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Development of Force and Motion Concept Self-Efficacy Inventory (FMCSEI) for Senior High School Students

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Albert Andry E. Panergayo[1*]

[1]College of Teacher Education, Laguna State Polytechnic University, San Pablo City, Philippines
Corresponding Author: *albertandry.panergayo@lspu.edu.ph

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Abstract

This study aimed to develop and validate the Force and Motion Concept Self-Efficacy Inventory (FMCSEI), a content-specific self-efficacy inventory for the senior high school level. This study involved 1361 senior high school students from the Schools Division Office of San Pablo City, Laguna. Exploratory Factor Analysis (EFA) was initiated to determine the underlying factors within the initial 39-item scale. Based on EFA, FMCSEI managed to capture three factors related to force and motion learning self-efficacy, namely: applications of knowledge of force and motion, conceptual understanding of force concept, and real-life application of Newton's laws of motion. FMCSEI component structure obtained an excellent reliability index as revealed by the Cronbach's alpha (>0.80). Correlation analysis among the extracted components emerged to be strongly associated which further established high internal consistency of the developed instrument. Therefore, FMCSEI, composed of 34 items, can be utilized as a valid and reliable instrument by educators or researchers to assess the self-efficacy towards learning force and motion concept in senior high school level. This tool can provide physics teachers, useful insights in instructional planning and designing towards improved attitude and disposition of senior high students in physics courses.

Keywords: Force and Motion, Laws of Motion, Physics Self-efficacy, Self-Efficacy

INTRODUCTION

The concept of self-efficacy is a psychological construct theoretically based on Bandura's Social Cognition Theory. Bandura's theory emphasizes that behavior is explained by some cognitive and affective factors. Self-efficacy is a main figure across several theories and was uncovered in studies to be the strongest predictor of motivation and behavior (Lippke, 2020). Bandura (1977) defined self-efficacy as "beliefs in one's capabilities to organize and execute the course of action required to produce given attainments". According to Schunk (1995), self-efficacy also pertains to one's beliefs about completing a task which can influence choice of activities, effort, persistence, and achievement. The principal components of Bandura's self-efficacy theory are perceived self-efficacy and outcome expectancies, which determine the individual's change in behavior (Sutton, 2002). The perceived self-efficacy is the individual's perception of confidence in their ability to execute specific activity, while outcome expectancy is the belief that performing the behavior will lead to a specific outcome for the individual (Fitzgerald, 1991). Such components of self-efficacy predict both modification and maintenance of behavior; thus, providing a theoretical framework for behavioral change.

Self-efficacy beliefs stem from four main sources of information: (1) performance accomplishment, (2) vicarious experience, (3) social/verbal persuasion, and (4) affective state (Bandura, 1977). Performance accomplishment is the foremost source of efficacy information because it is based on personal mastery experiences. The actual experience of success in performing a task is likely to promote self-confidence. The other sources of efficacy information include the vicarious experiences of observing others succeed and making them as role models, verbal persuasion from influential people which strengthen our beliefs, and individual's state of mind from which people judge their level of confidence (Bandura & Adams, 1977). These sources of self-efficacy were highlighted to explain the variation to self-efficacy (Luszczynska et al., 2005; Usher & Parajes, 2009). Self-efficacy is widely understood as domain-oriented and task-specific in nature, but can also be identified in a more general level of structure. As a domain-oriented concept, self-efficacy is influenced by direct and indirect experience in a certain process (Bandura, 1977).

Bandura's conceptualization of self-efficacy is anchored in the capability to accomplish task or outcomes (Nielsen, Makransky, Vang, & Danmeyer, 2017).

