



RESEARCH PAPER

Project-Based Learning in Teacher Education: Effect on Prospective Science Teachers' Science Teaching Efficacy Beliefs

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PAPER INFO

Received:
March 12, 2021
Accepted:
May 01, 2021
Online:
May 15, 2021

Keywords:
Project-Based Learning,
Prospective Science Teachers,
Science Education
Science Teaching Efficacy Beliefs,
Science Teaching,
Teacher Education

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ABSTRACT

Science teaching efficacy beliefs (STEBs) of prospective science teachers predict their success in their future science teaching. This research study was designed to examine the effect of the project-based learning approach (PjBL) on the STEBs of prospective science teachers. A quasi-experimental design with a pretest-posttest control-group research design was used. The study was delimited to the prospective teachers at a public university in Lahore, Pakistan. Science Teaching Efficacy Belief Instrument was adapted as a tool for data collection. The instrument was validated through the experts' opinions, and the reliability of the instrument was established through pilot testing. The experimental group was taught by the PjBL approach, whereas the traditional teaching approach was used to teach the control group. Independent samples t-test was used to compare the STEBs of prospective science teachers of both groups after intervention. Findings revealed that STEBs of prospective science teachers were enhanced by applying PjBL. It is suggested to incorporate the PjBL approach in the training of science teachers

Introduction

Quality of education depends upon the effective teachers. Nowadays, as part of its complex nature, our world has changed and expanded. The education sector is the most significant element in this complex system. To manage the requirements, scientists, engineers, and innovators are required. To meet the demands of time, science teachers are essential, so they need to demonstrate vital skills to meet the demands of the complex world (Campbell, Zhang, & Neilson, 2011). The world's future depends on teachers who can fulfill the demand of time.

Draft of National Education Policy (2017) and Pakistan-Vision 2025 (2014) emphasizes the importance of the affective domain of teachers in the teacher training

programs. These documents envisaged that the teachers should be trained using innovative methods, which provide hands-on minds-on experiences so that they could enhance the learning of the students. Moreover, the teachers' self-concept should be enhanced so that the teachers might teach the students effectively which could lead towards developing a sustainable society.

Instructional behavior of a teacher can be predicted by the teacher's efficacy beliefs (Bandura, 1997). According to Enochs, Scharmann, and Riggs (1995), that teachers who are graduated with great science teaching efficacy belief (STEB) would select innovative teaching approaches in teaching. Furthermore, the prospective teachers with high "personal science teaching efficacy" (PSTE) and "student outcome expectancy" (STOE) are predicted to be effective in the teaching of science. Thus, science teachers that have high self-efficacy are required.

Literature Review

The term "self-efficacy" was coined by Albert Bandura in late 1970s. Self-efficacy refers, according to him (Bandura, 1997), to the confidence in one's ability to plan and conduct the course of action required to achieve a particular accomplishment. Bandura said that motivation based on personal beliefs is a significant part of learning. Self-efficacy beliefs is an essential predictor of teaching practices including the decision regarding teaching activities, preparation to handle challenging situations and organization of lessons (Bandura, 1997).

Tschannen-Moran, Hoy, and Hoy (1998) stated that highly efficacious instructors will teach with more determination and effort. Moreover, they are more likely to utilize innovative teaching approaches and will try to cope with difficult situations. According to Hodson (1999), numerous in-service teachers had low science teaching efficacy, and as a consequence innovative teaching methods are not utilized while teaching science. Similarly, prospective science teachers have a similar impact on beliefs upon the teaching of science.

Teachers who graduate with higher efficacy beliefs will make great progress as science teachers, according to Appleton and Kindt (2002). Gunning and Mensah, (2011) stated that prospective science teachers mostly had low efficacy for teaching science. Menon and Sadler (2016) found prospective science teachers have negative science teaching beliefs which adversely affect their science teaching. This is an important issue, therefore numerous researches (Avery & Meyer, 2012; Cinici, 2016; Nthiga, 2016; Yildiz & Akdag, 2017) have committed to enhancing the STEBs of the prospective science teachers.

Project-based learning (PjBL) is a constructivist approach. PjBL creates knowledge-curiosity in learners, makes learners critical thinkers, and students in becoming creative thinkers. According to Lamer, Mergendoller, and Boss (2015), PjBL is an influential teaching method that increases motivation among the students; prepares students for their practical life; assists students in enhancing their thinking

skills; assists teachers in effective teaching; and provides innovative ways to integrate the learning institute and the society. PjBL is used by numerous researchers to determine its effectiveness on professional development in the field of engineering (Mills & Treagust, 2003), medical (Bedard, Lison, Dalle, Cote & Boutin, 2012), and teaching (Bagheri, Ali, Abdullah, & Daud, 2013; Holubova, 2008).

