Available online at: http://journal.uny.ac.id/index.php/jpms

Jurnal Pendidikan Matematika dan Sains, 14 (2), 2026, 424–432

Measuring Students' Self-concept: Instrument Development and Validation Using Exploratory Factor Analysis

Jafar Dahlan[1]*, Sudarto M. Abukasim [2], Desfi Annisa [3], Rasamimanana Joronavalona[4]

[1] Mathematics Education Department, Universitas Bumi Hijrah Tidore, Indonesia

[2] Mathematics Department, Universitas Muhammadiyah Maluku Utara, Indonesia

[3]Chemistry Education Department, Universitas Negeri Yogyakarta, Indonesia

[4]Pharmacology and Cosmetology, University of Antananarivo, Madagascar

*Corresponding author: dahlanjafar13@gmail.com

Abstract

This study aims to develop and examine the validity and reliability of an instrument designed to assess students' self-concept using an exploratory factor analysis (EFA) approach. A quantitative survey was conducted with 120 high school students in Pekanbaru, Indonesia, using a 12-item Likert-scale instrument. Content validity was established using Aiken's V, with all items exceeding 0.80. Construct validity was examined through EFA. The Kaiser-Meyer-Olkin (KMO) value was 0.752, and Bartlett's test was significant (p < 0.001), indicating data suitability. The analysis identified three factors: self-appearance, chemical knowledge, and evaluation of chemistry learning experience explaining 54.7% of total variance, with loadings above 0.30. The instrument showed good reliability (Cronbach's alpha = 0.806). These findings indicate that the instrument is valid and reliable for assessing students' self-concept in chemistry learning.

Keywords: *Construct validity, Content validity, Instrument development, Students' self-concept*

How to Cite: Dahlan, J., Abukasim, S. M., Annisa, D., & Joronavalona, R. (2026). Measuring students' self-concept: Instrument development and validation using exploratory factor analysis. *Jurnal Pendidikan Matematika dan Sains, 14*(2), 424–432. https://doi.org/10.21831/jpms.v14i2.96861

DOI: https://doi.org/10.21831/jpms.v14i2.96861

INTRODUCTION

Educational processes play an important role in shaping students' development, as learning and education are inherently interconnected, particularly in science-related contexts (Pratama et al., 2026). At the secondary school level, learning is closely linked to various psychological constructs that reflect both positive and negative student attitudes. Academic achievement is not determined solely by cognitive abilities; rather, it is also influenced by affective and motivational factors such as self-concept, interest, attitudes, and values. Within this framework, self-concept has been recognized as a critical factor that influences students' motivation and learning strategies, which subsequently affect their academic performance (Chacón-cuberos et al., 2025). Moreover, affective elements, including students' attitudes and motivation, significantly contribute to their level of engagement and overall success in learning (Liu, 2024; Ripsam & Nerdel, 2024). Self-concept itself is understood as a multidimensional construct consisting of interconnected components, incorporating both cognitive and affective perceptions individuals hold about themselves (García-Martínez et al., 2022). Recent findings further indicate that self-concept can be conceptualized across multiple domains that represent students' perceived competence as well as their emotional evaluations of learning experiences (Galán-arroyo et al., 2024).

Self-concept is a generic phrase that describes an individual's thoughts, assessments, or self-perception (Bharathi & Sreedevi, 2016). Similarly, a person's domain-specific views about their abilities are known as their self-concept, and this is also how students build their appraisals of their talents in a topic like chemistry (Nielsen & Yezierski, 2015). Individuals will act according to their self-concept and views of themselves. Academic self-concept, in particular, is a crucial issue in psychology and education. It is described as the self-perception a person has of their academic performance (Nja et al., 2022). This behavior is strongly influenced by the individual's perception of himself as a part of the system as a whole (Lichner et al., 2021). Self-concept is shaped by ongoing experience rather than being innate (Aufirandra & Khairani, 2020). Reveals self-concept as a psychological construct that encompasses an individual's positive or negative self-perception (Sikhwari, 2014). A person's self-concept encompasses their understanding of the physical, psychological, social, and other components of their self-image, as well as aspects derived from their experiences and relationships with others. A person who has a positive self-concept will know who he is, what he is capable of, and how to use his interests and skills to further his career. Academic self-concept and academic achievement indicators were found to be favorably correlated with general concepts and to be highly correlated with success in that curriculum area. In the context of chemistry learning, many students still lack confidence in their ability to solve chemistry-related problems (Wilkins, 2004).

