Journal of Chemistry Studies
DOI: 10.32996/jcs
Journal Homepage: www.al-kindipublisher.com/index.php/jcs

JCS
AL-KINDI CENTER FOR RESEARCH AND DEVELOPMENT

| RESEARCH ARTICLE

Identifying the Process Skills Involved in Teaching Chemistry through the Extraction of Oil from Castor Oil Seed

Juliana Nkiru Nnoli[1] ✉, and Felicity Uju Onwudinjo[2]
[12]Department of Chemistry, Nwafor Orizu College of Education Nsugbe, Anambra State, Nigeria
Corresponding Author: Juliana Nkiru Nnoli, **E-mail**: nkejul@yahoo.com

| ABSTRACT

The purpose of the study was to discover the process skills needed to teach chemistry by extracting oil from castor oil seeds. A pure experimental research design was used for the investigation. The study is guided by one null hypothesis and three research questions. The population was made up of all 2,305 SS1 Chemistry students from five government-owned secondary schools in the local government area of Otuocha, Anambra East. 120 SS1 chemistry students were selected as a sample using basic random instruction. The instrument for data collection was established using fifteen (15) Process Skills Observation Guide (PSOG). Observing, classifying, communicating, measuring, counting and using number, inferring, predicting, experimenting, questioning, manipulating, formulating hypothesis, controlling variable, formulating models, interpreting data and making operational definitions. The mean and standard deviation were used to validate and assess the instrument. The hypothesis was tested at the 0.05 significant levels using the Z test. The results showed that 4.8 kg of castor seed was required to produce 1000 cm3, that 13 out of 15 process skills were acquired, only classifying and inferring were not acquired, that male students had a high level of acquisition of science process skills, and that gender had no discernible effect. Nonetheless, recommendations were made and the educational ramifications were mentioned.

| KEYWORDS

Identifying, process skills, teaching, chemistry, extraction, castor oil seed

| ARTICLE INFORMATION

ACCEPTED: 01 December 2023 **PUBLISHED:** 01 January 2023 **DOI:** 10.32996/jcs.2024.3.1.1

1. Introduction

The discipline of scientific education is concerned with imparting to people the knowledge and methods of science. Teaching scientific courses like physics, chemistry, biology, and other science courses is how science education is accomplished (Nnoli, 2022). Additionally, science is a methodical endeavor that creates and arranges information in the form of universe-related hypotheses and tested explanations. One of the primary areas of science that deals with matter is chemistry. It is the study of matter and its characteristics, as well as the changes that matter goes through and the energy that causes such changes. The study of matter, including its composition, properties, and transformations, is the main goal of the scientific field of chemistry. As a result, a strong foundation is necessary for successful and efficient chemistry instruction in secondary schools, especially in Nigeria (Nwafor, Eke, and Ibe, 2023). The basis of future disciplines such as engineering, astronomy, space science, and medicine is laid by understanding of chemistry.

The things that scientists research and investigate are known as process skills. According to Safaah et al. (2017), the process skills are thinking skills that use scientific procedures and approaches to identify science components, concepts, and theories. These science abilities have been referred to by a number of names over time, including scientific thinking, the scientific method, and critical thinking. The curriculum initiative popularized the phrase "science process skills," which are now widely used to describe a set of generally transferable talents that are acceptable for various science fields and resemble the behavior of scientists (Yakubu et al., 2021).

Scientific skills play a vital role in the process of inquiry and exploration. These skills encompass various facets of scientific investigation. The observation skill involves gathering information using the senses or instruments, and it can be quantitative, qualitative, or focused on change (Azonuche, 2020; Azonuche, (2021). Classifying involves grouping objects based on properties or criteria, while quantifying deals with data that can be counted or measured numerically. Inferring requires making educated guesses based on prior data, while predicting involves stating the outcome of a future event based on evidence patterns. Communication employs words or symbols to describe actions, objects, or events, while comparing examines characteristics for resemblances or differences (Kurniawan et al., 2023). Questioning enhances specific scientific processes, and manipulating emphasizes the use of scientific apparatus and substances during investigations. Experimentation involves asking appropriate questions, stating hypotheses, and controlling variables (Gizaw & Sota, 2023). Hypotheses state expected outcomes, and controlling variables involves identifying factors affecting outcomes. Interpreting data organizes and draws conclusions from recorded information, while recording involves documenting data in various forms. Finally, measuring uses standard and nonstandard measures to describe dimensions. These skills collectively contribute to a comprehensive scientific approach (Azonuche, 2015).