The introduction of self-efficacy around 40 years ago is a valuable contribution to educational psychology (Dinther, Dochy & Segers, 2010). It is an important variable which allows students to reflect on their learning, highlighting about their beliefs in order to realize the usefulness of learning process (Zimmerman, Bonner & Kovach, 2006; Tezer & Aşıksoy, 2015). Since then, this area has gained increasing interest from researchers and focuses mainly on the concept of self-efficacy which is considered as “one of the most theoretically, heuristically and practically useful concepts formulated in modern psychology” (Betz et al., 1996, p. 47 as cited by Sharma & Nasa, 2014). There is a wide agreement in the literature that self-efficacy is associated with students’ academic performance (e.g., Meral et. al., 2012; Luszczynska et. al., 2005; Sharma & Nasa, 2014; Zimmerman, Bandura, & Martinez-Pons, 1992), demonstrating that students with high in academic self-efficacy are more participative, hardworking, and persistent, and attain higher academic performance level (Schunk & Pajares, 2002).

Students hold beliefs about their capabilities for science learning (Panergayo, 2023). These self-perceptions about their personal aptitudes to facilitate science learning (Nurhasnah et al., 2022) have been shown to causally influence success through motivation and their ability to perform in a given science learning environment (Evans, 2014; Tuan et al., 2005). Such self-efficacy beliefs are essential to improve science education (Burns et al., 2021) and support active learning (Ballen et al., 2017). In the same manner, learning content is an influencing factor to the development of self-efficacy (Zhu, 2007). Students with low self-efficacy for learning may demonstrate task-avoidance and doubt about their capabilities when they encounter difficult problems and learning content. The perspective of conceptual change prompts research to explore the motivational processes in the teaching and learning. Thus, the application of the concept of self-efficacy in understanding science learning attracts educational researchers to determine its impact to teaching and learning process. This prompts science educationists to explore measuring the self-efficacy of learners relative to science learning leading to the development of different scales in science education.

In the field of physics education, relevant literature regarding the available self-efficacy scales are generally related to learning physics alone e.g. Çalişkan, Selçuk & Erol (2007), Fidan & Tuncel (2021), Gurcay & Ferah (2018), Hu, Jiang, & Bi (2022), Lindstrøm & Sharma

(2011), Lin, Liang & Tsai (2015), Selcuk, Caliskan & Demircioglu (2018), Shaw (2004). These scales are insufficient to gauge the self-efficacy beliefs in terms of learning a content-specific field (Fidan & Tuncel, 2021). Content-specific inventory will help better understand the students' intrinsic factors such as self-efficacy that leads them towards enhanced conceptual understanding (Suprapto et al., 2017). It identifies the sources of self-confidence and motivation that supports students to learn effectively on a given subject content. In view of this, the upper secondary level also known as senior high in Philippine K to 12 basic education curricula would be taken into account as the context in this study. In order to address the gaps in the literature, this researcher seeks to develop and validate a content-based self-efficacy scale in physics highlighting the force and motion concept appropriate for the upper secondary level. This study would further identify the factors of self-efficacy in terms of learning force and motion concept.

Considerable research has connections between students' self-efficacy about physics and their academic performance and learning motivation (e.g., Kalambo & Lynch, 2021; Richardson, 2019; Sağlam & Toğrol, 2018; Tanel, 2020). This suggests that the motivational factors and their self-confidence in learning physics can substantially improve their learning performance on the subject. This placed self-efficacy belief as a focal construct determining whether students can learn subjects and concepts in physics courses or not (Fidan & Tuncel, 2021). In view of this, numerous scales were developed in order to measure the level of self-efficacy of students towards learning physics as shown in Table 1. The attempt to measure the self-efficacy in physics learning was well-documented in the literature emphasizing its critical role in enhancing the students motivational (Ayoola, 2019). and academic performance (Mayasari, et al., 2019) towards the subject.

