analysis Phase) which consisted of (a) developing the research instruments (b) content and face validation of the research instruments (c) seeking permission through a letter request to the Schools Division Superintendent of Lanao del Norte where the needs analysis would be conducted (d) conduct the needs analysis through Google Forms, to identify the Challenges in Basic Science Process Skills Integration in the New Normal Education as Experienced by Science Teachers" and Science Process Skills Test to determine the knowledge of science teachers in SPS. The research was conducted in the Division of Lanao del Norte, Region X, during the academic year 2020-2021 with 64 science teachers as respondents. This study made use of qualitative and quantitative methods for the development of

Self-Learning Modules. The quantitative method was utilized for analyzing the numerical data from the survey and the qualitative part was the in-depth analysis of teachers' experiences in the Basic SPS integration in modular distance learning. Based on DepEd's Most Essential Learning Competencies (MELCs) under Science 9, Self-Learning Modules (SLMs) were developed to foster Basic Science Process Skills in observing, classifying, communicating, measuring, predicting, and making inferences.

2.1. Research Instruments

The study made use of two research instruments. This section describes each instrument.

2.1.1. Challenges in Basic SPS Integration in the New Normal as Experienced by Science Teachers

This instrument was used to determine the profile of the respondents, their level of integration of the Basic Science Process Skills in their class, and the challenges experienced. The instrument was a researcher-made questionnaire, and face and content validation were done by three Science Education experts. This instrument was divided into three parts: (1) Profile of the respondents, (2) Integration of Basic Science Process Skills, and (3) Challenges Experienced by Science Teachers. The suggestions and corrections were incorporated in the final format of the instrument before disseminating it online.

2.1.2. Basic Science Process Skills Test for Teachers.

The science process skills test was used to determine the performance of science teachers on each basic science process skills. This instrument was adopted from the study of [9] but this study only included the items related to six Basic Science Process Skills, namely: classification, predicting, inferring, measuring, communicating and observation. The 19 questions were correlated with a specific basic science process skill, determined by the original instrument. The instrument has a Cohen's kappa score of 0.764 that indicated a strong inter-rater reliability for the instrument. According to the author, the science process skill test was a compilation of test items from published reliable and valid process skill performance tests. It was reported that to ensure instrument validity of the compilation, three qualified science education experts from the Department of Curriculum and Instruction at Southern Illinois University Carbondale evaluated the science process skills test. It was stated that the university experts were given a copy of the instrument and a copy of the process skills and were asked to identify each question with its associated process skill. The adopted questions were grouped and arranged by the researcher as shown in the table below.

Table 1. BASIC SCIENCE PROCESS SKILLS TEST AND ITEM PLACEMENT

Basic Science Process Skills	Number of Items	Items Placement
Classification	3	1,2,3
Predicting	3	4,5,6
Inferring	3	7,8,9
Measuring	4	10,11,12,13
Communicating	3	14,15,16
Observation	3	17,18,19
Total	19	

3. Results and Discussion

Table 2 reveals the scores of science teachers in the Basic Science Process Skills Test conducted. It can be observed that the science teachers got 77.63% of correctly answered items in the Basic Science Process Skills test. In particular, teachers performed well on the skills of Predict (91.67%), Measure (82.75%), Infer (82.67%), and Classify (81.67%). However, skills of Communicate and Observe got low scores of 66% and 59%, respectively.

Table 2. PERFORMANCE OF TEACHERS ON BASIC SCIENCE PROCESS SKILLS TEST

Science Process Skills	Highest Score	Mean	Std. Deviation	Mean percentage score (%)
Observe	3	1.77	.868	59.00
Classify	3	2.45	.665	81.67
Infer	3	2.48	.504	82.67
Measure	4	3.31	.614	82.75
Communicate	3	1.98	.654	66.00
Predict	3	2.75	.471	91.67
Basic Science Process Skills	19	14.75	1.799	77.63

Making observation is a fundamental science process skill. It involves using the five senses and science tools to learn about the world around us. Students' learning can be maximized if they have developed well their observation skills. Good observation includes detailed qualitative and quantitative data or information about the environment essential to the understanding of science phenomena and science concepts. Observe and communicate compliments each other. Observations must be communicated properly and effectively to be understood among learners. Both skills should be well-developed to foster academic achievement. These results are interesting as it differed with other studies involving pre-service and in-service teachers [10] who found that teachers excelled in communicate but did not perform well in observe and infer. Meanwhile, it was found that the most commonly developed science process skills are making data interpretation and inference [11]. The findings have implications on the training of future science teachers as well as to the continuing professional development of in-service science teachers.

