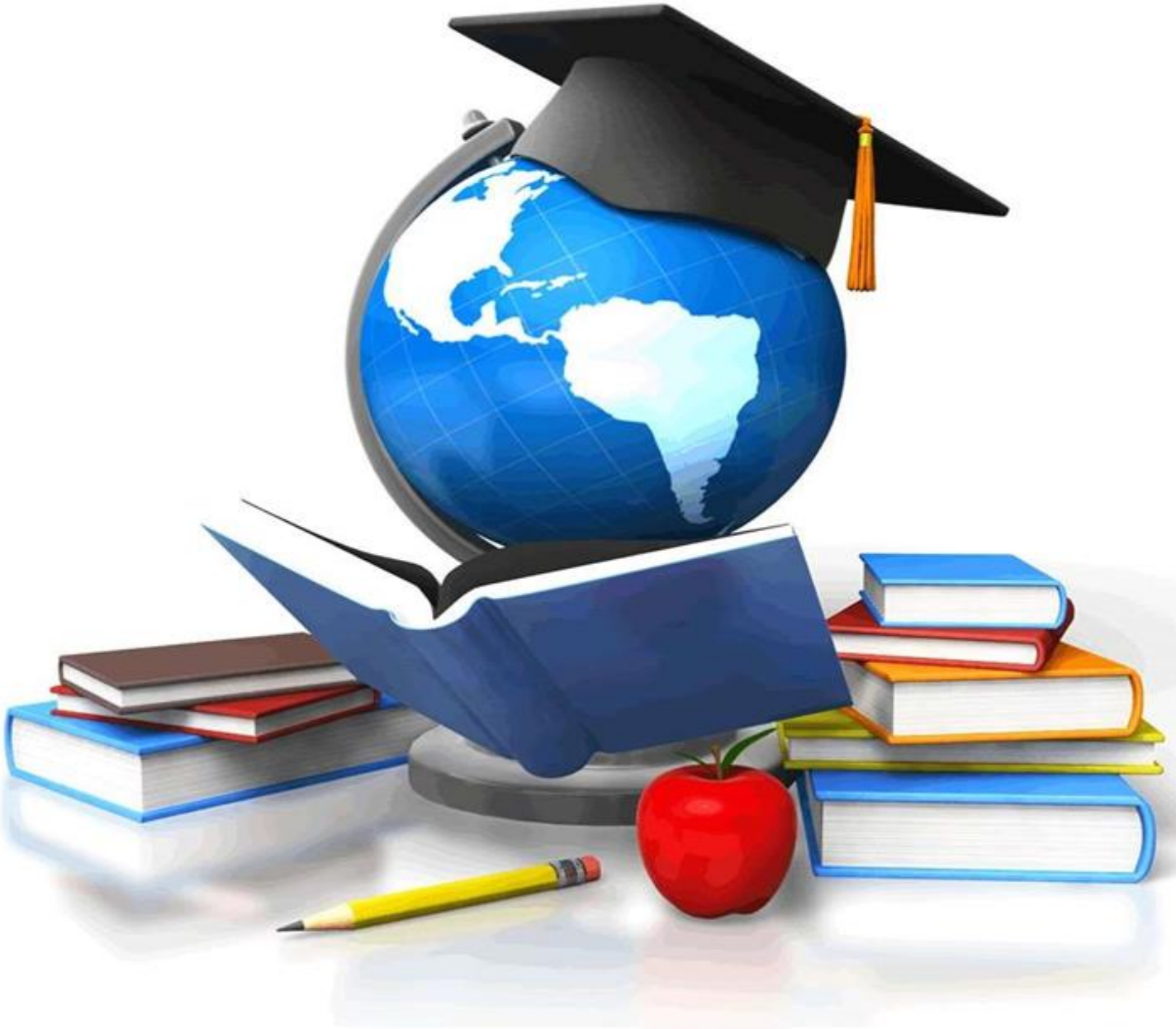
Journal of
Education and Practice
(JEP)

Cameroonian Pre-service Science Teachers' Conceptions of the Nature of Science and its Determinants.



CARI Journals

Journal of Education and Practice
ISSN 2520-467X (Online)
Vol.8, Issue No.2, pp. 51 – 63, 2024
www.carijournals.org

Cameroonian Pre-service Science Teachers' Conceptions of the Nature of Science and its Determinants.

