UNDERSTANDING OF THE 'NATURE OF SCIENCE' AMONG UNDERGRADUATE STUDENTS AT MUTAH UNIVERSITY IN JORDAN

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Abstract

The current study aimed at investigating Understanding of the 'Nature of Science' among undergraduate Students at Mutah University in Jordan and its relation with some variables. The sample of the study consisted of 392 undergraduate students, 274 females and 118 males who were chosen randomly from faculty of science and faculty of educational sciences in the academic year (2013/2014). To collect data, instrument which consisted of 23 items arranged into 5 domains covering various aspects of the nature of science was applied. The results showed that the level of understanding the nature of science among science and educational science students was of medium level with mean percentage (59.36). There were statistical differences found in the understanding of the nature of science among students due to the variable of student's gender in favor of females, while the results showed no statistical differences attributed to variable of college. The research ended by suggesting several recommendations and further studies related to the nature of science for improving the teaching of NOS in high schools and college classrooms.

Keywords: Nature of Science, Undergraduate Students, Science Teaching

Introduction

One of the most important tasks which seek to deepen the teaching of science is to understand the nature of science (NOS) among students. Science is not a collection of accumulated and disjointed scientific facts organized in disciplines such as chemistry, physics and biology, but it is organized body of scientific knowledge which could be reached by using

the scientific methodology which is mainly based on the survey, exploration and research in natural phenomena (Atallah, 2001).

The concept (Nature of Science) refers to the values and assumptions inherent to scientific knowledge and the development of scientific knowledge (Lederman & Lederman, 2004). Meanwhile most educators define the nature of science (NOS) as the epistemological underpinnings of science, which includes empirically-based, tentative, subjective, creative, unified, cultural and socially embedded characteristics.

Individuals who understand the NOS can recognize the functions of their subject matter and distinguish the differences among observations, inferences, scientific facts, laws, and theories (Gess-Newsome, 2002, Lederman, 1998, Lederman, Abd-El-Khalick, Bell & Schwartz, 2002).

In this context, projects and most science programs have included developing an adequate understanding of the NOS and understanding science as a way of knowing. Scientific literacy involves understanding not only scientific knowledge, but also understanding of NOS and the development of the skills of scientific inquiry, problem solving, critical thinking, adapt to the change in the science and its applications, increase the community's confidence in the value of knowledge and the importance of science, technology and their relationship to the mutual and overlapping with the community (Ziatone, 2013, 2010, Tobin and McRobbie, 1997, Matthews, 1998, Abd-El-Khalick, Bell, & Lederman, 1998).

To achieve these goals, teachers try to translate the written curriculum into a form required for classroom application and decide what, how and why to learn. Despite the pervasive and critical role of curricula, evidence is clear and substantial that teachers are the most influential factor in educational change (McComas and Almazroa, 1988). Thus science teachers need to understand the NOS in order to improve the scientific literacy of their students (Abd-El-Khalic, 2001). In this direction, studies, which focused on the nature of science and its relationship to a number of variables, showed that a low level of understanding of the nature of science among students (Zoubi , 2008, Abdullah, Abboud & Al-Hamdani, 2007), while Leaderman indicates that many studies have shown that misconceptions about the NOS are prevalent among high school and college students and even among teachers (Lederman, 2007).

In light of repeated calls to disseminate scientific literacy among students and teachers about the nature of science, and because the future power coming is the authority possessed of scientific knowledge and produced, it is important to reveal the level of understanding of the NOS

among undergraduate and other levels of students.

Very few studies have been conducted in Jordan to understand the views held by undergraduate students about the nature of science, the most important studies that the researcher was able to access as follows:

Miller, Montplaiser, Offerdahl, Cheng and Ketterling (2010) made a study to explore (NOS) views of undergraduates in introductory environmental science and upper-level animal behavior courses were measured using Likert type items and open-ended prompts. Analysis revealed similarities in students' views between the two courses; both populations held a mix of transitional and moderately informed views.

Karakas (2008) led to examine undergraduate students' understanding of nature of science (NOS), by collecting data from 52 undergraduates (mostly freshmen) at a Private Research University in Northeastern U.S., who were enrolled in a Biology course. The study reveals that there is no significant difference of the understanding of NOS among science majors, non-science majors and undecided group of undergraduate students and that they hold contemporary views about some aspects of NOS and traditionalist views about other aspects. This study calls for improving the teaching of NOS in high school and college classrooms.