The majority of castor oils are bought as cold-pressed oil in various regions of the world. Studies have shown that pressing is a viable method for extracting castor oil. Super critical carbon ii oxide and n-hexane are the two main ingredients in the solvent extraction process. Zhang and Guo (2018). Castor seeds are cleansed to get rid of any undesirable material before extraction. After that, the seed is handled or using decorticating machinery to remove the shells and reveal the kernels. The lighter the oil color, the more effective the decorticating procedure was. Solvent extraction is often used to produce more than 80% of castor oil. However, the main issue with using these approaches is the high cost and sustainability of solvents based on biodiesel. Consequently, several ethanol and carbonii oxide-based solvents have been investigated and used for the extraction of castor oil. It has been shown that using aqueous solvents is just as effective as using hexane, with the added advantage of using less solvent. However, a drawback of aqueous solvents is the large energy output required to extract the oil from the liquid (Patel et al., 2020).

More innovative boi-based compounds and materials have been made from castor oil than from any other plant-produced oil, making it an essential raw resource (Anjani, 2018). Castor oil was once primarily used in the production of industrial lubricants, lamp oils, and pharmaceuticals. Nonetheless, a deeper comprehension of the molecular structure has expanded its applications and led to the creation of additional human-beneficial byproducts. Because of its anti-inflammatory qualities, castor oil has been widely utilized in medicine and other health-related disciplines to treat a variety of disorders. Minor conditions such as menstruation discomfort, gastrointestinal infections, athlete's foot, sunburns, and pain during induction of labor have been treated using castor products (Kelly et al., 2017). It can be useful in treating constipation since it includes laxatives or purgatives. Detoxified castor seed, which improves eyesight, is used as a culinary condiment in Nigeria (Salihu et al., 2022). There isn't much information about castor oilseed's application in the food business. The oil is used in the production of flavors, additives, and candy as a mold inhibitor and to preserve food. Pomace, a high-nitrogen castor waste, is utilized as organic fertilizer and animal feed with no known negative effects (Borja, 2017).

1.1. Statement of the problem

One of the biggest obstacles to generating self-reliant chemistry students is getting pupils to retain chemistry lessons in both academic and real-world settings. As Nwagbo (2018) correctly pointed out, the main goal of teaching science in general and chemistry in particular is to increase student comprehension of the material in order to apply it to practical settings. Despite the benefits of teaching science process skills to students in chemistry classes, there are still drawbacks. One of these is that students often do not receive enough laboratory experience to develop the necessary skills, which impedes their ability to learn science process skills and to comprehend the material. For the purpose of helping students develop science process skills, this study aims to identify the process skills used in the extraction of oil from castor seeds.

1.2 Purpose of the Study

The general purpose of this study is to identify the process skills acquired in the extraction of oil from castor seeds by chemistry students. Specifically, this study sought to.

1. determine the quantity of castor seeds in kg that will produce at least 1000cm^3 of castor oil?
2. determine the process skills involves in the production of castor oil seed.
3. determine the influence of gender on the process skills in the acquisition of science process skill.

1.3 Research Question

1. What quantity of castor seeds in kg will produce at least 1000cm^3 of castor oil?

2. What are the process skill involves in the production of castor oil from castor seed?
3. What are the gender difference in the process skills?

1.4 Research Hypothesis

The null hypothesis was tested at 0.05 level of significance.
There is no significant difference between male and female students in the acquisition of science process skills in the extraction of oil from castor oil seed.

2. Methodology

In this study, a pure experimental research design was used. Anambra East in the state of Anambra served as the study's area. South-central Nigeria's Anambra state has the local government area known as Anambra East. The 2,305 SS1 chemistry students in five government-owned secondary schools in the Otuocha Anambra East local government area make up the target population for this study project. 120 SS1 chemistry students were selected at random to make up the sample. The student's gender made the sample purposeful. Process skills, observation guide (PSOG), questioning, manipulating, classifying, communicating, measuring, counting, and using numbers, inferring, predicting, experimenting, controlling variables, creating models, interpreting data, and formulating operational definitions were the instruments used for data collection. Two chemistry department professors and a measurement and evaluation specialist from Nwafor Orizu College of Education Nsugbe verified the instrument.