[1]* Dr. Lawrence Ntam Nchia, [2] Dr. Ayina Bouni, [3] Dr. Awomo Ateba Jeremie, [4] Dr. Hamadou Halidou

[1*]Senior lecturer: Higher Teacher Training College Yaounde, University of Yaounde 1

[2]Associate Professor: Higher Teacher Training College Yaounde, University of Yaounde 1

[3]Assistant lecturer: Higher Teacher Training College Yaounde, University of Yaounde 1

[4]Regional Pedagogic Inspector: ministry of secondary education Yaounde.

https://orcid.org/0009-0003-5805-6445

Accepted: 20th Mar 2024 Received in Revised Form: 4th Apr 2024 Published: 18th Apr 2024

Abstract

Purpose: The inadequacy knowledge about the nature of science (NOS) motivated the researchers to investigate Pre-service teachers' conception and their determinant in view of proposing strategy to overcome them and effectively train pre-service science teachers to efficiently implement the competency based approach to teaching, learning and evaluation of sciences.

Methodology: A cross sectional descriptive survey was carried out on a purposeful and convenient sample of 118 Pre-service teachers of Higher Teacher Training College Yaoundé using MOSQ questionnaire. Descriptive and inferential statistical analysis of data was done using SPSS V23.

Findings: More than half of respondents held an informed correct view only on their conception of scientific enterprise and non-coherent uniformed views about scientific knowledge, scientific method and scientists' work. The major inconsistency and misconception was about hierarchical relationship between hypothesis, theories and laws and cumulative nature of scientific knowledge. These misconceptions was determined by the department the students belong to and not by their age, sex, religion or level of education. Physics pre-service teachers were more informed about NOS compared to Chemistry and Biology teachers, with the least informed being pre-service teachers of History & Geography departments.

Unique contribution to theory, practice and policy: These results fills the knowledge gap about teachers' conception of NOS in the Cameroonian context. It has practical implication in the designing of didactic strategies to overcome these misconceptions and bring about conceptual change in pre-service teachers. Including NOS implicitly or explicitly in the science curriculum will enhance scientific literacy in teachers and eventually students.

Keywords: *Nature of Science; Pre-Service Science Teachers; Misconception; Cameroon*

1. INTRODUCTION.

Law no. 98/004 of 14th April 1998 to lay down guidelines for education in Cameroon stipulate in Article 25 that teaching in school establishments must consider the evolution of science and technology, its content and method should be adapted to the economic, scientific, technological, social and cultural evolution of Cameroon and the international environment. The implementation of this law led to the adoption of a pedagogic paradigm for the development of syllabuses in 2014 according to the competence based approach (CBA) using problem situation as point of entry in the national syllabuses for primary and secondary schools. This socio-constructivist approach require the construction of knowledge by learners which can only be effectively achieved if teachers have a mastery of the nature of science (NOS) or scientific literacy. According to Widayoko et al. (2019) developing scientific literacy in learners is one of the basic competencies of the 21st century. Unfortunately, most studies have shown that science teachers have an inadequate knowledge about NOS (Buaraphan, 2010; Dogan & Abd-ElKhalick, 2008; Lederman, 2007; Seung et al., 2009; Jatsho & Dorji, 2022, Wangdi et al., 2019). Thus the ability to understand and apply scientific knowledge while making informed decision on controversial socio-scientific issues will be ineffective as viewed by Peterson et al. (2020)

2. LITERATURE REVIEW

Research has already established that teachers' instructional methods and their level of information on the NOS will affect students' view of the NOS (Golabek & Amrane-Cooper, 2011; Lederman & Lederman, 2019; Prachagool & Nuangchalerm, 2019; Ural, 2016; Widowati et al., 2017). Thus it is necessary to investigate teachers' conception of NOS in view of identifying obstacles and proposing methods to overcome them.

