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Science Self-efficacy of Secondary School Students

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Abstract

Context: *Efficacy is a belief in own capacity of an individual and science self-efficacy is a belief of an individual in his capacity to complete a scientific task effectively. Science is an important subject in school curriculum, an individual possessing a higher level of efficacy in science is expected to possess high performance in the scientific field. Secondary school students are expected to have a higher level of science self-efficacy beyond the effect of demographic variables.* ***Aims:*** *1. To study the level of science self-efficacy of secondary school students. 2. To study the significant difference in science self-efficacy of secondary school students based on gender. 3. To study the significant difference in science self-efficacy of secondary school students based on locality. 4. To study the significant difference in science self-efficacy of secondary school students based on age.*

Settings and Design: *Descriptive research methodology as a survey was used in this research. Materials and Methods: A sample of 84 students was selected but 68 students participated and the sample was selected by purposive sampling technique from Govt. High School Sec- 20 D, Chandigarh, and a descriptive research methodology was used. Science self-efficacy was measured by a science achievement scale developed by Shivani (2018).* ***Statistical analysis Used:*** *Kolmogorov-Smirnov (K-S) test, Shapiro-Wilk, Percentage analysis, Mean, Standard deviation, t-test and ANOVA one-way were used in this study.* ***Results:*** *There were no significant differences in science self-efficacy of secondary school students based on gender, locality, and different age groups.* ***Conclusions:*** *There were contradictory findings with some previous studies so more studies can be conducted in this field.*

Keywords: Albert Bandura's self-efficacy theory, Science Self-efficacy, Gender, Locality, Age

Introduction

Albert Bandura (1977) introduced the theory of self-efficacy. It is determined by outcome value, outcome expectancy, and self-efficacy expectancy (Lippke, 2020; & Maddux, n. d.). Psychological procedures affect the strength of self-efficacy, personal efficacy determines a specific mechanism to face obstacles and aversive experiences. Performance accomplishments, vicarious experience, verbal persuasion, and physiological states are the fundamental principles of personal efficacy, and efficacy is affected by enactive, vicarious, exhortative, and emotive sources (Bandura, 1977). Self-efficacy refers to a person's belief in his own capability to perform any task successfully, it is the most powerful motivational predictor of task completion and it is a determinant of a person's effort, persistence, strategizing, training and job performance (Heslin & Klehe, 2006; & Williams & George-Jackson, 2014). The cognitive load did not affect self-efficacy, yet there was an increase in self-efficacy over time compared to the decision to invest in mental efforts (Feldon, 2023). Self-efficacy and work-related performance are highly related (Stajkovic & Luthans), stress negatively predicts academic self-efficacy over time (Liu et al., 2024) however, perceived engineering barriers and perceived engineering supports are related to perceived self-efficacy (Lee et al., 2024). Learning outcomes are affected by a teacher's self-efficacy. Teaching experiences and responsibilities both influence the perfection of a prospective teacher in the teaching profession. The teacher's self-efficacy through early teaching experiences and master teaching practice cultivates self-efficacy in his teaching (Edwards & Gerberry, 2024).

Science self-efficacy is an individual's belief in his ability to complete specific tasks in the field of science successfully (Robnett et al., 2015). It affects students' achievement in science and is more related to

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students' science self-efficacy through home cultural resources, home educational resources or a composite indicator than parental education levels or occupational status. It is independent of science teachers' instructional practices examined (Tan et al., 2023). Students' science self-efficacy can be nourished by teachers through practicum training (Kartimi et al., 2021) and teacher and student science hardiness play important roles in science learning self-efficacy (Wang & Tsai, 2016). Student-teacher relations affect both science self-efficacy and anxiety, and the face-to-face mode of instruction develops more science self-efficacy than the distant mode (Kurbanoglu et al., 2023). A low level of self-efficacy of students towards a subject acts as an obstacle to enrolling the students in the concerned subject, which affects the institutional and departmental finances, and science learning is highly related to the level of self-efficacy (Dalgety & Coll, 2006). A higher level of science self-efficacy results in a positive academic and vocational outcome in science and technology programs (Larose et al., 2006).

