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Development and Validation of a Self-Efficacy Instrument for University Students in Swimming Lessons

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ABSTRACT

Objective: This study aims to develop a self-efficacy measurement instrument for university students in swimming lessons based on Bandura's (1977) Self-Efficacy theory. The instrument was developed through 4 main dimensions, namely (1) D1 performance accomplishment, (2) D2 vicarious learning, (3) D3 verbal encouragement, and (4) D4 emotional states.
Methods and Materials: The development stages began with the preparation of instrument grids based on literature studies, content validity testing by experts, trial I with 203 students using exploratory factor analysis (EFA), and trial II with 323 students using confirmatory factor analysis (CFA). Measurements were taken with Google Forms while students were attending swimming lessons.
Results: The results showed that trial I, data feasibility testing, gave Kaiser-Meyer-Olkin (KMO) value of 0.946 and a significant Bartlett's Test ($\chi^2 = 5328$; $p < 0.001$). This indicated that the data were suitable for factor analysis. EFA produced 4 main factors that explained 62% of the total variance, with factor loadings of 0.343 to 0.828. A total of 31 items had a uniqueness value below 0.5, while 1 item was >0.8, leading to its removal. After the removal, a final instrument consisting of 31 statement items spread across the 4 dimensions was obtained. Test II, which examined the feasibility of the first-order CFA model, demonstrated acceptable model fit. The results indicated $\chi^2 = 990$, df = 430, $p < .001$, with a χ^2/df ratio of 2.302. Additional fit indices further supported the model's adequacy, namely Root Mean Square Error of Approximation (RMSEA) = 0.064 (90% CI: 0.058–0.069, $p < .001$), Standardized Root Mean Square Residual (SRMR) = 0.045, Comparative Fit Index (CFI) = 0.997, and Tucker–Lewis Index (TLI) = 0.997. All items in the 4 dimensions were declared valid, as evidenced by factor loading values of 0.688-0.966 and Average Variance Extracted (AVE) of 0.595-0.901. McDonald's omega ω_{1-3} values ranged from 0.882 to 0.939, and Cronbach's α ranged from 0.876 to 0.945. In the second order, the 4 dimensions were declared valid with loading factors of 0.93-0.97, AVE of 0.901, reliability ω_{1-3} of 0.926-0.935, and Cronbach's α of 0.945.
Conclusion: The developed self-efficacy instrument for swimming students proved to be psychometrically valid and reliable, making it suitable for use in identifying students' psychological readiness in swimming lessons.
Keywords: *Self-efficacy; swimming education; instrument development; factor analysis; content validity and reliability*

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1. Introduction

Prospective physical education teachers often do not all have sufficient swimming experience. This assumption is reflected in a previous study where the proportion of adults who cannot swim in high-income countries is 25% lower compared to low-income countries, reaching 75% (1). Several studies have shown that swimming ability affects mental readiness in learning to swim (2) and determines the accuracy of self-perceptions (3, 4). However, several students have been reported to possess perceptions that exceed their actual swimming ability (5).

Overestimating swimming ability can pose significant risks during swim learning, as such misjudgment may lead an individual to attempt tasks or enter water environments beyond actual competence, thereby increasing the likelihood of injury or drowning. The capacity for accurate self-assessment is therefore a critical component of water safety. When a learner perceives personal ability as exceeding actual competence, a tendency arises to select overly challenging tasks or water situations, which elevates safety risks (6). However, strong water safety knowledge can mitigate the negative effects of overconfidence by enabling adolescents to regulate behavior effectively and respond appropriately in demanding aquatic situations (7). In addition, the discrepancy between perception and actual ability is associated with frustration (8) and decreased motivation (9), which negatively impacts long-term engagement in physical activity (10).

To reduce these misperceptions, accurate and structured feedback from instructors, who play a crucial role in swimming instruction, is necessary (11, 12). Feedback can be provided on psychological aspects that play a significant role in determining an individual's success in facing challenges and achieving learning objectives, such as self-efficacy (13-15). The concept of self-efficacy was first introduced by Bandura (1977) as an individual's belief in their ability to organize and carry out the actions necessary to achieve a certain performance (16). In swimming instruction, self-efficacy not only influences students' motivation and perseverance (17), but also has a direct impact on learning outcomes in the form of performance (18, 19), technical mastery, and self-confidence (20).