Although there is no consensus agreement of the definition of NOS, some scientist who construe NOS as the epistemology of sciences such as Buaraphan, (2010); Lederman, (2007) amongst others have agreed on the following six concepts about science on which our research is based on:

1) Scientific knowledge is durable, yet tentative and subject to change (AAAS,1990; Popper, 1998 & National Science Teachers Association, 2000);
2) Scientific knowledge is the product of human creativity and imagination (Aikenhead & Ryan,1992; Akerson, Abd-El-Khalick, & Lederman, 2000);
3) Scientific knowledge is socially and culturally embedded (Akerson, Abd-El-Khalick, & Lederman, 2000);
4) Scientific knowledge development involves a combination of both observations and inferences (Lederman, Abd-El-Khalick, Bell, & Schwartz,2000);
5) Scientific theories and laws are functionally different types of scientific knowledge (Lederman, Abd-El-Khalick, Bell, & Schwartz, 2000;
6) There is no universal step-by-step scientific method (Kuhn, 1970); and

With the above six conceptual framework to guide our research, we developed the following research questions to understand teachers' Conception of NOS in a multicultural country like Cameroon often referred to as Africa in miniature because of its diversity. This was motivated by the established fact that science is socially and culturally embedded.

- RQ1: What are pre-service teachers' conception of the NOS?
- RQ2: To what extent will these conception facilitate or serve as obstacle to the construction of scientific knowledge?
- RQ3: Which factors determine Pre-service science teachers' conception of NOS?

3. METHODOLOGY.

We used a descriptive cross-sectional survey to provide a quantitative description of the Cameroonian pre-service teachers' conceptions of the NOS in terms of frequency and commonness. The Myths of Science Questionnaire (MOSQ) designed by Buaraphan (2009) and modified by us, was used on a convenient sample of HTTC Pre-service teachers in Yaounde. The data collected through MOSQ was analysed using descriptive statistics. The responses to each MOSQ item were grouped into three categories, i.e. "agree", "uncertain", and "disagree".

The frequency of each response category (agree, uncertain, and disagree) was computed and its percentage was subsequently calculated. Further, the responses to the "agree" "disagree" and "uncertain", were labelled and interpreted as "uninformed", "informed" and "uncertain" conceptions of the NOS respectively (Buaraphan, 2009).

4. RESULTS & DISCUSSION.

4.1. Demographic analysis of Pre-service Teachers

Table 1: Demographic data

Item	Modality	Frequency (%)
Sex (P1)	Male	85 (45.2%)
	Female	103 **(54.8%)**
Age group (P2)	19-25 years	109 (58%)
	Above 56 years	79 (42%)
Religion (p3)	Christianity	171 (91%)
	Islamism	13 (6.9%)
	African Traditionalist	4 (2.1%)
Department (P4)	Biology	58 (30.9%)
	Physics	49 (26.1%)
	Chemistry	21 (11.2%)
	History / Geography	60 (31.9%)
Level of education (P5)	Third Year	142 (78.9%)
	Fifth Year	38 (21.1%)

The 188 teachers who participated in the study were predominately Christian (91%), majority of whom were females (54.8%) and below 25 years of age. They were at the end of their first or second cycle of study in the Higher Teachers' Training College as shown on table 1 above.

4.2. Descriptive Analysis of Teachers' Misconception about NOS.

Table 2: misconception about nature of sciences in decreasing order of magnitude

		Frequency (percentage)		
		Agree (Uninformed)	Uncertain	Disagree (informed)
SN	Statements about nature of science	Agree	Uncertain	Disagree
A. Conceptions of the NOS: Scientific knowledge (n=188)				
3	SK3 - Scientific theories can be developed to become laws	133 (60.1%)	25 (13.3%)	50 (26.6%)
8	SK5 - Accumulation of evidence makes Scientific knowledge more stable	98 (52.1%)	35 (18.6%)	55 (29.3%)
2	SK2 - Scientific theories are less secure than laws	74 (39.4%)	39 (20.7%)	75 (39.9%)
1	SK1- Hypotheses are developed to become theories only	70 (37.2%)	44 (23.4%)	74 (39.4%)
9	SK6 - A scientific model (e.g., the atomic model) expresses a copy of reality	67 (35.6%)	47 (25.0%)	74 (39.4%)
4	SK4 - Scientific knowledge cannot be changed	35 (18.6%)	20 (10.6%)	133 (70.7%)
B. Conceptions of the NOS: Scientific method (n=188)				
5	SM1 - The scientific method is a fixed step-by-step process	110 (58.5%)	17 (9.0%)	61 (32.5%)
7	SM3 - Scientific knowledge comes from experiments only	72 (38.3%)	26 (13.8%)	90 (47.9%)
6	SM2 - Science and the scientific method can answer all questions	35 (18.6%)	41 (21.8%)	112 (59.6%)
C. Conceptions of the NOS: Scientist's Work (n=188)				
11	SW2 - Scientists are open-minded without any biases	110 (58.5%)	26 (13.8%)	52 (27.7%)
10	SW1 - Scientists do not use creativity and imagination in developing scientific knowledge	72 (38.3%)	21 (11.2%)	95 (50.5%)
D. Conceptions of the NOS: Scientific Enterprise (n=188)				
12	SE1 - Science and technology are identical	36 (19.1%)	46 (24.5%)	106 (56.4%)
14	SE3 - Society, politics, and culture do not affect the development of scientific knowledge	33 (17.6%)	23 (12.2%)	132 (70.2 %)
13	SE2 - Scientific enterprise is an individual enterprise	24 (12.8%)	29 (15.4%)	135 (71.8%)

