Investigating level of the scientific literacy of primary school teacher candidates

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Received 30 Apr., 2009
Revised 18 Jun., 2009

Contents

Abstract

The purpose of this study is twofold; first, to determine the level of primary school teacher candidates' scientific literacy acquired with the current science education, and second, to find out whether there is a relationship between gender and levels of scientific literacy. This research was implemented during the fall semester of 2008-2009 academic year as a case study approach. The sample consists of ninety females and forty-two male fourth-year student teachers from the primary school teacher training program at Amasya University. In this research, a multiple choice test developed by researchers and Sperman-Brown, which had 35 items, was used with the aim of assessing scientific literacy of student teachers. The correlation coefficient was calculated 0.80. As a result, the mean of teacher candidates' whole scores was determined to be 56.71%. The findings could be interpreted that males are not more significantly scientific literate than females except in the life sciences.

Keywords: Scientific literacy, Primary School Teacher Candidates, Gender

Introduction

Over the past fifty years, the concept of scientific literacy was introduced to the science education community by Hurd (1958) and McCurdy (1958). There has been considerable debate over the various meanings entailed by the use of this term and the associated aims for teaching science (Shamos, 1995; Laugksch, 2000; Fensham, 2002; Roberts, 1983, 2007a). Scientific literacy and several closely related terms, like science literacy or public understanding of science, are very much a part of the landscape of science education writing and research of the past half century.

While few people argue against the value or the proposition of scientific literacy, no ultimate consensus has been reached on its definition (Roberts, 2007b). According to Hurd (1998: 410), "Scientific literacy is seen as a civic competency required for rational thinking about science in relation to personal, social, political, economical problems and issues that one is likely to meet throughout life." In a much earlier analysis of this concept, Roberts (1983) suggested that scientific literacy "has had so many interpretations that it now means virtually everything to do with science education" (p. 22) and that it had "come to be an umbrella concept to signify comprehensiveness in the purposes of science teaching in the schools" (p. 29).

Especially during the early 1960s, scientific literacy was primarily a concept about curriculum goals. It suggests in very broad terms that the overall character of what school science should be about and what it should emphasize about science. The means of scientific literacy, as a concept, may vary from day-to-day, but the fact remains that "scientific literacy" still occupies a central position in the rationale and statement of aims for many contemporary curriculum reform projects (e.g. AAAS, 1989,1993, 2001; NRC, 1996; CMEC, 1997; Millar & Osborne, 1998; OECD, 1999; Ministry of Education (MEB), 2006; Wei & Thomas, 2006; Millar, 2008).

Since the 1960s, educational reform has become a continuous worldwide movement in order to promote students' literacy in different disciplines. Along the same trend, Turkey started its educational reform at universities in 1997. And finally, in 2004, the primary school curriculum has been changed. But as in the previous curriculum, the new curriculum has scientific literacy among its main purpose.

All people need some science education so that they can think, speak and act on social and science related issues, which influences their quality of life (Solomon, 2001). Therefore, a student can't become a scientifically literate person without knowing some science, and everyone agrees that the concept needs to include some other types of understanding about science (Roberts, 2007a; 2007b). The differences in definition have to do with just what, how much, for whom, and in what sort of conceptual balance.

Universities, as other schools, are one of the places that prepare the students for the real world and real life. In realizing this aim, universities must help their students gain scientific literacy abilities and to grow scientific literate citizens. Therefore, science in our schools and universities must be for all students. National Science Education Standards (NRC, 1996) describe science standards for all students, "regardless of age, gender, cultural or ethnic background, disabilities, aspirations, or interest and motivation in science" (p.2) and "all students ...should have the opportunity to attain high levels of scientific literacy" (p.20).

In the Turkish context, primary school teacher candidates' high school backgrounds areas varied. However, their training program at the faculty of education is comprised of some science courses, such as biology, physics, chemistry and science laboratory practice. All student teachers have experienced the disciplines of physics, biology and chemistry during university. These teachers are also eligible to teach science courses at the primary schools. There has been some evidence that teacher candidates have graduated without some crucial characteristics of scientific literacy (Çepni, 1997; Çepni & Bacanak, 2002), and they do not associate the science curriculum and everyday life (Ayas, Karamustafaoğlu, Sevim & Karamustafaoğlu, 2001).

It is essential to understand the levels of scientific literacy held by primary school teacher candidates if the goal is to have a scientifically literate population in the next generation. The purpose of this study is twofold; (1) to determine the level of primary school teacher candidates' scientific literacy acquired with the current science education, and (2) to find out whether there is a relationship between gender and level of scientific literacy.

Methods

This research was implemented during the fall semester of 2008-2009 academic year as a case study approach. The sample consists of ninety female and forty-two male fourth-year student teachers from the primary school teacher training program in the faculty of education at Amasya University. The characteristics of the sample can be seen in Table 1.

