Academic Self-Concept of Secondary Science Education Students: A Structural Equation Modeling Approach

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Abstract

Academic self-concept (ASC), a construct recognized in education and psychology, is a significant factor influencing academic performance. Although numerous reports have examined college students' academic self-concept globally, little research has been conducted to ascertain the underlying factor structure and constructs of ASC among undergraduate secondary science majors in the Philippines. The primary objectives of this study were to examine the ASC of BSED college students and to ascertain the underlying factor structure of the ASC variables. The survey of 94 BSED Science students revealed an average general ASC. The EFA model revealed a two-factor structure for the observed variables. The SEM indicates a slight negative correlation between Positive ASC and Negative ASC. Students' sense of capability, pride in their college grades, and belief that studying hard pays off are all strongly associated with the Positive ACS. Students' feelings of being behind on classwork and a lack of necessary abilities for specific majors are heavily attributed to the negative ACS. According to the generated values for the model's good fit indices, the ACS SEM model of the study is an acceptable model. Additional research shall be conducted to further our understanding of students' Academic Self-concepts across disciplines and to validate the two-factor structure model developed in this study.

Keywords: Academic Self-Concept, Exploratory factor analysis, Structural-equation modeling, college students, JASP

Introduction

The self-concept, which is at the heart of human personality, is an individual's perception of his or her personal, social, and academic abilities. It is his set of self-perceptions, attributes, characteristics, qualities, deficiencies, limitations, and values that are descriptive of him. Academic self-concept is a critical aspect of self-concept. Academic self-concept is a psychological and educational construct that is defined as a person's perception of self in relation to academic achievement (Reyes, 1984). Generally, it has been demonstrated that students' academic self-concept has an effect on their academic achievement (Awad, 2007; Marsh, 2006; Cokley, 2000; Marsh et al., 2002). Marsh and Yeung (1997) argue that both are mutually reinforcing, with each contributing to the other's growth. This relationship creates a self-perpetuating cycle that benefits all school administrators. It demonstrates a relatively simple method for improving academic outcomes by focusing interventions on each student's academic self-concept.

The positive relationship between an individual's self-concept and his perception of himself as a student cannot be overlooked, as a growing body of evidence substantiates their existence. The Academic Self-Concept Scale (ASCS), developed by William Reynolds (Reynolds, 1988), is the only instrument currently available for assessing students' academic self-concept. The ASCS is the

most widely used quantitative instrument for assessing academic self-concept and for assessing students' confidence in their educational capabilities (Reynolds, 1988).

Marsh (1993) asserts that the academic self-concept varies by academic discipline. It is multifaceted. Consistent with the Shavelson model, this term encompasses both descriptive (e.g., I enjoy science) and evaluative (e.g., I am good at mathematics) aspects of self-perception; and b) when associated with academic self-concept, self-perceptions tend to emphasize scholastic competence rather than attitudes (Strein, 1993). Academic self-concept is defined broadly by Guay (2003) as students' feelings about themselves as learners; Trautwein (2006) defines it as how an individual views himself across a range of academic domains, abilities, and perceptions. It is founded on self-awareness acquired through personal experiences and interpretation of one's educational environment (Eccles, 2005).

Numerous studies have been conducted to examine college students' academic self-concepts and the underlying factor structure and constructs of academic self-concept, revealing variable factor structures across the sample studied (Cokley, 2000; Michie, Glachan, and Bray, 2001). One could argue that cultural values have an impact on an individual's academic self-concept. Interestingly, there have been few attempts to examine the academic self-concept of secondary education Science major students using ASCS. Given the critical role of academic self-concept in academic achievement, it appears worthwhile to conduct a detailed examination of the academic self-concept construct among BSED Science students in the Philippines. Thus, the primary objective of this study is to examine the academic self-concept of the sampled BSED Science college students and to ascertain the factor structure of the variables using exploratory factor analysis (EFA) and structural equation modeling (SEM).