Table 3 shows the descriptive statistics of the science teachers' responses regarding how often they integrated Basic Science Process Skills in their classes.

Table 3. TEACHERS' INTEGRATION OF THE BASIC SCIENCE PROCESS SKILLS

Science Process Skills	Mean	Std Dev.	Interpretation
Observe	4.45	.589	Very Often
Classify	4.14	.664	Often
Infer	4.14	.687	Often
Measure	3.94	.614	Often
Communicate	4.44	.614	Very Often
Predict	4.17	.579	Often

The science teachers claimed that the science process skills that they very often integrate in their lessons are observe and communicate. However, these are the SPS that the teachers scored the lowest in the assessment. Study shows that pre-service teachers have limited

conceptual understanding of the science process skills, an explicit intervention on science process skills in teacher education programs for pre-service teachers to develop conceptual understanding of the science processes is thereby recommended [12]. This is imperative as science teachers' science process skills, scientific attitudes and students' performance in Chemistry has positive bivariate and multiple relationships [13].

Table 4 presents the percentage and mean values of responses ranked by teachers on how easily each Basic Science Process Skills can be developed.

Table 4. RANKING OF BASIC SCIENCE PROCESS SKILLS FOR EASE OF DEVELOPMENT

Science Process Skills	Mean	Std. Dev	Rank
Observe	1.67	1.38076	1
Classify	2.82	1.22869	2
Infer	4.23	1.42252	5
Measure	3.75	1.39158	3
Communicate	4.02	1.46377	4
Predict	4.50	1.58365	6

Teacher respondents ranked Observe as first when it comes to ease of developing the skills among students with a mean score of 1.67, followed by Classify, Measure, Communicate, Infer and Predict with mean scores of 2.82, 3.75, 4.02, 4.23, and 4.50, respectively. This means that the easiest Basic Science Process Skills that can be developed is Observe as perceived by the science teachers, and the most challenging is Predict. However, observe is a science process skill that the science teachers scored the lowest in the assessment. This is a need to investigate further the science teachers' understanding of science process skills and their implementation or integration practices to be able to design the intervention that is meant to benefit their students' academic achievement.

These findings may be considered as a good input for continuing professional development for in-service teachers and for the training of pre-service teachers for improving science literacy skills of students via the development of science process skills. Science process skills may be inherently more important than basic skills in student's epistemic development because of the important role they play in science achievement [14]. Various pedagogical approaches were found to be effective in developing science process skills among students [15,16,17]. Science teachers may use a variety of these teaching strategies that are most suitable to the needs of their students.

It can be surmised that this science process integration practice depends on the knowledge of the science teachers and their efficacy in teaching sciences. Science teachers have different self-efficacy level across the different sciences such as physics, chemistry, biology and earth and space that is taught in spiral progression in the Philippine basic education curriculum [18]. This has implication on the teacher training for science process skills development [19].

4. Conclusion

The development of science process skills is dependent on the amount of attention science teachers gave to it, that is, integration and implementation and the confidence or efficacy training provided for them to help their students acquire the skills. As such, it is possible that science teachers may differ greatly in their knowledge about science process skills and in their ability to incorporate it in their science lessons.

5. Recommendation

Science process skills enables the development of students' scientific literacy necessary the navigate the complexities of the modern world. The science teachers are in the best position to facilitate the acquisition of these skills in the new normal. Whether in face to face or modular modality, the science teachers must have the instructional competence and the instructional materials available to make it possible. In order to maximize the effectiveness of any self-learning module for distance education mode, science teachers may be provided with the necessary training and continuing professional development opportunities to be able to incorporate the teaching of science process skills across the science curriculum.

It is also recommended that similar investigation on science teachers' capacity and confidence to promote the acquisition of science process skills across the different grade levels be conducted.

Acknowledgements

The authors acknowledged the scholarship support received from the Department of Science and Technology (DOST) Science Education Institute.

References

[1] Tosun, C. "Scientific process skills test development within the topic "Matter and its Nature" and the predictive effect of different variables on 7th and 8th grade students' scientific process skill levels. *Chemistry Education Research and Practice*, 20(1), 2019. 160-174.