Table I. *Characteristics of the sample*

Gender	**Male**	**Female**	**Total**
Number	42	90	132
Completed Science Courses (Credits)	General Biology (2) General Chemistry (2) General Physics (2) Science and Technology Laboratory I (1) Science and Technology Laboratory II (1) Environmental Education (2) Science and Technology Teaching I (3) Science and Technology Teaching II (3) Life Science Teaching (3) Astronomy (2)		21

In this research, a multiple choice test of 35 items was used with the aim of assessing scientific literacy of primary school teacher candidates. It consisted of 5 items related to physical science, 5 items related to life science, 5 items related to earth science, 5 items related to scientist properties, 10 items related to the nature of science and science and technology and 5 items related to the social perspective of science. Each test item has four options. Correct scores were given one point, and incorrect scores were given zero points. Instrumentation and language experts reviewed the test to establish content and face validity. Some modifications were made according to the experts' comments. The test was first piloted and then applied to the sample group. The Sperman-Brown correlation coefficient was calculated at 0.80. The final test consists of 35 items.

Some example questions are given:

What kind of particles are there in the core of an atom? (*Physical Science*)

a) Only Protons b) Only Neutrons
c) Protons and neutrons d) Electrons and neutrons

Some reactions occur during photosynthesis. Which of these reactions should occur during the process of photosynthesis? (*Life Sciences*)

a) Carbon dioxide and water are combined to create sugar.
b) Hydrogen atoms are combined to create helium atoms.
c) An egg and sperm are combined to create a new cell.
d) Water is decomposed into hydrogen and oxygen.

Which of these factors has less importance when a new theory is accepted or rejected by scientists? (*Nature of Science*)

a) The theory is suggested by a famous scientist.
b) The theory is guided new scientific research.
c) Information explained by the theory is obtained from experiments.
d) The theory is compatible with previous theories.

Findings

In this section findings about the characteristics of the distribution of scores were examined. Furthermore, simple statistical procedures were used to assess the significance of differences between genders within the sample (independent samples t-test). Independent t-tests were conducted at the 0.05 level of significance for all data.

Table II. *Distribution of gender-related frequency of true answers*

	Female	**Male**	**Total**
	%	%	%
Physical Science	53.78	48.57	52.12
Life Science	47.11	57.14	50.30
Earth Science	48.22	56.19	50.76
Nature of Science	74.89	73.81	74.55
Scientist Properties	73.56	77.14	74.70
Science and Technology	38.22	42.86	39.70
Social Perspective of Science	52.89	59.05	54.85
General total	**55.52**	**59.25**	**56.71**

As seen in Table II, the highest average is the nature of science (74.55 %) and scientist properties (74.70 %) items, and the lowest average is on the science and technology (39.70 %) items.

Table III. *Distribution of gender-related t-test scores on physical science items*

Gender	N	Mean	Std. Deviation	df	t	Sig. (2-tailed)
Female	90	2.69	1.03	130	1.242	.217
Male	42	2.43	1.29			

Table III indicated the significant gender-related difference in scores on physical science test items [t_{130}=1.242, p>0.05]. Although the mean score of females (2.69) was higher than males (2.43), the difference is not meaningful.

Table IV. *Distribution of gender-related t-test scores on life science items*

Gender	N	Mean	Std. Deviation	df	t	Sig. (2-tailed)
Female	90	2.36	.94	130	-2.820	.006
Male	42	2.86	.98			

Table IV indicated the significant gender-related differences in scores on life science test items [t_{130}=-2.820, p<0.05]. The mean score of males (2.86) was significantly higher than the females (2.36), and the difference is meaningful.

Table V. *Distribution of gender-related t-test scores on earth science items*

Gender	N	Mean	Std. Deviation	df	t	Sig. (2-tailed)
Female	90	2.41	1.12	130	-1.874	.063
Male	42	2.81	1.17			

Table V indicated the significant gender-related difference in scores on the earth science test items [t_{130}= -1.874, p>0.05]. Although the mean score of males (2.81) was higher than the females (2.41), the difference is not meaningful.

Table VI. *Distribution of gender-related t-test scores on nature of science items*

Gender	N	Mean	Std. Deviation	df	t	Sig. (2-tailed)
Female	90	3.74	.79	130	.373	.710
Male	42	3.69	.75			

Table VI indicated the significant gender-related difference in scores on nature of science test items [t_{130}=.373, p>0.05]. Although the mean score of females (3.74) was higher than the males (3.69), the difference is not meaningful.