Materials and Methods
Participants
The participants were 94 Bachelor of Secondary Education, Major in Science college students of the Polytechnic University of the Philippines enrolled during the 1st semester, 2020-2021.

Instrument
The Academic Self-Concept Survey (ASCS) was administered to participants (Reynolds, Ramirez, Magrina, and Allen, 1980). The ASCS is a 40-item questionnaire designed to ascertain students' attitudes toward academic activities. The ASCS employs a five-point Likert-type scale with a range of 1 (strongly disagree) to 5 (strongly agree). The ASCS score is interpreted in terms of its cumulative value. The greater the number or score, the more higher the ASC. Additionally, participants completed a demographic form that requested their gender, age, birth year, and section.

Procedure
Data collection took place between March 3 and 5, 2021. Respondents were recruited from three BSED Science undergraduate courses at the Polytechnic University of the Philippines' College of Education, Department of Elementary and Secondary Education. The 40-item ASCS questionnaire was converted to an online form using Google Forms and the link to the form, along with the confidentiality statement and agreement form, was sent to the participants' email addresses. For statistical processing and analysis, responses were downloaded and converted to comma-separated values (CSV).

Statistical Analysis
The validity of the ASCS construct was established using exploratory factor analysis (EFA). Kaiser–Meyer–Olkin (KMO) data were used to assess the data for factorization, as was Bartlett's test of sphericity. The number of factors to consider was determined using parallel analysis. The promax method was used, and a scree plot was created to confirm the factor count. The number of factors

was determined using this method by examining the eigenvalues of the scree plot. Variables were evaluated using the factor loadings. Factor loadings of 0.5 or greater were considered, while loadings of less than 0.5 were discarded (Field, 2009; Costello and Osborne, 2005). At least three variables were required for each factor to be stable (Comrey, 1988). The root mean square error of approximation (RMSEA) was used to assess the EFA model's additional fit.

The interrelationships between variables (observed variables and latent variables) were examined using Structural Equation Modeling (SEM) (MacCallum and Austin, 2000). SEM was used to validate the constructed model, which encompasses the domains of academic self-concept. The SEM model was generated using the Lavaan syntax. SEM analysis was conducted following the development of well-defined research questions. This was followed by the estimation of the parameters' significant levels. Following that, the model's fitness was determined using the recommended parameters for determining model fit. We considered chi-square values (Jöreskog and Sördom, 1992), the Goodness-of-Fit index (GFI) (Jöreskog and Sördom, 1992), the Comparative Fit Index (CFI) (Bentler, 1990), the Root Mean Square Error of Approximation (RMSEA) (Steiger, 1990), and the Parsimony GFI (Jöreskog and Sördom, 1992). (Mulaik et al., 1989). The fit model's estimates and significant levels of correlation were presented. The model indices used in the SEM analysis are summarized in Table 1.

Table 1. Model Fit Indices for SEM Analysis

Index	Name	Accepted Values
X2	Model Chi-Square	p-value >0.05
GFI	Goodness of Fit	GFI ≥ 0.95
(N) NFI	(Non) Normed Fit Index	NFI ≥ 0.95
TLI	Tucker Lewis Index (TLI)	NNFI ≥ 0.095
CFI	Comparative Fit Index	CFI ≥ 0.90
RMSEA	Root Mean Square Error of Approximation	RMSEA < 0.08
PGFI	Parsimony Goodness of Fit Index (PGFI)	PGFI ≥ 0.50

Results and Discussion

The survey received 94 responses. The sample included 50 females (53.2%) and 44 males (46.7%) with ages ranging from 17 to 21, with a mean of 19.68. The sample's mean Academic Self-Concept Score (ASCS) is 133.70, ranging from an average ASCS of 86.2 percent to a high ASCS of 11.7 percent (2.1 percent). The distribution of scale items exhibited a trend toward normality (Table 2), with a standard deviation of 13.699.

Table 2. Descriptive statistics of the respondents' profile and ASCS data.