The study indicated from table 2 above that the more than half of Cameroonian pre-service science teachers held an **informed correct view** only on the conception of scientific enterprise (SE1 to SE3) and non-coherent views about scientific knowledge, scientific work and scientists' work.

Although they hold **informed correct conception** on a few areas of the NOS such as tentativeness of scientific knowledge (SK4 = 70.7%), source of scientific knowledge using creativity and imagination (SW1 = 50.5%), and Science and the scientific method cannot answer all questions (SM2 = 59.6%), many of them had naive conceptions in other aspects of the NOS.

Majority demonstrated **misconceptions inconsistent with reality** as they held hierarchical relationship between hypotheses, theories, and laws (SK3 = 60.1%); scientific knowledge as cumulative in nature (SK5 = 52.1%); or scientific method is a single universally fixed step-by-step method (SM1 = 58.5%). Further, pre-service science teachers also held an inappropriate notion that scientist are irrefutably objective and open-minded (SW2 = 58.5%).

The first two uninformed NOS conceptions held by Cameroonian pre-service teachers were identical to those equally reported amongst Thai and Bangladeshi in-service teachers in a study by Buaraphan, K & Abedin F, Z. (2014), but in the reversed order.

Overall the result were similar to that of Jatsho, S., & Dorji, K. (2022) that reveal Bhutanese pre-service science teachers do not possess mature and informed view of the NOS in many areas of scientific knowledge, scientific methods, scientists' practices, and scientific enterprise.

4.2.1. Domain 1- Conceptions about Scientific knowledge

More than one third of the pre-service science teachers had uninformed view about the concepts of hypotheses, theories and laws. More than half of respondent (60.1%) belief scientific theories can be developed to become laws, while about one third (39.4 %) scientific theories can be developed to become laws and 37.2% believed in hypotheses being developed to become theories only. This is a didactic obstacle found in some sciences official textbooks stating that with the accumulation of evidence, hypothesis develop into theories, and thence theories into laws after proven with more evidence from a wider domain. Thus they argue that laws are more stable than theories. It could also have been as a result of epistemological obstacle whereby in daily language the phrase: "This is just a theory" gives theory the same status as a hypothesis. Also the legal meaning of a law has influence their belief that a law has a higher status than a theory since laws are never argued in courts.

Less than one quarter of respondents (13.3 to 23.4%) were uncertain about the concepts of hypothesis, theories and laws. This indicate the need for NOS to be included in the curriculum and taught explicitly or implicitly.

Surprisingly, 70.7% have informed view about the tentativeness of scientific knowledge, as they disagree that scientific knowledge cannot be changed, though only 29.3% are informed that accumulation of evidence makes scientific knowledge more stable.

Sonleitner (1989) labelled the hypotheses becoming laws as the "generalizing hypotheses" and the hypotheses becoming theories as the "explanatory hypotheses." Laws are therefore generalizations, principles or patterns in the nature. They show the relationship between observed phenomena. Theories are the explanations of these generalizations, principles or patterns. A theory can therefore be used to explain a law. Theories and laws therefore have different status and functions in science.

4.2.2. Domain 2- conception about Scientific method

Majority of pre-service teachers (58.5%) are uninformed about the scientific process as they believe that the scientific method is a fixed step-by-step process. This is in line with the misconception identified by Ryan & Aikenhead, (1992) and McCosmos (1998) whereby teachers and students belief experiments are the principal route to the development of scientific knowledge, and a unique scientific method is used to ensure valid and accurate results.

Nine percent of respondents declared they are uncertain, one third (32.5%) expressed informed views of the scientific method.

