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PROMOTION OF STEM CAREER CULTURE AMONG SECONDARY SCHOOL STUDENTS: MEDIATING ROLE OF SCIENCE IDENTITY IN RELATIONSHIP BETWEEN SCIENCE SELF-EFFICACY AND SCIENCE CAREER COMMITMENT

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ABSTRACT

Given the importance of Science, Technology, Engineering and Mathematics (STEM) education, a certain culture of inclination towards careers associated with this field must be developed at school level. In this context, certain psychological variables such as self- efficacy and science identity play a crucial role for developing career commitment in STEM related fields. The present study aims to analyze the relationship between science self-efficacy, science career commitment and the possible mediating role of science identity among secondary school students. Data was collected from 1125 students with boys (N= 659,58.57%) and girls (N=466, 41.43%) from secondary schools of Odisha, India. The instruments used for the study were, the Science Career Commitment scale(SCCS), originally developed by Chemers et. al. (2011), Science Identity (SciID) scale, originally developed by Lockhart et al., (2022) and Science Motivation Questionnaire II (SMQ-II) scale, originally developed by Glynn and Koballa (2006), which were validated in Indian context. The results of the study revealed that there are significant correlations between science self-efficacy, science identity and science career commitment. The high correlation among the three variables indicates that the students with high self-efficacy in science, identify himself or herself as science person and also show commitment towards science related field. It was also found that, science identity plays a mediatory role between science self-efficacy and science career commitment. The implications of the study indicates that by promoting such psychological entities, STEM career culture can be deeply rooted among the secondary school students.

KEYWORDS: STEM Career Culture, Science Self-Efficacy, Science Identity, Science Career Commitment, Secondary School Students.

1. INTRODUCTION

In all stages of school education, science learning is an important part that fosters curiosity, inquiry and observation based learning along with 21st century skills among learners. It ignites young minds to search for innovative things around their surroundings. The present need of any country towards the creation of knowledge based economy, focuses on the implementation of the Science, Technology, Engineering and Mathematics (STEM) education at school level, which may lead to a vibrant science and techno-based society. Different studies indicate that STEM field significantly contribute for the economic growth of the nation (Barro, 1991; Salai-Martin, Doppelhofer, & Miller, 2004; Mankiw, Romer, & Weil, 1992). But irrespective of the rising demands of STEM education, enrolment in STEM education is gradually declining, that compels the educationists and policy makers to take certain concrete steps to encourage students to undertake STEM as career (Ali & Shubra, 2010; Sjøberg & Schreiner, 2005). In the research report developed by Sharma & Yarlagadda (2018), the researchers emphasized that Government of India is aware about the STEM education situation in the country and developed strategies to improve the quality of STEM education at school level. National Innovation and Science Agenda Report (2015) and National Policy on Education (2016) emphasized on providing innovative and vibrant education for developing competencies of the students through quality infrastructural and skilled teacher development. But Malti and Sarangapani(2017) reported that there are three most important factors that affect science education adversely. These factors are unavailability of quality infrastructure and equipment, trained science teachers and science education focused curriculum. At the same time Sharma & Yarlagadda (2018) reported that lack of experiential, inquiry – based learning along with hands on activities at high school level, increases dropout rate of science education. Science, Technology and Innovation Policy (2013) emphasized that for sustainable development and economic growth science, technology and innovation act as key factors. This can be achieved by providing an equity based support in science education at all levels, especially at school level. Along with this exercise, the psychological variables such as self-efficacy, intrinsic motivation and science identity etc. need to be fostered among the students to sustain their continuous engagement which may leads to their career commitment. Science identity refers to students' perceptions of who they are, what they believe they are capable of, and what they want to do and become with regard to science (Stanly & Brickhouse, 2001). This construct can also be based on students' view on themselves and their thinking towards others while participating in science-related tasks (Aschbacher et al., 2010). On the other hand, the variable science self-efficacy was defined by Robnelt et al.(2015) as a person's belief in the ability for completing a science related task completely. This psychological construct determines one's capability to organize and perform certain task wholeheartedly. Different researchers revealed that students with high self-efficacy, engaged them in the academic activities meaningfully and also have high academic achievement (Oliver et al.,2019). Hence, students with strong science self-efficacy, belief in his ability to succeed in the field of science. Chen et al., (2016) and Shang et al., (2022) find out that there is a relation between students' engagement in academic activities and career outcomes.

