The Effects of Background and Gender on Pre-Service Science Teachers’ Self-Efficacy towards Socioscientific Issues

Jamil Mikhail Yahaya PhD

School of Early Childhood Care and Primary Education, Federal College of Education (Technical) PMB 060 Gombe, Gombe State Nigeria
jamilgombe@yahoo.com

ABSTRACT
The study sought to find out the effect of background and gender on the pre-service teachers’ self-efficacy in teaching and learning controversial science content of school science curricula. The participants were divided into experimental and control groups where the former was taught the content using socioscientific issues instruction and the latter was taught using a conventional teaching approach. Teacher sense of efficacy scale was the instrument used for data collection where scores before the intervention (pre-test scores) served as the covariates and scores after the intervention (post-test scores) served as the dependent variable used in analysing the data. Result obtained indicated that there was no statistically significant difference in terms of background and gender as far as self-efficacy of the research participants are concerned. One of the limitations of the study is the use of quantitative data only to arrive at the findings without some qualitative data that might elaborate and widen understanding of the quantitative results. It is therefore recommended for further research in similar area.

Keywords: self-efficacy; pre-service teachers; socioscientific issues; socioscientific inquiry

INTRODUCTION
Self-Efficacy (SE) in frequent use mostly in psychology denotes simply an individual’s beliefs in his/her capacity in performing a given task. Some viewed it as the belief of an individual in his/her personal ability in achieving a certain objective. In the context of this study, SE was viewed as the belief in confidence and competency of an individual in performing assigned function. With reference to the participants of the study - pre-service science teachers - it is their confidence and competence in learning and teaching some controversial science content known as socioscientific issues (SSIs). Bandura’s (1995) definition of SE states that it is a belief in one’s own abilities to execute an organised course of action. This stresses that SE has to do with person’s belief in his/her ability to succeed or otherwise in a given situation. The belief can be strong or weak as the situation requires or present itself. However, all individuals personally identify some certain goals they want to achieve or to bring about a change when condition warrants. Nevertheless, putting them into action is not quite simple as it may seem. This might be the reason behind Bandura’s (1995) articulation that people’s SE plays a major role in their approach in achieving or accomplishing such goals, tasks or challenges. He further pointed that there are people with strong and weak sense of SE. Individuals with a strong sense of SE see challenges as tasks needing mastery and exerts much efforts to master and overcome them. They would initiate a stronger and deeper interest in all the activities they are doing to the extent that they do not feel bored or tired of the hitches involved in the activities.
Furthermore, people with strong sense of SE are able to form a stronger sense of commitment to their interest and functions. They neither allow distraction to affect their activity nor interest. Besides, they quickly recover from setbacks and disappointment seizing the opportunity to learn from them for preparation against future occurrence in case they happen in future (Bandura, 1995). On the other hand, persons of weaker sense of SE avoid challenging tasks because hardly do they believe in trial and error as means of solving problems. Furthermore, they believe that difficult tasks are beyond their abilities and dare not a trial but focus much on fear of failure and negative outcomes. Finally, a person with a weaker sense of SE quickly loses confidence in personal competence that strongly contributes to continuous failure even on trial ground (Bandura, 1994). Besides, SE is neither natural nor permanent (Bandura, 1997; Palmer, 2006; Cantrell, Young, and Moore, 2003; Wingfield, Freeman and Ramsey, 2000; Settlage 2000). Therefore, it can be influenced by some factors (figure 1 below). It starts developing in early childhood of human life as child deals with wide but varied experiences, tasks or situations and continues through life. This is happening as people are getting new knowledge, ideas skills, attitude and experience as well as increased understanding (Bandura, 1992, 1995, 1997).

Bandura (1997, 1994) and Palmer (2006) observed that there are four major sources of SE namely: mastery of experience, social modelling, persuasions and psychological response (Figure 1).

**Fig. 1: Psychological Sources of Strong Self-Efficacy (Yahaya, 2015)**

Mastery of experience is one of the most important, effective and efficient way of developing individual’s SE. In other words, when one accomplishes a given task successfully, it strengthen his/her SE otherwise
weakens it. Personal satisfaction closely follows accomplishment of difficult or challenging task. Success becomes a motivating factor that develops sense of SE leading to the same success subsequently. Social modelling as a source of SE happens as people witness others successfully accomplish a given task. It kindles their belief in doing the same, similar or more tasks especially where people of the same age group, class, environment and abilities are involved (Bandura, 1997; Palmer, 2006; Cantrell, Young and Moore, 2003). Accomplishing the given task is strengthened leading to mastery and success in comparable activities. Besides, individuals can be persuaded to believe in having the capability and skill to succeed in achieving a specific objective which is referred to as social persuasion (Bandura, 1997; Palmer, 2006). It is a significant source of SE because it is a common experience to many people to have persuaded someone or be persuaded, that leads to a record success. Persuasion holds the secret of clearing doubt thereby encouraging much effort to accomplish some challenging tasks.