More than one third of respondents (38.3%) belief in empiricism. They are uninformed about scientific methods as they agreed that scientific knowledge comes from experiments only. This is an epistemological obstacle which holds that knowledge comes only from sensory experience. They ignore the role of reasoning and creativity in developing hypothesis. However, 47.9% of pre-service science teachers held correct conceptions regarding the source of scientific knowledge, while only 13.8% are uncertain.

While 21.8% of the pre-service science teachers were uncertain and 18.6% uninformed, more than half (59.6%) of the respondents held the correct conception that science and scientific method cannot answer all questions. They correctly belief that science cannot make ethical, moral and aesthetic judgments. Furthermore, science cannot explain supernatural phenomena.

4.2.3. Domain 3- Conceptions about Scientist's Work

More than half of the respondent (58.5%) were uninformed that Scientists are open-minded without any biases. Only 27.7% had informed view that scientists' backgrounds, experiences and biases scientific knowledge could influence their observations of the natural world. 13.8% were uncertain whether scientist work are influenced by bias or not.

Half of the respondents (50.5%) expressed an informed correct view that scientists use creativity and imagination in developing scientific knowledge. This view is support by arguments that the concept of an atom or a gene are scientist creativity and imagination to explain phenomena or observed behaviours. More than one third of respondents (38.3%) had uninformed view about the involvement of human creativity and imagination in producing scientific knowledge, and the fact that science is socially and culturally embedded. 11.2% were undecided on the role of creativity and imagination.

4.2.4. Domain 4 - Conceptions of the NOS: Scientific Enterprise

Majority of the respondent had correct informed conception that Society, politics, and culture affect the development of scientific knowledge (70.2%) ; that scientific enterprise is NOT an individual enterprise (71.8%); and that Science and technology are NOT identical (56.4%).

They firmly believe that in collaboration in science and sees it as an institution rather than an individual affair. They affirm peer review is necessary to validate scientific knowledge. They equally affirmed that religion and culture can hinder development of scientific knowledge like the antagonistic views of the Creationism and Neo-Darwinism to explain evolution or the view of diseases as divine punishment rather than caused by pathogen, behavioural lifestyle or environmental hazards.

Between 12 to 19% held uninformed conception about the nature of scientific enterprise and a similar percentage were undecided. They do not known that technology is the application of scientific knowledge to solve daily life problems, or for the development of the numerous devices, machines, or methods we use to provide goods and services to mankind.

Most uncertainly expressed by 24.5% of respondent was whether science and technology are identical or not.

4.3. Factors Determining Teachers' Conception about NOS.

Multiple Analysis of variance (MANOVA) was used as an inferential statistics test to investigate group differences with respect to our multiple dependent variables of our studies (the four main domains of NOS) to enable us determine the factors or independent variables that affect pre-service teachers' conception of NOS.

MANOVA test results showed that age, religion, sex, and level of study does not influence pre-service teachers' conception of NOS. Only the department in which they study influences their conception of NOS as presented in table 3 below:

Table 3. Summary of MANOVA Test Results

Determinant	**Wilks' Lambda Value**	**F Value**	**Sig.**	**Partial Eta Square**
Department	*0.852*	*2.487*	***0.004***	*0.052*
Sex	0.980	0.982	0.458	0.020
Age	0.982	0.847	0.497	0.018
Religion	0.946	1.286	0.250	0.027
Level of education	0.973	0.421	0.956	0.009

From the fourth column of table 3, there is no statistically significant difference between males and female respondents mean scores for the different domains of NOS studied as Wilks' Lambda value

of 0.980, F = 0.982 at p= 0.485 and not significant (p > 0.05). Thus sex of the respondents does not influence the conception of pre-service teacher in HTTC Yaounde**.** Males and females therefore have the same conception.

Similarly, there is no statistically significance difference between ages of respondents for mean scores for the different domains of NOS studied as Wilks' lambda value of 0.982, F = 0.847 at p= 0.497 and not significant (p > 0.05). Thus age group of the respondent does not influence the conception of pre-service teacher in HTTC Yaounde**.** Also religion and level of student does not influence conception of pre-service teacher in HTTC Yaounde as revealed by the above table.

Only the department or subject studied in the HTTC show statistically significant differences in pre-service teachers' conception of NOS terms of scientific knowledge, method, work and enterprise from the multivariate Wilks' Lambda test scores with p = 0.004 (p < 0.05) for all four domains of NOS.