Table VII. *Distribution of gender-related t-test scores on scientist properties items*

Gender	N	Mean	Std. Deviation	df	t	Sig. (2-tailed)
Female	90	3.68	1.05	130	-.936	.351
Male	42	3.86	.98			

Table VII indicated the significant gender-related difference in scores on scientist properties test items [t_{130}=-.936, p>0.05]. Although the mean score of male (3.86) was higher than the female (3.68), the difference is not meaningful.

Table VIII. *Distribution of gender-related t-test scores on science and technology items*

Gender	N	Mean	Std. Deviation	df	t	Sig. (2-tailed)
Female	90	1.91	1.03	130	-1.238	.218
Male	42	2.14	.93			

Table VIII indicated the significant gender-related difference in scores on science and technology test items [t_{130}=-1.238, p>0.05]. Although the mean score of males (2.14) was higher than the females (1.91), the difference is not meaningful.

Table IX. *Distribution of gender-related t-test scores on social perspective of science items*

Gender	N	Mean	Std. Deviation	df	t	Sig. (2-tailed)
Female	90	2.64	1.03	130	-1.492	.138
Male	42	2.95	1.25			

Table IX indicated the significant gender-related difference in scores on social perspective of science test items [t_{130}=-1.492, p>0.05]. Although the mean score of males (2.95) was higher than the females (2.64), the difference is not meaningful.

Discussion and Results

When we look at the distribution of the percentage of correct answers (Table II), male teacher candidates have more correct answers than female teacher candidates. Although the mean score of male teacher candidates was higher than those of the female teacher candidates, the comparison of the total mean score of correct answers with independent t-test results show that the difference is not meaningful. Bacanak and Çepni (2002) investigated gender differences of mathematics teacher candidates' scientific literacy levels. They argued that the male teacher candidates' scientific literacy test results better than the female teacher candidates. When the results from this study were compared to the results of Bacanak and Çepni (2002) study, the scientific literacy level of male teacher candidates is higher than female teacher candidates.

In the study, two scientific literacy tests were applied to science teacher candidates. Bacanak (2002) determined that the overall average 54.30% and 59.10%. In this study, the average gained 56.71%. Accordingly, the results are similar in both studies. However, Manhart (1997) made a study with K11 and K12 students. He found average achievement of students in the science literacy test to be approximately 61.50%. It is known that one of the most important and a fundamental goal of contemporary education is to develop students' scientific literacy levels. Teachers must be achieving this aim. Science teacher candidates, who will raise the future generations level of science literacy, and students scientific literacy levels closer to each other, and even lower, is quite engrossing.

Table II showed that teacher candidates the lowest success rate (39.70) on the items of science and technology. A teacher who does not pay attention to the perspectives of science, technology and society, is not able to transmit a complete science to their students (Solbes & Vilches, 1997). One of the most important obstacles for even becoming an effective teacher are this negative findings related with teacher candidates.

Science today is much more part of the layman's life than it was a few decades ago. Issues and debates about scientific research are no more only a concern of scientists and those directly involved. It has now become the responsibility of each and every citizen across the globe. Citizens need to be educated in science that enables them to understand scientific and technological issues. To achieve this, a teacher should follow-up on new developments in science or technology. A teacher should motivate his/her students to have habits of following-up on new developments, from television to today's contemporary media (Solomon, 2001). Therefore, it is expected that teachers have high levels of scientific literacy.

A study conducted by Laugksch (2000) surveyed the scientific literacy of selected high schools' grade 12 at the secondary/tertiary educational interface in South Africa. In contrast to biology, physical science plays a more significant role in the achievement of scientific literacy in the case of these students. Students taking physical science possessed a better understanding and awareness of all three dimensions of scientific literacy than students taking biology. However, in this study, there is not an important distinction between physical science and biology. The differences between the data in this study and the study of Laugksch (2000) may arise from the diversity of courses in the teacher education curriculum. In addition, although one of the most important objectives of teacher education programs is to educate scientifically literate teachers, this outcome can be derived from implementing the content of the courses.

Manhart (1997) investigated gender differences with regard to three factors of scientific literacy. His study involved students in Grades 9 and 10. A 100-item multiple choice test based on National Science Education standards was used to assess scientific literacy while gender differences were explored using analysis of variance procedures. Males tended to perform better than females on the constructs of science factor. Females tended to do better than males on the abilities necessary to do scientific inquiry and the social aspects of science. However, in this study, there is not an important distinction between social perspectives of science items between genders (Table IX). This difference is raised from the Turkish community's perspective on science.

Teachers who have low scientific literacy level cannot be expected to grow scientifically literate people or to apply the curriculum effectively. When we take into account the data obtained from this study, university-level curricula should increase the level of the teacher candidates' scientific literacy.

Despite the difficulty of delineating the meaning of scientific literacy (Gallagher, 1997), it is accepted that scientifically literate teachers are essential in meeting society's expectations of science education (European Commission, 2002).

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