



EFFECT OF PRE-SERVICE TEACHERS' SCIENTIFIC LITERACY ON THEIR SELF-EFFICACY IN TEACHING SCIENCE AT SECONDARY LEVEL

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ABSTRACT

The main objective of the present study was to investigate the effect of pre-service science teachers' scientific literacy and their self-efficacy in teaching science. The study is quantitative in nature and causal-comparative research design was used. The sample of the study was comprised on 240 pre-service teachers' from three different public sector universities of Lahore. Two instruments were used for data collection named as Test of basic scientific literacy (TBSL) and STEBI-B. The results of the study showed that pre-service science teachers' scientific literacy on the whole and its components significantly and positively predicted the outcome variable (self-efficacy). It is concluded that there is a statistically significant effect of pre-service science teachers' scientific literacy on their self-efficacy. Specifically, this study provided an attempt to inform policy makers and educational researchers about how realistic they are in their perception related to the pre-service secondary teachers' skills to achieve the goals of science curriculum.

Key words: Pre-service teachers, Scientific literacy, self-efficacy

Introduction

Education is a necessary human asset, a necessity of society, basis of a fine life and sign of freedom (Bhardwaj, 2016). Education is considered as an important factor of one's life, because one may be able to make robust decisions, if he/she get the knowledge about certain things (Smith, Loughran, Berry, & Dimitrak, 2012). Command in science is considered as a significant key to solving the scientific problems. Such factors contribute to the advancement of quality of life, equal growth and the capacity for human capital to expand. Thus science education, as part of the school curriculum, play an essential role in preparing students who may have science literacy skills that are able to think critically, dynamically, objectively, and have the strategy to respond to problems in society that have been triggered by the impact of scientific and technological growth (Sultan, Henson, & Fadde, 2018). Science literacy is a capability of understanding science, able to understand science and problem-solving knowledge of science, so that learners get a high level of knowledge of themselves and about their surroundings while making decisions based on the potential ramifications of science (Yılmaz & Çavaş, 2008). Science education is a vital educational field and today, it is the main concern of the educational institutions. Science teachers are the key contributors at all levels of education mostly to acquisition of scientific literacy, since teachers have an important role in creating a scientifically literate person (Chin, 2005).

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Ozdem, Ertepinar, and Cavas (2009) suggested that, the primary aim of science education is a scientifically literate culture. The person who concerned with science, such as scientists and science teachers, also have sufficient rates of scientific literacy. Scientific literacy's has been recognized as a significant science education target worldwide (Ozdemir, 2010). Promoting scientific literacy around the globe has been identified as a central objective of science education (Miller, 2004). Several educators and institutions have attempted to describe the term 'scientific literacy' Some scholars regard scientific literacy as an individual's ability to think rationally and pragmatically about science in relation to personal, social, political possibilities (Bacanak&Gokdere, 2009). Some scholars have proposed that a scientifically literate person can clearly understand the meaning of science and effect of technology and science on societies (Ozdemir, 2010). In many studies, scientific literacy viewed as the ability of an individual to think about science holistically and rationally in relation to possible individual, social, political and economic difficulties and issues experienced in daily life. (Bacanak&Gokdere, 2009). Many researchers believe that both the effects of technology and science on society and the essence of science can be completely understood by a scientifically literate individual (Ahmet& Murat, 2009). In educational systems, teachers play a pivotal role in the growth of science literacy among students. Scientific literacy contributes to the insight and perception of the fundamental scientific methods or strategies necessary for personal decision-making, social and cultural participation and economic efficiency. Previous researches indicated that educators with a lower level of scientific literacy, both pre-service and in-service, can never really be intended to increase and maintain scientific literacy (Ebrahim, 2012). The most significant element in promoting science literacy is teachers. Therefore, they have to be well qualified in science subjects. In addition, they must have a detailed knowledge of science and to be up-to - date with the latest scientific developments that impact society on a daily basis. Researchers based on teachers' knowledge suggests that the both teachers' knowledge of the subject and teachers' instructional knowledge are important to effective science teaching and student comprehension. The self-efficacy of science teachers affects their capacity and motivation to adopt effective learning strategies as well as their preference of unique teaching activities (Yilmaz &Çavaş, 2008). The individual who is scientifically literate admires and recognizes the effect of science on daily life and participates confidently in discussions about science-related things. A person who is scientifically literate has high level of motivation and abilities which increase their self-efficacy. The view of the self-efficacy of teachers in science learning is connected to their assumptions about their ability to efficiently and effectively teach science and their ability to enhance student achievement (Akbaú&Çelikkaleli, 2006).). Self-efficacy theory assumes that a person's behavior is determined by his or her own confidence in his or her ability to perform an action, as well as the expectation that his or her methods would be successful. Self-efficacy can be defined simply as the reliance on a person to complete a task in his or her competence (Bernadowski, Perry, & Greco, 2013). Strategies must be understood and applied, observed to improve teacher effectiveness as they have a crucial role in student success. Becoming conscious of one's self-efficacy and enhancing this skill allows people to work more efficiently and effectively (Hoy, 2004).