Engaging and motivating prospective science teachers (PSTs) would be a key factor for successful learning. It is necessary to enhance the self-efficacy of PSTs if one wants to polish the future of a country. Numerous studies (e.g. Duke, Halverson, Strachan, Kim & Konstantopoulos 2018; Bilgin, Karakuyu, & Ay, 2015) that have concentrated on PjBL, proved PjBL to be more effective than traditional approaches. Katz and Chard (2000), state that there are positive effects of PBL on learners' self-concept and dispositions. Project-based learning has been proved in assisting students to learn cooperation, communication, and problem-solving skills. Attitudes and self-efficacy of students are also improved through PjBL has been effective in improving attitudes and self-efficacy (Duke et al. 2018; Tseng, Chang, Lou, & Chen, 2013).

Owing to the necessity of STEBs among prospective science teachers, this research is designed to investigate the effect of PjBL on STEBs of prospective science teachers.

Research Hypotheses

Following null hypotheses were developed to address the above objective:

- Ho 1 There is no significant mean difference between science teaching efficacy beliefs of prospective science teachers who were taught through traditional teaching method and those who were taught through project based learning in pre-test scores.
- Ho 2 There is no significant difference between mean gain scores of science teaching efficacy beliefs of prospective science teachers, taught through project based learning and traditional teaching approach.
- Ho 3 There is no significant mean difference between self-efficacy of prospective science teachers who were taught through project based learning approach before and after intervention.

Material and Methods

In this research quasi-experimental non-equivalent pretest-posttest control-group was used as a research design. Science teaching efficacy belief was the dependent variable, while the independent variable was the traditional teaching and project-based learning (PjBL) approach. PjBL was used to teach the experimental group, while the control group was taught by traditional teaching. Interactive and challenging projects were designed so that students learn through hands-on minds-

on activities. After the intervention post-test was administered. In this study, the positivist research paradigm was used.

Sample for the Study

A public university was utilized to draw the sample of the study for research purposes. The sample was selected utilizing the purposive sampling technique. Prospective science teachers were selected as the sample of the study. Intact groups were taken for the research purpose. The number of subjects in the control group was 37. Whereas, the sample size of the experimental group was 32. The teaching of biology course was selected to be taught for the intervention.

Instrumentation

Science teaching belief instrument (STEBI-B) which was modified by Bleicher (2004) was utilized to measure STEBs. There are two factors in STEBI-B (i.e. PSTE, and STOE), which are founded on Bandura's model. Personal science teaching efficacy (PSTE) deals with measuring personal efficacy beliefs of prospective science teachers, while science teaching outcome expectancy (STOE) measures the outcome expectancy of the prospective science teachers. STEBI-B is based upon the 5 points Likert type scale. The instrument was adapted. To ensure the reliability of the instrument in the Pakistani context, pilot testing was done before the implementation of intervention on 93 prospective science teachers.

Results and Discussions

In this section, data analysis is presented. Each hypothesis is discussed separately. Data analysis is done in the tabular form and it is given below.

Ho1 There is no significant mean difference between science teaching efficacy beliefs of prospective science teachers who were taught through traditional teaching method and those who were taught through project based learning in pre-test scores.

Table 1
Comparison between Pre-test Scores of Science Teaching Efficacy Beliefs of Prospective science Teachers in Experimental and Control Group

	Group	N	Mean	SD	df	t	P
STEB	Experimental	37	39.76	3.05	67	0.92	0.36
	Control	32	40.44	3.06			
PSTE	Experimental	37	16.46	1.94	67	1.77	0.08
	Control	32	17.22	1.56			
STOE	Experimental	37	23.39	2.22	67	4.61	0.65
	Control	32	23.06	1.97			

Table 1 shows that *t*-test score is non-significant, the Ho 1 that is “there is no significant mean difference between science teaching efficacy beliefs (science teaching outcome expectancy and personal science teaching efficacy) of prospective science teachers who were taught through traditional teaching method and those who were taught through project-based learning in pre-test scores.” is rejected. So, it can be determined that there is no significant mean difference between STEBs (PSTEB and STOE) of prospective science teachers in both groups before the intervention.

Ho 2 There is no significant difference between mean gain scores of science teaching efficacy beliefs of prospective science teachers, taught through project based learning and traditional teaching approach.