Shaw (2004) develop and instrument to examine the relationship between physics self-efficacy and student performance in introductory physics classrooms. The eight-item scale was modeled after self-efficacy questions from surveys in other disciplines. The scale involves classroom-specific task in physics such as solving algebraic equations, word problems, and other facets of physics classroom learning experience. This instrument was validated using a sample of 522 students enrolled university students enrolled in either conceptual, college or university physics. The results showed that there is no considerable difference regarding the self-efficacy of the students as to gender. Similarly, Çalişkan, Selçuk & Erol (2007) constructed a self-administered scale to assess physics self-efficacy beliefs concerning one's ability to effectively accomplish physics tasks in physics. The scale is composed of 56 items, initially validated using 30 fifth grade university students, was trimmed down to 50 items based on expert's validation and students' feedback. The final version of the Physics Self-efficacy Scale (PSES) was administered to 558 undergraduate students completing a fundamental physics course. Statistical analysis using Cronbach's Alpha Reliability Coefficients revealed a favorable 0.94 suggesting an excellent reliability of the scale. This scale measures self-efficacy towards solving physics problems, learning physics, memorizing physics knowledge, and conducting physics laboratory. These instruments both focused on classroom-specific tasks taking into account the context of physics subject.

Lindstrøm & Sharma (2011) adapted and validated a short physics self-efficacy questionnaire using first year university students. This scale is considered as one-factor instrument for physics self-efficacy that would translates single scores per individual student. Further, In the study conducted by Gurcay & Ferah (2018), physics self-efficacy belief scale was utilized to determine the relationship of physics self-efficacy to metacognitive and critical thinking skills. The instrument was developed by reorganizing the self-efficacy belief scale to relate the items to physics learning. The scale is composed of eight items which assess the students' beliefs to learn physics. It is intended to measure the students' belief about learning physics as a subject. The study established an acceptable internal consistency of .89 which indicated an excellent reliability index. Fidan and Tuncel (2021) develop a valid and reliable scale measuring the students' self-efficacy beliefs toward physics subjects for lower-secondary. The collected data from 2737 students at 6th, 7th, and 8th grades in a certain province located in northern Turkey. The validation resulted to a 28-item scale with a single factor gauging the student's self-efficacy beliefs about physics as a discipline. The scales developed by Lindstrøm & Sharma (2011), Gurcay & Ferah (2018), and Fidan and Tuncel (2021) were focused in understanding self-efficacy in physics learning as a general structure. It only accounts for general beliefs, task-specific and classroom-specific activities in physics.

Table 1 Summary of Existing Instruments Used to Measure the Physics Self-Efficacy

Name of Instrument	Author/ Year	Number of Survey Items	Constructs Measured
Self-Efficacy in Physics (SEP) Instruments	Shaw (2004)	8 Items	Classroom-specific task in Physics
Physics Self-Efficacy Scale (PSES)	Çalişkan, Selçuk & Erol (2007)	30 items	Solving physics problems, physics laboratory, learning physics, application of physics knowledge, and memorizing physics knowledge.
Physics Self-Efficacy Questionnaire (PSEQ)	Lindstrøm & Sharma (2011)	5 items	General self-efficacy in Physics
Physics Learning Self-Efficacy Questionnaire (PLSE)	Lin, Liang & Tsai (2015)	32 items	Conceptual understanding, higher-order cognitive skills, practical work, everyday application, science communication
High School Level Physics Self-Efficacy Scale	Selcuk, Caliskan & Demircioglu (2018)	21 items	Physics achievement, using physics knowledge
Physics Self-Efficacy Belief Scale	Gurcay & Ferah (2018)	8 items	Students' beliefs to learn physics
Self-Efficacy Scale Towards Physics Subjects	Fidan & Tuncel (2021)	28 items	Self-efficacy beliefs towards Physics subject

Lin et al. (2015) modified their previously developed instrument appropriate for science learning to a 32-item scale measuring self-efficacy in physics learning. The scale was in a multidimensional sense composed of five dimensions: conceptual understanding, higher-order cognitive skills, practical work, everyday application, science communication. The instrument's items were reworded and tailored-fit to the context and content of physics subject. Using a sample of 250 Taiwanese undergraduate students specializing in physics answered the developed instruments which emerged to have satisfactory validity and reliability. Selcuk et al. (2018) created a high school physics self-efficacy scale with two variables and 21 items. The first element, self-efficacy beliefs in physics achievement, is linked to problem solving and remembering the necessary formulae in physics class, whereas the second factor, motivation to learn physics, is linked to motivation to learn physics. The ability to transfer physics concepts or subjects into daily life is linked to the second aspect, self-efficacy belief in the competence of employing physics knowledge. These scales, on the other hand, were created for grades ranging from upper secondary school to higher education.