Abdulla, Abboud. & Al-Hamdani (2007) made a study aims at knowing the university student's abilities of understanding science nature and its relation with their scientific thinking. The sample consisted of 146 students (females and males) in the fourth stage of physics and biology department from both science and education college / university of Mosul, Iraq. Tools consisted of two parts: "Science nature test (NOS) and "Scientific thinking test". Results showed that the level of understanding science nature was very low on the part of fourth stage students sample, in physics and biology departments of both, educational and science college, beside their low scientific thinking.

There were no statistical meaningful difference in the linking relation between science nature and scientific thinking of the research sample according to the three variables: College, Scientific department and gender.

Miller (2006) made a study to examine gender differences in 79 high-school students' attitudes towards their science classes, their perceptions of science and scientists, and their views about majoring in science. The study identified some of the subtleties underlying females' low participation in, and interest in documented in previous research. Four themes emerged from responses on the rating scales and questionnaire. First, even when females planned to major in science, they were more interested than males in the people-oriented aspects of their planned majors. Second, biology was the one exception to females' low interest in science.

Third, females often planned a science major mainly because they needed a science background in order to enter a health profession such as medicine or physical therapy. Fourth, females generally found science uninteresting and the scientific lifestyle unattractive.

Notes from previous studies show that most of it focuses on measuring the views and aspects students toward science except the study of Karakas (2008) which dealt with understanding of the nature of science among students.

There is disagreement in the results of some studies related to gender variable such as Miller study (2006), Abdullah and Aboud Al-Hamdani (2007), while the only study which dealt with the variable of major was Karakas (2008).

Study Problem

The knowledge of the nature of science is an urgent need and basic science education and the understanding of the nature of science affect the evaluation of the results of teaching and learning, but information shows that there are many problems that affect the achievement of the goals of science education, and most of them show the inability of students to absorb the basic concepts and principles in science and non science courses which play an important role in their lives.

Through the experience of the researcher in the field of teaching at universities enabled him to realize that a large proportion of students in the colleges of science and humanities have limited perceptions about the nature of science and also they perceive scientific content with organized learning only in classrooms and laboratories, they absorb and recovers this knowledge only for the tests. The problem of the current study is determined in the following major question:

What is the level of understanding of undergraduate students' at Mutah University about the 'Nature of Science' considering some variables?

The study has attempted to find out answers to the following sub questions related to the major question:

1. What is the level of understanding about the nature of science among undergraduate students in the overall dimensions of the tool of the study?
2. Are there any statistically significant differences at the level ($\alpha \leq 0.05$) in the level of understanding of nature of science among under graduate students due to the college variable (science, educational science)?
3. Are there any statistically significant differences at the level ($\alpha \leq 0.05$) in the level of understanding of nature of science among under graduate students due to the gender variable?

Methodology

Participants

The population of the study comprised of all students (males and females) enrolled in the faculty of science and Faculty of Educational Sciences at Mutah University in Jordan, for the academic year 2013/2014. Total numbers of students in the faculty of science were 1824 while in the faculty of education their number was 2096.

The sample was selected randomly with a rate (10%) of the study population, the total number of respondents from both college (N=392) students. Table (1) shows members of the study sample distributed according to the college and gender.

Table (**1**) distribution of the study community according to the college and gender

College	Gender		Total
	Males	Females	
Faculty of Science	71	111	182
Faculty of Educational sciences	47	163	210
Total	118	274	392

Instrumentation

In order to measure the level of understanding the NOS among students, a modified form of questionnaire prepared by Iqbal et al. (Iqbal, Azam & Rana, 2009) and from a research study conducted in United Arab Emirates by Haider (1999) was used. A modified form of questionnaire consisted of 23 item distributed to five domains depicting various aspects of the NOS. Responses of students against statements of questionnaire reflect either their constructivist views or traditional views about science.

Answers to items indicating (agree received a score of 1), (disagree or I do not know, received a score of 0). Table (2) Shown the distribution of items of the questionnaire on each domain.