A culture to promote secondary school students to pursue STEM related careers early in their education must be promoted in the country. Such a trend can be developed in the schools if the critical science education variables and their interrelationships are accurately measured using robust statistical techniques. Also a culture of using open ware for conducting research in science education by the teachers in the secondary schools must be promoted. The present study tried to address this relevant aspects of science education by identifying science identity, science self-efficacy and science career commitment as the pertinent variables and conducted mediation analysis using Jamovi open ware. So, looking into the importance of science self-efficacy and science identity towards science career commitment the present study focuses to establish the relationship of science self-efficacy, science identity and science career commitment in Indian context.

1.2. Theoretical Background of Career Commitment

"Social Cognitive Career Theory (SCCT)", developed by Lent, Brown, and Hackett (1994) is widely accepted theory that helps to understand career choice and commitment. This theory suggests that the career commitment is based on three factors such as, self-efficacy beliefs, outcome expectations and personal goals. If an individual believes on his/her capability and is aware about the outcomes of the success, then he/she can show interest in choosing career in that particular field and set goals to get success. In this context, this theory can be extended to science education, where an individual with high science self-efficacy and knowledge of the expected outcomes of a particular field in science, may be committed to choose a career in that particular field. Kalbers and Fogarty (1995) reported that a person with career commitment shows development of self-esteem and productive income. Blau (1985) & Carson and Bedeian (1994), explained that, ‘career commitment is one’s attitude towards a particular profession or vocation, that includes, one’s willingness and enthusiasm to work in order to achieve the goal of that chosen career’. It is also explained as, “one’s attitude towards one’s profession or vocation" (Blau, 1985) or “one’s motivation to work in a chosen career role” (Hall, 1971). Research studies highlighted that career success is determined by career commitment and it develops self-esteem and confidence among the person (Kalbers and Fogarty, 1995). Some of the studies conducted by Littman-Ovadia & Lavy (2016) revealed that, an individual despite of several challenges shows high level of commitment towards desired goal, if he or she has high career commitment. This study intended to show the importance of this variable among the secondary school students in order to show commitment towards STEM related career especially in the field of science.

1.3. Theoretical Background of Science Self-Efficacy

In an educational set-up, the term self-efficacy coined by Bandura (1997) explained as an important variable that relates person’s belief on his/her ability to perform certain task (Wigfield et al., 2011; Wigfield and Eccles, 2023). Bandura (1977, 1986 and 1997) proposed that,’ Self- efficacy refers to individual’s belief on his/her capacity to display certain behaviour which is essential to achieve specific goal’. Studies conducted by Zeldin et al., (2008), Usher et al., (2019) and Zimmerman and Cleary (2009) revealed that, students’ academic achievement, task choice and planning for certain learning situation is determined by self-efficacy. Hence self-efficacy is considered as an important variable that builds confidence among the students on their ability. This factor needs to be nurtured carefully so that students can lead a better academic life focusing on their career commitment. Olivier et al., (2019) found out that students’ engagement and academic achievement are associated with self-efficacy. It was also found out by Azila-Gbettor et al.,(2021) and Close and Solberg, (2008) that self-efficacy plays a crucial role for self-regulation and academic engagement of the students. It also explained that science self-efficacy enables a person to do a particular task successfully, in the field of science by understanding his/her ability (Robnett et al., 2015). This variable strongly predicts academic achievement (Britnner, 2008) and career commitment (Chemers et al., 2010).

1.4. Theoretical Background of Science Identity

Science identity is an important variable that enables a person to identify himself/herself as science person. This term was initially proposed by Erikson (1959) who explained it as a primary task that enables an individual to choose a committed life by coping with the demands of developmental changes and social needs, among the adolescent human being (Erickson ,1959&1968; Bosma & Kunnen, 2008; Jensen, 2011; Schwartz et al., 2011; Hewlett, 2013; McLean & Syed, 2014; Was et al., 2009; Gee, 2000). Being an important psychological factor that is responsible for career choice and commitment, researches conducted several studies to find out different dimensions of science identity along with their predictors (Carlone & Johnson, 2007). In this context, Trujillo and Tanner (2014) revealed students with strong science identity, do science work innovatively. High school students with high science identity, actively participated in the science related activities (Vincent-Ruz and Schunn, 2019). A study conducted by Aschbacher et al. (2010) and Hazari et al.(2010) showed that students’ ‘persistence in science learning’ as well as ‘career selection’ are determined by science identity.

