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Effect of STEM-7E Inquiry-Based Learningon Secondary School Student's Self-efficacy in Learning Science Subjects in Nigeria

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Abstract

Numerous studies have documented the benefits of high self-efficacy in raising student achievement, in addition to the urgent need to address poor self-efficacy among Nigerian secondary school students. Educators in Nigeria are required to use instructional strategies that motivate and help students build a strong sense of self-efficacy to appreciate and value the sciences. Science, Technology, Engineering, and Mathematic 7E Inquiry-Based Learning (STEM-7EIBL) is becoming more effective, producing concrete learning, and changing students' perspectives on potential future careers. There are many studies in the literature integrating various STEM components into 7E approach. However, contrary to expectations in earlier research, the effect of STEM-7EIBL on increasing students' levels of self-efficacy in science subjects especially biology at the secondary school level in Nigeria has not been demonstrated. This study compares the effect of STEM-7EIBL with conventional teaching methods on students' self-efficacy level in learning biology among 80 fourth-grade students using the social cognitive theory as its theoretical foundation. A non-equivalent control group design was adopted. Purposive sampling was used in two schools to compose experimental and control groups. Each intact class contains 40 participants. The data was obtained using the Diffusion and Osmosis Self-Efficacy Questionnaire (DOSQ). Descriptive statistics and the sample t-test were used to examine the variables. The findings showed that STEM-7EIBL increases students' confidence in their ability to solve diffusion and osmosis problems. Additionally, students in the experimental group performed better in conducting experiments and other activities and retained the skills more than students in the control group.

Keywords: STEM-7E Inquiry-Based Learning; Conventional Teaching Methods; Biology; Self-efficacy.

I. INTRODUCTION

High self-efficacy is needed to raise the achievement level of students in science subjects. The need for teachers to use teaching strategies that motivate and prepare students to develop high levels of self-efficacy in order to embrace sciences is greater than ever (Dakhi, Jama, & Irfan, 2020). There was also an intensive need around the world for the best way students in the 21st century should learn science for high self-efficacy (Saavedra & Opfer, 2012; Dakhi, Jama, & Irfan, 2020). Educators in the world, are now trying to overcome the challenge in terms of students' inability to perform certain activities in science due to learning styles employed by teachers (Nugent et al., 2015; Atsumbe, 2019; Ugo & Akpogohol, 2016; Adzape, 2015; Ugwuanyi et al., 2020; Ayodele, 2016).This was because science impacts countless decisions we make each day.

Self-efficacy has been identified as one of the most powerful determinants of interest and academic achievement (Bandura, 1997; Ugwuanyi et al., 2020). It is one's own ability to complete a specific task. One's beliefs, therefore, dictate the actions one will take to solve a problem. It has been demonstrated that students' self-efficacy influences their choice of science subjects, the amount of cognitive effort they put into these subjects to solve real-world problems, and their overall success (Nugent et al., 2015). They went on to state that students are more inclined to select occupations in which they are confident in their talents rather than careers in which they are unsure of their performance.

However, low self-efficacy among students in Nigeria was reported as one of the major challenges to their comprehension of scientific concepts (Abdullahi et al., 2021; Oladipo & Ihemedu, 2018). High self-efficacy among students in Nigeria is reported to be available to only a very few students (Ugwuanyi et al., 2020; Ugwu et al., 2013; Oladipo et al., 2019). This challenge was brought about by the use of conventional teaching methods (Oladipo & Ihemedu, 2018; Etobro &

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Fabino, 2017; Adzape, 2015). In most schools in Nigeria, science subjects particularly biology, is taught in an abstract and disjointed fashion (Atsumbe, 2019), resulting in low self-efficacy(Okoli & Mbonu, 2020; Etobro & Fabino, 2017). Hence the rationale behind the use of the STEM 7E Inquiry-Based Learning (STEM-7EIBL) to offer solutions to this classroom challenge.

STEM-7EIBL is a student-centered learning process that uses 7Es (elicit, engage, explore, explain, elaborate, evaluate and extend) learning stages to implement the learning of STEM subjects. The process is an inquiry approach and a good alternative to improve students' self-efficacy and comprehension (Dervic et al., 2018; Erdogan et al., 2016). However, the effects of this approach on self-efficacy for secondary school students in Kebbi State, Nigeria, are not yet clear (Ameen, Salawu, Ajibade, & Nasrudeen, 2022; Zudonu, Ekpeno, & Onyije, 2020). Many of the studies found were centered on a particular topic, focusing on the university level (Osuyi, 2021). References related to high school students are few in the area of self-efficacy, the STEM field, and the STEM-7EIBL process (Ameen et al., 2022; Samsudin, Jamali, Zain, & Ebrahim, 2020Oladipo,& Ogundiwin, 2018).