Measurement of self-efficacy strengthens the ability of instructors to identify students' beliefs about learning to swim and provide appropriate guidance. This is particularly important for beginner swimmers, who need to be psychologically prepared to face the challenges of learning new techniques (21). Measuring self-efficacy in the context of swimming classes is crucial to understanding students' readiness and potential to learn optimally. Although various self- efficacy instruments have been developed in the fields of education and sports, there is no measurement tool specifically designed for the context of swimming classes in Indonesia. Therefore, this study aims to develop an instrument for measuring students' self-efficacy in swimming classes based on Bandura's 4 main sources, namely (1) performance accomplishment, (2) vicarious learning, (3) verbal encouragement, and (4) emotional states (16). The instrument was developed through systematic stages, starting from the preparation of a grid based on theory and literature, content validation by experts, preliminary testing using exploratory factor analysis (EFA), and construct validity testing through confirmatory factor analysis (CFA) (22-24). The results are expected to produce a valid and reliable instrument for use in evaluating swimming learning and developing intervention programs to improve students' self-efficacy.

2. Methods and Materials

2.1 Participants

The questionnaire trial was conducted in 2 trials, namely trials I and II. All participants were selected offline using the convenience sampling method. Students from swimming course in the Bachelor of Physical Education, Health and Recreation Study Program, Faculty of Sports Science and Health, Surabaya State University, were recruited as trial participants. In this study, participants were selected by filling out the questionnaire through a Google form provided during swimming lectures in the session when the material was explained in the classroom (not during swimming practice). Trial I was conducted in the even semester of the 2024/2025 academic year (completed June 7-17, 2024). Out of 241 students, a total of 203 students completed the questionnaire. Participants in Pilot Study II were recruited during the Fall Semester of 2025/2026 (questionnaire completion period: September 28 to October 5, 2025). Google Forms, used solely to reduce paper usage, was administered in class during lectures, with students completing the questionnaires under the supervision of a team of lecturers. This procedure minimized the risk of inaccuracies, missing data, or input errors. Although this had limitations, future studies including participants outside of the lecture context were encouraged to consider more controlled data collection methods or use survey platforms that offered additional verification features.

The total number of students enrolled in the swimming course was 367, with 323 students participating in the study. Those who did not complete the questionnaire were absent from class and did not bring their devices. The details of participant characteristics were as follows.

Table 1. Participant characteristics

Stage	Target	Participants	Gender		Age	
			Female	Male	Mean	Range
Trial I	Second-year students	203	74 (36%)	129 (64%)	19.9	18-22
Trial II	First-year students	323	103 (32%)	220 (68%)	18.5	17-22

This study used a convenience sampling method because the participants were students taking swimming courses this semester, making random sampling impossible. Although this method had limitations in terms of generalizing findings to a broader population, this approach was commonly used in classroom-based educational studies, especially when the target population was specific and related to the curriculum structure (25-27). Furthermore, the sample size in both testing stages met the minimum recommendation for factor analysis, which was 10 items (28, 29), thereby providing a strong empirical basis for the instrument's construct validity.

2.2 Initial Instrument Grid

Self-efficacy measurement according to Bandura's theory was assessed based on 4 main aspects, including performance accomplishment (mastery experiences), vicarious learning (vicarious experiences), verbal encouragement (verbal/social persuasion), and emotional states (physiological and emotional states) (16). These aspects were described and measured in several studies and used as the basis for developing self-efficacy instruments in various fields (30-32), including education, sports, and health (33). In this study, self-efficacy was developed to measure the self-efficacy of students taking swimming courses. Based on the results of a literature review, the following grid was developed for measuring self-efficacy.