The main purpose of this study is to develop a content-specific science learning self-efficacy inventory highlighting the force and motion topic. It further sought to determine the multi-dimensionality of the developed instrument based on Bandura's self-efficacy theory.

METHOD

The instrument development method was conducted in this study.

Sample

The target sample of this study was senior high school students who are enrolled this academic year 2022-2023. There were 1,361 senior high school students who responded on the web-based survey. The majority of the participants are female (61.7%), followed by the male (38.3%). The mean age of the respondents is 17.64 years ranging from 16 years to 25 years. In terms of age distribution, 48.6% of the respondents came from 16 and 17 years old, while the 18 year and 19 years old represented 48.2% of the sample. The remaining 3.2% are students who are 20 years old and above. The study was dominated by the participants who are studying in public school (73.3%). The private school students only represent the 26.7% of the sample. In terms of grade level, the respondents came from both grade 11 (29.4%) and grade 12 (70.6%).

Development of the Instrument

Item Development and preparation of Item pool

The development of the items was based on the review of related literature emphasizing the learning competencies needed to fully understand the concepts of forces and motion as a physical principle along with the extensive review of Bandura's self-efficacy theory. The items associated with self-efficacy towards the Forces and Motion topic further focus on the learning competencies included in the Philippine science education curriculum and international standards such as the Next Generation Science Standards (NGSS), and Programme for International Student Assessment (PISA). Initially, the instrument was developed containing 50 items following the Bandura's (2006) standards for developing items for self-efficacy. For example, the items were reported using the phrase "I can" rather than "I will" to provide positive impression rather than negative, and to connote judgement of capability.

Expert validation

The opinions of the experts were taken into consideration in order to determine the validity and reliability of the items developed. There are 17 experts in the fields of science education (n=6), physics teaching (n=6), and measurement and evaluation (n=5). The experts evaluated the developed instruments in terms of the appropriateness of: (1) content; (2) format; (3) response system; (4) language; and (5) suitability for the sample. The validation form, encoded and distributed via web-based program, was measured in a three-point Likert scale from 1 to 3 with a degree range of “not necessary”, “useful but not essential”, “essential” respectively. The validation form also included sections where the experts can write their comments and suggestions about a specific item, and the instrument as a whole. In line with this, the Content Validity Ratio (CVR) of the items was computed from the ratings of the experts following the guidelines of Lawshe (1975). CVR ranges from 1 to -1. The higher score specifies further agreement of members of the panel on the necessity of an item in an instrument. The numeric value of content validity ratio is determined by Lawshe Table. In the present study, the critical CVR of .529 was used as a threshold for acceptable items given a panel size of 17 experts.

Item reduction and Revision

A total of 11 items were removed from the item pool. Five items were removed from the initial draft since it does not meet the required reference for CVR. An additional six items were removed further due to item content replication as indicated by the expert validators. Moreover, some items were revised according to the comments and suggestions of the experts in terms of alignment to Bandura’s self-efficacy theory, and to the learning standards of senior high school learners, appropriateness of action verbs used for the items, clarity and ambiguity of statements, and use of grammar and spelling.