In this study, fourth-grade secondary school students in biologywere given an unstructured real-world problem to solve. They were encouraged to perform some experiments, demonstrations, illustrations, and other activities to solve the diffusion and osmosis problems in a STEM-7EIBL environment. The aim is to examine the effects of this method on their level of self-efficacy. For this reason, research question and hypotheses were stated as follows:

RESEARCH QUESTIONS

1. Is there any mean difference in the scores of the Diffusion and Osmosis Self-Efficacy Questionnaire (DOSQ) between students exposed to STEM-7EIBLand CTM?

HYPOTHESIS

1. There is no significant mean difference in the self-efficacy scores between students exposed to STEM-7EIBLand CTM.
2. There is no significant difference in the mean scores of post-questionnaire scores and delayed post-questionnaire scores on the self-efficacies of students exposed to STEM-7EIBL.

II. LITERATURE REVIEW

(a) STEM 7E Inquiry-based Learning (STEM-7EIBL)

STEM 7E Inquiry-Based Learning is a constructivist and innovative approach for improving 21st century skills in students (Erdogan, Capraro, Robert, and Navruz, 2016). The approach enhances self-efficacy and student knowledge retention and allows for hands-on activities (Aidoo, Boateng, Kissi, & Ofori, 2016; Dibyantini, Silvan, & Suyanti, 2018). It encourages active student participation and collaboration to find solutions to the problems, communicating the results, and judging the findings, and the activities were always related to real-life scenarios (Dibiyantini et al., 2018; Welch et al., 2015).

It was discovered that when students are taught using STEM-7EIBL, their self-efficacy increases, are able to perform scientific activities no matter the difficulty, and retained material learned longer compared to students in the conventional teaching methods(Ameen, Salawu, Ajibade, & Nasrudeen, 2022; Bicer et al., 2015; Laforce & Noble, 2017). Many educators increasingly promote student engagement in STEM-PBL contexts rather than using conventional methods (Zudonu et al., 2020; Brush & Saye, 2017; Kasemsap, 2017). It requires them to do a number of challenging tasks, including planning and designing, solving problems, and making decisions (Dervic et al., 2018). It's a style of constructivist instruction in which the students are given a particular task or problem to solve but are not provided with any exact solutions beforehand (Kasemsap, 2017). STEM 7EIBL is widely recognized as an effective teaching and learning strategy (Funa & Prudente, 2021; Snijders, Wijnia, Rikers, & Loyens, 2019; Dibyantini, Silaban, & Suyanti, 2018).

The STEM-7EIBL activity-based, encourages practical tasks, increases learning possibilities, allows for decision-making, and provides feedback and suggestions to improve learning. (Sakir & Kim, 2020). Students in the STEM-7EIBL now have the opportunity to actively engage in their learning, in contrast to traditional teaching techniques that required them to be passive participants in their education (Fitriani, Zubaidah, Susilo, & Al Muhdhar, 2020b). STEM-7EIBL is based on the constructivism principle since self-efficacy, according to constructivists, is gained and improved via engagement and interactions with others and the environment, which are the focus of STEM-7EIBL (Banihashem et al., 2022). In comparison to conventional teaching methods (CTM), STEM-PBL improves student self-efficacy, performance, and retention (Osuyi, 2021; Arifin, Setyosari, Sa'dijah, & Kuswandi, 2020; Osuyi, 2021).

(b) Conventional Teaching Method (CTM)

Previous researches has concluded that among the reasons why students fail science courses in schools is the way they learn the subject (Sellers et al., 2007; Adzape, 2015; Atsumbe, 2019; Shuaibu & Ishak, 2020). In most schools in Nigeria, biology is taught in an abstract and disjointed fashion with no resources, resulting in comprehension deficiencies and learning difficulties (Atsumbe, 2019). Most classroom lessons are dominated by conventional teaching approaches, which are teacher-centered methods (Ugo & Akpogohol, 2016; Adzape, 2015). Teacher-centered instructional methods make students passive with less interaction, and a lack of active participation leads to low self-efficacy and interest (Ketelhut, 2007) and consequently poor performance (Gambari et al., 2013). Biology learning needs novel STEM approaches that encourage students to participate fully, construct their knowledge, and apply it in real-world situations (Gulen, 2018; Guzey et al., 2017; Karamin, 2017).