SE is also strengthened by psychological response that denotes the feelings of personal capabilities (Bandura, 1997; Palmer, 2006). Sometimes, feeling about personal capabilities is a function of physical reaction to situations, tolerance to high degree of stress, emotional state and mood (Bandura 1994, 1997). Bandura also noted that people can strengthen their sense of efficacy by minimising stress and maximising their moods in handling complex tasks. Their response and emotional reactions to the tasks are essential for successful accomplishment. Consequently, the study participants’ SE can possibly and positively be influenced by one of these sources. At the moment, literature indicated that only very little or nothing is known about the effects of background or gender in influencing SE especially pre-service teachers’ efficacy towards teaching and learning some controversial science content. Therefore, understanding the role an individual’s background and gender can play in improving SE from a weaker to stronger one for a better science teaching and learning is important. A study with such objective is at the moment necessary.

**Socioscientific Issues**

Socioscientific issues (SSIs) are problems that appeared to be socially significant yet they form some of the subjects’ content of school science curricula. They are referred to SSIs by many researchers such as Yahaya, Zain & Karpudewan (2016); Yahaya, Zain & Karpudewan (2014); Yahaya, Zain & Karpudewan (2013); Yahaya, Zain & Karpudewan (2012); Eastwood, Sadler, Sherwood & Schlegel (2012); Reis and Galvão (2009); Sadler, Barab and Scott (2007); Sadler, (2004) and Sadler & Zeidler (2005a, 2004). With respect to faith, cultural tradition or socio-economic background, they are meaningful to the life of students.
Table 1: SSIs and the controversies surrounding them

<table>
<thead>
<tr>
<th>SSIs</th>
<th>Controversies surrounding the Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global Warming</td>
<td>global climate change due to air and water pollution, green house gases emission, human activities in environmental exploitation, ozone layer damaging, solar energy</td>
</tr>
<tr>
<td>Desert Encroachment</td>
<td>human activities in deforestation, decreasing annual rainfall, urban and industrial development, bush burning, biodiversity loss</td>
</tr>
<tr>
<td>Water Quality and Pollution</td>
<td>domestic and industrial pollutants, water purification, sewage disposal and management, aquatic life, bacteria and organic matter decomposition, water borne diseases, water microbiology</td>
</tr>
<tr>
<td>Water Recycling</td>
<td>liquid waste management, water purification, activities of microscopic organism in water purification, chemical neutralisation and extraction, disinfection</td>
</tr>
<tr>
<td>Genetic Engineering</td>
<td>gene therapy, reproductive gene cloning and stem culture, gene modification for disease control, genetically modified foods, animal cross breeding, in-vitro fertilisation/artificial insemination</td>
</tr>
<tr>
<td>Health Effect of Mobile Phone</td>
<td>Radiation &amp; waves effect, sound waves, noise pollution, gene mutation, sense organs</td>
</tr>
<tr>
<td>Biodiversity Conservation</td>
<td>rising temperature, water cycle, toxic herbicides and pesticides, over-exploitation, air and water pollution, habitat degradation, food chain</td>
</tr>
</tbody>
</table>

Klosterman & Sadler (2013) and Sadler and Zeidler (2005a) articulated that SSIs are open-ended, ill-structured and arguable problems or issues. They do not have a direct answer or solution while they are controversial in nature besides having explanation from varied areas. They are based on individual’s or group of individuals’ opinion and understanding taking into consideration ethical, political, economic, cultural and sometimes even spiritual concern of doing so.

To distinguish science-technology-society (STS) from SSIs, it is pertinent to note that STS focuses on the impact of science and technology on the society, but SSIs focus and explores moral and ethical implications that underlie them (Sadler, 2004).

The SSIs found in school science curricula used in the study are culled from Yahaya (2015) and table 1 above depicts them. All these issues are surrounded by one or more controversies with traditional, cultural, political, economic or spiritual inclination. For instance, there are quite a number of individuals in Nigeria that do not believe in the causes and effects of global warming. They hold a spiritual belief that God is their creator and is in total control. Another example is deforestation as a result of lumbering for fuel wood and timber. It is the people’s only cheap source of energy in Nigeria while other sources like kerosene, liquefied gas are unaffordable by the common man. This science content was taught to youths in a teacher training college. They are part of the society and hold the same belief like any member of the society. The youths, being the most active members of the society are opposed to anything contradicting religious and societal norms, values and beliefs. In the study, it was their first experience, as college student-teachers, exploring controversies surrounding scientific issues. This is significant because in their service years, they must have a stronger self-efficacy in teaching and learning similar or same controversial issues.
Consequently, the specific objectives of the study were to find out the significant difference between urban and rural pre-service science teachers’ towards teaching and learning the SSIs. Four areas of SE formed the constructs covered in the study. They include SE to influence decision making and school resources, instructional SE, disciplinary SE as well as SE to create a positive school climate.