Teachers need to understand students' perspectives and mindsets during the learning process, as these factors influence how students engage with classroom activities and respond to subject matter. Therefore, the development of instruments to measure students' self-concept is essential, particularly within specific learning contexts. Self-concept has been widely recognized as a crucial psychological construct contributing to students' academic performance and emotional development, emphasizing the importance of valid and reliable measurement tools (Hapsari et al., 2023; García-Martínez et al., 2022). Recent studies further highlight that self-concept is multidimensional and closely associated with students' motivation, resilience, and learning outcomes, making its accurate assessment increasingly important in educational research (Sabando-García et al., 2024; Sainz et al., 2025; Yu & Bailey, 2025).

However, despite extensive research, there remains a lack of consensus regarding the dimensional structure of self-concept, particularly in domain-specific learning contexts. Prior studies have proposed various dimensions, such as cognitive, affective, and behavioral components (Ranny et al., 2017; Veiga & Leite, 2016; Ordaz-Villegas et al., 2013), yet these frameworks are often generalized and not tailored to specific subject areas. Moreover, previous studies on self-concept instruments in secondary education have generally focused on theoretical aspects, while empirical studies examining the validity and reliability of the instruments through Exploratory Factor Analysis (EFA) remain limited. In addition, the dimensional structure of students' self-concept in chemistry learning contexts has not been widely explored, limiting the understanding of the nuanced and context-dependent nature of students' self-concept in science learning. Therefore, this study contributes to the development and validation of a self-concept instrument with empirically tested psychometric properties.

To address this gap, the present study develops a context-specific self-concept instrument based on three synthesized dimensions: self-appearance, chemistry knowledge, and learning evaluation, and examines its underlying factor structure using EFA. This approach offers a novel contribution by integrating general psychological constructs with subject-specific dimensions, thereby providing a more comprehensive and empirically validated measurement tool. The findings are expected to enhance the understanding of students' self-concept in chemistry learning and support the design of more effective educational interventions.

METHOD

The survey approach was employed in this quantitative study to collect numerical data related to students' attitudes, perceptions, and learning variables. According to Creswell & Creswell (2018), survey research is used to obtain quantitative information from a research sample. The study was conducted between May and June 2023 and involved 120 students from two public senior high schools in Pekanbaru, Indonesia. A cluster random sampling technique was applied. A cluster random sampling technique was applied. The respondents consisted of Grade 10 and Grade 11 students, comprising 40 male and 80 female students.. Instrument validity was assessed using EFA, while reliability was measured using Cronbach's alpha. The sample size (N = 120) was considered adequate for EFA because it met the minimum requirement for factor analysis and was proportional to the number of research indicators, as recommended by (Hair et al., 2019).

The variables in this study were measured using a self-report questionnaire designed to assess students' self-concept. The questionnaire must be appropriately developed for it to be an efficient tool for gathering data and to ensure that valid and reliable results are obtained. To gather information about the elements that influence students' perceptions of themselves when learning chemistry, the researcher employed a questionnaire. Twelve self-concept statement questions with alternative answer options (Strongly Agree, Agree, Moderately Agree, Disagree, Strongly Disagree) are included in the 5-point Likert scale.

Researchers created the data-gathering tool to gauge students' perceptions of their abilities in the classroom when learning chemistry. Self-concept consists of three dimensions: physical appearance, chemical knowledge, and evaluation of chemistry learning experience (Ranny et al., 2017; Veiga & Leite, 2016; Ordaz-Villegas et al., 2013). These are the definitions of the three components of self-concept: (1) self-appearance refers to students' perceptions of their physical appearance and self-image when engaging in chemistry learning, and (2) chemistry knowledge refers to students' intellectual understanding, including reasoning, thinking, and problem-solving abilities in chemistry.Additional information is shown in Table 1.