2. THE PRESENT STUDY

Different psychological studies emphasized that the construct like self-efficacy, identity, motivation etc. play crucial roles for career choice and career commitment in STEM related fields.

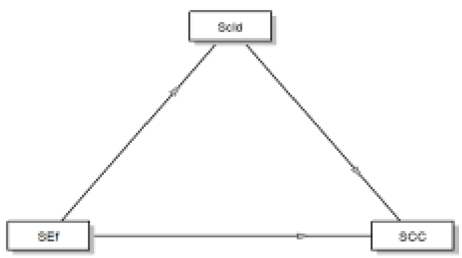

Figure 1: Proposed Model (ScId–Science Identity, SEf–Science Self-Efficacy, and SCC–Science Career Commitment).

The present study focuses on investigating the relationship between three variables; science self-efficacy, science identity and science career commitment. Along with this objective, the study estimates the mediatory role of science identity in relation with science self-efficacy and science career commitment. The proposed model is given in fig.1.

3. METHODS

3.1. Sample

1125 students (659boys and 466 girls) from eight schools of three zones of Odisha, India, affiliated to the Central Board of Secondary Education, voluntarily participated in the study. All the students received instructions in English throughout their academic life and were fluent in the language. The investigator sought and obtained formal permission from the institution to gather data for her research work having personally visited it.

3.2. Instruments

Science Self-efficacy was measured by using the Indian context validated tool of Science Motivation Questionnaire –II originally developed by Glynn et. al., (2009). The original scale has five items for measuring self-efficacy with responses as: never (0), rarely (1), sometimes (2), often (3) or always (4). The score range for each of the five items of the scale is 0-20 (Glynn et. al., 2009). The original scale reported a reliability estimate Cronbach's alpha coefficient of 0.9. Sample items of this scale are "I am confident I will do well on science tests" and "I am confident I will do well on science labs and projects". After scale validation, the same five number of items retained with scale reliability, Cronbach's alpha coefficient measured 0.862.

In this study for measuring science Identity of the secondary school students an Indian context validated scale, originally developed by Lockhart et al., (2022) was used. The original scale contains 16 items and the responses are collected using a five-point Likert scale with categories varying from, Strongly Disagree -1 to Strongly Agree-5. After validation of the scale in Indian context, it was found that 14 items retained in the scale and with scale reliability 0.862.

To measure science career commitment for the secondary school students an Indian context validated scale, originally developed by Chemers et. al. (2011) was used in the study. The original scale with 07 items and the responses are collected by using a five-point Likert scale and the scores ranged from the categories Strongly Disagree -1 to Strongly Agree -5. The validated scale retained the same seven items with reliability 0.96.

3.3. Procedure of Data Collection

At first the approval of the Ethics committee, Lovely Professional University, Punjab was done. Then the permission was taken from Principals of the sample school for data collection. Then researcher explained the purpose of the study in the classroom. Both boys and girls voluntarily participated in the survey. The participants also signed on the informed consent before the survey. On an average 45 minutes was taken by the participants to give their response on the questionnaire.

4. RESULT

The collected data were analysed by using SPSS Amos Version 23. Along with descriptive statistics analysis, internal consistency and correlation among the variables were found out. The hypothesized model is tested by a series of statistical analysis through Structural Equation Modelling (SEM).

4.1. Descriptive Statistic Analysis

The mean value of science career commitment was found as 3.727 that indicated that the sample subjects gave positive response towards science career commitment i.e they had moderate to high science career commitment. Negative skewness indicated that the data was distributed towards left i.e major participant gave high scoring.

Table 1: Descriptive Statistic Analysis of Three Variables.

"Descriptive Statistics"						
"Variables"	"'Mean"	"Standard deviation"	"Skewness"		"Kutosis"	
			"Statistics"	"Std. Error"	"Statistics"	"Std. Error"
Science Career Commitment(SCC)	3.727	0.94418	-1.148	0.073	0.384	0.146
Science Self-efficacy(SEf)	3.1979	0.58789	-1.822	0.073	2.598	0.146
Science Identity (ScId)	3.9765	0.77697	-1.691	0.073	1.558	0.146

The positive kutosis (0.384) with standard error (0.146) indicates that the data were distributed normally. The mean value of Science Self-efficacy was found as 3.1979, that indicated the subject gave positive response towards science motivation. Negative skewness indicated that the data was distributed towards left and major participant gave high scoring. The positive kutosis (2.598) indicated that most of the responses lies near to mean. It was found that science identity (Sid) had high value mean3.9765) among the three variables, showed that students identify them as science person strongly. The negative skewness (-1.691) indicated that students had high science identity.