Table (2): Items distribution according to the domains of the questionnaire

No.	Domain	Number of Items
1	Scientific Theories	5
2	The Role of Scientist	5
3	Scientific Knowledge	5
4	Scientific Methods	4
5	Scientific Laws	4

To calculate the reliability coefficient of the questionnaire, the instrument was pilot tested on a sample of 25 students selected from the same population, and then re-applied after two weeks from the first application on the same sample, Kuder-Richardson formula (K-R 20) was

used to calculate the reliability coefficient of the questionnaire which was found to be 0.80, this is acceptable for the purposes of the study.

To determine the students' level of understanding of the nature of science, (74%) of the total score of the instrument was considered as criterion. On the basis of the results analysis of the distributed questionnaire which determined the students' level understanding the nature of science by Category described in Table (3)

Table (3): the criterion adopted for the analysis of the paragraphs of the tool

Level	Score	Percent (%)
High	17 – 23	74 - 100
Medium	12 – less than 17	52.2 – less than 74
Low	Less than 12	Less than 52.2

Results and Discussion

Answers of the questionnaire were analyzed according to the student's understanding of NOS which were presented as follows

Question (1) what level of understanding of nature of science among under graduate students in the overall dimensions of the tool of the study?

The researcher extracted the total frequencies of the correct answers for each item of the study tool within domains, and the percentages. Tables of (4-8) show the results of the analysis of the responses of the students in each domain:

Scientific Theories: There were five statements relating to the scientific theories. Table 4 shows frequencies, mean percent and level of understanding regarding each item.

Table (4): Frequencies of the correct answers and mean percent for items of domain (1)

No.	Item	Freq.	Percent	Level
1.	Observation is influenced by theories scientists hold. Because experimental procedures differ according to theories, hence observation differs.	175	44.6	Low
2.	Scientists invent theories, because theory invention come from the mind	232	59.2	medium
3.	Theories fit within certain paradigms, hence if these are old or untrue these are still helpful to scientists.	133	33.9	Low
4.	A theory is validated by its connections to other theories generally accepted within the scientific community.	181	46.2	Low
5.	Scientific models do not describe reality as it is. These are scientist's ideas or educated guesses, because scientists cannot see real things.	186	47.5	Low
Overall Mean			**46.3**	**Low**

As seen in Table (4) participants showed low level of understanding of scientific theories with a total percent (46.3%) which is lower than the average set by the study (74%), and further notes slightly lower understanding in all items from (1-5) with the exception of item relating to the understanding that Scientists invent theories, because theory invention

come from the mind, where the level of understanding of its average percent (59.2%).

The Role of Scientist: There were five statements pertaining to the role of scientist. Table (5) shows frequencies, mean percent and level of understanding regarding each item.

Table (5): Frequencies of the correct answers and mean percent for items of domain (2)

No.	Item	Freq.	Percent	Level
6.	A scientist dose not exclusively needs to use empirical evidence; he may use imagination or creativity.	365	93.1	High
7.	A scientist is influenced by many factors, e.g. previous knowledge, logic and social factors.	252	64.3	Medium
8.	The best scientists are those who use any method that might obtain favorable results.	355	90.6	High
9.	A scientist works within the scientific community to find the best way to explain the part of nature..	287	73.2	Medium
10.	Recording data is influenced by other factors, e.g. previous knowledge.	181	46.2	Low
Overall Mean			**73.6**	**medium**

Results in table (5) above shows that the level of understanding of the role of scientists among students moderately with a percentage of (73.6%), and indicates that the level of students' understanding of the role of scientists represented item sixth high percentage (93.1%) as they believe that the scientist dose not exclusively needs to use empirical evidence; because he may use imagination or creativity., and the level of understanding of the role of scientists represented item eighth high percentage (90.6%) as they believe that the best scientists are those who use any method that can lead to positive results, but their view that the data was recorded by the scientist affected by other factors such as previous knowledge, this belief came to make the percentage decrease (46.2%).

Scientific Knowledge: Table (6) below shows frequencies, mean percentage and level of understanding regarding each item of the scientific knowledge domain.