[2] Ngoh, T. "Mastery of the science process skills". *Unpublished manuscript*. 2009.

[3] Irwanto, Rohaeti, E., & Prodjosantoso, A. K. "Undergraduate students' science process skills in terms of some variables: A perspective from Indonesia". *Journal of Baltic Science Education*, 17(5), 2018. 751-764.

[4] Fosnot, C. T., & Perry, R. S. "Constructivism: A Psychological Theory of Learning. Constructivism: Theory, Perspectives, and Practices", 1996. 0, 28. Retrieved from http://rsperry.com/fosnotandperry.pdf.

[5] Ramnath, R. "Constructivism Based Learning Strategy (CBLS) in the Acquisition Science Process Skills". *Shanlax International Journal of Education*, 3(1), December 2014.

[6] Serin, O., Serin, N. B., & Özbaş, L. F. "The effect of computer-assisted science instruction attitude towards science and the computer". *International Journal of New Trends in Arts, Sports & Science Education (IJTASE)*, 2015 *4*(3).

[7] Abuhassna, H., & Yahaya, N. (2018). "Students' utilization of distance learning through an interventional online module based on moore transactional distance theory". *Eurasia Journal of Mathematics, Science and Technology Education*, 14(7), 3043-3052.

[8] Bete, A. O. "Students ' knowledge and process skills in learning grade-8 chemistry". 10(1), 2020. 1-13.

[9] Miles, E. (2010). "In-service elementary teachers' familiarity, interest, conceptual knowledge, and performance on science process skills". Southern Illinois University at Carbondale.

[10] Kruea-In, C., Kruea-In, N., & Fakcharoenphol, W. "A study of Thai in-service and pre-service science teachers' understanding of science process skills." *Procedia-Social and Behavioral Sciences*, 2015. 197, 993-997.

[11] Ozkan, G., & Umdu Topsakal, U. 'Analysis of Turkish Science Education Curricula's Learning Outcomes According to Science Process Skills". In *Elementary School Forum (Mimbar Sekolah Dasar)* (Vol. 8, No. 3, pp. 295-306). 2021, December. Indonesia University of Education. Jl. Mayor Abdurachman No. 211, Sumedang, Jawa Barat, 45322, Indonesia. Web site: https://ejournal. upi. edu/index. php/mimbar/index.

[12] Chabalengula, V. M., Mumba, F., & Mbewe, S. "How pre-service teachers' understand and perform science process skills". *Eurasia journal of mathematics, science and technology education*, 8(3), 2012. 167-176.

[13] Ogunleye, B. O. "Relationship among teachers' science process skills, scientific attitudes and students' performance in Chemistry". *International Journal of Educational Leadership*, *4*(4), 2012. 41-48.

[14] Abungu, H. E., Okere, M. I., & Wachanga, S. W. "The effect of science process skills teaching approach on secondary school students' achievement in chemistry in Nyando District, Kenya". *Journal of Educational and Social Research*, 4(6), 2014. 359-359.

[15] Mulyeni, T., Jamaris, M., & Supriyati, Y. "Improving Basic Science Process Skills through Inquiry-Based Approach in Learning Science for Early Elementary Students". *Journal of Turkish Science Education*, *16*(2), 2019. 187-201.

[16] Setiani, R., Surasmi, W. A., & Tresnaningsih, S. "Increasing the Potential of Student Science Process Skills Through Project Based Laboratory". In *Journal of Physics: Conference Series* (Vol. 1569, No. 4, July 2020, p. 042066). IOP Publishing.

[17] Elfeky, A. I. M., Masadeh, T. S. Y., & Elbyaly, M. Y. H. Advance organizers in flipped classroom via e-learning management system and the promotion of integrated science process skills. *Thinking Skills and Creativity*, *35*, 2020 100622.

[18] Bug-os, M. A. A. C., Walag, A. M. P., & Fajardo, M. T. M. "Science Teacher's Personal and Subject-Specific Self-Efficacy in Teaching Science: The Case of El Salvador City, Philippines". *Science International*, 33(3). 2021. 179-186.

[19] Zeha, Y. Effect of teacher education program on science process skills of pre-service science teachers. *Educational Research and Reviews*, *9*(1), 2014. 17-23.