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Article

An Investigation of the Sources of Self-Efficacy and Science Achievement: A Case of Cambodian University Students

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Abstract

Building qualified workforces in Science, Technology, Engineering and Mathematics (STEM) is one of the top agendas of the Royal Government of Cambodia (RGC) to respond to the country development to transform its nation to an upper-middle income country by 2030 and a high-income country by 2050. Yet, there has been a declining trend in upper secondary school enrolment in science track in the last decade and in the long return of human resource investment, this trend may affect the country demand in STEM-related fields. Therefore, the current study aims to investigate the four primary sources of science self-efficacy on Cambodian students' science achievement. The study employs a survey with first-year students at both public and private higher educational institutions. A total of 819 freshmen from four public and two private universities were selected through a multi-phase random sampling. A simultaneous multiple linear regression is used for the investigation in the study. The results reveal that mastery experience, social persuasion and physiological state significantly predict the science achievement, and mastery experience is found the most significantly predictor while vicarious experience does not influence the outcome variable. The findings provide new insights and concrete evidence for implications to key policy makers, practitioners and development partners working on promoting STEM education.

Keywords: Self-efficacy; Cambodian university student; sources of science self-efficacy; STEM education; science achievement

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1. Introduction

According to the RGC's Industrial Development Policy 2015-2025, the government envisions to transform its current status of low-middle income country to upper-middle income status by 2030 and to move forward to a developed country by 2050 (RGC, 2015). To realize this vision, the RGC set out the National Strategic Development Plan (NSDP) 2019-2023, one of the top prioritized areas is to promote qualified human resources in STEM-related fields (RGC, 2019). To contribute to realizing the vision of the RGC, the Ministry of Education, Youth and Sport (MoEYS) has put in place a number of key initiatives. For instance, a policy on STEM was formulated in 2016 with its vision to promote quality of STEM education (MoEYS, 2016). Furthermore, the Education Strategic Plan 2019-2023 clearly emphasized the ministry's continued effort to promote STEM education from primary to upper secondary education (MoEYS, 2019).

Although a lot of policies and efforts have been put in place, the trend of enrolment in science track at the upper secondary education gradually shifted downward in the last six school academic years 2013-2019 (MoEYS, 2020). The continuation of this negative trend may affect the enrolment of STEM-related majors at higher education upon high school graduation and in the long-term, this may negatively affect the government's vision to produce highly qualified skilled workforces in STEM as the country will move forward to a skilled workforce economy in 2030.

There are various studies on students' choices in STEM related fields at higher education and high school science tracks choice across the country. For instance, Eam, Keo, Leng, Song, and Khieng (2021); Kao and Kinya (2019) found that there was a significant association between science and mathematics self-efficacy to choices in STEM-related majors. In these two studies, the authors jumped to the same conclusion that students who were more efficacious in science and mathematics were more likely to choose STEM-related fields at universities. In particular to the students' choices in science streams at high schools, two studies revealed that individual factor on science and mathematics self-efficacy significantly influenced students' choices in science stream (Kao & Kinya, 2020; Seang, Chey, Souk, Hak, & Ob, 2021). In the context of a study on the sources of self-efficacy, Chey (2021) investigated the trends and patterns of the sources of Cambodian science self-efficacy and found that the mean scores of

the four sources differed from low to moderate levels and the vicarious experience was at the highest level. In addition, the author further revealed that Cambodian students' science self-efficacy significantly differed across demographic characteristics, namely gender, high school tracks, place of origin, majors at university, family background and age.

Yet, investigating the sources of self-efficacy on science achievement remains untouched. Therefore, it is imperative to examine the effects of the four primary sources of self-efficacy on Cambodian students' science achievement as to provide more concrete evidence to policy makers, practitioners and relevant stakeholders to address the above-mentioned issue. Hence, the current study was guided by one research question as follow.

Do sources of self-efficacy significantly predict students' science achievement?

2. Literature Review

Self-Efficacy

Several studies in educational fields have investigated the self-efficacy theory by researchers and scholars (Joët, Usher, & Bressoux, 2011). According to Bandura (1995), self-efficacy is defined as "beliefs in one's capabilities to organize and execute the courses of action required to manage prospective situations". Self-efficacy is found to be an influential actor in the way people thinks and execute tasks (Kumar & Lal, 2006), and it affects the efforts people put in the work as those who possess high self-efficacy tends to work harder toward the task and vice versa (Schunk, 1985).