	YEAR AND SECTION	SEX	AGE	Academic Self Concept Score
Valid	94	94	94	94
Missing	0	0	0	0
Mean			19.681	133.702
Std. Error of Mean			0.101	1.413
Std. Deviation			0.975	13.699
Minimum			17.000	80.000
Maximum			21.000	166.000
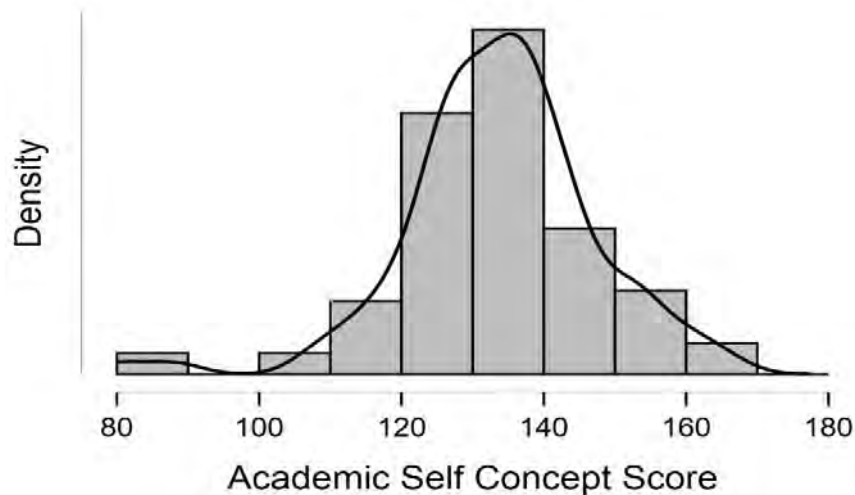
Figure 1. Academic Self-Concept Score of the respondents

Exploratory Factor Analysis

The suitability of the current data was determined using model selection criteria. The survey results from the 40-item ASCS questionnaire were analyzed using EFA to determine the scale's factorial validity. The values for the model-fit indices for EFA are summarized in Table 3. The model's Chi-square value was 0.001, indicating that the model is not acceptable. Other indices, such as the KMO and Bartlett's test of sphericity, were considered for the model. Kaiser-Meyer-Olkin sampling adequacy was 0.819 in this case, and Bartlett's test of sphericity reached statistical significance (p =.001) with an RMSEA of 0.082, indicating that these data were well suited for factor analysis (Kaiser, 1974; Bartlett, 1954). The values indicated that the model fit the data reasonably well.

Table 3. Fit indices concerning the established model.

Index	Name	Accepted Values	Model Results	Interpretation
Chi-square	Model Chi-Square	p-value >0.05	<0.001	Not acceptable
Bartlett's Test	Bartlett's Test	BT <0.05	<0.001	Acceptable
KMO Test	Kaiser-Meyer-Olkin Test	KMO ≥ 0.70	0.819	Acceptable
RMSEA	Root Mean Square Error of Approximation	RMSEA < 0.08	0.082	Acceptable

We obtained a two-factor solution with 24 variables. A scree plot was created to confirm the two-factor solutions. The scree plot of the ASCS data is shown in Figure 2. Any factor with an eigenvalue greater than one fully accounts for more variance than a single observed variable (Lewis-Beck et al., 2004). Two factors are considered in this case that are greater than the eigenvalue of one.