Table (6): Frequencies of the correct answers and mean percent for items of domain (3)

No.	Item	Freq.	Percent	Level
11.	Scientific knowledge is our understanding of reality, not reality as it is.	198	50.1	Low
12.	Scientific knowledge is not cumulative; it also goes through jumps.	304	77.6	High
13.	Scientific knowledge is tentative..	134	34.2	Low
14.	Scientific knowledge is formed through scientific and non scientific means.	134	34.2	Low
15.	Scientific knowledge might also be generated through imagination or creativity.	196	50.0	Low
Overall Mean			**49.2**	**Low**

We notice from table (6) low level of understanding of students in all dimensions of scientific knowledge with percentage ranged between (50.1% - 34.2%). Where they believe scientific knowledge is considered for their understanding of reality, not reality as it is, and that scientific knowledge is temporary, and that scientific knowledge is formed through the means and purposes of scientific and non-scientific means. As well as understand that scientific knowledge can be generated through the imagination or creativity, but for understanding that scientific knowledge is not cumulative and disappears through changes came up as a percentage of (77.6%).

Scientific Methods: Table (7) shows frequencies, mean percentage and the level of understanding regarding each item pertaining to the scientific methods

Table (7): Frequencies of the correct answers and mean percent for items of domain (4)

No.	Item	Freq.	Percent	Level
16.	There is no single method to perform science. There are methods, e.g. creativity, imagination and originality.	135	34.4	Low
17.	Scientists do not necessarily have to follow the sequence of the scientific method.	326	83.2	High
18.	Scientist can adjust their method of inquiry in the middle of an investigation and still get valid results.	251	64.1	Medium
19.	Scientists use several methods according to circumstances. The scientific method is only one of those methods.	292	74.5	High
Overall Mean			**64.1**	**Medium**

The results of the answers of the students on the items of the fourth domain, the level of understanding of the scientific methods was moderate and as a percentage of (64.1%), although the level of their understanding of the high that scientists do not have to necessarily follow the sequence of steps of the scientific method and they believe that scientists use many methods and in accordance with the conditions The scientific method is one of those methods, but the low level of understanding for the belief that there is no one way to perform science, but there are ways, such as: creativity, imagination and originality.

Scientific Laws: There were four statements pertaining to the scientific laws. Table (8) shows frequencies, mean percentage and level of understanding regarding each item.

Table (8): Frequencies of the correct answers and mean percent for items of domain (5)

No.	**Item**	**Freq.**	**Percent**	**Level**
20.	Scientists invent scientific laws. Scientists do not invent what nature does but they invent the laws, which describe what nature does.	353	90.1	High
21.	One of The main goals of science is the interpretation of the facts and natural phenomena.	213	54.3	Medium
22.	Scientific laws are only scientists' best attempts to explain a part of nature.	313	79.9	High
23.	Most scientific discoveries as a result of logical and regulator thinking.	117	29.9	Low
Overall Mean			**64.1**	**Medium**

The results shown in the table (8) indicate that the level of students' understanding of the laws of science in general was average percentage (63.6%), but the students have a high level of understanding considering the item that scientists develop scientific laws do not develop what nature does, their role is to access the laws that describe what happens in nature, and that scientific laws are only representing the best attempts of scientists to explain a part of nature, while there is a declining in the level of understanding when they believed that most of the scientific discoveries at the present time is the result of logical thinking regulator. As the performance of students in the test understanding of the nature of science by the five areas that cover the students' understanding of the nature of science, the table (9) shows Percentage of arithmetic averages of the responses of students and the level of understanding by the areas of the test.

Table (9): mean percent level of understanding of NSO regarding domains

No.	Domain	M. Percent	Level
1.	Scientific Theories	46.3	Low
2.	The Role of Scientist	73.6	Medium
3.	Scientific Knowledge	49.2	Low
4.	Scientific Methods	64.1	Medium
5.	Scientific Laws	63.6	Medium
Overall		**59.36**	Medium

In general the students' understanding of NOS is Moderate with a percentage of (59.36%), where the level of their understanding is medium in three domains: the role of scientists, scientific methods and scientific laws, while low occurs in two domains: scientific theories and scientific knowledge, which attributed the cause of the low level of students' understanding of the nature of science to the adoption of the content of courses taught by the students, both in the College of Science and the

