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RELATIONSHIP BETWEEN CONFIDENCE AND KNOWLEDGE OF THE NATURE OF SCIENCE: STUDENT-TEACHERS PERSPECTIVE IN ZIMBABWE

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ABSTRACT

Student-teachers are students that are undergoing academic courses leading to the teaching profession; the term can also be used to describe professional teachers that are undergoing continuous professional development. The study sought to measure student-teachers' confidence in teaching science and their knowledge of the nature of science (KNOS). We also sought to establish differences in terms of gender and between pre-service and in-service teachers. In the case study employed we made use of questionnaire to collect data. Independent samples t-tests were used to test the differences between groups of students. Correlation coefficients were computed to determine the relationship between confidence in teaching science and knowledge of the nature of science. Results show that there were no statistically significant differences between males and females, between pre-service and in-service teachers. The relationship between confidence in teaching science and knowledge of the nature of science was found to be low and positive, and not statistically significant. We recommend developing more robust ways of measuring confidence, knowledge of natural science, and pedagogical content knowledge for teaching nature of science (NOS) and then use these measures to investigate differences by gender, age and programme. We also recommend that universities must offer NOS courses to all student teachers as a way of improving science literacy.

Keywords: Teaching, Science Subjects, Knowledge of Science, Zimbabwe

1. INTRODUCTION

Nature of science is a multifaceted term which includes processes, product of science, scientific knowledge, science-technology-systems (STS), scientific inquiry and scientific enterprise. There is a lack of consensus on the nature of science (NOS) among science educators, teachers, scientists, philosophers and sociologists of science (Alters, 1997). Three different groups of people seem to agree on some common elements of NOS (Osborne, Ratcliffe, Collins, Millar and Duschl, 2003). Three such examples are, first, that science is intended to be a true account of the natural world and objective. Secondly, that there is a need for the development of science and improvement of scientific knowledge. Thirdly, science is not influenced by cultural and social contexts (Macaroglu et. al., 1998). The place of the nature of science in current teacher education programs should be reconsidered and appropriate ways of incorporating it into the curriculum should be sought (Macaroglu et. al., 1998).

Driver et. al. (1996) have suggested 5 reasons for studying about NOS: a utilitarian argument, that is, an understanding of NOS is necessary if people are to make sense of science and manage technological objects and processes they encounter in everyday life; a democratic argument (that NOS is necessary to make sense of socio-scientific issues and participate in decision making process), cultural argument (that NOS is required to appreciate science as a major element of contemporary culture); moral argument (to develop awareness of NOS, and in particular norms of scientific community, embodying moral commitments which are of general value); and a science learning argument (that understanding of NOS supports successful learning of science content). Better understanding of NOS may influence positive attitudes toward science and science teaching (Harty, Samuel and Anderson, 1991). Evidence is also available to show that science teachers have been effective without a full understanding of NOS. Research findings would seem to suggest that teachers do not possess adequate conceptions of NOS, Lederman (1992). On the other hand some research findings suggest that there is no significant relationship between teachers' understanding of NOS and their classroom practice (Lederman & Zeidler, 1987). Such contradictions require further research to resolve.

Research on the nature of science (NOS) has been directed towards teachers' understanding (Schwartz, Lederman & Crawford, 2004; Akerson, Morrison & McDuffie, 2006) as opposed to pedagogical content knowledge (PCK). The few studies that have examined pedagogical content knowledge (PCK) for teaching the nature of science include Bartholomew, Osborne & Ratcliffe (2004) and Zohar & Schwartzer (2005). We take the position that research is required to connect KNOS and PCK for teaching nature of science.

Studying NOS is difficult because soliciting teachers' conceptions and practice are problematic for a number of reasons. There is research evidence that teachers develop their understanding through teaching as if to suggest that they commence practice without clear views of NOS (Water-Adams, 2006; Ratcliffe, Hanley & Osborne, 2006). Further teachers find it easy to use ready-made curriculum materials and quite difficult to develop their own teaching materials (Taylor & Dana, 2003). There are more studies of students' conceptions of NOS than teachers' conceptions (Taylor & Dana, 2003). There are possibilities that teaching practice might reflect, accurately teachers' KNOS and how that impacts on teaching science.

In our study we sought student teachers' confidence of teaching science and whether this was related to their knowledge of the nature of science. We believe that teaching nature of science will be meaningful if it increases teachers' confidence of teaching science. We also make the assumption that lack of confidence in teaching science could be related to lack of understanding of the nature of science.