Bandura (1977) further positioned that self-efficacy consisted of two main components, namely efficacy expectation and outcome expectation. Efficacy expectation specifically refers to the trust or belief of one's own ability in executing a certain job. Contrary to the first component, outcome expectation simply concerns with a person's expectation of the subsequent results from performing that particular task (Hackett & Betz, 1981).

Sources of Self-Efficacy

Mastery Experience

Mastery experience is one of the sources of self-efficacy synthesized by (Bandura, 1977). More recent studies (Kontaş & Özcan, 2022; Loo & Choy, 2013; Usher & Pajares, 2009) prove that mastery experience is the influential factor on personal efficacy. By definition, mastery

experience refers to a person's past achievement or performance toward a particular task or work (Van Dinther, Dochy, & Segers, 2011). When an individual experienced success in doing something in the past, he or she tends to feel more confident on what he is doing in similar thing he used to do well in the past. In contrast, if an individual experienced failures or low achievement in doing a particular work, he or she may not believe in their ability to perform similar task in the present time.

Social Persuasion

Besides mastery experience, self-efficacy is influenced by social persuasion. This source affects one's personal belief through motivation and encouragement from surrounding people and these praises can be negative and positive (Bandura, 1977). The author further elaborated that encouragement can build confidence in an individual's ability to perform task even a difficult one. In contrast, individuals become demotivated and lose self-confidence if they receive negative encouragement.

Vicarious Experience

Another factor that affects personal self-efficacy is vicarious experience. In his synthesized theory, Bandura (1977) argued that observation and learning from peers and other surrounding people influenced an individual's confidence toward the job he or she was doing. The author also pointed out that people starts to compare their own abilities to others who are completing similar tasks and then judge their own capability.

Physiological State

Physiological state, one of the sources affecting one's self-efficacy, refers to the state of an individual's emotion, fear, or anxiety toward a particular task or job(Bandura, 1977). It is evidenced by previous studies that people who possessed negative feeling or anxiety with a particular situation tend to perceive low personal efficacy while those who experience fearless and stress-free are more likely to be more efficacious in carrying out the work.

Self-Efficacy and Academic Achievement

Studies on self-efficacy and academic achievement have been carried out across fields and subject domains worldwide and found there is a significant association between the two variables. de Fátima Goulão (2014) revealed that there was a positive significant correlation between students' self-efficacy and their performance. A recent study by Fakhrou and Habib

(2022) confirmed that there is a significant association between student's self-efficacy and their academic achievement in an undergraduate program.

In the context of science and mathematics, several studies confirmed this association. Juan, Hannan, and Namome (2018) examined the connection between the self-efficacy and science achievement of twelfth graders in South Africa using data from TIMSS 2015 for science achievement. Through multiple linear regression analysis, the authors found that science self-efficacy significantly predicted the science achievement of the respondents. Consistently, an investigation of the sources of science self-efficacy on middle school students by Britner and Pajares (2006) revealed that science achievement was the strong predictor for science performance, especially for male students. In parallel with the above-mentioned studies, Andrew (1998) examined the relationship between self-efficacy and science performance and found that science self-efficacy positively predicted students' achievement in physical science and bioscience subjects at 24% and 18.5% of academic cohorts respectively.

Sources of Self-Efficacy and Academic Achievement

Evidences confirmed in previous studies suggested that the four sources, namely mastery experience, vicarious experience, social persuasion significantly predicted students' academic achievement regardless of subject domains and fields of study while some contradictorily pointed out that not all the synthesized sources predicted the individuals' academic performance or success.

Zarei and Naghdi (2017) investigated the sources of self-efficacy on the performance of EFL learners and revealed that only mastery experience significantly predicted the course achievement in their study context. In science and mathematics domains, however, various studies (Loo & Choy, 2013; Usher & Pajares, 2009) confirmed that all the four primary sources of self-efficacy were significant predictors for student's academic performance, and mastery experience was the main predictor.

With respect to vicarious experience, Keşan and Kaya (2018) carried out a study on the mathematics and science self-efficacy resources and academic achievement, and the authors found that vicarious experience could predict science and math achievement at 60% of variance when all the four sources were run in the multiple linear regression. The finding from this study was consistent (Kontaş & Özcan, 2022; Loo & Choy, 2013; Usher & Pajares, 2009).

Similarly, various studies found that social persuasion is a significant predictor for academic achievement across subject domains. As argued by Keşan and Kaya (2018), social

persuasion significantly influenced math and science achievement. This finding is consistent with a study by Kontaş and Özcan (2022).