Draft Scale for Pilot Research

The pilot instrument is composed of 39 items and followed an 11-point Likert scale from “0 – cannot do at all” to “10 – highly certain can do.” This format was adapted since it is claimed to be more sensitive and reliable in measuring the students’ perceived self-efficacy compared to scales with few steps (Bandura, 2006). All items are expressed in positive items in accordance with the guidelines of constructing perceived self-efficacy scale of Bandura (2006). Before pilot testing, 10 senior high school learners were asked to provide feedback regarding the overall construction and appearance of the instrument and the ease of understanding each item. The students reported that they did not experienced difficulty in understanding the content of the instruments. The pilot testing was administered through an online platform due to existing physical restrictions in the country due to COVID-19 pandemic.

Data Collection

The data were collected during the 3rd grading period of academic year 2022-2023. Prior to the conduct of the survey, the students were oriented regarding the research objectives and procedures. Instrument was accomplished by the students through a web-based program in groups with the assistance of their respective science teachers. Informe consent form was watched on the survey which was presented prior answering the actual instrument. The students were able to complete the instrument within 15 to 20 minutes.

Data Analysis

In order to answer the research questions, various statistical analyses were used to treat the data. After data collection, the data were tallied and coded using the Statistical Package for Social Science (SPSS). Assumptions such as normality were established using the Shapiro–Wilk test, which showed the data to be normal and with the significant value presented as less than the .05. Descriptive statistics such as mean and standard deviation were used to describe the students' self-efficacy in learning force and motion concept. Exploratory Factor Analysis (EFA) using Principal Component Analysis (PCA) with Promax rotation was employed to extract the underlying factors of FMCSEI. Prior to EFA, Kaiser-Meyer-Olkin Measure of Sampling Adequacy and Bartlett's Test of Sphericity were used to determine the applicability of the data for factor analysis. To establish the reliability and validity of the developed instrument, Cronbach's alpha and correlation analysis was initiated for the extracted components.

RESULT AND DISCUSSION

The web-based survey was completed by 1361 senior high school students from both private and public schools in San Pablo City, Laguna. The mean and standard deviation of the students in FMCSEI are presented in table 2. The mean values are approximately ranging from 5 to 7 which suggest that students are average to above average in performing tasks related to learning force and motion concepts. However, it can also be noted that the responses of the students are dispersed since the standard deviation emerged to be consistently in the order of 2.0.

Table 2 Mean and Standard Deviation of Students' Self-efficacy in Learning Force and Motion Concept

Item	$\bar{x}$	sd
1	6.40	2.10
2	6.80	2.14
3	6.21	2.27
4	5.84	2.24
5	6.38	2.23

Item	$\bar{x}$	sd
6	7.21	2.40
7	6.78	2.19
8	6.82	2.27
9	7.82	2.15
10	7.78	2.13
11	7.13	2.18
12	6.31	2.24
13	6.56	2.24
14	7.54	2.18
15	6.63	2.20
16	6.34	2.47
17	6.36	2.42
18	6.23	2.33
19	5.97	2.47
20	6.18	2.36
21	6.76	2.39
22	6.08	2.28
23	6.35	2.37
24	6.26	2.22
25	6.33	2.21
26	6.08	2.19
27	6.53	2.20
28	6.58	2.24
29	6.51	2.21
30	5.93	2.21
31	6.35	2.26
32	6.11	2.23
33	6.12	2.31
34	6.07	2.34
35	6.24	2.37
36	5.92	2.26
37	5.96	2.29
38	6.67	2.24
39	6.98	2.19

Component Structure

The EFA was initiated in order to extract the underlying factors for FMCSEI, originally composed of 39 items after expert validation. Prior to EFA, the Kaiser–Meyer–Olkin Measure and Bartlett's Test of Sphericity were conducted to determine the adequacy of the sample and suitability of the data respectively. The results yielded to an overall KMO index of 0.988 indicating a commendable outcome. This KMO index can be colorfully described as "marvelous" based on Kaiser (1974, p. 35) since it exceeded the 0.90 threshold. Hoelzle & Meyer (2013) further contended that an overall KMO values ≥.70 are desired. The Bartlett's test of sphericity statistic for the correlation matrix emerged to be significant. This suggests that the correlation between items were satisfactorily large enough for EFA, x2=65,127.578, df=741, p=0.000.