2. METHODS AND MATERIALS

Researchers studying NOS have successfully used questionnaires, interviews and observations as data collection methods. These methods are useful in soliciting teachers' beliefs about the nature of science. Teachers' beliefs tend to influence how they interpret and implement the curriculum in their teaching process (Aldridge, at. al., 1997).

The investigation was a case study of student teachers at one university in Zimbabwe offering a Bachelor of Science Education honours degree programme. Researchers used questionnaire (adapted from Murphy 2004) to collect data. A total of 58 in-service and pre-service teachers voluntarily participated during the study drawn from final year students. The questionnaire sought bio-data of participants, confidence in teaching science and knowledge of the nature of science.

The data were analysed using SPSS version 15.0. Frequency counts, expressed as percentages were computed to determine the degree of confidence in teaching science and percentage of participants who gave correct answers to KNOS questions. Independent samples

t-tests were used to test differences between groups of students. Correlation coefficients were computed to determine the relationship between confidence in teaching science and knowledge of the nature of science. The research questions are:

- Are there differences of confidence in teaching science between gender groups, among different age groups and between pre-service and in-service teachers?
- Are there differences of knowledge of nature of science between gender groups, among different age groups and between pre-service and in-service teachers?
- What is the relationship between student teachers' confidence in teaching science and knowledge of the nature of science?

3. RESULTS

The majority of participants were confident in teaching science (97%). This confidence had increased during training (98%) from both the method aspect (88%) and school-based aspect (95%). It appears the school-based aspect of the training was valued more than the university-based aspect in increasing confidence in teaching science. The majority of participants enjoyed teaching science (98%). The same degree of agreement was noted in the reversed statement. At least 50% participants were able to give correct answers to 13 items on the knowledge of the nature of science scale, and 60% participants gave correct answers to only 9 items. We conducted the independent samples t-tests and the Levene's test for equality of differences. We found $p \geq .05$ and used equal variances assumed.

Test variable: confidence in teaching science
Grouping variable: gender
Equal variances assumed.
$F = .22$, $p = .64$; $t = 2.06$, $df = 56$, $p = .44$
There were no statistically significant differences of confidence in teaching science between male and female student teachers.

Test variable: confidence in teaching science
Grouping variable: age
$F = .09$, $p = .85$; $t = -1.11$, $df = 56$, $p = .27$.
There were no statistically significant differences of confidence in teaching science between student teachers of different age groups.

Test variable: knowledge of nature of science
Grouping variable: gender
$F = .13$, $p = .73$; $t = .76$, $df = 56$, $p = 45$.
There were no statistically significant gender differences of knowledge of the nature of science among student teachers.

Test variable: knowledge of science
Grouping variable: age
$F = .50$, $p = .48$; $t = -.86$, $df = 56$, $p = 39$.
There were no statistically significant differences of knowledge of the nature of science between student teachers of different age groups.

Correlation between confidence in teaching science and knowledge of nature of science
Pearson's correlation coefficient: r = .16, p = .23.
Spearman's correlation coefficient: R = .19, p = .19.

There was a small positive correlation between confidence in teaching science and knowledge of the nature of science suggesting a weak relationship. Further, the relationship was not statistically significant.

4. DISCUSSION

We sought the students' confidence in teaching science and knowledge of the nature of science. We assumed that gender, age and programme were variables likely to affect perceptions. As an example science anxiety might affect females somewhat more than males. The good thing is it can be overcome. Enrolments of girls in science subjects at A-level continue to be an issue. The same is true for enrolments of students learning to become science teachers at university. In the classroom at high school pupils respond differently to female and male teachers. Teachers in turn tend to treat boys and girls differently. We therefore strongly believe that gender is an important variable in a study seeking teacher efficacy.

We assumed that women and men may have differences in confidence in teaching science as well as knowledge of nature of science. The differences reported here neither appear to be great or significant. Despite that we still believe that in as much as there are gender differences in enrolments of students learning to be science teachers gender is an issue in confidence of teaching science and knowledge of the nature of science. Science teaching continues to be male dominated and shy of female membership. However this does not imply that few women who enroll as student teachers in science do not develop confidence as much as their male counterparts.