The last source of self-efficacy is physiological state which is well documented by researchers and scholars as the significant predictor for achievement. Obviously, (Loo & Choy, 2013; Usher & Pajares, 2009) found consistent findings confirming that physiological state could predict students' performance in math and engineering.

3. Methodology

A quantitative method was employed through a self-rated survey with Cambodian university freshmen. A total of 819 students were selected from four public and two private higher educational institutions through multi-phase random sampling. In the first stage, the researchers purposively chose the universities based on two criteria. For the first criterion, the selected institutions offered both STEM and non-STEM fields and at least 40 students or more in STEM classes at those respectively universities. In doing so, the authors could ensure the sufficient sample size for the study. On the other hand, for the non-STEM participants, there were no any inclusion criteria due to the fact that there were a lot of students in these fields. The last sampling procedure was to select the freshmen participants by utilizing simple random technique. Firstly, the researchers approached the persons in charge of students' lists and then requested all the lists from them. Once obtaining all class lists, the researchers classified the classes into two groups, namely STEM and non-STEM accordingly. With the two separate groups, the authors began to randomly select the two classes and finally there were, in total, four classes from each university.

For the data instrument, the current study adapted the construct by (Usher & Pajares, 2009). The measurement of the four primary sources comprised of twenty-four six-point-Likert-scale items. To fit the context of the study, the authors reworded 'Mathematics self-efficacy' to 'Science self-efficacy' because the original study developed the construct to measure the sources of mathematics self-efficacy. To ensure the internal consistency of reliability of the construct, Factor Analysis was conducted and finally twenty-two items remained in the study. It was noted that one item was removed from the mastery experience, and another one was also excluded from the vicarious experience as these two loading values of these removed items were low. Based on the overall value of the Cronbach's alpha, the construct showed high reliability for the study.

To make the questionnaire much more convenient and easier for the respondents, the questionnaire was translated into Khmer language to ensure the participants clearly understand the questions and provide sufficient, appropriate answers. Also, the researchers piloted the instrument with 237 students from two private universities before the actual data collection. The result of the pilot stage, the value of Cronbach's alpha was .850 and after some modification the final overall value of the Cronbach's alpha was .929, which was the high reliability (Leech, Barrett, & Morgan, 2005).

For the outcome variable, the researchers requested the respondents to do self-rating toward their overall performance in the four science subjects in the last grade at high school, namely Chemistry, Physics, Biology and Earth Science. Measure of science achievement was categorized into five levels, namely A: Excellent, B: Very good, C: Good, D: Fairly good, E: Average, and F: Fail. The scale was adopted from high school national exam grading system.

As mentioned in the beginning of this section, six higher educational institutions were selected with a total of 819 freshmen. To collect the data, the main researcher directly went to the field and met with the participants in classrooms at each research site. Prior to handing the questionnaires to the respondents, the researcher introduced himself and clearly explained the purposes of the study, and the consent form was given to the students to request their approval. The researcher was with students until they finished filling out the questionnaire. All questionnaires were collected and participants voluntarily participated in the study.

To analyze the data, the study employed the Statistical Package for Social Sciences (SPSS), version 23. For statistical analysis method, the researchers used simultaneous multiple linear regression to identify the predictor variables on students' science achievement.

4. Findings

The table below showed the results of the simultaneous multiple linear regression. The four predictor variables, namely mastery experience, vicarious experience, social persuasion and physiological state, on the students' science achievement were included in the model. The model could explain 54% of the variance in students' science achievement ($R2 = .546$, $F (4, 814) = 246.646$) with the level of significance being $p < .001$. As for mastery experience, it was observed that the better students performed in the past on science subjects, the higher students could achieve scores in science ($ß = .402$, $p < .001$). Vicarious experience did not significantly predict students' science achievement. In this model, it also revealed that social persuasion significantly influenced the outcome variable with a .001 level of significance (ß =

.321, p < .001). The result of the last predictor, physiological state, showed a strong predictor on students' science achievement (ß = .117, p < .001). In overall, the findings clearly revealed that mastery was the most influential source influencing student's science achievement and followed by social persuasion and physiological state.