A number of studies showed that teachers with a strong level of self-efficiency in their teaching ability will provide excellent student achievement across a wide range of academic subjects (Ross, Gray, & Hanay, 2001). Self-efficacy has an impact on teaching practice and the

mindset towards the educational process. There has been a lot of interest in investigating the relationship between teacher self-efficacy studies in recent decades (Aydin & Boz, 2010). Altun-Yalcin, Acisli, & Turgut, (2011) stated that the main element in the promotion of scientific literacy is teachers. So they have to be educated in the science subject. Additionally, they need to have a strong understanding of science and be aware of the latest developments in science that impact society every day. The role of teachers in the promotion of scientific literacy in schools and higher education is crucial. Bleicher and Lindgren (2005) highlighted that, research on teacher competence indicated that competence of both teachers' subject matter and teacher pedagogical knowledge is important for students' good science teaching and understanding. Avery and Meyer (2012) stated that, the self-efficacy of science teachers affects their capacity and motivation to adopt effective learning strategies as well as their preference of unique teaching activities.

Scientific literacy is the combination of mental or cognitive activities which includes practical and emotional experiences. In Pakistan, there are many issues and problems which affect students or learners practices and perceptions towards science education. Countries like Pakistan, in which there is no role of teachers in decision making so that professional perceptions itself also very critically low (Chin, 2005). The science textbooks were over emphasized on factual information or knowledge and have lack of personal relevance and appeal for learners. The teacher's dominance or authoritative role is another issue of traditional science classrooms. It is think that the role of teacher is to transmit the knowledge to students because the teachers are the source of knowledge so that the students hardly see autonomy in their science classrooms due to traditional teaching methods. These issues demands reforms in traditional science education in Pakistan. Iqbal (2010) expressed that in Pakistan highly qualified teachers done their administrative tasks so they did not focused on their class and not spend enough time in their classrooms to teach. Students who have weak learning abilities did not get enough teachers time due to teachers administrative works or tasks. In Pakistani educational system the major issue is to enhance teachers' self-efficacy and professional competences or abilities which improve students' learning and achievement. For this reason, this study focused on pre-service teachers' scientific literacy and their self-efficacy in teaching science because high scientific literacy ultimately enhances the teachers' level of self-efficacy.

1.1 Statement of the Problem

The present study was designed to study the pre-service teachers' scientific literacy and their self-efficacy in teaching science at secondary level.

1.2 Objectives of the Study

Objective of the study was to

1. Identify the effect of pre-service teachers' scientific literacy on their self-efficacy in teaching science at secondary level.

1.3 Research Hypotheses

H_{01} . There was no significant effect of pre-service teachers' scientific literacy on their self-efficacy in teaching science at secondary level.

H_{1.1}: There was no significant effect of nature of science on pre-service teachers' self-efficacy on teaching science at secondary level.

H_{1.2}: There was no significant effect of science content knowledge on pre-service teachers' self-efficacy on teaching science at secondary level.

H_{1.3}: There was no significant effect of science and technology on pre-service teachers' self-efficacy on teaching science at secondary level.