Table 2. Theoretical model of self-efficacy questionnaire framework for swimming students

Dimension	Indicators	Item
Performance accomplishment	*Participant modelling*	1,2
	Performance desensitization	3,4
	Performance Exposure	5,6
	Self-Instructed Performance	7,8
Vicarious learning	*Live Modelling*	9,10,11,12
	Symbolic Modelling	13,14,15,16
Verbal encouragement	*Suggestion*	17,18
	Exhortation	19,20
	Self-Instruction	21,22
	Interpretative Treatments	23,24
Emotional States	*Attribution*	25,26
	Relaxation	27,28
	Symbolic desensitization	29,30
	Symbolic exposure	31,32

Based on this table, it was explained that the performance accomplishment dimension was measured using 4 indicators, namely participant modeling, performance desensitization, performance exposure, and self-instructed performance. The vicarious learning dimension was measured using 2 indicators, namely live modeling and symbolic modeling. Furthermore, the verbal encouragement dimension was measured using 4 indicators, such as suggestion, exhortation, self-instruction, and interpretative treatments. The emotional states dimension was measured using 4 indicators, namely attribution, relaxation, symbolic desensitization, and symbolic exposure. From these 4 dimensions and 14 indicators, 32 statements were derived, with each dimension having 8 statements. In this study, 3 experts, consisting of a professor of sports psychology, a professor of sports pedagogy, and a professor who taught swimming at a university, validated the content of the instrument with CVI value of 0.89 for relevance and 0.88 for essentiality, which was declared valid (34).

2.3 Data Analysis

Data analysis was conducted in 2 stages, namely EFA in the first trial and CFA in the second trial. The use of EFA and CFA was chosen because it was in accordance with the standards of psychometric instrument development, as recommended in the psychometric instrument development literature (24, 35, 36). EFA was used to explore the initial structure of the new instrument and ensure that the items cluster according to the selected theory (37, 38), while CFA was used to confirm the structure more rigorously through testing of goodness-of-fit, validity, and reliability (39-41). Other methods, such as PCA, were not used because it only reduced the data without modeling the latent construct independent performance, and the Rasch Model was not chosen because it was more suitable for unidimensional, ability-based instruments. This was usually used at the advanced item calibration stage, not at the initial stage of construct validation (42). The two-stage EFA–CFA approach represented best practice in psychological instrument development. All analyses were performed using the Jamovi version 2.6.26 application with Maximum Likelihood (ML) estimation method. EFA was used to identify the initial factor structure with the criteria of Kaiser-Meyer-Olkin (KMO) ≥ 0.70, Bartlett's Test significant ($p < 0.05$) (43, 44), factor loading ≥ 0.30, and uniqueness < 0.50 (36). CFA was used to test construct validity with model adequacy criteria $\chi^2/df \leq 5$, Root Mean Square Error of Approximation (RMSEA) ≤ 0.08, Standardized Root Mean Square Residual (SRMR) ≤ 0.08, Comparative Fit Index (CFI) ≥ 0.90, and Tucker–Lewis Index (TLI) ≥ 0.90 (36). Convergent validity was indicated by factor loadings ≥ 0.50, while construct reliability was considered adequate with Cronbach's α and McDonald's ω ≥ 0.70 (45).

3. Results

3.1 Trial I: Exploratory Factor Analysis (EFA)

Data suitability was used to explain whether the data being tested was suitable for factor analysis. Testing was carried out using 2 assumptions, namely KMO and Bartlett's Test of Sphericity.

Table 3. Model fit test

Test	Acceptance Threshold	Results	Description
Kaiser-Meyer-Olkin (KMO)	KMO ≥ 0.50 or ideal ≥ 0.70	0.946	Suitable
Bartlett's Test of Sphericity	*Chi-Square* (X^2) is large, $p < 0.05$	$X^2 = 5328$, $p<0.001$	Suitable

The data suitability test showed a KMO value of 0.946, and Bartlett's Test of Sphericity was significant ($\chi^2 = 5328$; $p < 0.001$), suggesting that the data were suitable for factor analysis.

3.2 Number of Factors Criteria

The extraction criteria explained the basis for determining the number of factors, which was determined based on the theory of self-efficacy measurement, namely 4 factors. This determination was commonly used because the number of factors retained was based on the clarity of theoretical interpretation, not just statistics (36). Results Eigenvalue ≥ 1 (Kaiser's criterion) s formed could be seen in Figure 1.