**Theoretical Framework**

Bandura’s Social Learning Theory (SLT) forms the basis of this study, which is also called Social Cognitive Theory (SCT). It states that behavioural change is determined by environment, personal and behavioural elements. It happens as people are learning within a social context where models are significant. Here, models are important sources of learning new behaviour that helps in significant achievement of behavioural change (Bandura, 1997). In SSIs teaching and learning, learners are allowed to take position on a problem of discussions, and they are allowed to make some extra findings to deliberate with other students in defence of their opinions. In doing so, a social cooperative learning has been established and those making presentations in defence of their positions become models described in the theory.

**METHODOLOGY**

**The Participants of the Study**

The participants of the study are year one male and female students of two teacher training institutions in Nigeria numbering 159 with different backgrounds in the age range of 18 – 25 years. They are mostly singles with few married ones. One college was assigned experimental group and the other a control group. The former received the SSIs teaching and the later was taught the same content but with a conventional method. Table 2 gives a detailed descriptive of the study participants. The colleges are science, vocational and technical teacher-training institutions located at more than 150 km apart.

**The Instrument**

The instrument used for data collection was adapted from the *Teacher Sense of Efficacy Scale* (TSES) developed by Tschanen-Moran and Hoy (2001). The choice of the scale was informed by its excellent internal consistency of $\alpha = .94$. Some educational researchers were given the instrument for validation after a table of specification was developed. All their observations and suggestions were considered and corrections were made to that effect. It was originally a 9 point scale but was reduced to 5 point in response to the validation’s recommendations. Besides, the scale was pilot tested on 50 students who are not the participants of the study. On the overall, a Cronbach’s alpha reliability coefficient value obtained was excellent at $\alpha = .9$, giving a cause to the suitability of using the 5 point scale.

**Experimentation**

**Experimental Group**

The instructional approach involves framing a particular issue in a story and the learners were allowed to argue and debate among themselves in support or against the controversy surrounding the issue. The issues for discussion here is, for instance, water recycling for human activities. After a brief lecture on the topic and some notes given, students would be asked to say their opinions on the controversy surrounding the issue because of its ethical, moral, cultural, traditional, and political as well as spiritual concern. Example, the class was told that to bring an end to water shortage, used water in the society shall be recycled. This means that all domestic waste water and sewage is going to be collected and treated for reuse. The problem here is that people would start to argue on the purity of the water particularly for religious practices. Others hold the view that they can never use recycled water from toilets, surface run-off from gutters and trenches. The class was asked of their opinions of using the recycled water. Some agreed while some opposed. They were grouped based on the two opinions and given time to make some findings to support their argument in the next class. They are encouraged to use scientific evidences and religious or traditional quotations to substantiate their claims.

In the following class, there was a group-wise presentation in an organised debate in which the participants’ representative would come out with their opinion supported by evidences. Argumentation was allowed among them for a period of one and a half hour. The topic for next contact was introduced
and everybody took their position, hence groups are again formed based on the positions and set for argumentation in the following contact. Figure 2 below adopted from Yahaya, et al. (2014) depicts the distinction between SSIs teaching and conventional approaches:

![Figure 2: Differences between SSIs and Conventional Teaching Approaches (Yahaya, et al. 2014)](image)

**Control Group**
The normal conventional instructional method for the control group followed the usual lectures delivered to students. For the purpose of this study, this group were not involved in the exploration of any controversial issues. The teaching was based on the traditional approach and the students were neither given a story nor allowed to take a position (figure 2). The students passively listened to the lectures delivered by the teacher and sometimes asked questions when in need. For instance, the teacher began by introducing the topic water recycling. The students also gave the examples of where recycling of some objects was seen. The teacher then proceeded with more explanation of the different stages of the recycling process from collection to treatment and distribution.