Table 1. Self-concept instrument

Dimensions	Items
Self-appearance	If the chemistry teacher assigns me to work on problems in front of the class, I'm excited about it. (1)
	I wear a lab coat when working in the lab to keep myself safe from chemical splashes. (2)
	I try my best to complete my chemistry tasks with diligence and seriousness. (3)
	I think that chemistry education is very beneficial. (4)
Chemistry knowledge	When the teacher gave me chemistry questions to complete, I became anxious. (5)
	I don't care if I'm running late for chemistry class. (6)
	It was just by chance that I was able to solve chemical issues successfully; if not, my incapacity would be the explanation. (7)
	When I have too difficult a chemistry task, I usually give up. (8)
	I'm not very good at chemistry stuff. (9)
	My chemistry exam results left me feeling let down. (10)
Learning evaluation	I am capable of handling difficult and demanding chemistry tasks. (11)
	I am happy with my chemistry exam results. (12)

The degree to which the instrument's items accurately reflect both the traits of the behavior to be measured and the elements that make up the object's overall content area is known as the instrument's content validity (Retnawati, 2016). The degree of content validity is determined by expert agreement on the topic of study, which is often referred to as the measured domain. This is because a measuring tool, such as a test or questionnaire, is considered legitimate if the expert evaluating it deems it to be an accurate indicator of the mastery of skills specified in the measurement domain or psychological field. For every item, the rater assigns a number between 1 (very imprecise) and 4 (very appropriate). We asked 12 items to be rated on aspects of self-concept by 7 raters. A method for determining content validity is to apply the V Aiken formula (Aiken, 1985).

A scaled construct validity test called EFA. To categorize and group numerous questionnaire questions from the research sample into components under a particular concept, EFA was used (Tabachnick & Fidell, 2007). Furthermore, EFA was performed using data from research samples to identify the best new components (Hair et al., 2010). Through the use of EFA, correlated original variables are reduced to new variables (sometimes referred to as factors or dimensions) that are uncorrelated with one another, and where the number of factors is less than the number of original variables (Kusno et al., 2021). Finding the latent construct in a set of items in a variable and defining a factor or dimension construct are the goals EFA. To determine whether the scale items can measure the construct and determine how the theoretical construct is simultaneous, it is important to examine the construct validity of the EFA.

The EFA analysis was performed using JASP 0.16.2.0 for Windows. Before conducting EFA, preliminary analyses, including Bartlett's Test of Sphericity and the Kaiser–Meyer–Olkin (KMO) test, were conducted to determine data suitability (Chan & Idris, 2017). EFA was conducted using maximum likelihood estimation (Kassim et al., 2013) with varimax rotation (Osborne, 2015). Factors were retained based on the criterion of eigenvalues greater than 1 (Yong & Pearce, 2013). In addition, items with factor loadings of 0.30 or higher were considered acceptable for retention (Prasetyo et al., 2019).

An instrument is considered reliable if it consistently yields the same results. For this reason, when the instrument is utilized at different times, it needs to have a consistent score (Mohamad et al., 2015). The instrument's Cronbach's alpha value is used to gauge its reliability. If the Cronbach Alpha (α) value of a variable or construct is greater than 0.6, it is considered dependable (Ghozali, 2011).

RESULT AND DISCUSSION

Every item has a value of V > 0.80, according to the validity calculation using Aiken's V. When V is more than 0.80, and there are seven expert opinions, the items are deemed valid (Retnawati, 2016). As a result, based on content validity, all items on the self-concept dimension are accepted.

Table 2. Result score on self-concept item

Item	V Aiken
Item 1	0,905
Item 2	0,905
Item 3	0,905
Item 4	0,810
Item 5	0,905
Item 6	0,905
Item 7	0,905
Item 8	0,905
Item 9	0,905
Item 10	0,905
Item 11	0.905
Item 12	0,857

The Kaiser–Meyer–Olkin Measure of Sampling Adequacy (KMO-MSA) was conducted to evaluate the suitability of the data for EFA. The results showed an overall KMO value of 0.752 (KMO > 0.50), indicating that the sample size was adequate for factor analysis (Table 3). In addition, all item MSA values exceeded 0.50, suggesting that each item was sufficiently correlated and appropriate for inclusion in the factor analysis procedure.