The procedures that are planned and executed are as follows: The process of making castor oil involves gathering the seed (pods), shelling and dehulling the pods, drying the seeds to eliminate moisture, grinding the seeds, combining the ground seeds with water, and lastly boiling the seeds to extract oil. Students in the experimental group and the gender control group were given the tool to ascertain their prior knowledge of extracting castor oil from castor seed. Students were taught and conducted experiments on this topic, which required recognizing the process skills needed in teaching chemistry through the extraction of oil from castor oil seed. The students carried out the experiment gently and observed a clear product of the castor oil from castor oil seed.

4. Results and Discussion

This **Research Question 1**

What quantity of castor seeds in kg that will produce at least 1000cm^3 of castor oil seed? Since 7.5kg of the castor seed was peeled/dehulled from the weighted castor seed. After drying of the seeds, we have 2.4kg using 500ml of water. Since 2.4kg is being prepared with 500mlkg will be used to prepare at least 1000ml**.** Using the formulae $C_1V_1 = C_2V_2$

Where C1 = 2.4kg, V_1 = 500ml, C_2 = X, V_2 = 1000ml

2.4 = 500ml

X = 1000ml

Making X the subject of formulae, we have that

$$C_2 = \frac{C_1 V_2}{V_1}$$

$$\frac{2.4kg \times 1000}{500}$$

$$\frac{2400}{500}$$

= 4.8kg

This showed that 4.8kg of the castor seed will be needed to produced 1000cm^3 of castor oil.

Research Question 2

What are the process skill involved in the extraction of oil from castor oil seed?

Table 2: Mean rating scores and standard deviation of chemistry students on science process skills involved in the extraction of oil using castor oil seed?

S/N	Process Skills	Mean X	Standard Deviation
1.	Observation	2.78	1.15
2.	Classifying	2.21	1.48
3.	Communicating	3.01	1.73
4.	Measuring	2.73	1.65

5.	Counting and using number	2.82	1.68
6.	Interfering	2.00	1.50
7.	Predicting	3.00	1.73
8.	Experimenting	3.01	1.73
9.	Questioning	2.90	1.70
10.	Manipulating	3.03	1.74
11.	Formulating hypothesis	3.10	1.76
12.	Controlling variable	2.90	1.70
13.	Formulating models	2.77	1.66
14.	Interpreting data	2.54	1.74
15.	Making operational definitions	2.58	0.94

The mean scores and standard deviation of the process skills attained in the oil extraction from castor oil seed are displayed in Table 2. Out of the fifteen process skills, the mean scores showed that just two—classifying and inferring—were not learned. Additionally, it demonstrates how the extraction of castor oil led to an increase in the development of science process skills.

Research Question 3

What is the influence of gender on level of science process skills acquired in the extraction of castor oil from castor seeds.

Table 3: Mean ratings scores of male and female students on the acquisition of science process skills.

Gender	Number of students	Means	SD
Males	70	2.75	0.89
Females	50	2.63	0.54

Table 3 demonstrates that when it comes to observing, communicating, measuring, counting, and utilizing numbers, as well as inferring, experimenting, establishing hypotheses, controlling variables, interpreting data, and creating operational definitions, men score better on average than women. In the categories of classification, prediction, questioning, manipulation, and model-making, men outscored females on mean scores. When it came to categorizing, challenging and manipulating, forecasting, and creating models, women showed poor acquisition. Lastly, male students demonstrated a high degree of proficiency in the scientific method of extracting castor oil from castor seed.

Table 4: Z – test comparison of the mean scores of male and female chemistry students on the level of science process skills acquired in the extraction of castor oil from castor seeds.

Gender	N	Mean	SD	Z-cal	Z-critical	Decision
Male	70	2.99	0.62	1.30	1.96	Accepted
Female	50	2.66	0.68			

From table 4: Z calculated value in respect of gender for students mean process skills scores in quantitative analysis items is seen to be 1.30 while the Z – critical value at 0.05 level of significance is 1.96. this Z-calculated value is less than the Z- critical value. Hence the null hypothesis is Accepted.