**Data Collection and Analysis**
The statistical tool used for data analysis was the analysis of covariance (ANCOVA) where data collected before the experimentation from both groups are the pre-test scores and were used as covariates. Data collected after the experimentation was the post-test scores and serves as the dependent variable. Moreover, Yahaya, et al. (2014) reported using a Bonferroni adjustment – \( \alpha_{adj} = \alpha/n \), \((.0125)\) (Napierala, 2012; Price, 2000). This was because of the measurement of four constructs of sense of efficacy where \( n \) is the total number of tests conducted in their study - to keep the alpha level for the total experiment at \( \alpha_{exp} = .05 \).

Similarly, the study was conducted to find out the effect of background and gender on pre-service teachers SE in some SSIs. The same four constructs of SE used by Yahaya, et al. (2014) were also used in the study and therefore it is apt to use the adjustment here to keep the alpha level at \( p .013 \).
RESULTS

Table 2: Descriptive Statistics of Background Data

<table>
<thead>
<tr>
<th>Groups</th>
<th>Means</th>
<th>Standard Deviation</th>
<th>95% Confidence Interval</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exp Grp Urban</td>
<td>3.36</td>
<td>.77</td>
<td>3.06 - 3.65</td>
<td>29</td>
</tr>
<tr>
<td>Suburban</td>
<td>3.27</td>
<td>.86</td>
<td>2.96 - 3.58</td>
<td>27</td>
</tr>
<tr>
<td>Rural</td>
<td>3.09</td>
<td>.68</td>
<td>2.77 - 3.40</td>
<td>28</td>
</tr>
<tr>
<td>Ctr Grp Urban</td>
<td>3.20</td>
<td>.80</td>
<td>2.84 - 3.56</td>
<td>21</td>
</tr>
<tr>
<td>Suburban</td>
<td>3.21</td>
<td>.89</td>
<td>2.91 - 3.51</td>
<td>30</td>
</tr>
<tr>
<td>Rural</td>
<td>2.99</td>
<td>.84</td>
<td>2.67 - 3.32</td>
<td>24</td>
</tr>
</tbody>
</table>

Table 3: Descriptive Statistics of Gender Data

<table>
<thead>
<tr>
<th>Groups</th>
<th>Means</th>
<th>Standard Deviation</th>
<th>95% Confidence Interval</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>Exp Grp Males</td>
<td>3.34</td>
<td>.79</td>
<td>3.10 - 3.55</td>
<td>53</td>
</tr>
<tr>
<td>Females</td>
<td>3.12</td>
<td>.72</td>
<td>2.83 - 3.41</td>
<td>31</td>
</tr>
<tr>
<td>Ctr Grp Males</td>
<td>3.07</td>
<td>.85</td>
<td>2.85 - 3.33</td>
<td>47</td>
</tr>
<tr>
<td>Females</td>
<td>3.16</td>
<td>.84</td>
<td>2.87 - 3.48</td>
<td>38</td>
</tr>
</tbody>
</table>

Table 4: Results Summary of the effects of background and Gender on SE

<table>
<thead>
<tr>
<th>Self-Efficacy Constructs</th>
<th>Means (Background)</th>
<th>Urban</th>
<th>S/Urban</th>
<th>Rural</th>
<th>df</th>
<th>F</th>
<th>p = .013</th>
<th>PES*</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Background</td>
<td></td>
<td>3.28</td>
<td>3.22</td>
<td>3.19</td>
<td>155</td>
<td>.05</td>
<td>.95</td>
<td>.01</td>
<td>Uphold H₀</td>
</tr>
<tr>
<td>Gender</td>
<td>Means (Gender)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Males</td>
<td>3.21</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Uphold H₀</td>
</tr>
<tr>
<td>Females</td>
<td>3.15</td>
<td></td>
<td></td>
<td></td>
<td>154</td>
<td>1.20</td>
<td>.28</td>
<td>.08</td>
<td></td>
</tr>
</tbody>
</table>

*Partial eta squared

Tables 2 and 3 above have shown the descriptive statistics of the data collected and used for the research. Groups’ means and standard deviations as well as the upper and lower bound means could be seen in the tables. The actual number of participants that constitute the sample of the study for each group was from the actual instruments distributed and successfully returned. Some were not returned and some were damaged beyond recognition and have been thrown away.

Besides, a two-way analysis of covariance was performed to find out the effectiveness of SSIs and conventional teaching approach in improving SE of pre-service teachers in a teacher training college. The independent variables were the intervention and the participants’ background and gender. The dependent variable was the post-test scores of the experimental and control group. Scores of the groups obtained prior to the commencement of the intervention were used as the covariates to control for individual differences. Preliminary checks have been conducted on the data to ensure that there was no violation of the assumption of normality, linearity, homogeneity of variance, homogeneity of regression slopes and reliability of the covariates. After adjusting for the covariates, there was no statistical significant interaction effect of background F (2, 152) =.05 p > .95 with a small effect size (partial eta squared = .01).  