Table 3. KMO value output in JASP

Item	MSA
Overall MSA	0.752
Item1	0.757
Item2	0.731
Item3	0.739
Item4	0.692
Item5	0.614
Item6	0.711
Item7	0.746
Item8	0.792
Item9	0.816
Item10	0.875
Item11	0.713
Item12	0.793

The results of Bartlett's Test of Sphericity indicated a significant correlation among the variables, suggesting that the data were suitable for exploratory factor analysis ($p < 0.05$; Table 4). A significance value below 0.05 indicates that the correlation matrix is not an identity matrix and that the variables are sufficiently correlated for factor analysis

Table 4. Bartlett's test value output

X^2	df	p
632.118	66.00	<0.001

The variables are represented by the three factors using normal Eigenvalues of 1. Eigenvalues > 1 for all three factors indicate that there are more components than there are. Consequently, the variations of 21.8%, 20.3%, and 12.6% may be explained by Factor 1, Factor 2, and Factor 3. This means that 54.7% of the variance can be explained by the three factors.

Table 5. Total variance explained output

Factors	Sum Sq Loadings	Proporsi var	Cumulative
1	2.621	0.218	0.218
2	2.441	0.203	0.422
3	1.507	0.126	0.547

EFA results revealed three factors in the self-concept construct. Items 1, 2, 3, and 4 loaded onto the first factor, namely self-appearance. Items 5, 6, 7, 8, 9, and 10 loaded onto the second factor, namely chemistry knowledge. Items 11 and 12 loaded onto the third factor, namely, learning evaluation (Table 6). Based on the criterion that items with factor loadings below 0.30 should be excluded, all items in Factors 1, 2, and 3 were retained because they met the minimum loading requirement. In addition, the factor structure of the self-concept instrument is presented in the scree plot shown in Figure 2.

Table 6. Factor loading

Item	Factor 1	Factor 2	Factor 3	Uniqueness
Item1	0.367			0.322
Item2	0.822			0.294
Item3	0.928			0.559
Item4	0.812			0.672
Item5		0.648		0.413
Item6		0.532		0.123
Item7		0.560		0.659
Item8		0.755		0.401
Item9		0.562		0.263
Item10		0.686		0.549
Item11			0.756	0.677
Item12			0.432	0.501

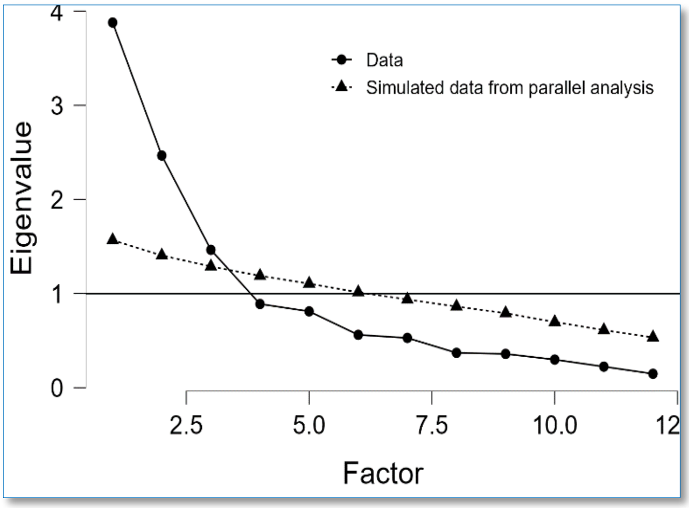

Figure 2. Self-concept scree plot on EFA model

Table 7. The Cronbach's alpha for each component and construct

Component	No of Items	Cronbach's Alpha
Self-appearance	4	0.842
Chemistry knowledge	6	0.793
Learning evaluation	2	0.469
Overall Self-Concept	12	0.806

Table 7 presents the reliability analysis of the 12 self-concept questionnaire items, with an overall Cronbach's alpha value of 0.806, indicating good reliability. However, the "learning evaluation" component showed a low reliability value ($\alpha = 0.469$), possibly due to the small number of items in the component. Nevertheless, the component was retained because the items demonstrated acceptable factor loadings and were conceptually relevant. Low Cronbach's alpha values may be influenced by a limited number of items and low inter-item correlations (Taber, 2018; Tavakol & Dennick, 2011). Overall, the results indicate that the instrument has adequate reliability for measuring students' self-concept, although the findings for this component should be interpreted cautiously.