Science self-efficacy and its proposed sources do not vary as a function of gender (Kiran & Sungur, 2012) however, science self-efficacy and mathematics self-efficacy affect academic success (Kesan & Kaya, 2018) and science self-efficacy predicts science achievement, and gender plays a significant role in it. Mastery experiences, vicarious experiences, social persuasions, physiological arousal, and self-efficacy are significantly related (Britner & Pajares 2006). Through scientific civic engagements the poP-CUREs develop students' knowledge, skills, values, and self-efficacy (Dunbar-Wallis & Jennifer, 2024). Science self-concept and self-efficacy in science are different constructs. Science self-efficacy is affected highly by inquiry-based learning and science self-concept is predicted by peer achievement. Self-efficacy is a predictor of current ability however, self-concept is an important motivating factor in a future career in science (Jansen et al., 2015). Anxiety is negatively associated with academic achievement in science and science self-efficacy (Burns et al., 2021).

Rationale of the Study

STEM career awareness influences STEM knowledge achievement directly or indirectly through student STEM attitudes, self-efficacy and expectancy-value beliefs, and 21st-century skills (Han et al., 2021). Learners are aware of factors for becoming a scientist, the confusion about the role of race and social stigma in scientific training acts as an obstacle in science learning, and the culture of science, exhibits strong science identities and high self-efficacy in ‘‘doing science’’ when the students learn in collaboration with experts (Hurtado et al., 2009). Self-efficacy and outcome expectations affect interests and career-choice intentions meanwhile, support and barrier percepts have weak relations to career choice (Lent et al., 2001), and in recent years, a large part of the student population has been entering science, technology, engineering, and mathematics (STEM) courses after school in 4-year higher education institutions. STEM major is directly influenced by math achievement in high school and 12th grade, and initial post-secondary experiences, like academic interaction and financial support, affect self-efficacy (Xueli, 2013) and women's participation in STEM education can be increased by providing masculine cultures and early experiences for success equally to both genders (Cheryan et al., 2017). Gender differences play an important role in self-efficacy, females had a higher level of language arts self-efficacy than males however, males had a higher level of mathematics self-efficacy, computer self-efficacy, and social sciences self-efficacy than females. Gender differences in academic self-efficacy relate to age (Huang, 2013). Self-efficacy patterns are different in girls and boys across the years (Uysal & Arikan, 2018), and sources of self-efficacy beliefs may be stronger for women than the traditional settings and may be useful to overcome academic and career obstacles (Zeldin & Frank, 2000). Hence demographic variables related to teachers and students play an important role in science self-efficacy. In the present study, the science self-efficacy of secondary school students was studied based on gender, locality, and age.

Materials and Methods

The population consisted of all the students studying in secondary schools in Chandigarh (U.T.). A sample of 84 students of the 9th class was selected from Govt. High School Sec-20 D, Chandigarh, by purposive sampling, and only 68 students participated in this research.

Settings and Design

In this study, descriptive research methodology, as a survey was used in secondary schools of Chandigarh (U.T.) to study science self-efficacy of secondary school students.

Objectives

The following objectives were formulated in this study

1. To study the level of science self-efficacy of secondary school students.
2. To study the significant difference in science self-efficacy of secondary school students based on gender.
3. To study the significant difference in science self-efficacy of secondary school students based on locality.
4. To study the significant difference in science self-efficacy of secondary school students based on age.

Hypotheses

The following hypotheses were formulated in this study

H_{O1}: There is no significant difference in science self-efficacy of secondary school students based on gender.

H_{A1}: There is a significant difference in science self-efficacy of secondary school students based on gender.

H_{O2}: There is no significant difference in science self-efficacy of secondary school students based on locality.

H_{A2}: There is a significant difference in science self-efficacy of secondary school students based on locality.

H_{O3}: There is no significant difference in science self-efficacy of secondary school students based on age.

H_{A3}: There is a significant difference in science self-efficacy of secondary school students based on age.

Statistical Tools Used in the Study

The science self-efficacy scale (SAS) developed by Shivani (2018) was used for data collection.

Statistical Techniques Used in the Study

Kolmogorov-Smirnov (K-S) test, Shapiro-Wilk, Percentage analysis, Mean, Standard deviation, t-test AND ANOVA one -way were used in this study.

Data Analysis and Interpretation

Section: I. Computation of Normality of Sample.

Table No. 1: Normality of science self-efficacy of secondary school students.

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	Df	Sig.
Science self-efficacy	.145	68	.001	.935	68	.002
a. Lilliefors Significance Correction						

It is found from Table no.1 that the calculated values of the Kolmogorov-Smirnov (K-S) test was .145 and the Shapiro-Wilk test was .935 and was found more than .05 level of significance, therefore these were statistically insignificant, so the data was found normally distributed.