Yahaya.....Int. J. Inno. Psychology & Social Development 6(2): 54-63, 2018
There was also no statistically significant difference in the interaction effects of gender $F(1, 154) = 1.20$, $p > .28$ with a small effect size (partial eta squared = .08). Table 4 above depicts a summary of the result. It was discovered that neither background nor gender affects the participants’ SE in the course of teaching and learning the controversial content found in their school science curricular. The effect size indicated by the partial eta squared is very small according to Cohen’s (1988) guidelines. The values showed how much of the variance was explained by the independent variable. Moreover, the pre-service teachers responded almost indifferently after the intervention and their SE was shown to be encouraging.

DISCUSSIONS
All efforts to find similar studies that directly reported effects of gender and background to pre-service science teachers’ SE nearly prove abortive. But there are a number of studies linked directly to increased learners’ performance with teachers of strong sense of SE. One of such studies is the research conducted by Lewandowski (2005) who articulated that teachers with strong sense of SE give a good care and necessary support to their students for a strong academic performance and accomplishment. A reverse is the case with teachers of weaker sense of SE. The current global demand for high quality teachers in every classroom has gained an upper hand even in the political class of global societies for improved economy. Stronger sense of SE towards teaching and learning is one of the most important qualities needed of classroom teachers to raise the academic achievement of learners so that the global demand for economic development parameters such as scientists, technologist and other experts could be satisfied. It is in such a situation that Carles, Howes and Green (2010); Scruggs and Smiths (2004); Hoy, (2000); Lewandowski (1995) as well as Smylie (1990), independently found out a strong positive relationship between teachers’ perceived SE and students’ achievement. In this instance, teachers with strong SE are found to be discharging their duties diligently with a sense of responsibility. They motivate learners, they create and maintain learners’ interest, they actively overcome challenging task and create conducive environment for their students. This perceived SE is the belief an individual hold in his/her ability to perform a particular action which brings a required result (Bandura, 1997).

In a similar development, Caprara, et al (2006) reported that teacher’s SE beliefs have an important implication for policies (rule and regulations) purposely meant to create and maintain effective and conducive learning environment. They also showed that a high sense of efficacy influence the exhibition of high levels of planning and organisation of a formal school system. It influences openness to, and acceptance of, new ideas, skills, knowledge and experience in addition to experimenting with new methods or techniques to better meet the needs and interests of learners (Allinder, 1994). Stronger sense of SE also makes teachers show enthusiasm for instruction. It also makes teachers become very much committed to their career which if combined together brings about positive influence on their learners’ achievement and improve their sense of SE too (Allinder, 1994; Tschannen-Moran and Hoy, 2001; Podell and Soodak 1993).

Caprara et al (2006) also contended that the significance of teacher’s sense of SE in totality can never be over emphasised. They discovered that it is a global indicator of functional school system and the average grade earned by learners. It is also a function of stronger sense of SE beliefs of teacher, the ability to create favourable condition. It improves interpersonal network among teachers which nourishes and maintain their work contentment. This is very important because whenever teachers lack job satisfaction, the teaching career is at the risk of losing competent teachers. Lesser job satisfaction can result into inability to manage classroom’s issues and didactic task. There will be ill-interpersonal relationship with other members of the school (Caprara, et al, 2003) since school teachers, as Caprara et al (2006) asserted, cannot avoid making reference to the significant contribution of their fellow colleagues to their own competence.

Consequently it has been indicated in the literature how important it is to have teachers with stronger SE beliefs to influence learners’ achievement, leadership quality, interpersonal relationship among
themselves and other school members. It has been also shown that it can be developed through some sources like mastery of experience, social modelling and persuasion as well as psychological response. Teachers of weaker sense of SE beliefs are detrimental to the school system and the instructional situations would be translated into a corresponding weaker performance of learners entrusted to them. One of the limitations of the study is the restriction of the investigation to the effects of gender and background. Other factors that may play significant roles abound such as educational background of parents, state of origin in Nigeria, socio-economic background of parents and faith to mention but a few. This happened because of the limited research on the background and gender variables. Therefore, it is recommended for other researchers to carry on in these aspects. Another important limitation is the number of females and males of which the latter nearly doubles the former. This is one of the characteristics of the northern Nigeria to have more males in tertiary institutions of learning particularly the two colleges that train teachers in vocational, science and technology courses. There was also no qualitative data to elaborate more on the quantitative findings of the study. This is also recommended to those who might be interested in similar studies to consider qualitative data collection which can deepen and increase understanding of the quantitative findings made.

REFERENCES