The development of a valid and reliable instrument to measure students' self-concept requires both expert judgment and empirical testing (Kania et al., 2024; Setiawan et al., 2024; Yudha & Masrukan, 2014). In this study, expert judgment was employed to assess the relevance, clarity, and appropriateness of each questionnaire item before empirical analysis. The results of content validation using Aiken's V ranged from 0.810 to 0.905, exceeding the recommended threshold of 0.80, indicating acceptable content validity and that the items adequately represent the construct of students' self-concept (Prasetyo et al., 2019; Delgado-Rico, Elena Carretero-Dios & Ruch, 2012).

EFA confirmed that the data were suitable for factor analysis, with a Kaiser-Meyer-Olkin (KMO) value of 0.752 and a significant Bartlett's Test of Sphericity ($p < 0.001$), suggesting sufficient sample adequacy and inter-item correlations (Manzar et al., 2016; Leech et al., 2012; Horn, 1965). The analysis identified three dimensions of students' self-concept: self-appearance, chemistry knowledge, and learning evaluation, which together explained 54.7% of the total variance (21.8%, 20.3%, and 12.6%, respectively). All items demonstrated factor loadings ranging from 0.367 to 0.812, exceeding the acceptable threshold of 0.30, confirming the construct validity of the instrument.

These findings indicate that self-appearance reflects students' self-perception within the learning environment, chemistry understanding relates to cognitive abilities such as problem-solving and critical thinking, and learning evaluation reflects students' self-reflection on their learning experiences. This supports the view that self-concept is a multidimensional construct encompassing cognitive, affective, and evaluative dimensions (Shi et al., 2025; Wang & Yu, 2023; Marsh & Martin, 2011).

Finally, the instrument demonstrated good internal consistency (Cronbach's alpha = 0.806) and provides a practical tool for educators and researchers to assess students' self-concept in chemistry learning (Chinasa & Adanna, 2021; Amadi, 2021; Ahmed & Bruinsma, 2006). This instrument can support the identification of students' strengths and weaknesses and inform targeted interventions. Future research is recommended to apply Confirmatory Factor Analysis (CFA) to further validate the measurement model in broader educational contexts.

CONCLUSION

This study developed and validated a students' self-concept instrument using an EFA approach. The findings revealed three dimensions of self-concept: Self-Appearance, Chemistry Knowledge, and Learning Evaluation. All items showed factor loadings above 0.30, indicating adequate construct validity. The instrument also demonstrated good reliability, with a Cronbach's alpha of 0.806. However, this study was limited by the relatively small sample size and the low reliability of the Learning Evaluation dimension. Therefore, the findings should be interpreted cautiously. Future studies are recommended to involve larger samples and apply CFA to further validate the measurement model.

REFERENCES

Ahmed, W., & Bruinsma, M. (2006). A structural model of self-concept, autonomous motivation and academic performance in cross-cultural perspective. *Electronic Journal of Research in Educational Psychology*, *4*(10), 551–576.

Aiken. (1985). Three coefficients for analyzing the reliability and validity of ratings. *Educational and Psychological Measurement*, *45*(1), 131–142. https://doi.org/https://doi.org/10.1177/0013164485451012

Amadi, J. N. (2021). Relationship between self-concept, study habit and students' academic achievement in chemistry. *Rivers State University Journal of Education (RSUJOE)*, *24*(2), 140–146. https://rsujoe.com.ng/index.php/joe/article/view/70

Aufirandra, F., & Khairani, K. (2020). Self-concept of teenagers living with parents single parent in SMPN 25 Padang. *Jurnal Neo Konseling*, *3*(1), 104–110. https://doi.org/10.24036/00364kons2021

Bharathi, T., & Sreedevi, P. (2016). A study on the self-concept of adolescents. *International Journal of Science and Rsearch(ITSR)*, *5*(10), 512–516. https://www.ijsr.net/search_index_results_paperid.php?id=ART20162167

Chacón-cuberos, R., Serrano-garcía, J., & Serrano-garcía, I. (2025). Self-concept modulates motivation and learning strategies in higher education : Comparison according to sex. *Education Sciences*, 15(7), 1–19. https://doi.org/10.3390/ educsci15070873