The EFA employing no rotation technique was carried out to determine the eigenvalues for each factor of the data. The results shows that three components displayed eigenvalues over a Kaiser's criterion of 1. In order to attain simpler structure, another EFA was initiated. The extraction was done with PCA method using an oblique rotation specifically Promax with Kaiser Normalization, which allows the factors to be correlated. The factor analysis revealed three factors as can be seen in table 2, which in total can explain the 73.822% of the variance. The repeated extraction removed items 6, 7, 19, 23, 38 due to low factor loading less than 0.40, and cut off points lower than .10 by loading in two factors. The factor analysis shows that the remaining 34 items have a factor loading ranging from 0.403 to 0.947. After employing rotation technique, the variance was redistributed to the three extracted factors with 24.236%, 23.332%, and 19.788% respectively.

The same observation can be deduced from the scree plot, figure 1 illustrated that inflexions would retain three components, and this was consistent with the Kaiser's criterion. Based on Figure 1, the line is almost flat from the third factor on. This indicates that each successive factor is accounting for lesser and lesser amounts of the total variance.

Table 3 Total Variance Explained by the Three Extracted Components

		Component		
		1	2	3
Initial Eigenvalues	Total	26.082	1.647	1.099
	% of Variance	66.772	4.224	2.817
	Cumulative %	68.772	72.995	75.812
Extraction Sums of Squared Loadings	Total	26.560	1.396	0.834
	% of Variance	68.103	3.579	2.139
	Cumulative %	68.103	71.682	73.822
Rotation Sums of Squared	Total	24.236	23.332	19.788

Figure 1 shows the scree plot based from the exploratory analysis initiated.

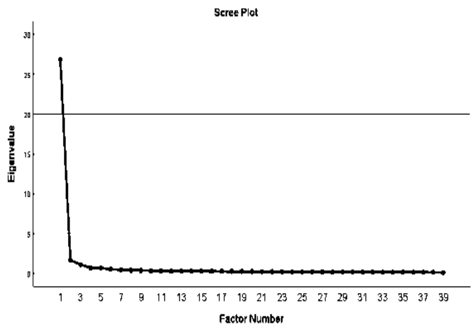

Figure 1. Scree Plot of the exploratory factor analysis

Table 4 presents the factor loadings of the items to the three factors. PCA revealed that 19 items, 9 items, and 6 items are largely loading to factors 1, 2, and 3 respectively. The item loadings in factor 1 were primarily concerned with the application of knowledge in force and motion concept in laboratory investigations, data analysis, and real-life settings. It involves designing solutions to real world problems, performing a scientific experiment, and analyzing data obtained from investigation. The item loading in factor 2 focused on understanding of the Force concept. It pertains to students' ability to explain the concept of force, and how it affects the motion of an object, and perform numerical analysis involving vector force. On the others hand, item loadings in factor 3 is mainly concerned in explaining Newton's Laws of Motion. It includes items that ask students to explain a given physical situation using the Newtonian laws.

Table 4 Principal Components Analysis for all participants, Promax rotation with Kaiser Normalization

Items	Components		
	Factor 1	Factor 2	Factor 3
32	.946		
30	.917		
33	.865		
36	.827		
26	.783		
35	.768		
34	.731		
37	.721		
27	.679		
31	.630		
25	.617		
22	.615		
24	.604		
29	.601		
28	.505		
18	.498		
12	.495		
15	.439		
39	.427		
38			
3		.897	
4		.783	
5		.701	
1		.696	
16		.693	
2		.644	
6		.639	.407
19	.428	.578	
20		.567	
17		.554	
21		.492	
23	.440	.488	
10			.971
9			.967
14			.776
11			.565
8			.490
7		.413	.462
13			.403
No. of Items	19	9	6
$\bar{x}$	6.27	6.36	7.27
sd	2.25	2.29	2.19
α	0.980	.959	.939