Research Design

This study was quantitative in nature and causal-comparative research method was used to conduct this research.

Participants of the study

Population of the present study was comprised of all pre-service science teachers of public universities of Lahore. In this study, sample comprised on three public sector universities of Lahore from which 240 B.Ed. (Hons) science education students were selected conveniently.

Instrument of the Study

Two instruments were adapted in this study for data collection. Test of Basic Scientific Literacy (TBSL), was conducted to check the scientific literacy of pre-service science teachers. This test was developed by Laugksch and Spargo (1996) and the Test of Basic Scientific Literacy (TBSL) includes 110 items: the Nature of science (22 items), Science content knowledge (72 items), and the impact of science and technology on society (16 items). The second instrument (STEBI-B) was developed by Enochs and Riggs (1990) to determine the personal self-efficacy beliefs of pre-service teachers toward teaching science. Pilot study of the instrument was also conducted. Thirty pre-service teachers were taken as sample of pilot study which was exempted later on in final research study. The .82 reliability was found for TBSL (test of basic scientific literacy) and .79 reliability was found for teachers' self-efficacy in teaching science questionnaire.

Data analysis

Data analysis was done by using regression analysis technique to see the effect of independent variable (scientific literacy) on dependent variables (self-efficacy).

Results

In order to study the effect of overall pre-service teachers' scientific literacy on their self-efficacy in teaching science, null hypotheses were formulated as under (at the level of significance $\alpha = 0.05$).

H₀₁: There is no significant effect of overall pre-service teachers' scientific literacy on their self-efficacy in teaching science at secondary level.

Step 1: Evaluating the model. The Model Summary (see Table 1 below) showed how much of the variance in the dependent variable (Self-efficacy) was explained by the model. In this case, the value was .184 indicating that the model explained 0.184 % of the variance in the science teachers’ self-efficacy. In this case, there was a minor difference i.e. the adjusted value was 0.180(as compared to R Square = 0.184). Therefore, the linear regression analysis revealed that scientific literacy of teachers’ significantly and positively predicted the outcome variable teacher self-efficacy i.e. Adjusted R Square = .180, F = 55.8, $p < .0005$ (Sig. = .000).

In other words, there is strong evidence to conclude that overall teachers’ scientific literacy lead to higher predictions of teachers’ self-efficacy. The model reaches statistical significance at $\alpha = 0.05$, thus rejecting the null hypothesis that ‘*There is no significant effect of overall pre-service teachers’ scientific literacy on their self-efficacy in teaching science at secondary level*’.

Table 1

Model summary

Model	R	R Square	Adjusted R Square	Std. Error	F	Sig.
1	.429(a)	.184	.180	20.47	55.8	.000(a)

Predictors: (Constant), Scientific Literacy_Total

Dependent Variable: SE_Total

Step 2: Constructing the Regression Equation. The regression equation used to predict the pre-service teachers’ self-efficacy, shown in Table 2

Table 2

Regression Coefficients (n = 240)

Model	Unstandardized Coefficients		Standardized Coefficients		Sig
	B	Std. Error	Beta	t	
(Constant)	3.326	8.954		.371	.711
Scientific literacy	.311	.042	.429	7.471	.000

Dependent Variable = Self-Efficacy

The table 2 provides the data required to predict pre-service science teachers’ self-efficacy from their scientific literacy. It reveals that scientific literacy contributes significantly to the model (Sig .000). Using the Unstandardized Coefficients, the regression equation is:

$$\text{Teachers' self-efficacy} = .3.326+ (.311) (\text{scientific literacy})$$

H_{2.1}: There was no significant effect of Nature of science on pre-service teachers’ self-efficacy on teaching science at secondary level.

Step 1: Evaluating the model. *The Model Summary* (see Table 3 below) showed how much of the variance in the dependent variable (Self-efficacy) was explained by the model. In this case, the value was .117 indicating that the model explained 0.117 % of the variance in the science teachers’ self-efficacy. In this case, there was a minor difference i.e. the adjusted value was 0.114(as compared to R Square = 0.117). Therefore, the linear regression analysis revealed that nature of science (NOS) significantly and positively predicted the outcome variable teacher self-efficacy i.e. Adjusted R Square = .114, F = 32.99, p< .005 (Sig. = .000).