Factor 1 consisted of 14 observed variables referred to as the negative academic self-concept/self-doubt (NASC/Self-Doubt) and explained 58.33 percent of the variance, while Factor 2 consisted of ten observed variables referred to as the positive academic self-concept/self-confidence (PASC/Academic Confidence) explained 41.67 percent of the variance. Table 4 summarizes the items and their respective loadings in each factor.
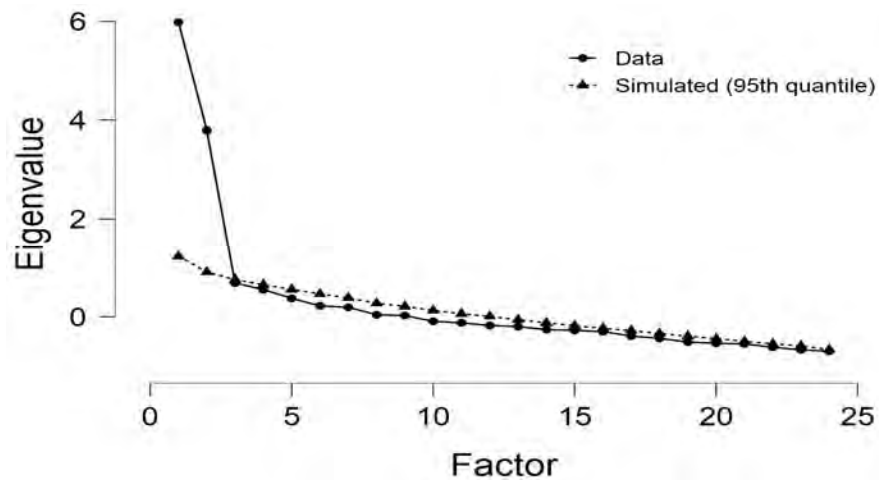
Figure 2. EFA Scree plot.

The variables have been grouped according to the generated two-factor structures. The factor loading values were used to identify and select variables for each factor. Variables with factor loadings greater than five were considered, while those with factor loadings less than five were deleted (Costello and Osborne, 2005). According to the factor loading values, q39 (I believe that I lack the necessary abilities for certain courses in my major.) has the highest loading value of .745 under Factor 1 (NASC/ Self-Doubt), while q01 (Studying is a very rewarding experience.) has the highest loading value under Factor 2 (PASC/ Academic-Confidence). The two variables have been analyzed and further interpreted in light of the concepts contained within them.

Table 4. Factor Loadings from EFA.

| ITEM	Factor Loadings	Variance Explained
Factor 1: Negative Academic Self Concept (Self-Doubt)		58.33%
q39. I feel that I do not have the necessary abilities for certain courses in my major.	0.745	
q19. It is hard for me to keep up with my class work.	0.719	
q26. I have a hard time getting through school.	0.678	
q21. At times I feel like a failure.	0.674	
q11. I sometimes feel like dropping out of school.	0.665	
q04. No matter how hard I try I do not do well in school.	0.64	
q12. Most of my classmates do better in school than I do.	0.618	
q38. In most of the subjects, I feel that my classmates are better prepared than I am.	0.61	
q24. I have doubts that I will do well in my major.	0.601	
q30. I often get discouraged about school.	0.586	
q14. At times I feel college is too difficult for me.	0.584	
q05. I often expect to do poorly on exams.	0.581	
q40. I have poor study habits.	0.572	
q18. I feel teachers' standards are too high for me.	0.557	

Factor 2: Positive Academic Self Concept (Academic-Confidence)		41.67%
q01. Being a student is a very rewarding experience.	0.7	
q02. If I try hard enough, I will be able to get good grades.	0.678	
q03. Most of the time my efforts in school are rewarded.	0.598	
q06. All in all, I feel I am a capable student.	0.632	
q07. I do well in my courses given the amount of time I dedicate to studying.	0.535	
q15. All in all, I am proud of my grades in college.	0.669	
q16. Most of the time while taking a test I feel confident.	0.523	
q17. I feel capable of helping others with their class work.	0.502	
q25. For me, studying hard pays off.	0.795	
q29. I'd like to be a much better student than I am now.	0.561	
Note. Applied rotation method is promax.		

Structural Equation Modeling

Table 5 details the goodness-of-fit indices for SEM models. The final models with the best fit had adequate goodness of fit indices (2/df = 0.054; CFI = 0.976; RMSEA (95 percent confidence interval) = 0.04; GFI 0.905; TLI = 0.973; and Parsimony of Goodness of Fit Index = 0.887). The model generated indicated significant residual covariances. The final SEM model's significant pathways are depicted in Figure 3. The model's diagnostics indicated that the variables are correlated with the generated latent variables. With 0.06 correlations, latent variable 1 (LV1) (NASC/Self-Doubt) and latent variable 2 (PASC/Academic-Confidence) are slightly negatively correlated. LV1 (NASC/Self-doubt) is highly correlated with the observed variables q19 and q39, which refer to students' perceptions of falling behind on classwork and not possessing the necessary abilities for certain courses in their majors, respectively. On the other hand, LV2 (PASC/Academic-Confidence) is highly correlated with the observed variables q6, q15, and q25, which measure students' sense of capability, pride in their college grades, and belief that studying hard pays off.