Null Hypothesis 2: There is no statistically significant influence of gender on students using process skills.

This revealed that at 0.05 level of significant Z- calculated of 1.30 is less than the Z – critical 1.96. hence the null hypothesis is accepted.

4. Discussion

The study's descriptive and inferential data were displayed in tables 1, 2, 3, and 4. Table 2's findings demonstrated that while the mean scores for inferring and classifying were below the proficiency level for those abilities, the proficiency level for other abilities—such as observation, experimentation, measurement, communication, and prediction—was high according to the instrument's quantitative analysis items.

The fact that the students were not taught practical skills may be the reason why the means scores for formulating variables and formulating models were below the level of acquisition of those skills. In contrast, the means scores for manipulating, communicating, experimenting, and formulating hypotheses showed a high level of acquisition of inferring, classifying, and measuring. This might also be explained by the professors' inability to possess the abilities that they were supposed to impart. This result is consistent with earlier research by Okinugo et al. (2020), which demonstrated that teachers' learning of science process skills was not at a satisfactory level. According to Table 3, the mean score for male students in the degree of acquisition of science process abilities in quantitative analysis items was 2.99, whereas the mean score for female students was 2.66. These often imply that the male pupils acquired the abilities at a greater level than their female peers. Additional study of Z-test on Table 4 showed that, at the 0.05 level of significance, the calculated Z-value in the quantitative analysis items is more than the Z-value owing to level, which is 1.30, and the calculated Z-critical, which is 1.96. The researcher agreed with the null hypothesis in both analyses as a result.

As a result, gender has no statistically significant impact on the chemistry students' degree of science process abilities when it comes to extracting oil from castor oil seeds. This result is consistent with that of Akor & Amadioha (2020), who discovered that gender had no appreciable impact on the development of science process skills. That, however, runs counter to Ashma's (2019) findings, which indicate that gender significantly influences students' learning of process skills, favoring male students. Despite the dispute, this study clearly shows that certain disparities may have arisen as a result of certain circumstances, such as the backgrounds, subjects, and character of teachers and learners.

5. Conclusion

The researcher found that exposure to or experience in a laboratory greatly improves students' academic achievement understanding and, in particular, their acquisition of science process skills. Learners who were exposed to this type of learning environment demonstrated greater awareness of science process skills and performed better than those who were only taught theoretically. Persistent use of theoretical methods in chemistry education leaves students with little to no science process skills. Consequently, it is evident that students will not acquire science process skills in the absence of laboratory experience or experimental studies. It is thought that exposure to laboratories and experiment investigations provides students with the process skills they need to become competent chemists. It is also common knowledge that kids have not learned as much or any science process skills in certain educational zones due to a shortage of chemistry equipment and chemicals. After working with the students, the researcher discovered that 4.8 kg of castor seed are required to extract 1000 cm3 of castor oil.

6. Recommendation

In line with the findings of this study, the researcher recommended

1. Teachers should be trained in science process skills and how to teach them to students in order to improve the educational sector since no country can do better than its teachers in terms of raising living standards, lowering crime rates, reducing unemployment, etc.
2. The instructor should include or expose the students to laboratory work or investigations in order to familiarize them with the essential science process abilities.
3. The ministries of education, federal and state schools should provide funds for the provision and acquisition of chemicals and chemistry lab equipment.
4. Since they are in a better position to use the laboratory activities to promote students' level of acquisition of abilities in chemistry in every school, more qualified science instructors should be hired and equitably placed.
5. Science and model schools should be constructed by the state government to operate as hubs for hands-on learning. Furthermore to make land accessible for school labs and other facilities to help pupils learn science process skills.
6. To improve the acquisition of science process skills, professional organizations like the National Association of Business Educators (NABS), governmental organizations like the National Business and Technical Education Board (NABTEB), West African Examination Council (WAEC), etc., should host seminars, practical workshops, and in-house teacher training on the use of inquiry-based learning and deductive reasoning.

Funding: This research received no external funding.
Conflicts of Interest: The authors declare no conflict of interest.
Publisher's Note: All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated organizations, or those of the publisher, the editors and the reviewers.