Table 1: Results of Simultaneous Multiple Linear Regression for the four primary sources of science self-efficacy predicting science achievement

Variables	B(SE)	Beta
Mastery Experience	.033	.402***
Vicarious Experience	.032	-.004
Social Persuasion	.028	.321***
Physiological State	.022	.117***
Constant	.621	

(R^2 = .548, adjusted R^2 = .546, F (4, 814) = 246.646)
(*** p < .001)

5. Discussions

The findings from the current study provides new insights and more rigorous supporting evidence to confirm the four primary sources of self-efficacy synthesized by Albert Bandura and other previous studies in the same area of focus across the world. With an attempt to investigate the four primary sources of science self-efficacy on students' science achievement, the results generated from the simultaneous multiple linear regression could uncover the mystery in the context of the study and a concrete evidence for rich discussion.

Firstly, mastery experience was found the most influential factor on science achievement and the current finding supported the previous studies (Kontaş & Özcan, 2022; Loo & Choy, 2013; Usher & Pajares, 2009). With this consistent result, the study suggested and reflected the fact that students with success experience in doing science subjects in the previous grades are more likely to constantly perform well in the upcoming academic years. In this sense, strengthening students' ability in science subjects from the past may help students perform better and better as they have strong foundation from the previous grades. More than this, building students' foundation in science is even more effective from the primary grades as suggested by the current study.

Secondly, the current study also confirmed the previous findings that social persuasion was another source in predicting the science achievement of the students (Keşan & Kaya, 2018; Loo & Choy, 2013; Usher & Pajares, 2009). From this evidence, students might accept the facts that the praises from family, peers and other people truly reflect their ability, and those encouragements become the driver to motivate them to learn harder in science subjects. Not to mention, it could be true in the context of the research sample that students in high schools need to be constantly encouraged as negative praises may lead to demotivating them. Therefore, all key relevant stakeholders such as parents, schools and teachers play a crucial role in constantly encouraging and motivating students in a positive manner as their good praises are very helpful in motivating learners to work harder in learning as evidenced by the study.

The study further revealed that students' performance in science was significantly influenced by the physiological state and the finding supported previous studies (Loo & Choy, 2013; Usher & Pajares, 2009). However, the result was inconsistent with a study by (Keşan & Kaya, 2018). In the context of this particular study, the finding reflects the current situation of the students' perception that science is not an easy subject, so this idea scared them and even to good performers. Hence, increasing students' success in science, addressing the fear and anxiety cannot be ignored, and consultation should be made available at the ground levels. Not only schools and teachers but also parents play an active role in supporting their children emotionally as it is helpful to nurture the physiological state.

Last but not least, the current study found no significance in vicarious experience on students' science achievement from the results generated in regression analysis. The finding was paralleled with the studies (Kontaş & Özcan, 2022; Zarei & Naghdi, 2017) although the focus was on different subject domains. In the context of the current study, students might not judge their own ability toward their peers when learning science and they might perceive that people have different talent and skills among individuals. Thus, comparing student's performance or abilities with their peers does not work in science education. In return, it could potentially deteriorate the situation as comparing their abilities with other well performing peers causes their psychological consequence on learning science.

6. Conclusion

The current study aims to investigate the effects of the four primary sources of science self-efficacy on students' science achievement in the context of Cambodian freshmen. From the findings, the current study positioned that students' achievement in science subjects at high

schools were significantly predicted by the sources synthesized by Albert Bandura, except vicarious experience.

Furthermore, the findings suggested that mastery experience was found to be the main factor predicting science achievement. Students who experienced success or did well in science in the previous grades tended to maintain their good performance in the present time and the next upcoming years. In this sense, building an individual's success experience is the good foundation for the future success in learning science.

In addition to the mastery experience, social persuasion becomes the crucial player in promoting students' science performance. The positive encouragement and motivation are helpful in supporting learners as they take the praises into account. Moreover, it is more likely that the more students receive positive messages about their performance, the better they are going to achieve as at their ages, frequent positive encourages are needed.

Study also positioned that addressing students' fear and anxiety toward learning science is a preferable option to boost learners' progress in science as the findings suggested that the physiological state significantly influenced academic achievement in science subjects. Students' psychological aspect becomes one of the issues which needs to be addressed at ground levels as it affects students' performance and further their stream choices in science.

Judging oneself in performing science through observing peers and surrounding people was not truly reflected in students when talking about learning science as evidenced in this study. Hence, what students perceived their ability by comparing to others did not affect their science achievement.

Overall, to further investigate and help promote STEM education in Cambodia, future research should take other key aspects into consideration such as teacher self-efficacy, students' perceptions toward teachers' classroom management, and other relevant factors as these may affect students' performance in science.

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