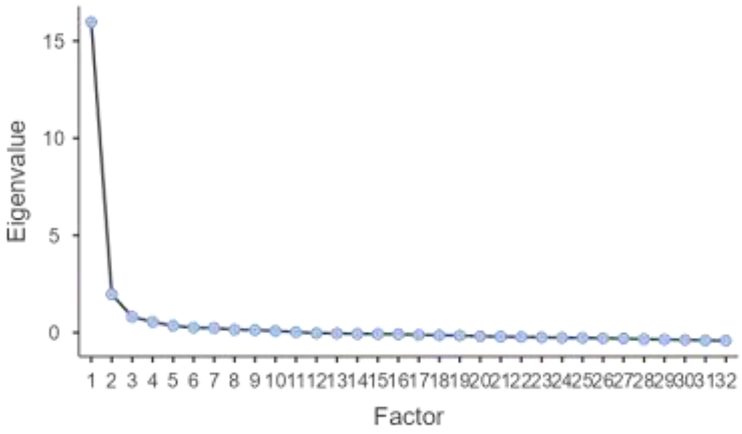

Figure 1. Eigenvalue plot formed by 4 factors

3.3 Factor Loading Values

After determining the 4 measurement factors, the factor loadings obtained from EFA analysis were explained as follows.

Table 4. Grouping and acceptance of items based on factor loadings and uniqueness

Item	*Factor*				Uniqueness (ψi)	
	1	2	3	4	Value	Category and Decision
B_11	0.466	0.350			0.484	Good, used
B_12	0.358	0.481			0.453	Good, used
B_13	0.443	0.302			0.480	Good, used
B_14	0.368				0.403	Good, used
B_15	0.409				0.483	Good, used
B_16	0.397	0.347			0.482	Good, used
B_17	0.307	0.343	0.310		0.415	Good, used
B_18	0.343		0.523		0.392	Good, used
B_21		0.667			0.356	Good, used
B_22		0.807			0.248	Good, used
B_23		0.828			0.264	Good, used
B_24		0.795			0.282	Good, used
B_25		0.780			0.320	Good, used
B_26		0.586			0.397	Good, used
B_27		0.739			0.308	Good, used
B_28		0.603			0.325	Good, used
B_31			0.377		0.427	Good, used
B_32			0.810		0.269	Good, used
B_33			0.845		0.244	Good, used
B_34			0.638		0.335	Good, used
B_35			0.552		0.321	Good, used
B_36			0.501		0.339	Good, used
B_37			0.499	0.329	0.267	Good, used
B_38			0.504	0.319	0.356	Good, used
B_41				0.391	0.813	Poor, deleted
B_42				0.539	0.464	Good, used
B_43			0.401	0.459	0.405	Good, used
B_44				0.554	0.420	Good, used
B_45				0.601	0.431	Good, used
B_46				0.790	0.269	Good, used
B_47			0.339	0.502	0.290	Good, used
B_48				0.570	0.424	Good, used

Note: items are accepted if λ ≥ 0.3 (36), and Uniqueness <0.5= Good; 0.5-0.7= Fair; >0.7= Poor (46).

Based on Table 4, the factor loading for all items met the requirement of being >0.3. Although some items showed cross-loading (B_11, 12, 13, 16, 17, 18, 37, 38, 43, and 47), factor selection was based on substantive considerations and theoretical suitability with the intended construct. This approach was consistent with the practices recommended in the literature (47-49), where content validity and conceptual relevance formed the basis for analytical decision-making. Based on uniqueness, 31 items with values between 0.244 and 0.484 were classified as good. B_41 had a value of 0.813 and was classified as poor in terms of uniqueness, as a result, this item was deleted. The measurement results of the proportion of total variance explained from the extraction results was presented in Table 5.

Table 5. Total variance explained

Factor	SS Loadings	% of Variance	Cumulative %
1	7.26	22.68	22.70
2	5.66	17.69	40.40
3	4.67	14.60	55.00
4	2.24	7.00	62.00

Based on the extraction results and Scree Plot display, 4 main factors were obtained that explained 62% of the total variance. These results were suitable for use in a social study where the total variance acceptance level was ≥50% (50)or ≥60% (36).