Table 5. Results of the Model Fit Indices of the SEM analysis

Index	Name	Accepted Values	Model Results	Interpreattion
X2	Model Chi-Square	p-value >0.05	0.054	Acceptable
GFI	Goodness of Fit	GFI ≥ 0.95	0.905	Acceptable
(N) NFI	(Non) Normed Fit Index	NFI ≥ 0.95	0.905	Acceptable
TLI	Tucker Lewis Index (TLI)	NNFI ≥ 0.095	0.973	Acceptable
CFI	Comparative Fit Index	CFI ≥ 0.90	0.976	Acceptable
RMSEA	Root Mean Square Error of Approximation	RMSEA < 0.08	0.04	Acceptable
PGFI	Parsimony Goodness of Fit Index (PGFI)	PGFI ≥ 0.50	0.887	Acceptable
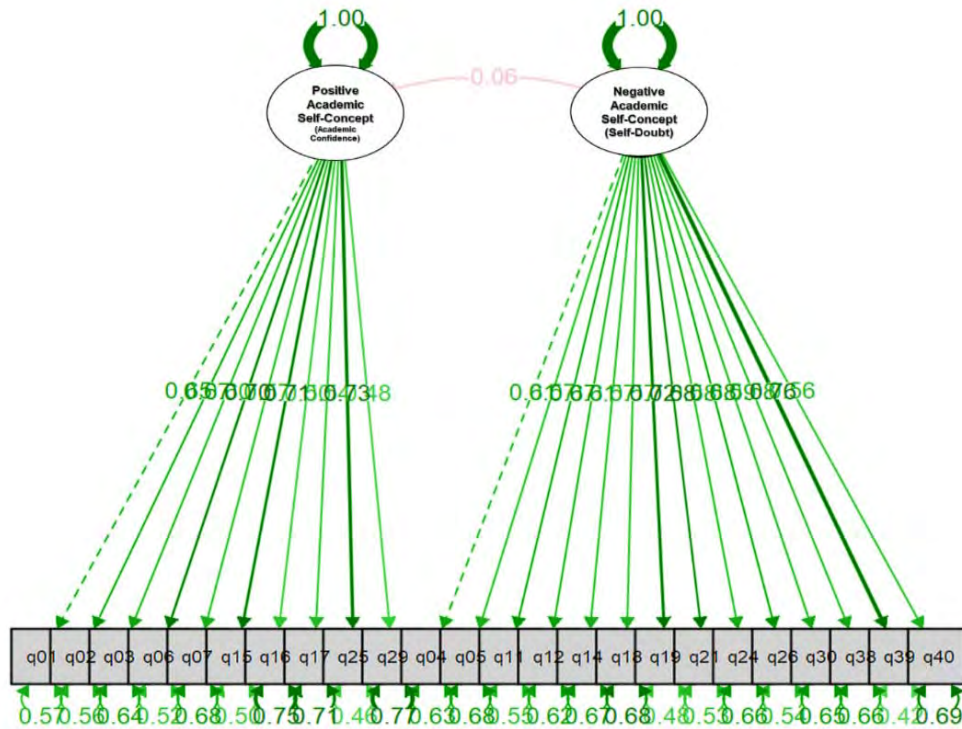
Figure 3. The SEM Model of Academic Self-concept

The model indicates a slight negative correlation between Factor 1 (Negative Academic Self-Concept/Self-Doubt) and Factor 2 (Positive Academic Self-Concept/Academic Confidence) (= 0.15, p.001).