Component reliability and validity analyses

In order to establish the internal consistency, Cronbach's alpha was used as presented in Table 3. For 19 items on the first subscale, Cronbach's alpha was .980. For 9 items for second subscale, Cronbach's alpha was .959. And, for the three items for the last subscale, a 0.939 Cronbach's alpha was computed. The reliability test emerged to establish high internal consistency for extracted factors. For all three subscale reliability analyses, no item removal could increase the subscale's alpha coefficient. Component correlations between these three subscales are presented in Table 5.

Table 5 Component Correlation Matrix

Component	1	2	3
1			
2	.821		.
3	.727	.752	

Table 5 shows that the correlation coefficients among the extracted components are $0.60 < r < 0.79$. This can be verbally interpreted as strong association based on the guide formulated by Evans (1996). Positive relationship can also be gleaned from the table among factors. A positive correlation coefficient indicates that an increase in a given component would correspond to an increase in another component; thus, implying a direct relationship between the components.

For the discussion, the purpose of this study is to develop and validate a self-efficacy learning inventory to measure the beliefs in learning force and motion concept for senior high school students; henceforth, Force and Motion Concept Self-Efficacy Inventory (FMCSEI). The descriptive statistics presented that the task with the lowest mean rating is indicator 4 which asks the students to explain the concept of an inertial frame of reference. This suggests that instructors must focus on explaining the aforementioned concept to further strengthen the students' belief to develop their conceptual understanding of the topic; thereby, increasing their ability to explain the idea. On the other hand, indicator 9 yielded to the highest mean rating. This item calls students to determine their stance to explain why it is harder to push a truck than a car. The underlying physical concept on this item is inertia. This shows that students' stance on their ability to explain item 9 emerged to be capable of comprehending the inertia as applied in a certain situation. Overall, the senior high school students established an average to above an average rating regarding their belief to accomplish the given tasks related to force and motion concept. This result may be attributed to the sample involved in the study. Since the study includes both Grade 11 and Grade 12 from both academic and technical-vocational track, their students encounter in physics courses is vital to their self-efficacy rating. Students who have recently studied physics courses emerged to established higher rating. Likewise, STEM track students also have an edge over the other students since they are immersed in physics learning as part of their academic program. Similar findings were uncovered by Novinta and Partana (2020) on their study about senior high school acid-base self-efficacy, a content-specific self-efficacy measure in the field of chemistry. The findings revealed that average students in Yogyakarta, Indonesia has enough until good category of self-efficacy in learning acid-base in all dimensions, including task orientation, effort, persistence, beliefs, and performance.

Based on the EFA, three-component structure was generated that can explain the self-efficacy to learn force and motion concept in the context of the senior high school students. These potential factors were identified, namely: (1) applications of knowledge of force and motion (n=19); (2) Understanding of Force Concept (n=9); and (3) Real-life application of Newton's laws of Motion (n=). This indicates that learning force and motion concept can be explained based on three factors focusing on their knowledge application, conceptual understanding, and real-life application of Newtonian Laws. The first two components have been present in the existing self-efficacy scale in physics e.g., Caliscan et al. (2007); Lin et al. (2015). Students' conceptual understanding and its application to practical works and everyday life are imperative to effectively comprehend physics as a discipline. The final version of the instrument consists of 34 items with three subscales were found to be reliable and valid. Cronbach's alphas of each subscale indicate an excellent reliability as shown in table 4. The correlation analysis among the subscales yield to a positive correlation which further indicates an internal consistency of the developed instrument. Hence, the inventory can be utilized as a valid and reliable instrument by educators or researchers to comprehend students' self-efficacy towards learning force and motion concept.