3.4 Trial II: Confirmatory Factor Analysis (CFA)

First-order CFA was conducted to test construct validity, consisting of 4 latent factors, namely D1: Performance accomplishment, D2: Vicarious learning, D3: Verbal encouragement, and D4: Emotional States. Each was measured by several indicators through statement items. The purpose of this analysis was to ensure that each indicator and statement truly represented the latent dimensions being measured. Furthermore, CFA model was estimated using the Maximum Likelihood (ML) method with a sample size of 323 participants. The analysis results showed that the model converged well without any error warnings during the estimation process (converged = TRUE).

Model Suitability (Goodness of Fit)

The results of CFA model feasibility test showed feasibility index values based on Chi-square (χ^2) = 990; df = 430; p < .001 (χ^2/df= 2.302), for RMSEA = 0.064 (CI: 0.058–0.069, p < .001), based on SRMR = 0.045, for CFI = 0.997, based on TLI = 0.997, indicating that this model was still acceptable (36). Overall, based on the parameters, the model could be categorized as having a good fit.

3.5 Loading Factor Results (Standardized Loading)

All indicators in the 4 factors had loading factor values ranging from 0.688 to 0.966 >0.5, AVE ranging from 0.595 to 0.901 >0.5. This showed that each indicator contributed strongly to the latent factor it represented, as presented in Table 6.

Table 6. Descriptive statistics and CFA results

Latent	Observed	Mean	SD	Shapiro-Wilk	β	AVE	α	ω_{1-3}
D1	B_11	4.29	0.679	0.776	0.761	0.595	0.876	0.882-0.905
	B_12	4.10	0.726	0.801	0.780			
	B_13	4.09	0.773	0.807	0.808			
	B_14	4.26	0.659	0.771	0.847			
	B_15	4.24	0.747	0.777	0.776			
	B_16	3.72	0.818	0.852	0.712			
	B_17	3.87	0.709	0.812	0.754			
	B_18	3.92	0.725	0.817	0.725			
D2	B_21	4.01	0.806	0.834	0.786	0.717	0.924	0.923-0.939
	B_22	4.16	0.686	0.796	0.865			
	B_23	4.04	0.730	0.823	0.860			
	B_24	4.10	0.726	0.801	0.858			
	B_25	3.93	0.803	0.841	0.842			
	B_26	3.85	0.803	0.848	0.796			

	B_27	3.88	0.777	0.843	0.899			
	B_28	4.07	0.708	0.799	0.862			
D3	B_31	4.26	0.627	0.769	0.894	0.756	0.936	0.929-0.936
	B_32	4.11	0.693	0.791	0.877			
	B_33	4.20	0.690	0.791	0.837			
	B_34	4.03	0.788	0.838	0.811			
	B_35	4.03	0.741	0.826	0.814			
	B_36	4.23	0.665	0.780	0.892			
	B_37	4.02	0.720	0.812	0.911			
	B_38	4.13	0.716	0.810	0.915			
D4	B_42	4.10	0.805	0.817	0.688	0.727	0.923	0.910-0.914
	B_43	4.11	0.752	0.792	0.874			
	B_44	4.02	0.752	0.822	0.848			
	B_45	3.95	0.764	0.834	0.819			
	B_46	4.12	0.689	0.800	0.921			
	B_47	3.99	0.768	0.824	0.913			
	B_48	4.07	0.730	0.820	0.882			
SE	D1	4.06	0.538	0.948	0.966	0.901	0.945	0.926-0.935
	D2	4.01	0.611	0.950	0.941			
	D3	4.13	0.587	0.925	0.957			
	D4	4.05	0.622	0.923	0.933			

The reliability of CFA results in dimension 1 had ω_{1-3} of 0.882-0.905 and Cronbach's α of 0.876. Dimension 2 had ω_{1-3} of 0.923-0.939, as well as Cronbach's α of 0.924; dimension 3 had ω_{1-3} of 0.929-0.936 and Cronbach's α of 0.936. Meanwhile, dimension 4 had ω_{1-3} of 0.910-0.914 and Cronbach's α of 0.923. This showed that the items in this instrument were reliable.