(c) Self-efficacy

Self-efficacy is the belief that one can carry out a task successfully and is at the heart of social cognitive theory (Bandura 1977). This theory, suggests that some of the knowledge gained by an individual can have direct relations with observation of how people behave in social interactions, experiences and influence of the media (Bardach et al., 2010; Kelly, 2015). The theory holds that individuals base their decisions about future conduct on information they gather from the outside environment. This idea asserts that an individual's behavior is determined by how confident they are in their own abilities (Nugent et al., 2015; Pleiss et al., 2012). It is important to research how self-efficacy affects academic performance since it is anticipated that students with high self-efficacy will succeed in school and choose career paths that require intellectual achievement (Ugwuanyi, 2020).

There are two beliefs that may be relevant or restrictive in terms of enhancing one's self-confidence when choosing a demanding science field. The first is the notion that one cannot succeed in a specific field. The second is the importance of finding a balance between work and personal life (Buday et al., 2012). It has been shown that students' science self-efficacy affects whether or not they choose to participate in science-related activities, how much mental effort they put into these activities, and how successful they are in general (Nugent et al., 2015). Students are more likely to pursue careers where they are confident in their abilities than those where they are dubious of their performance or ability (Nugent et al., 2015).

The support of teachers and self-efficacy beliefs are related to careers and have an impact on a positive career view (Nugent et al., 2015). Friends, family, and teachers, according to Bandura's (1977) social cognitive theory, have an impact on self-efficacy development as well as the decision of which career path to take. Previous research has demonstrated that when parents, teachers, and peers stress the value and application of STEM abilities, children's self-efficacy—or belief in their own competence—in the topic increases (Nugent et al., 2015; Rice et al., 2013). As a result, teachers should focus more on STEM skills when instructing while using student-centered strategies that emphasize hands-on activities.

(d) STEM-7EIBL and Self-Efficacy

Self-efficacy has been shown to be one of the most significant predictors of academic performance (Bandura, 1997; Doordinejad & Afshar, 2014). According to studies, students who are immersed in a learning environment that includes real-world challenges like those of STEM-7EIBL are more likely to hold positive attitudes about their own abilities to master that subject matter (Jungert et al., 2014). Greater self-efficacy can be achieved when students are involved in the learning process, which is the focus of STEM-7EIBL (Cetin-Dindar, 2016). Other investigations have found that STEM-7EIBL learning increases efficacy and encourages meaningful learning through student-directed study (Tseng et al., 2013).In the quest to provide students with a greater level of learning that will develop high self-efficacy, STEM-7EIBL arose as a comprehensive approach to classroom teaching and learning (Blumenfeld et al., 1991).

It has been found that students who were exposed to and engaged in constructivists approaches had positive attitudes toward learning due to teamwork, cooperation, and communication (Shaheen & Kayani 2017;Han et al., 2014; Dominguez & Jaime, 2010). Additionally, the method was assessed for its capacity to foster and boost students' engagement, self-efficacy, and confidence (Baran & Maskan, 2010). Students who have taken STEM-7EIBL courses are less likely to leave subjects or institutions than other students (Dominguez & Jaime, 2010; Han et al., 2014). In order to encourage students' self-efficacy, attitudes, interests, and views, which will result in career ambitions in STEM-related disciplines, it is critical to implement STEM-7EIBL in the classroom (Wyss et al., 2012).

III. METHODOLOGY

A quasi-experimental design, specifically, non-equivalent control group pre- and post-test design was adopted (Kenny & Kenny, 1975; Campbell & Stanley, 2015). According to Gribbons and Herman (1996), a pre-test, post-test, and delayed post-test could be used on both the treatment group and the control group as measurements in the non-equivalent control group design. The research design is presented in table 1.

Table 1 Research Design

Group	Pre-test	Intervention	Post-test	Delayed Post-test
EG	O1,	X1,	O2,	O3,
CG	O1,	X2,	O2,	O3,

EG = Experimental group; C = Control group; O1 = Measure of the dependent variable before treatment; X1 = is for the experimental group, meaning it receive treatment with STEM-7EIBL; X2 = is for the control group, indicating it receive intervention with CTM; O2 = measure of the dependent variable after treatment with dependent variables; O3 = Measure of the dependent variables 2 weeks after the posttest (Adapted Campbell & Stanley, 1966).