Section: II. Level of Science Self-efficacy of secondary school students

Table no. 2: Level of Science Self-efficacy of secondary school students

Sr. No.	Range	N	Percentage	Interpretation
1	146 and above	21	30.88	Very Good

2	136-145	18	26.47	Good
3	120-135	28	41.17	Average
4	110-117	01	1.47	Poor
5	109 and below	00	0.0	Very Poor

It is analyzed from Table no.2 that 21, 18, 28, 01, and 00 numbers of secondary school students possessed a very good, good, average, poor, and very poor levels of science self-efficacy and the percentage-wise contribution of the secondary school students in each level was 30.88, 26.47, 41.17, 1.47, and 0.0 respectively.

Section III: Differential analysis of science self-efficacy

H_{O1}: There is no significant difference in science self-efficacy of secondary school students on gender basis.

H_{A1}: There is a significant difference in science self-efficacy of secondary school students on gender basis.

Table No. 3: Science self-efficacy of secondary school students on gender basis

Variable	Gender	N	Mean	SD	t-value	Sig
Metacognitive Awareness	Male	31	138.38	13.26	1.389	.170
	Female	37	143.16	14.79		

*Significance Level = 0.05 and df = 66

It was found in Table no. 3, that the mean and SD of science self-efficacy of male students were 138.38 and 13.26, and for female students were 143.16 and 14.79 respectively. The calculated t-value was 1.389 and lower than the table t-value = 1.994 at a level of significance 0.05 at df 66 however, p = (.170 > .05), so it was found statistically insignificant, hence there was no significant difference in science self-efficacy of secondary school students based on gender. So, H_{O1}: There is no significant difference in science self-efficacy of secondary school students on gender basis, is accepted.

H_{O2}: There is no significant difference in science self-efficacy of secondary school students on locality basis.

H_{A2}: There is a significant difference in science self-efficacy of secondary school students on locality basis.

Table No. 4: Science self-efficacy of secondary school students on locality basis

Variable	Locality	N	Mean	SD	t-value	Sig.
Science self-efficacy	Rural	16	139.00	13.59	0.636	.527
	Urban	52	141.59	14.47		

*Significance Level = 0.05 and df = 66

It was found in Table no. 4, that the mean and SD of science self-efficacy of rural students were 139.00 and 13.59, and for female students were 141.59 and 14.47 respectively. The calculated t-value was 0.636 and lower than the table t-value = 1.994 at a level of significance 0.05 at df 66 however, p = (.527 > .05), so it was found statistically insignificant, hence there was a significant difference in science self-efficacy of secondary school students. So, H_{O2}: There is no significant difference in science self-efficacy of secondary school students on locality bases, is accepted.

H_{O3}: There is no significant difference in science self-efficacy of secondary school students on age basis.

H_{A3}: There is a significant difference in science self-efficacy of secondary school students on age basis.

Table No. 5: Science self-efficacy of secondary school students on age basis

Science self-efficacy	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	812.235	5	162.447		
Within Groups	12736.751	62	205.431		
Total	13548.985	67		.791	.560

*Significance Level = 0.05 and df = 66

It was found in Table no. 5, the calculated F-value was 0.791 and lower than the table F-value = 1.96 at a level of significance 0.05 at df 66 however, p = (.560 > .05), so it was found statistically insignificant, hence there was a significant difference in science self-efficacy of secondary school students. So, H_{O2}: There is no significant difference in science self-efficacy of secondary school students on locality bases, is accepted.