Academic self-efficacy should draw attention to physics educators since it is an important factor that affects students' performance (Hayat et al., 2020; Honicke & Broadbent, 2016; Zhu, 2007). Self-efficacy belief as a focal construct determining whether students can learn subjects and concepts in physics courses or not (Fidan & Tuncel, 2021; Panergayo, 2023). In an effort to gauge self-efficacy in physics learning, numerous scales emerged in the literature. There are instruments made such as that of Shaw (2004) and Çalişkan et al. (2007) which focused on classroom-specific tasks considering the context of physics subject. Lin, Liang & Tsai (2015), Selcuk et al. (2018), on the other hand, created instrument as a scale for self-efficacy in physics learning emphasized the relevant academic tasks in learning physics considering the contemporary science literacy. There were also instruments developed to understand self-efficacy in physics learning as a general structure, which only accounts for general beliefs, task-specific and classroom-specific activities in physics, e.g., Lindstrøm & Sharma (2011), Gurcay & Ferah (2018), and Fidan and Tuncel (2022). A content-specific self-efficacy scale such as FMCSEI developed in the present study is vital in enhancing students learning on a given discipline. It can provide subject-based evidence in examining the cognitive or affective features of physics that influence students' beliefs about their capability to perform in physics courses (Fidan & Tuncel, 2021). A content-specific inventory will make it easier to understand the students' innate qualities, such self-efficacy, which contribute to their improved conceptual knowledge. It will also provide insights about the sources of motivation and self-assurance that help pupils learn a particular subject's information efficiently.

CONCLUSION

The current study developed and validated physics learning self-efficacy inventory that is content-specific named FMCSEI. This scale underwent a validation process, including expert evaluation using CVR to assess the necessity of the items to measure the self-efficacy in learning force and motion, pilot testing via EFA to filter the items with low loading and extract the underlying factors, and statistical analysis such as Cronbach’s alpha and correlation to establish the internal consistency of the developed instrument. All finding revealed that FMCSEI can be utilized as a valid and reliable instrument by educators or researchers to comprehend students’ self-efficacy towards learning force and motion concept in senior high school level. This tool can serve as an important assessment to allow physics teachers gain understanding of the factors that may affect their learning stances about force and motion. In line with this, an appropriate instructional plan can be made to enhance their self-efficacy on learning a given learning content. It can be contended that recognizing the student’s self-efficacy in learning force and motion will be an advantage in sustaining the student’s attention, interest and positive attitude towards learning force and movement.

Limitations in the study includes the profile of the respondents which only consist of senior high school students in the Division of San Pablo City, Laguna. There is a potential that the validity and reliability established in this study may vary if varied samples were involved comprised of junior high school and tertiary students. Since the sample was also obtained from only one city which is mainly urban-agricultural community, it is recommended to gain a sample from various cities both from urban and rural areas; thus, future research directions may include a sample that varies across grade levels, culture, and regions to gain more reliable and valid findings regarding the instrument developed. This will determine the applicability of the instrument in higher education since it includes topics taught in tertiary education. Likewise, a content-specific instrument appropriate for science educators should be developed to assess the level of the teachers’ belief about their capability to learn and teach force and motion concept. Sales et al. (2019) contended that enrichment of the science teachers on Classical Mechanics should be done. Previous study shows that while teachers give themselves high efficacy ratings about force concept, their performance in Force Concept Inventory

(FCI) occurred to be poor (Sales et al., 2019).

Moreover, future researchers may further investigate the factor structure of the developed instrument to improve the results attaining simple structure. Considering different sample size and research context would shed more light about the self-made instrument. Likewise, self-efficacy on learning force and motion in terms of demographic factors if significant variation occur across gender, grade levels, and the senior high school strand could also be studied. In connection with the aims of the study, similar content-based self-efficacy inventory can be developed in other content standards in physics such as electricity and magnetism, waves and optics, and heat and temperature. Confirmatory factor analysis is also encouraged to verify the validity and reliability of the instrument. Using Structural Equation Modelling can also be initiated to model the factors of the self-efficacy in learning force and motion concept.

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