(i) Selection of Schools and Groups

In order to determine the study schools, convenience sampling methods were used. Two schools in Argungu Education Zone of Kebbi State, Nigeria were seleted. These schools were Government Day Secondary School Bayawa (GDSSB) and Government Day Secondary School Tiggi (GDSST). The groups on the other hand, were selected using the purposive sampling method to assign participants to intact classes. Two intact classes, comprising 20 students in each class (the experimental and control classes), were composed. The research was carried out with 80 (see Table 2) senior secondary school biology students (48 males and 32 females). Table 2 represents a sample based on schools.

Table 2 Sample-Based on Schools

S/N	Schools	Male	Female	Total
1	GDSSB	23	17	40
2	GDSST	25	15	40
Total		48	32	80

GDSSB: Government Day Secondary School Bayawa
GDSST: Government Day Secondary School Tiggi

(ii) Diffusion and Osmosis Self-Efficacy Questionnaire (DOSQ)

The Sherer et al. (1982), self-efficacy scale was adapted. The adapted instrument was given to four experts in science education for validation. Based on their suggestions, this instrument was modified to composed of 20 items. The scale of scores for the questionnaire was based on a 5-point Likert scale. The negatively worded items in this instrument are employed to control acquiescence response bias and its effect on response accuracy and instrument validity (Schriesheim & Hill, 1981). Samples questions on DOSQ are given in table 3 below:

Table 3 Samples Questions on DOSQ

S/N	Item Statements	SA	A	N	D	SD
1	I rarely achieve my goals in diffusion and osmosis activities.					
2	I give up on diffusion and osmosis activities before completing them.					
3	I avoid facing difficult activities in diffusion and osmosis concepts.					
4	When I come across a tough diffusion and osmosis question, I don't attempt to solve it.					
5	I'm usually not at ease in diffusion and osmosis class.					

(iii) Training of Research Assistants (RA)

Five days of training on the principles and guidelines on how to implement STEM-7EIBL were given to the eight (8) research assistants, who were biology teachers at the selected schools. The training took place daily for four (4) hours. There were two training sessions. The instruction took place from 8:00 a.m. to 10:00 a.m. and from 10:00 a.m. to 1:00 p.m.

After the workshop training was successfully completed, a test was given to the trainees. The research assistants with the best test score and improved performance during the simulated instruction were chosen. These instructors were tasked with administering the intervention to the study participants. They were instructed to serve as guides to the students and not go beyond the instructional packages (STEM-7EIBL). The research assistants in the control group, on the other hand, were instructed to use their usual methods of instruction.

(iv) Implementation of STEM-7EIBL Activities (Intervention).

Five STEM 7EIBL activities were carried out within the scope of the diffusion and osmosis concepts of biology. The intervention was conducted after school hours (Monday and Thursday) with the permission of the two principals. Five weeks were spent on the full implementation of the intervention in the first term of the year 2024. This was because academic interventions need to last at least five weeks (Vaughn et al., 2012). Each lesson was conducted in 60 minutes. This was because the length and frequency of the intervention should be 30–120 minutes per day (Vaughn et al., 2012).

Table 4 Supportive Images for STEM-7EIBL Implementation

Performing Activities on Osmosis	Students observing osmosis process
	
Students performing diffusion experiment	Students observing diffusion process
	

Table 5 highlights the strategic plan and time frame for the implementation of the research.

Table 5Strategic Plan and Time Frame for the Implementation

WEEKS	ACTIVITIES	DURATION
Week 1	Selection of schools	One week
Week 2	Training forRA	Five days
Week 3	Pre-Test Administration;	(40 minutes)
Week 4-8	Intervention	5 Weeks
Module 1 (week4)	Rate of Diffusion	2 Hours (120 minutes)
Module 2 (week5)	Movement of Molecules across Membrane	2 Hours (120 minutes)
Module 3 (week6)	Exploring the Process of Osmosis	2 Hours (120 minutes)
Module 4 (week7)	Plasmolysis	2 Hours (120 minutes)
Module 5 (Week 8)	Haemolysis	2 Hours (120 minutes)
Week 9	Post-test	(40minutes)
Week 12	Delayed Test	(40 minutes)

(v) Data collection and analysis

As mentioned earlier, the self-efficacy scale developed by Sherer et al. (1982) was adapted in this study and named the Diffusion and Osmosis Self-Efficacy Questionnaire (DOSQ). This was used as a pre-test, post-test, and delayed post-test to measure the level of students' self-efficacy in diffusion and osmosis concepts in biology. The Cronbach's alpha reliability coefficient of this instrument was determined to be 0.88. Descriptive statistics were employed to address the research questions, while the hypotheses were analyzed using Analysis of Covariance (ANCOVA) and a two-sample t-test.