References

[1] Akor, V. & Amadioha, W.C. (2020). Basic education in Nigeria: *Matters arising. Research Gates. net* . Retrived May 5, 2022.
[2] Anjani, K. (2018). A re-evaluation of castor (Ricinus communis L.) as a crop plant. *Perspectives in Agriculture, Veterinary Science, Nutrition and Natural Resources,* 9(1), 1-21.
[3] Ashman, K. (2019). "No one Told Us What to Do" *Developing Explicit Teaching Strategies for Science Process.* Science Education. 89(1), 61-82.
[4] Azonuche, J. E. (2015). Availability and Utilization of ICT in Clothing and Textiles Education for Effective Technical Vocational Education and Training (TVET) and National Development. *Journal of Association of Vocational and Technical Educators of Nigeria*, *20*(2), 8-19.
[5] Azonuche, J. E. (2020). Revitalizing Home Economics Education in Tertiary Institutions in Nigeria Through ICT Use for Skill Acquisition for Global Relevance. *Journal of Educational and Social Research*, *10*(6), 332-340.

[6] Azonuche, J. E. (2021). Influence of Family Background on the Academic Performance of Married Female Students in Clothing and Textiles in Nigeria's Universities. *Journal of Educational and Social Research*, *11*(4), 124.

[7] Borja, M. S., Oliveira, R. L., Silva, T. M., Bezerra, L.R., Nascimento, N. G., & Borja, A. D.P (2017). Effectiveness of calcium oxide and autoclaving for the detoxification of castor seed meal in finishing diets for lambs. *Animal Feed Science and Technology*, 231, 76-88.

[8] Gizaw, G., & Sota, S. (2023). Improving Science Process Skills of Students: A Review of Literature. *Science Education International*, *34*(3), 216-224.

[9] Guo, S. & Zhang, X (2018). Analysis of volume ratio of castor / soybean oil mixture on minimum quantity lubrication grinding performance and microstructure evaluation by fractal dimension. *Industrial Crops and Products*, 111, 494-505.

[10] Kelly, A. J., Kavanagh, J., & Thomas, J. (2017). Castor oil, bath and/or enema for cervical priming and induction of labour.

[11] Kurniawan, D. A., Wirayuda, R. P., Putri, W. A., Rini, E. F. S., Ginting, B., Aktapianti, A., & Ratnawati, T. (2023). Impact of Science Process Skills on Thinking Skills in Rural and Urban Schools. *International Journal of Instruction*, *16*(2).

[12] literacy: Journal of STAN, 36(1&2), 43 -51.

[13] methods on achievement in chemistry of difference levels of scientific

[14] Nnoli, J. N. (2022). Teaching Chemistry through identification of science process skill involved in the production of perfume using pineapple rind. *Unizik Journal of STM Education, 5*(1). 112-120.

[15] Nwafor, S. C., Eke, J. A., & Ibe, F. N. (2023). Correlation between test anxiety and students' chemistry achievement. *Journal of Research in Instructional, 3*(1), 31-40. https://doi.org/10.30862/jri.v3i1.93

[16] Nwagbo, C. (2018). The relative efficacy of guided inquiry and expository

[17] Patel, V.R., Dumancas, G.G., Kasi Viswanath, L.C., Maples, R., & Subong, B.J. (2020). Castor oil: properties, uses, and optimization of processing parameters in commercial production. *Lipid Insights*, 9,1-12.

[18] Safaah, M. Muslim, & W. Liliawati (2017). "Teaching science process skills by using the 5-stage learning cycle in Junior High School", *Journal of Physics:* Conference Series 895(1).

[19] Salihu, B., Gana, A., & Apuyor, B. (2022). Castor oil plant (Ricinus communis L.): botany, ecology and uses. *International Journal of Scientific Research* 3(5), 1334-1341.

[20] Yakubu, A., Muhammad, A., Yusuf, M., Ismail, M., & Audu, A. (2021). Process Skills Involved in Teaching Chemistry through the Extraction of Castor Oil from Castor Seeds. An Exploratory Research. *International Journal of Learning, Teaching and Educational Research*, 19(1), 125-137.