Table 2
Comparison of Mean Gain Score of Science Teaching Efficacy Beliefs between Experimental and Control Group

	<i>Group</i>	<i>N</i>	<i>Mean</i>	<i>SD</i>	<i>df</i>	<i>t-value</i>	<i>P</i>
STEB	Experimental	37	59.68	5.33	67	37.29	0.00
	Control	32	14.22	4.70			
PSTE	Experimental	37	31.49	3.60	67	25.93	0.00
	Control	32	10.06	3.20			
STOE	Experimental	37	28.18	2.99	67	53.10	0.00
	Control	32	4.15	2.12			

Table 2 shows that *t*-test score is significant at the level of *p*, so the Ho 2 that is “there is no significant difference between mean gain scores of science teaching efficacy beliefs of prospective science teachers, taught through project based learning and traditional teaching approach” is rejected. It means that the difference in between science teaching efficacy beliefs (PSTE and STOE) of both groups is significant. The experimental group has higher mean value than the control group.

Ho 3 There is no significant mean difference between self-efficacy of prospective science teachers who were taught through project based learning approach before and after intervention

Table 3
Comparison of Pre-test and Post-test Scores of Prospective Science Teachers' Science Teaching Efficacy Beliefs in the Experiment Group

<i>Factor</i>	<i>Test</i>	<i>Mean</i>	<i>SD</i>	<i>df</i>	<i>t-val.</i>	<i>P</i>
STEB	Pre-test	39.76	3.05	36	68.12	0.00
	Post-test	99.43	3.97			
PSTE	Pre-test	23.30	2.22	36	53.16	0.00
	Post-test	54.78	2.73			
STOE	Pre-test	16.46	1.94	36	57.19	0.00
	Post-test	44.65	2.16			

Table 3 shows that the *t*-test score is significant, so the null hypothesis that is “there is no significant mean difference between self-efficacy of prospective science teachers who were taught through project-based learning method before and after intervention” is rejected. It means that there is a significant mean difference in STEBs (PSTE and STOE) of prospective science teachers taught through PjBL approach before the intervention and after the intervention. Also, the post-test mean scores were higher than the pre-test mean scores.

Bleicher and Lindgren (2005) in a study analyzed the effect of constructivist approaches on science content courses on prospective science teachers. The outcomes of the research revealed that the intervention enhanced the PSTE and STEBs. The findings of this research work are also in line with the present study's findings i.e. constructivist approach (PjBL) had an enhancing effect of PjBL on science teaching efficacy beliefs of PSTs. However, in the present research science method courses have been undertaken for intervention.

Frank and Brazilai (2004) state, that PjBL develops students' self-concept and thinking skills. Brazili (2004) also validates that project-based learning enhances the self-concepts of learners. The findings of the studies are also consistent with the present study.

Aydin and Boz (2010) suggested that prospective science teachers should be provided with real-life experiences to enhance the outcome expectancy. Prospective science teachers' science teaching outcome expectancy (STOE) is also improved through project-based learning which supports the suggestions of Aydin and Boz (2010). Flores (2015) explored that prospective science teachers' PSTE was significantly increased due to intervention, which is also confirmed by the results.

Menon and Azam (2020) reported in their study that PSTE of PSTs is enhanced as compared to STOE. It was suggested that this result is due to lack of field experience in the research study. However, the finding of this study reported that PjBL have a constructive impact on both sub-sales of science efficacy beliefs. This could be due to the hands-on minds on activities; also the field work is also part of PjBL

Findings

The findings revealed from the data analysis demonstrated the following findings:

1. STEBs of prospective science teachers were enhanced through PBL.
2. PSTEBs of prospective science teachers were also enhanced through project-based learning.

3. STOE of prospective science teachers was enhanced through project-based learning.

Conclusion

This research investigated the effect of PjBL on prospective science teachers' STEBs. The results of the study exposed that the STEBs of prospective science teachers of the experimental group was significantly enhanced through PBL (Bilgin, Karakyu, & Ay, 2015; Hernawati, Amin, Irawati, Indriwati, & Aziz, 2018).

This research's outcomes revealed that STEBs of prospective science teachers are enhanced by project-based learning (PjBL). The PjBL provides authentic learning environments, in-field experiences, and continuous feedback which ultimately help in building the self-efficacy of the learners. Therefore, it is imperative to provide preservice science teachers with authentic experiences. So, it is concluded that PjBL may enhance the STEBS (PSTE and STOE) of prospective science teachers.

Recommendations

The recommendations drawn based on the conclusion of the study are given below:

1. The results of the study proved that project-based learning (PjBL) is effective in enhancing prospective science teachers' STEBs. So, teacher educators may adopt project-based learning for effective training of prospective science teachers. Training seminars or workshops might be arranged to train teacher educators on implementing PjBL effectively in the classrooms.
2. PjBL enhances the quality of learning in the prospective science teachers as compared to traditional classrooms. So, while preparing the teaching aids at the teacher training institute, PjBL may be focused.

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