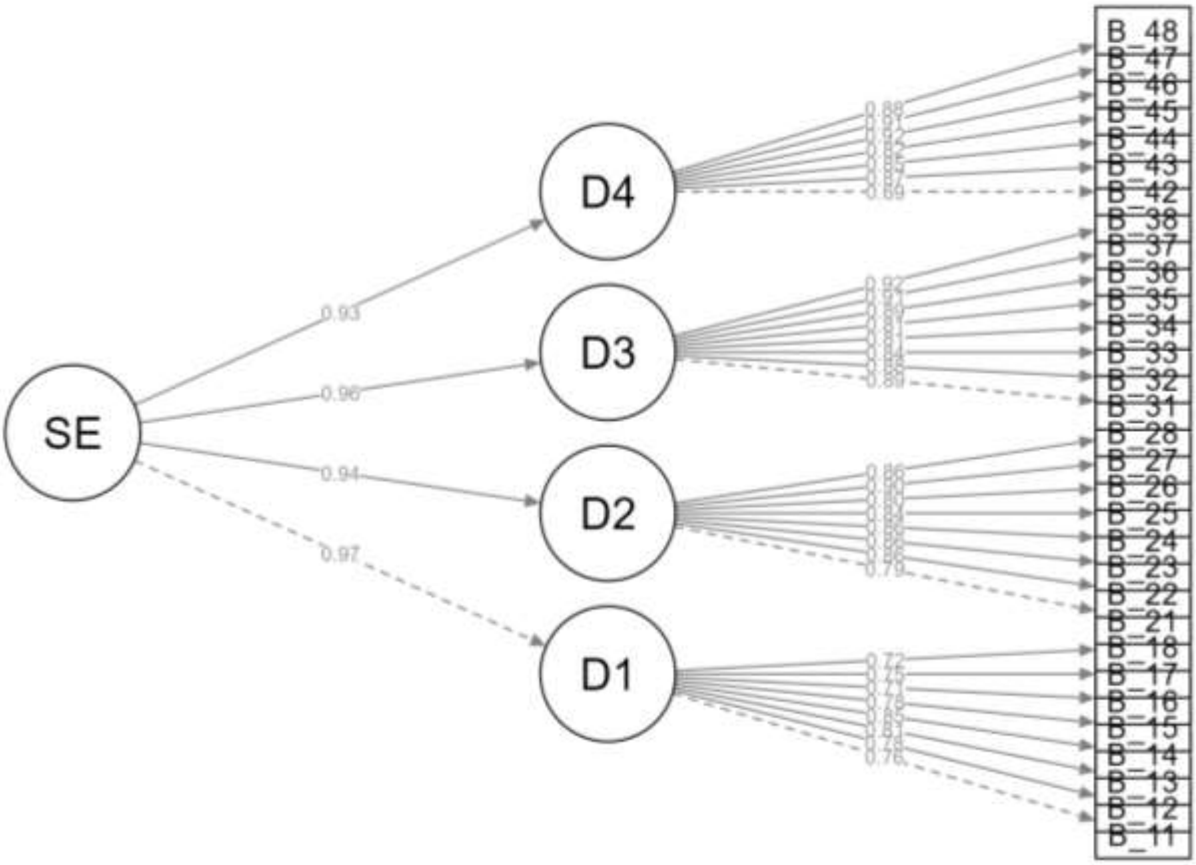

Figure 2. Path diagram formed in trial II

The factors leading to the fourth dimension of CFA (D1, D2, D3, and D4) were empirically well-formed with a range of 0.93-0.97, AVE of 4 dimensions of 0.945, reliability by ω_{1-3} of 0.926-0.935, and Cronbach's α of 0.945. All indicators had a significant contribution to the first-order CFA model and were eligible to proceed to the second-order CFA analysis stage. Furthermore, all were declared valid (β>0.5, AVE>0.5) (36) and reliable as indicated by McDonald's omega, ω ≥0.7 (51, 52) and Cronbach's α≥0.7 (53).