College of Education science on the side of knowledge without focusing on the methods and skills of science and the development of their scientific merit, including help in the acquisition of the concepts of scientific culture and the nature of science. This may be attributed also to the reason not to focus on the content of courses on topics that develop the concept of culture, the nature of science among students, these all results agreed with the results of many studies on students' understanding of the nature of science, such as the study of Abdulla, et al.(2007) which showed a low level of understanding of the nature of science among fourth grade students in sections of physics and life sciences at the University of Mosul/ Iraq, and study of Karakas (2008) which revealed that students hold contemporary views about some aspects of NOS and traditionalist views about other aspects. The study of Adas, et al.(2009) showed a moderate level of students' understanding of the nature of science.

Question (2) Are there any statistically significant differences at the level ($\alpha \leq 0.05$) in the level of understanding of nature of science among under graduate students due to the college variable (science, educational science)?

To investigate the differences between the mean scores of students' responses to questionnaire considering the understanding of NOS, independent t-test was conducted to see if there are any significant differences between science and educational science students. The results are shown in Table (10).

Table (10): T-Test means of students scores regarding college variable

College	N	Mean	St. Dev.	T value	Sig.
Science	182	13.72	3.01	1.035	0.301
Educational Science	210	13.41	2.91		

Table (10) above indicates that there were no statistically significant differences between the mean scores of students due to the variable college, as the value of ($t = 1.035$) at the level of significance (0.301), which is greater than the desired level of significance ($\alpha \leq 0.05$).This may be the reason for the lack of statistically significant differences between students in the Faculty of Science and Faculty of Educational Sciences in terms of their level of understanding of the nature of science to the low degree of attention to acquire scientific concepts and skills that develop their culture of science and nature, objectives and operations through the activities included in university courses, and may that is attributed to the lack of student interest with topics contained that frame of knowledge, and the researcher believes that this result may be due to the similarity of educational situations between students and teachers in the Faculty of Science and educational Sciences in terms of styles and methods of teaching, as the focus of the

teacher is on the theoretical side which is presented to students in a traditional manner and reflected negatively on the extent of acquisition of the concepts and processes of science, and this was confirmed by the result of the first question that indicate the level of students' understanding of the nature of science which came moderately. This result agrees with the results of Karakas study (2008), which reveals that there is no significant difference of the understanding of NOS among science majors, non-science majors.

Question (3) Are there any statistically significant differences at the level ($\alpha \leq 0.05$) in the level of understanding of nature of science among under graduate students due to the gender variable?

Analysis of the data regarding question (3) showed that the arithmetic average of the responses of male students on the questionnaire (13.55), while the average of females (13.86), and to investigate the significance of the difference apparent between the averages in males and females in the level of understanding of the nature of science according to the gender variable (T-Test) was performed between the averages, the table (11) shows the results of the analysis.

Table (11): T-Test means of students scores regarding gender variable

College	N	Mean	St. Dev.	T value	Sig.
Male	118	13.55	2.98	0.990	0.012
Female	274	13.86	2.96		

Table (11) shows that the value of (t) calculated (0.99), which is statistically significant at the level of significance (0.012), and this result shows that the difference observed in the level of students' understanding of the nature of science, according to the variable of gender statistically significant, in favor of females. This result was attributed to the reason that the female students of the Faculty of Science and Faculty of Educational Sciences are more interested in studying the courses' contents than males, on the other hand the female students who show more interesting in learning topics which focus on the concepts related to laws, scientific theories, the nature and role of scientists. This result disagreed with the result of study of Karakas (2008), which showed a statistically no significant difference between the mean of males and females in the level of scientific culture. And agreed with the results of Millers' study (2006), which showed that the students are better in understanding of the nature of science than males, but this result contrast the result of a study Adas et. Al. (2009), which showed no statistically significant differences in the level of understanding the nature of science among students attributed to gender variable.

On the basis of these results, the researcher recommended to develop methods of teaching commensurate with the developments of science and its operations and to Include plans of undergraduate tuition courses of study

focused concepts, facts and scientific theories in the light of modern standards of scientific education to raise the level of students' understanding of the nature of science. And to raise the level of culture and science education among under graduate students and of faculties at the university through organizing of training courses related to the nature of science.

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