Discussion of the Results

It was concluded that there were no significant differences in science self-efficacy of secondary school students based on gender, locality and age. Our findings support the previous studies conducted by Sezginturk and Sungur (2020) who reported no significant differences in science self-efficacy on gender basis. Chouhan (2019) reported no significant differences in general self-efficacy based on stream and gender. Griggs et al. (2013) reported no significant differences in math and science self-efficacy on gender bases and reported a negative association between students' anxiety and self-efficacy. Louis and Mistele (2011) reported no significant difference in science self-efficacy however, males had a higher level of math self-efficacy than females, and self-efficacy affected academic achievement and career choice of students in mathematics and science. Our findings are contradictory to the previous studies conducted by Zeldin et al. (2008) who reported different experiences of the self-efficacy beliefs of successful men and women in STEM careers. Carrol et al. (2024) found differences in students' self-efficacy to perform scientific skills and self-efficacy to answer the questions, and self-efficacy in performing scientific skills was found lower than their self-efficacy to answer questions. Boys had higher science self-efficacy than girls. Hu et al. (2022) found that students' science self-efficacy varied by grade and most females' science self-efficacy was higher than males for levels 1 and 4 however, males scored higher than females at levels 2 and 3. Ernawati et al. (2021) reported significant differences in self-efficacy towards science subjects and students' attitudes towards science subjects in class A and class B, and reported a significant relationship between students' attitudes and self-efficacy towards science subjects. Catherine (2017) reported that students' science self-efficacy is highly correlated to academic achievement and females had a higher level of science self-efficacy and academic achievement than males. Webb-Williams (2017) reported that males had higher science self-efficacy than females however, there were no significant differences in achievement in science. Schmidt and Shumow (2012) found that males had a higher level of change of science self-efficacy than females. Cordero et al. (2010) reported no significant differences in both groups in interest in technical careers, confidence in completing math or science courses successfully, and willingness to enroll in math/science courses, and males had higher math self-efficacy than females.

Educational Implications

1. This study found no significant effect of gender, locality and age on science self-efficacy, so these variables must be kept in mind while teaching in science classrooms.
2. These findings are useful for teachers, students, and researchers, who are engaged in related fields.
3. Science self-efficacy can be used as a determinant of academic achievement, subject selection and future career-choice of secondary school students.

Suggestions for Further Research

1. The investigator can study the cause of why gender, locality, and age had contradictory findings in various studies on science self-efficacy.
2. Experimental studies can be conducted to improve the science self-efficacy of secondary school students.
3. The relationship of science self-efficacy can be studied with other student and teacher-related domains in future studies.
4. The researcher can use other research tools to verify our findings.
5. The investigators can adopt a large sample size in further research.

6. The investigators can conduct similar research in other school subjects, and higher or vocational institutions.

References

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84 (2),* 191-215. DOI: 10.1037/0033-295X.84.2.191

Britner, S. L., & Pajares, F. (2006). Sources of science self-efficacy beliefs of middle school students. *Journal of Research in Science Teaching, 43 (5),* 485-499. https://doi.org/10.1002/tea.20131

Burns, E. C., Martin, A. J., Kennett, R. K., Pearson, J., & Munro-Smith, V. (2021). Optimizing science self-efficacy: A multilevel examination of the moderating effects of anxiety on the relationship between self-efficacy and achievement in science. *Contemporary Educational Psychology, 64,* 101937. https://doi.org/10.1016/j.cedpsych.2020.101937

Carroll, S., McCauley, V., & Grenon, M. (2024). Science self-efficacy beliefs of upper primary students in Ireland. *International Journal of Science Education, 46 (6)*, 503-523. https://doi.org/10.1080/09500693.2023.2245947

Catherine, A. (2017). Investigating the relationship between science self-efficacy beliefs, gender, and academic achievement, among high school students in Kenya. *Journal of Education and Practice, 8 (8),* 146-153. https://files.eric.ed.gov/fulltext/EJ1139069.pdf

Cheryan, S., Ziegler, S. A., Montoya, A. K., & Jiang, L. (2017). Why are some STEM fields more gender balanced than others? *Psychological Bulletin, 143 (1),* 1-35. DOI: 10.1037/bul0000052

Chouhan, M. (2019). Self-efficacy among science and arts students - A comparative study. *Journal of Emerging Technologies and Innovative Research, 6 (3),* 76-79. https://www.jetir.org/papers/JETIR1903L11.pdf

Cordero, E. D., Porter, S. H., Israel, T., & Brown, M. T. (2010). Math and science pursuits: A self-efficacy intervention comparison study. *Journal of Career Assessment 18 (4)*, 362-375. DOI: 10.1177/1069072710374572

Dalgety, J., & Coll, R. K. (2006). Exploring first-year science students' chemistry self-efficacy. *International Journal of Science and Mathematics Education, 4,* 97-116. https://link.springer.com/content/pdf/10.1007/s10763-005-1080-3.pdf

Dunbar-Wallis, A. K., & Jennifer, K. (2024). Bee The CURE: Increasing student science self-efficacy, science identity, and predictors of scientific civic engagement in a community college cure. *CBE Life Sciences Education*, 23 (4), Article ar46. DOI: 10.1187/cbe.24-01-0015