It is concluded with strong evidence that higher predictions of science teachers’ self-efficacy are lead by *nature of science* of scientific literacy. The model reaches statistical significance at $\alpha = 0.05$, thus rejecting the null hypothesis that ‘*There is no significant effect of nature of science on pre-service teachers’ self-efficacy in teaching science at secondary level*’.

Table 3

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error	F	Sig.
1	.343(a)	.117	.114	20.47	32.99	.000(a)

Constant: NOS

Dependent variable: SE_Total

Step 2: Constructing the Regression Equation. *The regression equation used to predict the pre-service teachers’ self-efficacy, shown in Table 4*

Table 4

Regression Coefficients (n = 240)

	Unstandardized Coefficients	Standardized Coefficients		

Model	B	Std. Error	Beta	t	Sig
(Constant)	21.8	8.40		2.60	.010
NOS	1.11	.195	.343	5.7	.000

Dependent Variable = SE_Total

The table 4 provides the data required to predict pre-service science teachers’ self-efficacy from their *nature of science(NOC)* of scientific literacy. It reveals that nature of science contributes significantly to the model (Sig .000). Using the Unstandardized Coefficients, the regression equation is:

$$\text{Teachers' self-efficacy} = 21.8 + (1.11) (\text{Nature of Science})$$

*H*_{2.2}: There was no significant effect of science content knowledge on pre-service teachers’ self-efficacy on teaching science at secondary level.

Step 1: Evaluating the model. The Model Summary (see Table 5 below) showed how much of the variance in the dependent variable (Self-efficacy) was explained by the model.

In this case, the value was .317 indicating that the model explained 0.317 % of the variance in the science teachers’ self-efficacy. In this case, there was a minor difference i.e. the adjusted value was 0.314(as compared to R Square = 0.317). Therefore, the linear regression analysis revealed that nature of science (SCK) significantly and positively predicted the outcome variable teacher self-efficacy i.e. Adjusted R Square = .314, F = 114.98, p < .005 (Sig. = .000).

It is concluded with strong evidence that higher predictions of science teachers’ self-efficacy are lead by science content knowledge of scientific literacy. The model reaches statistical significance at $\alpha = 0.05$, thus rejecting the null hypothesis that “*There was no significant effect of science content knowledge on pre-service teachers’ self-efficacy in teaching science at secondary level*”.

Table 5

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error	F	Sig.
1	.563(a)	.317	.314	18.7	114.98	.000(a)

Constant: SCK_Total

Dependent variable: SE_Total

Step 2: Constructing the Regression Equation. The regression equation used to predict the pre-service teachers' self-efficacy, shown in Table 6

Table 6

Regression Coefficients (n = 240)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig
	B	Std. Error	Beta		
(Constant)	67.89	1.19		56.85	.000
SCK	.006	.001	.563	10.72	.000

Dependent Variable = Self-Efficacy

The table 7 provides the data required to predict pre-service science teachers' self-efficacy from their science content knowledge of scientific literacy (SCK). It reveals that nature of science contributes significantly to the model (Sig .000). Using the Unstandardized Coefficients, the regression equation is:

$$\text{Teachers' self-efficacy} = 67.89 + (.006) (\text{Science content knowledge})$$

H_{1.3}: There was no significant effect of science and technology on pre-service teachers' self-efficacy on teaching science at secondary level.

Step 1: Evaluating the model. The Model Summary (see table 7 below) showed how much of the variance in the dependent variable (Self-efficacy) was explained by the model. In this case, the value was .088 indicating that the model explained 0.088 % of the variance in the science teachers' self-efficacy. In this case, there was a minor difference i.e. the adjusted value was 0.085 (as compared to R Square = 0.088). Therefore, the linear regression analysis revealed that nature of science (STS) significantly and positively predicted the outcome variable teacher self-efficacy i.e. Adjusted R Square = .085, F = 24.07, p < .005 (Sig. = .000).