4. Discussion

This study aimed to develop a measurement instrument for students' self-efficacy in swimming classes based on the 4 main dimensions of Bandura's theory (1977), namely performance accomplishment, vicarious learning, verbal encouragement, and emotional states (16). The instrument development process was carried out gradually and systematically, starting from the preparation of a grid based on theory and literature, content validation by experts, and empirical testing through EFA and CFA.

4.1 *EFA: Factor Structure and Item Validity*

The results of EFA analysis in trial I showed that the data were suitable for factorial analysis, as indicated by a KMO value of 0.946 and a significant Bartlett's Test (χ^2 = 5328; p < 0.001). In this study, 4 main factors were successfully extracted and explained 62% of the total variance, which met the feasibility criteria in social study (the minimum acceptance threshold can be 50- 60%), while the ideal for natural sciences is >95% (36, 54, 55). These results were also formed from the determination of factors from the outset as 4 factors, not using the Eigenvalue results, which only supported 2 main factors. With the support of a variance extraction result of 62%, the fixed factor approach was still justified (56) because it was based on literature to maintain the theoretical concept (57, 58).

All items had a factor loading value ≥ 0.30, thereby meeting the statistical requirements for acceptance (36). Although there were several items with cross-loading, the selection of factors was based on substantive considerations and theoretical suitability with the intended construct. This approach was consistent with literature recommendations that content validity and conceptual relevance could be the basis for analytical decision-making (47-49). Other opinions also emphasized that cross-loading was acceptable when there was a difference of <0.10 (59), but judgment of theoretical concepts was a strong consideration for resolving cross-loadings (60).

Uniqueness measured the unique variance of items that was not explained by common factors; a value < 0.5 indicated that factors explain >50% of the variance (good/excellent). Meanwhile, > 0.8 suggested that <20% of the variance was explained (poor, must be deleted) (61). In terms of uniqueness, 31 items had a value < 0.5 and were categorized as "good" (45), while 1 item (B_41) had a value > 0.8 and was declared "poor". As a result, it was removed from the instrument (56), showing that most items have a strong contribution to the construct and were not overly influenced by external factors.

4.2 *CFA: Construct Validity and Reliability*

In Trial II, the first-order CFA model demonstrated acceptable fit indices with χ^2 = 990; df = 430; p < .001 (χ^2/df = 2.302), RMSEA = 0.064 (CI: 0.058–0.069, p < .001), SRMR = 0.045, and both CFI and TLI reaching 0.997, showing that the model achieved an excellent level of goodness-of-fit (36).

All indicators had factor loadings between 0.688 and 0.966, with AVE of 0.595 and 0.901 for the 4 dimensions formed, showing that each item consistently represented the construct being measured. The internal reliability values were also very good, with McDonald's omega (ω_{1-3}) and Cronbach's α above 0.7 for all dimensions, and reaching 0.949 at the second-order level. Very high reliability (α and ω > 0.94) could indicate items that were too similar, potentially reducing the efficiency of the instrument (62, 63). However, in the context of initial development, high reliability actually showed strong internal consistency and stability of the measured construct (64, 65).

CFA results showed a significant contribution from all 4 dimensions of self-efficacy, indicating that students' confidence in learning to swim was shaped by a combination of performance achievement, indirect learning, verbal encouragement, and emotional states. Furthermore, the performance achievement dimension played a significant role because success in mastering basic techniques, such as breathing and gliding, provided concrete and observable experiences of mastery. Each time students completed a simple technical task, direct evidence of being "able" was received, thereby gradually increasing their confidence in their abilities. These repeated experiences of success then provided a strong psychological foundation for students to dare to attempt more complex techniques, as they had formed a pattern of expectations that consistent effort would be followed by achievable results (21, 66).

The indirect learning dimension made a strong contribution, showing that students gain confidence through observing peers or instructors demonstrating correct swimming techniques. Observing similar models (peer modeling) reduced anxiety and encouraged imitation of successful behavior, thereby improving swimming skills and self-efficacy (14, 67). This was consistent with the highly modeling-dependent nature of swimming motor learning, where observers learn complex skills through observing models (peers, themselves, or experts), which was more effective than verbal instruction alone for the acquisition of freestyle and basic skills in beginners (68, 69). Therefore, this dimension was crucial in self-efficacy instruments for students' swimming learning, as it supported the transition from observation to independent performance (70).