Edwards, L. A., & Gerberry, C. (2024). STEM major's decision to teach: examining teaching experiences in high-needs communities. *Disciplinary and Interdisciplinary Science Education Research, 6 (26),* 1-15. https://doi.org/10.1186/s43031-024-00112-w

Ernawati, M. D. W., Sanova, A., Kurniawan, D. A., & Citra, Y. D. (2022). The junior high school students' attitudes and self-efficacy towards science subjects. *Jurnal Inovasi Pendidikan IPA, 8 (1),* 23-36. doi: https://doi.org/10.21831/jipi.v8i1.42000

Feldon, D. F. (2023). Direct effects of cognitive load on self-efficacy during instruction. *Journal of Educational Psychology*, 116 (7), 1153-1171. DOI: 10.1037/edu0000826

Griggs, M. S., Rimm-Kaufman, S. E., Merritt, E. G., & Patton, C. L. (2013). The responsive classroom approach and fifth grade students' math and science anxiety and self-efficacy. *School Psychology Quarterly*, 1-14. doi: 10.1037/spq0000026

Han, J., Kelley, T., & Knowles, J. G. (2021). Factors influencing student stem learning: self-efficacy and outcome expectancy, 21st century skills, and career awareness. *Journal for STEM Education Research, 4,* 117-137. https://doi.org/10.1007/s41979-021-00053-3

Heslin, P. A., & Klehe, U. C. (2006). Self-efficacy. *In S. G. Rogelberg (Ed.), Encyclopedia of Industrial/Organizational Psychology, 2,* 705-708. Thousand Oaks: Sage

Hu, X., Yanxia Jiang, Y., & Bi, H. (2022). Measuring science self-efficacy with a focus on the perceived competence dimension: Using mixed methods to develop an instrument and explore changes through cross-sectional and longitudinal analyses in high school. *International Journal of STEM Education, 9 (47),* 1-24. https://doi.org/10.1186/s40594-022-00363-x

Huang, C. (2013). Gender differences in academic self-efficacy: a meta-analysis. *Eur J Psychol Educ, 28,* 1-35. DOI 10.1007/s10212-011-0097-y

Hurtado, S., Cabrera, N. L., Lin, M. H., Arellano, L., & Espinosa, L. L. (2009). Diversifying science: Underrepresented student experiences in structured research programs. *Res High Educ, 50,* 189-214. DOI: 10.1007/s11162-008-9114-7

Jansen, M., Scherer, R., & Schroeders, U. (2015). Students' self-concept and self-efficacy in the sciences: Differential relations to antecedents and educational outcomes. *Contemporary Educational Psychology, 41,* 13-24. https://doi.org/10.1016/j.cedpsych.2014.11.002

Kartimi., Anugrah, I. R., & Addiin, I. (2021). Systematic literature review: science self-efficacy in science learning. *Al-Khwarizmi: Jurnal Pendidikan Matematika dan Ilmu Pengetahuan Alam, 9 (2),* 13-34. DOI: http://dx.doi.org/10.24256/jpmipa.v9i2.2048

Kesan, C., & Kaya, D. (2018). Mathematics and science self-efficacy resources as the predictor of academic success. *International Online Journal of Educational Sciences, 10 (2),* 45-58. Doi: http://dx.doi.org/10.15345/iojes.2018.02.004

Kiran, D., & Sung, S. (2012). Middle school students' science self-efficacy and its sources: Examination of gender difference. *Journal of Science Education and Technology, 21 (5),* 619-630. Stable URL: https://www.jstor.org/stable/41674489

Kurbanoglu, N. I., Demirtasx, Z., & Batur, A. (2023). The role of student-teacher relation on science self-efficacy and science anxiety in face-to-face and distance education. *Sage Open,* 1-9. DOI: 10.1177/21582440231194408.