Chan, L. L., & Idris, N. (2017). Validity and reliability of the instrument using exploratory factor analysis and cronbachâ's alpha. *International Journal of Academic Research in Business and Social Sciences*, *7*(10), 400–410. https://doi.org/10.6007/ijarbss/v7-i10/3387

Chinasa, G. P., & Adanna, A. A. (2021). Impact of generative learning model on academic self. *Unizik Journal of Educational Research and Policy Studies*, *7*, 309–322. https://unijerps.org

Creswell, J. W., & Creswell, J. D. (2018). *Research design: Qualitative, quantitative, and mixed methods approaches* (5th ed.). SAGE Publications.

Delgado-Rico, Elena Carretero-Dios, H., & Ruch, W. (2012). Content validity evidences in test development : an applied perspective. *International Journal of Clinical and Health Psychology España*, *12*(3), 449–460. https://doi.org/10.5167/uzh-64551

Galán-arroyo, C., Gómez-paniagua, S., Castillo-paredes, A., & Rojo-ramos, J. (2024). Assessment of multidimensional self-concept in the area of physical education: validation of a scale. *Frontiers in Sports and Active Living*, *January*, 1–10. https://doi.org/10.3389/fspor.2024.1333751

García-Martínez, I., Augusto-Landa, J. M., Quijano-López, R., & León, S. P. (2022). Self-concept as a mediator of the relation between university students' resilience and academic achievement. *Frontiers in Psychology*, *12*(January), 1–10. https://doi.org/10.3389/fpsyg.2021.747168

Ghozali, I. (2011). *Aplikasi analisis multivariate dengan program IBM SPSS*. Badan Penerbit Universitas Diponegoro.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2010). *Multivariate data analysis* (7th ed.). Pearson Prentice Hall.

Hair, J. F., Black, W. C., Babin, B. J., & Anderson, R. E. (2019). *Multivariate Data Analysis (8th ed.)*. (8th ed.). Pearson Prentice.

Hapsari, H. I., Huang, M.-C., & Kanita, M. W. (2023). Evaluating Self-concept measurements in adolescents : A systematic review. *Children*, *10*(399), 1–20. https://doi.org/10.3390/children10020399

Horn, J. L. (1965). Factors in factor analysis. *Psychometrika*, *30*(2), 179–185. https://doi.org/10.1007/BF02289447

Kania, N., Kusumah, Y. S., Dahlan, J. A., Nurlaelah, E., & Gürbüz, F. (2024). Constructing and providing content validity evidence through the Aiken's V index based on the experts ' judgments of the instrument to measure mathematical problem-solving skills. *REID (Research and Evaluation in Education)*, *10*(1), 64–79. http://journal.uny.ac.id/index.php/reid%0AConstructing

Kassim, S., Hasan, H., Mohd Ismon, A., & Muhammad Asri, F. (2013). Parameter estimation in factor analysis: Maximum likelihood versus principal component. *AIP Conference Proceedings*, *1522*, 1293–1299. https://doi.org/10.1063/1.4801279

Kusno, K., Natawidjaja, R. S., Sulistyowati, L., & Saefudin, B. R. (2021). Analisis faktor yang mendasari harapan konsumen terhadap atribut produk beras. *mimbar Agribisnis: Jurnal Pemikiran Masyarakat Ilmiah Berwawasan Agribisnis*, *7*(2), 1461. https://doi.org/10.25157/ma.v7i2.5449

Leech, N. L., Barrett, K. C., & Morgan, G. A. (2012). *IBM SPSS for intermediate statistics: Use and interpretation* (4th ed.). Routledge.