KNOS, we believe is strongly influenced by culture. KNOS is consistent with western culture but might be at variance with African traditions. We are arguing that our culture permeates our understanding of KNOS, and inevitably gender and age become important confounding variables. If we are right gender and age are strong determinants of readiness and what we learn.

We examined pre-service and in-service (CPD) programmes at one university in Zimbabwe, and found that History and Philosophy of Science Education was taught to in-service teachers and not pre-service teachers. KNOS is part of history and philosophy of science education. Therefore by comparing pre-service and in-service students we were seeking whether taking a course in NOS makes a difference.

5. CONCLUSIONS

Despite the finding of 'no significant positive correlation' between the variables, we are of the suggestion that KNOS is an important ingredient in the curriculum for those learning to teach science and likely to promote science literacy among students of such candidates. There seems to be an insignificant relationship between student teachers' confidence in teaching science and their knowledge of nature of science. Our results suggest that the student teachers had high confidence in teaching science. Student teachers' knowledge of nature of science was low. This would seem to suggest that teachers can still have confidence in teaching science despite a lack of understanding of the nature of science.

We recommend developing more robust ways of measuring confidence, knowledge of nature science, and pedagogical content knowledge for teaching KNOS and then use these measures to investigate differences by gender, age and programme. Further research is required

to establish relationships between confidence in teaching science and knowledge of NOS in specific aspects of science, for example, carrying out experimental investigations.

We also recommend that universities offering science education degrees must consider NOS courses for both pre-service and in-service programmes in an attempt to increase teachers' and learners' science literacy.

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Appendix 1: *Student teachers' confidence in teaching science, n = 58*

	Confidence in Teaching Science	Agree	Disagree	Total
6.	I am very confident in teaching science	56 (97%)	2 (3%)	58 (100%)
7.	My confidence in science has improved during training.	57 (98%)	1 (2%)	58 (100%)
8.	School-based aspect of my training has improved my confidence in science.	55 (95%)	3 (5%)	58 (100%)
9.	A methods aspect of my training has improved my confidence in science.	51 (88%)	7 (12%)	58 (100%)
10.	I enjoy teaching science.	57 (98%)	1 (2%)	58 (100%)
11.	I am not confident at all in teaching science	3 (5%)	55 (95%)	58 (100%)
12.	My confidence in science has not changed during training.	11 (19%)	47 (81%)	58 (100%)
13.	School-based aspect of my training has not improved my confidence in teaching science.	7 (12%)	51 (88%)	58 (100%)
14.	A methods aspect of my training has not changed my confidence in science.	8 (14%)	50 (86%)	58 (100%)
15.	I find teaching science boring.	2 (3%)	56 (97%)	58 (100%)

Appendix 2: *Knowledge of nature of science, n = 58.*

	Knowledge of nature of science	Correct Idea	Wrong Idea
16.	The primary aim of science is to accumulate facts.	42 (72%)	16 (28%)
17.	Science is the study of natural events and conditions.	48 (83%)	10 (17%)
18.	Science causes pollution.	28 (48%)	30 (52%)
19.	Science knowledge is truth.	25 (43%)	33 (57%)
20.	Science is concerned mainly with solving problems.	53 (91%)	5 (9%)
21.	Scientists are certain about the structure of an atom.	27 (47%)	31 (53%)
22.	Science relies solely on empirical evidence.	37 (64%)	21 (36%)
23.	Scientists are not certain about the structure of an atom.	28 (48%)	30 (52%)
24.	Science does not rely solely on empirical evidence.	30 (52%)	28 (48%)
25.	Theories in science do not change due to new evidence.	54 (93%)	4 (7%)
26.	A collection of facts does not constitute scientific knowledge.	32 (55%)	26 (45%)
27.	Science is the study of all events and conditions.	36 (62%)	22 (50%)
28.	Science does not cause pollution.	21 (36%)	37 (64%)
29.	There is no absolute truth in science.	39 (67%)	19 (9%)
30.	Science seeks more than solving problems.	52 (90%)	6 (10%)
31.	Scientists are certain about the structure of an atom.	32 (55%)	26 (45%)
32.	Science relies solely on empirical evidence.	29 (50%)	29 (50%)
33.	Scientists are not certain about the structure of an atom.	25 (43%)	33 (57%)
34.	Science does not rely solely on empirical evidence.	21 (36%)	37 (64%)
35.	Theories in science change due to new evidence.	53 (91%)	5 (9%)