Larose, S., Ratelle, C. F., Guay, F., Senecal, C., & Harvey, M. (2006). Trajectories of science self-efficacy beliefs during the college transition and academic and vocational adjustment in science and technology programs. *Educational Research and Evaluation 12 (4),* 373-393. DOI: 10.1080/13803610600765836

Lee, B. H., Hu, X., Flores, L. Y., & Navarro, R. L. (2024). The role of contextual variables and structural diversity on college students' engineering self-efficacy. *Behav. Sci., 14 (564),* 1-16. https://doi.org/ 10.3390/bs14070564

Lent, R. W., Brown, S. D., Brenner, B., Chopra, S. B., Davis, T., Talleyrand, R., & Suthakaran, V. (2001). The role of contextual supports and barriers in the choice of Math/Science educational options: A test of social cognitive hypotheses. *Journal of Counseling Psychology, 48 (4),* 474-483. DOI: 10.1037/0022-0167.48.4.474

Lippke, S. (2020). Self-efficacy theory. *Encyclopedia of Personality and Individual Differences,* 4722-4727. https://link.springer.com/referenceworkentry/10.1007/978-3-319-24612-3_1167

Liu, X., Zhu, C., Dong, Z., & Luo, Y. (2024). The relationship between stress and academic self-efficacy among students at elite colleges: a longitudinal analysis. *Behav. Sci., 14 (537),* 1-14. https://doi.org/ 10.3390/bs14070537

Louis, R. A. & Mistele, J. M. (2011). The differences in scores and self-efficacy by student gender in mathematics and science. *International Journal of Science and Mathematics Education, 10,* 1163-1190. https://link.springer.com/content/pdf/10.1007/s10763-011-9325-9.pdf

Maddux, J. E. (n. d.). Self-efficacy. *Handbook of social and clinical psychology*, 57-78. file:///C:/Users/manga/Downloads/Chapter%204.pdf

Robnett, R. D., Chemers, M. M., & Zurbriggen, E. L. (2015). Longitudinal associations among undergraduates' research experience, self-efficacy, and identity. *Journal of Research in Science Teaching, 52 (6),* 847-867. https:// doi.org/10.1002/tea.21221

Schmidt, J. A., & Shumow, L. (2012). Change in self-efficacy in high school science classrooms: An analysis by gender. *Nova Science Publishers*. https://www.novapublishers.com/wp-content/uploads/2019/05/978-1-61470-828-5_ch3.pdf

Sezginturk, M., & Sungur, S. (2020). A multidimensional investigation of students' science self-efficacy: The role of gender. *Ilkogretim Online - Elementary Education Online, 19 (1),* 208-218. doi:10.17051/ilkonline.2020.653660

Shivani. (2018). Effect of experiential learning programme on academic achievement science self-efficacy and scientific attitude of secondary school students. [Doctoral thesis, Panjab University, Chandigarh]. http://hdl.handle.net/10603/326696

Stajkovic, A. D., & Luthans, F. (1998). Self-efficacy and work-related performance: A meta-analysis. *Psychological Bulletin, 124 (2),* 240-261. DOI: 10.1037/0033-2909.124.2.240

Tan, C. Y., Gao, L., Hong, X., Song, Q. (2023). Socioeconomic status and students' science self-efficacy. *British Educational Research Journal, 49 (4),* 782-832. https://doi.org/10.1002/berj.3869

Uysal, N. K., & Arikan, C. A. (2018). Measurement invariance of science self-efficacy scale in PISA. *International Journal of Assessment Tools in Education, 5 (2),* 325-338. DOI: 10.21449/ijate.379508

Wang, Y-L., & Tsai, C-C. (2016). Taiwanese students' science learning self-efficacy and teacher and student science hardiness: a multilevel model approach. *Eur J Psychol Educ, 31 (4),* 537-555. https://www.jstor.org/stable/44951851

Webb-Williams, J. (2017). Science self-efficacy in the primary classroom: Using mixed methods to investigate sources of self-efficacy. *Res Sci Educ, 48*, 939-961. DOI 10.1007/s11165-016-9592-0

Williams, M. M., & George-Jackson, C. E. (2014). Using and doing science: Gender, self-efficacy, and science identity of undergraduate students in stem. *Journal of Women and Minorities in Science and Engineering, 20 (2),* 99-126.

Xueli, W. (2013). Why students choose stem majors: Motivation, high school learning, and postsecondary context of support. *American Educational Research Journal*, 50 (5), 1081-1121. DOI: 10.3102/0002831213488622

Zeldin, A. L., & Frank, P. (2000). Against the odds: Self-efficacy beliefs of women in mathematical, scientific, and technological careers. *American Educational Research Journal*, 37 (1), 215-246. DOI: 10.3102/00028312037001215

Zeldin, A. L., Britner, S. L., & Pajares, F. (2008). A comparative study of the self-efficacy beliefs of successful men and women in mathematics, science, and technology careers. *Journal of Research in Science Teaching, 45 (9),* 1036-1058. DOI 10.1002/tea.20195