The Descriptive statistics & Tests of Between-Subjects Effects results shown in table 4 below shows the extent and aspects of NOS that are statistically significantly different in pre-service teachers' conception of NOS. This could be explain by either the nature of these science subjects, or the way they are taught by teachers of the department or the way they are perceived or understood by student teachers.

Table 4. Summary of Descriptive statistics & Tests of Between-Subjects Effects

Descriptive statistics				**Tests of Between-Subjects Effects**			
Family constructs	**Department (Frequency)**	**Mean scores**	**SD**	**Type III Sum of Squares**	**F Value**	**Sig.**	**Partial Eta Square**
Scientific Knowledge	Biology (58)	12.3103	2.55609	96.930	4.003	.009	.061
	Physics (49)	12.5714	3.09570				
	Chemistry (21)	12.8571	3.27545				
	Hist / Geo (60)	11.0000	2.72465				
Scientific Method	Biology (58)	6.2931	1.72707	35.260	3.502	.017	.054
	Physics (49)	6.8776	1.95398				
	Chemistry (21)	6.0476	2.06098				
	Hist / Geo (60)	5.7500	1.74302				
Scientific Works	Biology (58)	3.7414	1.19297	19.450	3.885	.010	.060
	Physics (49)	4.3061	1.29428				
	Chemistry (21)	3.8571	1.31475				
	Hist / Geo (60)	3.4667	1.37121				
Scientific Works	Biology (58)	7.4655	1.34054	30.775	4.579	.004	.069
	Physics (49)	8.0204	1.33057				
	Chemistry (21)	7.7619	1.30018				
	Hist / Geo (60)	6.9833	1.79917				

From the descriptive statistics table 4 above, as concern **Scientific knowledge**, students of the Chemistry department have the highest mean score (12.857) compared to their counterparts in the Physics and Biology departments (12.571 & 12.310 respectively) and the least mean score is observed with students of history and geography departments (11.000). This mean differences are

statistically significant at F= 4.003, p= 0.009 (p<0.05).These higher Mean scores signifies the students are more informed or hold a more correct conception of the nature of science.

History and geography students have lower mean scores in all the four domains of the nature of science probably because these subject have less experimental approach and does not involved laboratory activities compare to physics, chemistry and biology.

Also biology is least amongst the experimental sciences probably because of the socio-culturally and scientifically controversial topics it handles like Evolution, Genetically modified organism, abortion, and homosexuality with varied religious and ethical views.

Similarly, Physics students have the highest means score as concerns scientific method, scientists work and scientific enterprise while chemistry students have a highest mean scores on scientific knowledge amongst the experimental sciences.

This could be probably explained by the numerous application of physics and chemistry in many more areas of technology and engineering (electrical, mechanical, civil, nuclear etc) compared to biotechnology and genetic engineering which are more recent.

Also physics and chemistry has much more principles, theories and laws compared to biology.

5. CONCLUSION & IMPLICATION.

This study reveal that final year pre-service science teachers still have a lot of uninformed conceptions of NOS which will eventually be passed onto student during the process of didactic transposition when they become professional in-service science teachers. The main misconceptions or uniformed conceptions held by majority within the Cameroon context is found in decreasing order of magnitude concerns:

(1) The relationship between theory and law;

(2) The scientific method as a fixed step by step process;

(3) Scientists are open-minded without any biases; and

(4) Science as cumulative.

If these misconceptions are not handled, it will serve as epistemological and didactic obstacles to understanding the major theories, laws and principles governing the various science disciplines. It will hinder the construction of scientific knowledge the founding principles of constructivism that underline the competency based approach to teaching and learning science adopted by the Cameroon government.

There is therefore an urgent and important need for science teacher trainers to consider these misconceptions held by pre-service science teachers and develop a didactico-pedagogic strategy to overcome them and bring about a conceptual change in pre-service science teachers.

It is equally important to explicitly include the nature of science (NOS) or the history, philosophy and methodology of science as a course in the teachers training curriculum so that these issues of

NOS can be treated explicitly by teachers training. It could be introduced implicitly when teaching the various theories and laws governing these science subjects. This curricular framework will improve pre-service teachers' understanding of NOS and enhance their abilities to create activities that will promote the construction of scientific knowledge upon graduation.