4.2. Correlation Analysis

Science self-efficacy and science identity had strong positive correlation(r=0.772), this indicated that students with higher science self-efficacy, identify them as science person strongly. Science self-efficacy also had strong positive correlation with science career commitment(r=0.706), this indicated students with higher science self-efficacy, showed strong commitment towards science career. This was also found that science identity was strongly correlated to science career commitment (r=0.744), indicated that students with higher science identity, show greater commitment towards science related career.

Table 2: Correlation Analysis between Science Self-Efficacy, Science Identity, and Science Career.

Variables	SEf (Science Self-efficacy)	ScId (Science Identity)	Science Career Commitment (SCC)
SEf (Science Self-efficacy)	1		
ScId (Science Identity)	0.772**	1	
SCC(Science Career Commitment)	0.706**	0.744**	1

4.3. Mediation Analysis

The table-3 showed that the mediation estimates of science identity on the relationship between science self-efficacy and science career commitment. The analysis result showed that the measured value of direct effect of science self-efficacy on science career commitment was significant ("Estimate"= 0.522 and p< .001) and the indirect effect of science self-efficacy on science career commitment through the mediatory effect of science identity was also significant("Estimate"=0.611and p< .001). The total effect of the independent variables (science-self efficacy and science identity) on the dependent variable (Science career commitment) was also found to be significant ("Estimate"= 1.132 and p< .001), which showed that all variables had a strong relationship with each other.

Table 3: Direct and Indirect Effect of the Model.

Mediation Estimates 95% Confidence Interval								
Effect	Label	Estimate	SE	Lower	Upper	Z	P	% Mediation
Indirect	a*b	0.611	0.0400	0.532	0.689	15.3	< .001	53.9
Direct	C	0.522	0.0480	0.428	0.616	10.9	< .001	46.1
Total	C +a*b	1.132	0.0340	1.066	1.199	33.4	< .001	100.0

5. DISCUSSION

Research studies suggested that social and cultural factor especially ethnicity has an impact on the STEM career choice (Mansour, N.,2025). It was also found that different factors such as, students' science perception, stereotype association with science related activities and their engagement in extracurricular activities on science etc. determines STEM career choice (Mansour, N.,2025). Different psychological factors such as science self-efficacy, science identity determines STEM related career commitment. These psychological factors can be germinated through meaningful engagement of the learners. The present study examined the relationship between science self-efficacy, science career commitment and science identity. Along with this the mediating role of science identity in relationship between science self-efficacy and science career commitment were analyzed. Before applying structural equation modelling(SEM), the constructs were validated in Indian context, focusing on goodness-of-fit indices as per the criterion developed by Bentler and Bonett (1980) and Kline (2016). In this proposed model, science self-efficacy is taken as independent variable, science career commitment as dependent variable and science identity as mediating variable. The correlation analysis between the variables were analysed. It was found that science self-efficacy had strong, positive and highly significant correlations with both science identity and science career commitment, which indicated that the students with higher science self-efficacy, identify as science person strongly and showed strong commitment towards science related career. The correlation analysis also revealed that science identity was strongly correlated to science career commitment, which was highly significant also. This indicated that students with stronger science identity, show strong commitment towards science related career. The mediation analysis result showed that, science identity played a mediating role between the relationship of science self-efficacy and science career commitment.

Looking into the importance of these psychological variables for secondary school students pertinent to STEM education, this study will show a direction to prepare strategic plan to revamp science education at school level, in Indian context especially in Odisha. This study revealed that among the secondary school students of Odisha, science identity plays a crucial role towards science career commitment, even they have self-efficacy on science. This empirical study will help curriculum planner to develop a science curriculum integrated with experiential learning and hands-on activities. This work also shows a path for policy level decision on STEM education.

This study has certain limitations. Although the study covers a larger part of the Odisha, but the in order to generalize, it must be conducted in other geographically and culturally diverse part of this country on same sample. This study has societal implications with focusing on STEM education in Indian context.