IV. RESULTS

Table 6

Mean Scores of Pre-questionnaires and Post-questionnaire on Self-efficacies of Students Exposed to STEM-7EIBL and CTM

Group	N	Pre-score		Post-score		Mean difference
		Mean	Std. Dev.	Mean	Std. Dev.	
Control	40	40.00	21.341	65.40	28.791	25.40
Experimental	40	40.93	21.397	81.68	19.958	40.75
Mean difference		0.93		16.28		

The two groups have no difference in their self-efficacies at the pre-test level, as shown in Table 6. After the intervention, the control group's self-efficacy means improved and rose to 65.40 with a standard deviation of 28.791 and a mean difference of 25.40 compared to the experimental group that was exposed to the use of STEM-7EIBL, whose mean score rose from 40.93 to 81.68 with a mean difference of 40.75. After the treatment (post-test), the mean difference obtained between the control and experimental groups rose to 16.28. These observations showed a major positive effect of STEM-7EIBL on the self-efficacy of students exposed to it.

Table7

Mean Scores of Post-questionnaire and Delayed Post-questionnaire on Self-efficacies of Students Exposed to STEM-7IPBL and CTM

Group	N	Post-score means		Delayed Means		Mean difference
		Mean	Std. Dev.	Mean	Std. Dev.	
Control	40	65.40	28.791	60.92	29.246	-4.48
Experimental	40	81.68	19.958	84.60	15.988	2.93
Mean difference		16.28		23.68		

As indicated in Table 7, students in the experimental group had a higher mean (81.68) in their self-efficacy when compared with the control group's mean (65.40). The mean difference was 16.18. The students in the control group did not have the advantage of improved retention, as shown in the delayed mean score, which decreased with a mean difference of -4.48 compared with their counterparts in the experimental group, whose retention improved from 81.68 to 84.60 with a mean difference of 2.93. This is a clear indication that the use of the STEM-7EIBL had a major effect on the self-efficacy of students in the experimental group.

Hypothesis Testing

Table8

Analysis of Covariance on self-efficacies of Students in Learning Diffusion and Osmosis

Source	Sum of Squares	Df	Mean Square	F	Sig.
Pre-test Self-efficacy	1896.183	1	1896.183	3.176	.079
Group	5157.003	1	5157.003	8.639	.004
Error	45966.192	77	596.964		
Corrected Total	53159.888	79			

(F-critical = 3.84, $p < 0.05$)

The result of the test as showed in table 8, revealed that students in the two groups differed significantly in their self-efficacy after the intervention. The observed F-value for before and after was 8.639, obtained at Df = 1, 77. and the p-value was 0.004 ($p < 0.05$). Participation in theself-efficacy test before the two groups were exposed to the intervention did not have any significant effect, as the observed F-value for the pre-test score as the covariate factor was 3.176 with a p-value of 0.079 ($p > 0.05$). It was already observed in Table 8 that students exposed to the STEM-7EIBL had a higher mean efficacy score. The result of this test, therefore, revealed that the differences obtained between the two groups were statistically significant. With these observations, the null hypothesis that there is no significant mean difference in the self-efficacy scores between students exposed to STEM-7EIBL and CTM is therefore rejected.

Table9

Two samples t-test on post-questionnaire and delayed post-questionnaire on self-efficacy of students Exposed to the STEM-7EIPBL.

Stage	N	Mean	Std. Dev.	Std. Error	T	Df	p-value
Post-test	40	81.68	19.958	3.156	0.723	78	0.472
Delayed-test	40	84.60	15.988	2.528			

(t-critical =2.00, $p < 0.05$)

The result in Table 9 did not reveal a significant difference in self-efficacy of students taught diffusion and osmosis concepts in their post-questionnaire and delayed post-questionnaire scores. The mean scores of delayed post-questionnaires of self-efficacy slightly increased, but the difference was not significant. The t-value obtained was 0.723, with a p-value of 0.472 ($p > 0.05$) obtained at 78 degrees of freedom (df). These observations did not provide sufficient evidence to reject the null hypothesis. The null hypothesis that there is no significant difference in the mean scores of post-questionnaire scores and delayed post-questionnaire scores on the self-efficacies of students exposed to STEM-7EIBL is therefore retained.