Lichner, V., Petriková, F., & Žiaková, E. (2021). Adolescents' self-concept in the context of risk behaviour and self-care. *International Journal of Adolescence and Youth*, *26*(1), 57–70. https://doi.org/10.1080/02673843.2021.1884102

Liu, P. (2024). Improving Student Motivation and Perception of Chemistry's Relevance by Learning about Semiconductors in a General Chemistry Course for Engineering Students. *Journal of Chemical Education, 101*. 411-419. https://doi.org/10.1021/acs.jchemed.3c00721

Manzar, M. D., Zannat, W., Hussain, M. E., Pandi-Perumal, S. R., Bahammam, A. S., Barakat, D., Ojike, N. I., Olaish, A., & Spence, D. W. (2016). Dimensionality of the pittsburgh sleep quality index in the collegiate young adults. *SpringerPlus*, *5*(1), 0–5. https://doi.org/10.1186/s40064-016-3234-x

Marsh, H. W., & Martin, A. J. (2011). Academic self-concept and academic achievement: Relations and causal ordering. *British Journal of Educational Psychology*, *81*(1), 59–77. https://doi.org/10.1348/000709910X503501

Mohamad, M. M., Sulaiman, N. L., Sern, L. C., & Salleh, K. M. (2015). Measuring the validity and reliability of research instruments. *Procedia - Social and Behavioral Sciences*, *204*(November 2014), 164–171. https://doi.org/10.1016/j.sbspro.2015.08.129

Nielsen, S. E., & Yezierski, E. (2015). Exploring the structure and function of the chemistry self-concept inventory with high school chemistry students. *Journal of Chemical Education*, *92* (11), 1782-1789. https://doi.org/10.1021/acs.jchemed.5b00302

Nja, C. O., Ukwetang, J. O., Orim, R. E., Neji, H. A., Edu, G. O., Ukah, J. U., & Olofu, M. A. (2022). Cultural resources, academic self-concept, and achievement of chemistry students in senior secondary schools of Calabar Municipality, Cross River State, Nigeria. *Frontiers in Education*, *7*, 01–12. https://doi.org/10.3389/feduc.2022.896833

Ordaz-Villegas, G., Acle-Tomasini, G., & Isabel Reyes-Lagunes, L. (2013). Development of an academic self-concept for adolescents (ASCA) scale. *Journal of Behavior, Health & Social Issues*, *5*(2), 117–130. https://doi.org/10.5460/jbhsi.v5.2.42304

Osborne, J. W. (2015). What is rotating in exploratory factor analysis? *Practical Assessment, Research & Evaluation*, *20*(2), 1–7. https://doi.org/10.7275/j7xj-mg87

Prasetyo, K., Masrukan, M., & Sunawan, S. (2019). The development of mathematical literation instruments based on class IV geometry material conservation. *Journal of Educational Research and Evaluation*, *8*(1), 1–13. https://doi.org/10.15294/jere.v8i1.28261

Pratama, F. I., Rohaeti, E. ., Laksono, E. W. ., & Joronavalona, R. . (2026). Literacy and Research-oriented Cooperative Problem-based Learning Model: Bridging Students' Chemical Literacy to Support Sustainable Education. *Jurnal Pendidikan IPA Indonesia*, *15*(1). 65–76 https://doi.org/10.15294/jpii.v15i1.35071

Ranny, M., R. A. A., Rianti, E., Amelia, S. H., Novita, M. N. N., & Lestarina, E. (2017). Konsep diri remaja dan peranan konseling. *Jurnal Penelitian Guru Indonesia*, *2*(2), 40–47. https://doi.org/10.29210/02233jpgi0005

Retnawati, H. (2016). *Validitas, reliabilitas, dan karakteristik butir: Panduan untuk peneliti, mahasiswa, dan psikometrian* (edisi pertama). Parama Publishing.

Ripsam, M., & Nerdel, C. (2024). Teachers ' attitudes and self-efficacy toward augmented reality in chemistry education. *Frontiers in Education*, *January*, 1–11. https://doi.org/10.3389/feduc.2023.1293571

Sabando-García, A. R., Jiménez-Bustillo, O. J., Llacsa-Puma, L. J., Castro-Castillo, G. J., Moreira-Choez, J. S., & Rengifo-Lozano, R. A. (2024). Measurement through structural equations of the self-concept instrument in high-school students. *Frontiers in Education*, *9*, 1–14. https://doi.org/10.3389/feduc.2024.1507106

Sainz, V., Álvarez-arjona, J. J., & Gómez-gutiérrez, J. L. (2025). Self-concept and academic performance in students with and without learning difficulties : A longitudinal study in an inclusive school setting. *Original Research*, 1–18. https://doi.org/10.1177/21582440251356072