6. CONCLUSION

The present study tries to show that the role of science self-efficacy and science identity in developing science career commitment among the secondary school students. The result of this study indicated that science identity had the mediating effect in relationship between science self-efficacy and science career commitment. It was also found that science self-efficacy is the strong predictor of science career commitment. The finding of the study suggested that the psychological variables like, science self-efficacy and science identity need to be foster among the secondary school students through different interventions at school level, so that the commitment towards science related career can be developed among them, which could be possible through meaningful engagement of the students with innovative activities on science (Iztek-Greulich and Vollmer, 2017). Different innovative intervention programme on science at school level can ultimately foster the culture of STEM career opportunities at school level.

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REFERENCES

Ali, A., & Shubra, C. (2010). Efforts to reverse the trend of enrollment decline in computer science programs. Issues in Informing Science and Information Technology, 7, 209-224.

Aschbacher, P. R., Li, E., & Roth, E. J. (2010). Is science me? High school students' identities, participation and aspirations in science, engineering, and medicine. Journal of Research in Science Teaching, 47(5), 564–582

Azila-Gbettor, E. M., Mensah, C., Abiemo, M. K., Bokor, M., and Awan, R. U. N. (2021). Predicting student engagement from self-efficacy and autonomous motivation: a cross-sectional study. Cogent. Education 8, 1–14. doi: 10.1080/2331186X.

Bandura, A. (1977). Self-efficacy: toward a unifying theory of behavioral change. Psychological Review, 84(2), 191–215. https://doi.org/10.1037/0033- 295X.84.2.191.

Bandura, A. (2001). Social cognitive theory: An agentic perspective. Annual review of psychology, 52(1), 1-26.

Barro, R. J. (1991). Economic growth in a cross section of countries. The Quarterly Journal of Economics, 106(2), 407–443.

Bentler, P. M., and Bonett, D. G. (1980). Significance test and goodness of fit in the analysis of covariance structures. Psychol. Bull. 88:588.

Blau, G.J. The Measurement and Prediction of Career Commitment. J. Occup. Psychol. 1985, 58, 277–288.[CrossRef] 10. Brickhouse, N. W. (2001). Embodying science: a feminist perspective on learning. Journal of Research in Science Teaching, 38(3), 282–295.

Bosma, H. A., & Kunnen, E. S. (2008). Identity-in-context is not yet identity development-in-context. Journal of Adolescence, 31, 281–289. https://doi. org/10.1016/j.adolescence.2008.03.001

Carlone, H. B., & Johnson, A. (2007). Understanding the science experiences of successful women of color:

science identity as an analytic lens. Journal of Research in Science Teaching, 44(8), 1187–1218.
Carson, K. D. and Bedeian, A. G. (1994). Career Commitment: Construction of a measure and examination of its psychometric properties. Journal of Vocational Behaviour, 44, 237-262.
Chen, H., Fei, X., Guo, B., and Xin, X. (2016). The effects of career calling on study engagement: the perspective of social cognitive career theory. J. Psychol. Sci. 39, 659–665. doi: 10.16719/j.cnki.1671-6981.20160322.
Chemers, M. M., Zurbriggen, E. L., Syed, M., Goza, B. K., & Bearman, S. (2011). The role of efficacy and identity in science career commitment among underrepresented minority students. Journal of Social Issues, 67(3), 469-491.
Erikson, E. H. (1959). Identity and the life cycle. Norton.
Erikson, E. H. (1968). Identity, youth, and crisis. Norton.
Gee, J. P. (2000). Identity as an analytic lens for research in education. Review of Research in Education, 25, 99–125.
Glynn, S. M., Brickman, P., Armstrong, N., & Taasoobshirazi, G. (2011). Science motivation questionnaire II: Validation with science majors and nonscience majors. Journal of research in science teaching, 48(10), 1159-1176.
Hall, D. (1971). A theoretical model of career subidentity development in organizational settings. Organizational Behavior and Human Performance, 6, 50– 76.
Hazari, Z., Sonnert, G., Sadler, P. M., & Shanahan, M. C. (2010). Connecting high school physics experiences, outcome expectations, physics identity, and physics career choice: A gender study. Journal of research in science teaching, 47(8), 978-1003.
Hewlett, B. L. (2013). Adolescent identity: evolutionary, cultural and developmental perspectives. Routledge
Jensen, L. A. (2011). Bridging cultural and developmental approaches to psychology: new syntheses in theory, research, and policy. Oxford University Press.
Kalbers, L. P., & Fogarty, T. J. (1995). Professionalism and its consequences: A study of internal auditors. Auditing, 14(1), 64.
Kline, R. B. (2016). Principles and practice of structural equation modeling. New York, NY: Guilford Publications.
Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. Journal of vocational behavior, 45(1), 79-122.
Littman-Ovadia, H., & Lavy, S. (2016). Going the extra mile: Perseverance as a key character strength at work. Journal of Career Assessment, 24, 240–252.
Lockhart, M. E., Kwok, O. M., Yoon, M., & Wong, R. (2022). An important component to investigating STEM persistence: the development and validation of the science identity (SciID) scale. International Journal of STEM Education, 9(1), 34.
Malti. (2017). Need and importance of STEM education in Indian schools. Indian Journal of Research, 6(1), 852–853.
Mankiw, N. G., Romer, D., & Weil, D. N. (1992). A contribution to the empirics of economic growth. The Quarterly Journal of Economics, 107(2), 407–437.
Mansour, N. (2025). Exploring the impact of social, cultural, and science factors on students' STEM career preferences. Research in Science Education, 55(3), 641-668.
McLean, K. C., Syed, M., & Shucard, H. (2016). Bringing identity content to the fore: links to identity development processes.
Olivier, E., Archambault, I., De Clercq, M., and Galand, B. (2019). Student self-efficacy, classroom engagement, and academic achievement: comparing three theoretical frameworks. J. Youth Adoles. 48, 326–340. doi: 10.1007/s10964-018-0952-0.
Sala-i-Martin, X., Doppelhofer, G., & Miller, R. I. (2004). Determinants of long-term growth: A Bayesian averaging of classical estimates (BACE) approach. The American Economic Review, 94(4), 813–835
Sharma, J., & Yarlagadda, P. (2018). STEM education: strengthening policies for future skilled work-force. Science Reporter, 55(5), 43-46.
Science, Technology and Innovation Policy. (2013). Retrieved from http://www.dst. gov.in/sites/default/files/STI%20Policy% 202013-English.pdf
Shang, W., Yu, T., Liang, X., Wang, J., and Su, J. (2022). How does career calling influence preservice teachers' learning engagement? A multiple mediating roles of occupational self-efficacy and vocational outcome expectation. Front. Psychol. 13:874895. doi: 10.3389/fpsyg. 2022.874895.

Sharma, J., & Yarlagadda, P. K. (2018). Perspectives of 'STEM education and policies' for the development of a skilled workforce in Australia and India. International Journal of Science Education, 40(16), 1999-2022.

Sjøberg, S., & Schreiner, C. (2005, December). How do learners in different cultures relate to science and technology? Results and perspectives from the project ROSE (the Relevance of Science Education). In Asia-Pacific forum on science learning and teaching (Vol. 6, No. 2, pp. 1-17). The Education University of Hong Kong, Department of Science and Environmental Studies.

Stanley, W. B., & Brickhouse, N. W. (2001). Teaching sciences: The multicultural question revisited. Science Education, 85(1), 35-49.

Schwartz, S. J., Luyckx, K., & Vignoles, V. L. (2011). Handbook of identity theory and research. Springer. https://doi.org/10.1177/ 0894318411409427.

Trujillo, G., & Tanner, K. D. (2014). Considering the role of affect in learning: monitoring students' self-efficacy, sense of belonging, and science identity. CBE life Sciences Education, 13(1), 6–15.

Vincent-Ruz, P., & Schunn, C. D. (2019). Identity complexes and science identity in early secondary: monotopical or in combination with other topical identities. Research in Science Education, 1–22. Online published on 15 August 2019

Was, C. A., Al-Harthy, I., Stack-Oden, M., & Isaacson, R. M. (2009). Academic identity status and the relationship to achievement goal orientation. Electronic Journal of Research in Educational Psychology, 7(2), 627–652.

Wigfield, A., and Eccles, J. S. (2023). "The relevance of situated expectancy-value theory to understanding motivation and emotion in different contexts" in Motivation and emotion in learning and teaching across educational contexts (United Kingdom: Routledge), 3–18.