6. BIBLIOGRAPHY

Akerson, V. L., Abd-El-Khalick, F. & Lederman, N. (2000). Influence of a reflective explicit activity-based approach on elementary teachers' conceptions of nature of science. *Journal of Research in Science Teaching*, 37, 295–317.

American Association for the Advancement of Science (1990). Science for all Americans. New York: Oxford University Press.

Buaraphan, K. (2010). Pre-service and in-service science teachers' conceptions of the nature of science. *Science Educator*. *19*(2), 35–47.

Buaraphan, K., & ABEDIN FORHAD, Z. (2014).Thai and Bangladeshi in-service science teachers' conceptions of nature of science: A comparative study *Asia-Pacific Forum on Science Learning and Teaching*, 15 (1), p.3.

Dogan, N., & Abd-El-Khalick, F. (2008). Turkish grade 10 students' and science teachers' conceptions of nature of science: A national study. *Journal of Research in Science Teaching*, *45*(10), 1083-1112. https://doi.org/10.1002/tea.20243

Golabek, C., & Amrane-Cooper, L. (2011). Trainee teachers' perceptions of the nature of science and implications for pre-service teacher training in England. *Research in Secondary Teacher Education*, *1*(2), 9-13

Jatsho, S., & Dorji, K. (2022). Bhutanese pre-service Science Teachers' Conception of the Nature of Science: a view from cross-sectional study. *Anatolian Journal of Education*, 7 (1), 31-44.

Kuhn, T. S. (1970). The structure of scientific revolutions. Chicago: University of Chicago Press.

Lederman, N. G., Abd-El-Khalick, F., Bell, R. L. & Schwartz, R. S. (2002). Views of nature of science questionnaire: toward valid and meaningful assessment of learners' conceptions of nature of science. *Journal of Research in Science Teaching*, 39, 497–521.

Lederman, N. G. (2007). Nature of science: Past, present, and future. In S. K. Abell & N. G. Lederman (Eds.), *Handbook of research on science education*, (pp. 831–880). Lawrence Erlbaum Associates.

Lederman, N. G., & Lederman, J. S. (2019). Teaching and learning of nature of scientific knowledge and scientific inquiry: Building capacity through systematic research-based professional development. *Journal of Science Teacher Education*, *30*(7), 737-762. https://doi.org/10.1080/1046560X.2019.1625572

McComas, W. (1998). The principal elements of the nature of science: Dispelling the myths. In W.F. McComas (Ed.), The nature of science in science education: rationales and strategies (pp. 53–70). Dordrecht: Kluwer Academic Publishers.

National Science Teachers Association (2000). NSTA position statement: the nature of science. Arlington, VA: National Science Teachers Association Press.

Popper, K. (1998). The rationality of science revolutions. In J.A. Kourany (Ed.), scientific knowledge (pp. 286–300). Wadsworth, CA: Belmont.

Prachagool, V., & Nuangchalerm, P. (2019). Investigating understanding the nature of science. *International Journal of Evaluation and Research in Education, 8*(4), 719-725. https://doi:10.11591/ijere.v8i4.20282

Seung, E., Bryan, L. A., & Butler, M. B. (2009). Improving pre-service middle grades science teachers' understanding of the nature of science using three instructional approaches. *Journal of Science Teacher Education, 20*(2), 157-177. https://doi.org/10.1007/s10972-009-9130-2

Ural, E. (2016). Comparison of pre-service science and pre-service primary school teachers' nature of science views. *International Journal of Social Science & Education, 6,* 98-108.

Wangdi, D., Tshomo, S., & Lhamo, S. (2019). Bhutanese in-service teachers' conceptions of the nature of science. *Journal of Instructional Research, 8*(2), 80-90.

Widayoko, A., Femilia, P. S., Lesmono, A. D., Sudjatmi, H., Prastiwi, V. D., & Munfarikha, N. (2019). Description of Students' Scientific Literacy Competencies on the Scientific Issue of Flat Earth Theory. *Anatolian Journal of Education, 4*(2), 31-38. https://doi.org/10.29333/aje.2019.424a

Widowati, A., Widodo, E., Anjarsari, P. (2017). The Development of Scientific Literacy through nature of science (The NOS) within inquiry based learning approach. *Journal of Physocs Conference Series*, 909(1). https://ui.adsabs.harvard.edu/link_gateway/2017JPhCS.909a2067W/doi:10.1088/1742-6596/909/1/012067.