Setiawan, R., Wagiran, & Alsamiri, Y. (2024). Construction of an instrument for evaluating the teaching process in higher education : Content and construct validity. *REID (Research and Evaluation in Education)*, *10*(1), 50–63. http://journal.uny.ac.id/index.php/reid

Shi, Y., Chen, M., Wei, Y., Shen, J., Wu, M., & Zhu, K. (2025). Understanding effects of engaging online learning environments on students ' cognitive engagement and well-being : the role of academic self-concept and flow. *Frontiers in Psychology*, *October*, 1–15. https://doi.org/10.3389/fpsyg.2025.1614109

Sikhwari, T. D. (2014). A Study of the relationship between motivation, self-concept, and academic achievement of students at a University in Limpopo Province, South Africa. *International Journal of Educational Sciences*, *6*(1), 19–25. https://doi.org/10.1080/09751122.2014.11890113

Tabachnick, B. G., & Fidell, L. S. (2007). *Using multivariate statistics* (5th ed.). Allyn & Bacon.

Taber, K. S. (2018). The use of Cronbach's alpha when developing and reporting research instruments in science education. *Research in Science Education*, *48*(6), 1273–1296. https://doi.org/10.1007/s11165-016-9602-2

Tavakol, M., & Dennick, R. (2011). Making sense of Cronbach's alpha. *International Journal of Medical Education*, *2*, 53–55. https://doi.org/10.5116/ijme.4dfb.8dfd

Veiga, F., & Leite, A. (2016). Adolescents' Self-concept Short Scale: A Version of PHCSCS. *Procedia - Social and Behavioral Sciences*, *217*(351), 631–637. https://doi.org/10.1016/j.sbspro.2016.02.079

Wang, L., & Yu, Z. (2023). Gender-moderated effects of academic self-concept on achievement, motivation, performance, and self-efficacy: A systematic review. *Frontiers in Pharmacology*, *14*, 01–15. https://doi.org/10.3389/fpsyg.2023.1136141

Wilkins, J. L. M. (2004). Mathematics and science self-concept: An international investigation. *Journal of Experimental Education*, *72*(4), 331–346. https://doi.org/10.3200/JEXE.72.4.331-346

Yong, G., & Pearce, S. (2013). A beginner's guide to factor analysis: focusing on exploratory factor analysis. *Tutorials in Quantitative Methods for Psychology*, *19*(2), 79–94. https://doi.org/10.20982/tqmp.09.2.p079

Yu, Y., & Bailey, A. L. (2025). Self-concept in first grade and academic performance trajectories : roles of gender and dual-language immersion versus English-medium program enrollment. *International Multilingual Research Journal*, *19*(4), 298–317. https://doi.org/10.1080/19313152.2024.2387990

Yudha, R. P., & Masrukan, D. (2014). Pengembangan Instrumen Asesmen Otentik Unjuk Kerja Materi Bangun Ruang Di Sekolah Dasar. *Journal of Educational Research and Evaluation*, *3*(2), 62–67

PROFIL SINGKAT

Jafar Dahlan is a permanent lecturer at Universitas Bumi Hijrah Tidore, Indonesia. He earned his Master's degree in Educational Research and Evaluation from Universitas Negeri Jakarta. He can be contacted via email at: dahlanjafar13@gmail.com

Sudarto M. Abukasim is a permanent lecturer at the University of Muhammadiyah North Maluku. He is currently pursuing a doctoral program at the Universitas Negeri Yogyakarta. He can be contacted via email at: sudartoabukasim21@gmail.com

Desfi Annisa is a doctoral student in Chemistry Education at Universitas Negeri Yogyakarta. Her areas of interest include chemistry learning instruments, chemistry learning models (especially inquiry-based learning), and educational psychology. She can be contacted at email: desfiiannisaa@gmail.com

Rasamimanana Joronavalona holds a Bachelor's degree in Pharmacology and Cosmetology and a Master's degree (Master 1) in Cosmetology from the University of Antananarivo, Madagascar. His research interests include project-based learning, immersive technology in chemistry education, and green cosmetic formulation. He has published several scientific articles in education and applied chemistry. Contact: rasamimanana.2024@student.uny.ac.id