Verbal encouragement strengthened students' internal motivation, where positive feedback from instructors reduced self-doubt and increased readiness to face challenges in the water. Positive reinforcement from instructors strengthened students' internal motivation and helped change perceptions of self-doubt into beliefs of ability (71), thereby increasing students' readiness to face challenges in the water (72).

The emotional state dimension showed that psychological states such as water anxiety, tension, or fear significantly influenced students' confidence in performing swimming movements (73). When students could manage negative emotions, for instance, through recovery training or gradual success, a better readiness to follow instructions and try new techniques was observed as the interpretation of negative stimuli as signals of incompetence was reduced (66). Overall, these results confirmed that self-efficacy in swimming context was a multidimensional construct that influenced students' motivation, willingness to try, and performance quality during the learning process.

4.3 Comparison with Previous Studies

Self-efficacy instrument developed in this study exhibited a 4-dimensional structure consistent with Bandura's theory and in line with results from other instruments in the field of physical activity and sport. For instance, Exercise Self-Efficacy Scale (ESES) emphasized the importance of mastery experiences and social support as predictors of self-efficacy in physical activity, which was also reflected in the performance achievement and verbal encouragement dimensions of this instrument (74). Similarly, studies related to Sport Self-Efficacy Inventory showed the role of modeling and emotional regulation in shaping athletes' beliefs, which was consistent with the contribution of indirect learning and emotional state dimensions in swimming learning context (75). Several previous studies in swimming context also showed that water anxiety, early success experiences, and instructor observation were important factors in building students' self-efficacy (66, 76).

This instrument was not only consistent with previous results but also provided a novel contribution by providing a measurement tool specifically designed for the context of swimming learning in higher education. Furthermore, this instrument had been proven valid and reliable in mapping 4 key dimensions of self-efficacy, thus comprehensively describing students' beliefs in facing the demands of aquatic learning. Practically, this instrument could be used by lecturers or coaches to identify psychological aspects that required special attention and design more adaptive learning strategies. These results reinforced the importance of psychological assessment in physical education and opened up opportunities for its application in various other aquatic sport contexts.

4.4 Theoretical Implications, Limitations, and Future Study

Theoretically, the results of this study reinforced the validity of the 4-dimensional structure of self-efficacy in the context of swimming learning. Practically, this instrument could be used by lecturers, coaches, and physical education program managers to evaluate students' psychological readiness to take swimming classes (77, 78). This instrument could also be used as a basis for designing more adaptive and student-needs-based learning interventions.

This study had several methodological limitations that must be considered when interpreting the results. Initially, the use of simple random sampling (convenience sampling), while commonly used in classroom- and curriculum-bound subjects in education, limited the generalizability of the results to a broader and more diverse population. Second, the relatively homogeneous characteristics of the participants, in terms of age, academic background, and aquatic experience, limited the instrument's ability to capture variations in self-efficacy across groups with different ability levels or learning contexts. Third, although EFA and CFA analyses supported a 4-dimensional structure, some of the first-order model fit indices were not entirely ideal. The second-order model was retained even though the first-order fit index was not entirely ideal, which potentially caused interpretation bias (79). This note emphasized that although CFA supported the construct validity of the instrument, there were methodological limitations that must be considered. Adaptation and modification of items that potentially weakened the reliability of the instrument were highly recommended to ensure accurate measurement. Very high reliability values (>0.9) were obtained before redundancy refinement (80). Further study was recommended to conduct item reduction analysis to produce a more concise and efficient version of the instrument without reducing construct validity. These limitations provided direction for further study to broaden the context of instrument testing, improve model accuracy, and refine measurement quality.

Authors' Contributions

All authors equally contributed to this study.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

Data are available for research purposes upon reasonable request to the corresponding author.

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Declaration of Interest

The authors report no conflict of interest.

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Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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