Our analyses revealed an intriguing network of associations between several academic self-concept variables observed in BSED Science undergraduates. Taken together, the SEM analysis results revealed some valuable and practical implications for students and teachers regarding the connections between PASC/Academic Confidence and NASC/Self-Doubt. On the basis of the derived SEM model, some negative and positive correlations between the subscales of each main variable were identified. Existing research in education and psychology, particularly in the field of learning theories, explains how these observed variables are highly correlated with the derived latent variables in the SEM model (McLean et al., 2015; Strage and Brandth, 1999; Bandura, 1986; Erikson, 1969).

According to Erikson's theory of development, adolescents between the ages of 12 and 18 who are in the identity vs. role confusion stage struggle with questions such as "Who am I?" and "What do I want to do with my life?" (2015) (McLean et al.) As a result, they experiment with various roles and concepts, establish goals, and seek to discover their "adult" selves. This stage continues into early adulthood, when the concept of self becomes more complex than in the early stages of childhood. Additionally, as an individual matures, they recognize that their competence will vary across domains, recognizing that they may be skilled in one area but not in another (Harter, 1999).

Numerous factors may contribute to the development of self-concept. According to Azizi and Jaafar (2006), it is formed by a person's nature, maturity, and natural environment, particularly the family. Thus, the quality of these underlying influences has an effect on whether one develops a positive or negative self-concept. Strage and Brandth (1999) divided self-concept into two broad

categories or scales: positive and negative self-concept. The positive self concept refers to instances when an individual is more certain of himself, when he has positive interests and goals. A person who has a positive self-concept is capable of accepting criticism from others and then expressing logical opinions and outlooks, regardless of how illogical the surrounding circumstances are. On the other hand, a negative self-concept occurs when an individual's perceptions are excessively subjective and illogical. A negative self-concept is demonstrated by putting oneself and others down, rejecting compliments, performing poorly in school, and being hesitant to try new things, among other behaviors. Additionally, a negative self-concept has been linked to depression, substance abuse, and, in some girls, eating disorders. (2008) (Hadley) Negative self-concept divert an individual from learning and generates a feeling of incompetence and inferiority, as revealed by a study that is conducted to correlate self-concept and adjustment (Sarsani, 1997). When a person have negative self-concept, he tends to have no notion of who he really is, and experiences these subsequent feelings and manifestations: excessive self-defense; fear of being abandoned and rejected; reluctance in taking risks; failure to attain personal needs and wants; increased self-harm ideation patterns; incapability of developing personal and close relationships; and reduced capacity in solving problems. (2014) (Thomas).

According to Albert Bandura's Social Cognition Theory, learning occurs in a social context as a result of a dynamic and reciprocal interaction between the individual, the environment, and behavior. Bandura (1986) proposed that academic self-concept in particular school subjects influences task selection, motivation, sustained effort, and persistence, all of which contribute to an improved academic self-concept. Whether positive or negative, every student has an academic self-concept regarding his or her studies, examinations, and various subjects covered in class. Marsh, Byrne &Shavelson (1988) stated that Academic Self Concept involves a description and an evaluation of one's perceived academic abilities while Lent et al., (1997) have explained Academic Self Concept as specific attitudes, feelings and perceptions about one's intellectual or academic skills, representing a person's self-beliefs and self-feelings regarding the academic setting. According to Byrne (2003), Academic Self-Concept entails the description and evaluation of one's academic abilities. This includes global self-esteem beliefs connected to one's academic competence. There are a variety of social factors that contribute to the development of an academic self-concept and developing a positive academic self-concept has been related to people's behavior and emotions in other domains of their life, influencing happiness, self-esteem, self-confidence and anxiety levels to name a few. Self-confidence is an individual's characteristic (a self-construct) which enables a person to have a positive or realistic view onself or situations that the person is in (Sieler, 1998). Neill (2005) defined self-confidence as the combination of self-esteem and self-efficacy. Self-esteem, he defines, is a general sense of self-worth or self-value. A person with low self-esteem believes he or she is unimportant or insufficient, whereas a person with high self-esteem believes the opposite. On the other hand, self-efficacy is the belief in one's ability to succeed at tasks. Self-efficacy according to Neill (2005) can be general or specific where general self-efficacy is belief in one's general capacity to handle tasks and specific self-efficacy refers to beliefs about one's ability to perform specific tasks in certain things. Thus, academic self-confidence can be viewed as a component of self-efficacy, which also influences an individual's academic self-concept.