It is concluded with strong evidence that higher predictions of science teachers' self-efficacy are lead by science and technology of scientific literacy. The model reaches statistical significance at $\alpha = 0.05$, thus rejecting the null hypothesis that 'There is no significant effect of science and technology on pre-service science teachers' self-efficacy in teaching science at secondary level'.

Table 7

Model Summary

Model	R	R Square	Adjusted R Square	Std. Error	F	Sig.
1	.297(a)	.088	.085	21.63	24.07	.000(a)

Constant: SAT

Dependent variable: SE

Step 2: Constructing the Regression Equation. The regression equation used to predict the pre-service teachers' self-efficacy, shown in Table 8

Table 8

Regression Coefficients (n = 240)

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig
	B	Std. Error	Beta		
(Constant)	29.53	8.263		3.57	.000
STS	1.22	.249	.297	4.96	.000

Dependent Variable = Self-Efficacy

The table 8 provides the data required to predict pre-service science teachers' self-efficacy from their science and technology of scientific literacy (STS). It reveals that nature of science contributes significantly to the model (Sig .000). Using the Unstandardized Coefficients, the regression equation is: Teachers' self-efficacy = 29.53+ (1.22) (science and technology).

Discussion

The primary purpose of this research is to analyze the effect of pre-service teachers' scientific literacy on their self-efficacy in teaching science at secondary level. Results of the present study highlighted the significance of pre-service teachers' scientific literacy for their self-

efficacy in teaching science. The findings of the previous studies have supported to present study that pre-service teachers' scientific literacy with all its dimensions have significant positive contribution in predicting the pre-service teachers' self-efficacy in teaching science. It reveals from findings of present study that scientific literacy contributes significantly to the model of teachers' self-efficacy. It also finds that nature of science contributes significantly to the model science content knowledge. There is significant effect of science content knowledge on pre-service teachers' self-efficacy in teaching science at secondary level (Tosun, 2000). These findings are supported the results of past studies. Ebrahim (2012) explored in his study that respondents among pre-service secondary science teachers had a satisfactory degree of scientific literacy and a modest level of self-efficacy in science learning. This suggests that the pre-service science teachers of the university have constructed a logical and scientific solution on common everyday problems and are confident in their ability to provide guidance in science. Therefore, a reasonably significant relationship between science literacy and science teaching of self-efficacy has been developed. The science literacy also effects the self-efficacy ability of teachers. There is a growing belief in the ability to teach science as scientific literacy grows. Student performance, instructional methods and classroom management could assess the effectiveness of teachers (Yilmaz-Tuzun, 2008). The findings of this research also predict that teachers are generally at a loss when a student has trouble grasping a science concept as to how to make the student understand it better. It is due to poor awareness of science content that reduces the self-efficacy of pre-service teachers and they have found it challenging to grasp different science concepts. The current study also reveals that teachers' scientific literacy significantly and positively predicted the teachers' self-efficacy. Findings shows that there is significant effect of nature of science on pre-service teachers' self-efficacy in teaching science. There is significant effect of science and technology on pre-service science teachers' self-efficacy in teaching science. Yilmaz and Çavaş (2008) found that self-efficacy is affected by science and technology training in pre-service. Kahraman, Yilmaz, Bayrak, and Gunes (2014). found also that teachers' self-efficacy effected by scientific literacy, and teaching methods. Teachers with high self-efficacy adopt educational methods and set higher standards, have a sense of responsibility for student learning, and have a greater degree of creativity in the delivery of topics. High self-efficacy could contribute to an individual's increased commitment and motivation to accomplish more demanding goals, which could lead to improved outcomes, resulting in higher self-efficacy (Woolfolk & Spero, 2005). It is concluded that high scientific literacy of pre-service teachers' enhance their self-efficacy and they become confident to teach the science content in their classrooms. From this study, it was analyzed that pre-service teachers' continuously find better ways to teach science. Teachers' self-efficacy directly related to their students', if teachers' have low self-efficacy level then it will affect their students' achievement. Teachers' with high level of self-efficacy know the necessary steps to teach science concepts effectively and also they adopt effective ways organize the learning process (Yilmaz & Çavaş, 2008)

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