V. DISCUSSION

The study found that students in the experimental group who were exposed to the use of the STEM-7EIBL in learning diffusion and osmosis concepts had a higher mean efficacy that was significantly different from the mean score of students in the control group. This was because they actively participated, performing activities assigned to them to solve the given problems. The study confirmed the findings of Boz & Cetin-Dindar (2016) and Tseng et al. (2013), who stated that greater self-efficacy development can be assured when students are involved in the learning process. This result is also in line with Pleiss's (2012) findings that high self-efficacy is linked to suitable and innovative strategies that are able to improve and develop student self-efficacy, interest, and performance, whereas low self-efficacy is linked to worsened strategies that reduce interest and performance. The results are also consistent with Han's (2014), report that students who have participated in STEM 7EIBL classes have their efficacy improved and are less likely to drop out of school. The finding reflected the report of Burwell-Woo et al. (2015), and Shaheen and Kayani (2017), who stated that a person's confidence and positive attitudes can be created through constructivist, innovative approaches than the teacher-centered approaches.

The study found that the self-efficacy of the students at the post-questionnaire and the retention levels of the experimental group did not differ significantly. The study discovered that the scores obtained after using the STEM-7EIBL did not decrease or increase significantly at the delayed post-questionnaire level. The finding here is consistent with Nugent's (2015) report, which reported that students are able to retain information learned under STEM-7EIBL longer compared to conventional teaching methods. This study demonstrates its involvement by providing a broad application of the theory in the context of STEM-7EIBL. The study's findings are consistent with constructivism and experiential theories.

Self-efficacy, in accordance with Bandura's social cognitive theory (1977), is gained from experiences when a person observes others completing a task that they are concentrating their own performance on (Sawtelle et al., 2012). Students that engage in STEM-7EIBL study in groups, see what others are doing, and get knowledge from their peers on how to apply biology to a real-life situation. The STEM-7EIBL group activities are consistent with social cognitive theory (Erdogan et al., 2016), which has direct connections to observing other people in social interactions and personal experiences (Han, 2017). It is among the foundational ideas of this study to find out how STEM-7EIBL affects self-efficacy.

Positive effects on students' learning are seen when STEM education approaches are used, leading to increased student self-efficacy and interest (Mustafa et al., 2016). This supported the results of this study, which increased students' self-efficacy, interest, and success in biology instruction. The present study confirmed those of other related investigations (Baran & Maskan, 2010; Han et al., 2014; Olivarez, 2012). For study participants and biology teachers to solve difficulties in the real world, 7EIBL can be highly helpful. STEM-7EIBL in secondary education boosts students' self-efficacy in their ability to complete the educational requirements for potential future employment. The learning sequence employed in STEM-7EIBL greatly influenced the achievement of the students. the approach is found to be a learner-centered, practical, activity-focused learning style in which the teacher serves as a facilitator. Classroom observations show students conduct group activities, discuss findings, and deduce from their findings.

The learning concepts emphasized in this study's theoretical framework are supported by the study's findings. The social constructivist theory, for example, states that learning is an activity that takes place in a learning environment where students are active participants in the creation of their own knowledge (Han, 2013; Schreiber & Valle, 2013; Lewis, 2018). For constructivists, the teacher serves as a guide in the learning environment, allowing students to be guided by their curiosity and interest to associate and collaborate with other students to construct and build their knowledge (Laux, 2018; Martin et al., 2017). This theory supported and matched the principles of STEM-7EIBL, where students actively participated in their learning, collaborated, and cooperated among themselves while the teacher acted as a facilitator, assisting them in directing and controlling their learning.

VI. CONCLUSION

The results of this study have shown that teachers' choice of instructional technique has a substantial impact on students' self-efficacy and supported the use of STEM-7EIBL to increase students' confidence in their ability to solve diffusion and osmosis challenges. In which case, the findings of the present study lend support to those of other investigations. For biology teachers and high school students to tackle real-world problems, the 7EIBL approach can be very helpful. Students' confidence in their ability to achieve higher levels of achievement, which is a prerequisite for future employment prospects, increases when they participate in STEM-7EIBL environment. Teachers can maximize student engagement in the learning process by integrating STEM and 7EIBL. The process is a student-centered learning strategy that provides students more freedom to learn independently. The 7EIBL emphasizes the conduct of many hands-on activities which requires students to undergo through different stages and processes. This kind of activities influence the development of scientific skills in the students. It is necessary for future research to extend the current study's constrained parameters. This study was restricted to biology students in form four and the concepts of diffusion and osmosis. Future research is therefore required to test the effect of STEM-7EIBL on self-efficacy in other secondary school levels and other disciplines.

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