If students are accurate in their assessment of their abilities, their academic self-concept will eventually reflect their ability and achievement. However, evidence suggests that students are not always accurate in predicting their academic ability (Dunning, Heath, &Suls, 2004). Marsh and Craven (2006), however, demonstrate that academic self-concept has a positive effect on subsequent academic achievement (Byrne, 1996; Marsh & Craven, 2006; Marsh. 1993), implying that academic self-concept is multidimensional, indicating that it varies across academic subjects. Academic beha-

viors such as persistence, choice, and self-concept are hypothesized to be a function of task value and success expectations. Significant others' expectations, prior academic accomplishments, and interpretations of prior academic accomplishments all influence self-concept and ability, thereby affecting expectancies (Meece et al.,1982). The conclusion is that substantial empirical and theoretical evidence exists for a link between academic self-concept and subject course selection that may help students perform better in school. Baker (2004) identified skill and will as predictors of academic determination and motivation. These also define the students' academic self-concept, which incorporates their persistence into their learning strategy and pattern of learning. According to research, students who are autonomously motivated persist longer, organize their learning activities more effectively, are more concentrated, engage in deeper learning, earn higher grades, and feel better as a result of their motivation. Additionally, some studies examined the effect of self-determination abilities on classroom participation and direction-following abilities (Wehmeyer et al., 2005). While the various literatures in education and psychology have explored and explained the factors that contribute to a negative academic self-concept (Self-Doubt), According to Erikson's theory of development, an adolescent between the ages of 12 and 18, who is in the identity vs. role confusion stage, has difficulty answering questions such as "Who am I?" and "What do I want to do with my life?" (2015) (McLean et al.). As a result, they attempt to discover new roles, establish new goals, and come to terms with their "adult" selves. This stage continues into early adulthood, when the concept of self becomes more complex than in the early stages of childhood. Additionally, as a person matures, they begin to recognize that their competence will vary across domains; they recognize that they may be proficient in one area but not in another. (1999, Harter)

The process of developing one's self-esteem can be influenced by a variety of factors. Azizi and Jaafar (2006) identified it as being constructed by the individual's natural characteristics and his environment, most notably his family. Thus, these influences have an effect on a person's development of a positive or negative self-concept. A negative self-concept serves as a deterrent to learning. It instills feelings of inadequacy and inferiority (Sarsani, 1997). When a person has a negative self-concept, he or she is more likely to exhibit the following feelings and behaviors: excessive self-protection; fear of rejection or abandonment; reluctance to take risks; inability to address personal wants and needs; development of self-destructive thinking patterns that negatively characterize him; limited ability to form close, personal relationships or friendships. (2014) (Thomas). These detrimental behaviors have been observed frequently in our university classes. Additionally, students who feel more connected and friendly with their friends and who rely heavily on the assistance of their classmates perceive their classes as having less individualization and report less enjoyment from class activities.

Conclusions

The study reveals the BSED Science students' average Academic-Self concept. Based on the EFA model and the values generated to assess model fit, a two-factor structure for the observed variables was evident. The SEM indicates a slight negative correlation between Positive ASC and Negative ASC. Students' sense of capability, pride in their college grades, and belief that studying hard pays off are all strongly associated with the Positive ACS. Students' feelings of being behind on classwork and a lack of necessary abilities for specific majors are heavily attributed to the negative ACS. Based on the generated values for the model's goodness of fit indices, the SEM model is an acceptable model. Additional research should explore Academic Self-concepts across disciplines and to validate the two-factor structure model developed in this study.

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