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PHYSICS TEACHERS' SELF-EFFICACY, INNOVATIVE TEACHING AND COMPREHENSIVE TEACHING APPROACH: LATENT PROFILE ANALYSIS

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Abstract. *Physics education aims to develop sophisticated thinking abilities and enhance conceptual depth, but student interest has decreased, emphasizing the importance of teacher quality in fostering success and positive attitudes. The aim of the study was to examine the physics teachers' self-efficacy, innovative teaching, and comprehensive teaching approach levels. As data collecting instruments, self-efficacy, innovative physics teaching, and comprehensive teaching approach scores were utilized. In the pilot research group, validity and reliability assessments were conducted on the scales. The primary research involved 241 physics teachers. As the measurement variables were constantly changeable, Latent Profile Analysis was utilized. The present study's results suggest that teachers have high self-perceptions in various dimensions related to teaching effectiveness, including self-efficacy, innovative teaching, and comprehensive teaching approach. These results are consistent with previous research that has shown a positive relationship between teacher self-perceptions and teaching effectiveness. Future research could explore the relationship between teacher self-perceptions and student achievement to better understand the impact of self-perceptions on student outcomes. Overall, the results of this study highlight the importance of supporting teachers' self-efficacy and providing opportunities for innovative teaching and professional development to improve comprehensive teaching approach.*

Keywords: *physics teachers, self-efficacy, innovative teaching, comprehensive teaching approach, Latent Profile Analysis*

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Introduction

Physics education in lower and upper-secondary schools has been identified as a challenging area due to the abstract and complex nature of the subject matter (Duda & Garrett, 2008; Ekici, 2016). The purpose of physics education in the twenty-first century is to build sophisticated thinking abilities and enhance conceptual depth (Bao & Koenig, 2019). Research has indicated a decline in students' interest in the field, highlighting the need for effective teaching strategies to foster engagement and understanding (McDonald & Waite, 2019; Ozis et al., 2018; Veloo et al., 2015). As with all other courses, teachers play a crucial role in enhancing student success and attitudes in physics sessions.

More emphasis has been placed on the relationship between teacher quality and student accomplishment. Some research indicates that more qualified teachers may have an impact on student learning in the classroom (Clark et al., 2021; Darling-Hammond, 2000). As the understanding of the complex nature of student learning and teaching techniques has changed, so has the area of research on teacher efficacy. Recently, a multilayered approach has arisen that captures the convergence of numerous factors and settings on how teachers define teaching and 'practice' teaching in the classroom (Devine et al., 2013; Watt & Richardson, 2008).

Teacher quality, including teaching competence, is a significant component of teacher training. Numerous training practices and implementations occur in both pre-service teacher training and professional development. Teacher quality, particularly teaching competence, is linked to numerous variables such as teacher self-efficacy (Romel et al., 2021), teaching quality (Kennedy, 2006), subject expertise (Loewenberg Ball et al., 2008), pedagogical competence (Snoek, 2021), pedagogical content knowledge (Park et al., 2020), and technological pedagogical content knowledge (Karakaya & Avgin, 2016).

As a result of the school reforms taking place in China, learner-centered physics teaching is anticipated. In China, all lower-secondary and upper-secondary school students are required to study physics, a subject that is

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regarded as vital (Zhang et al., 2020). In this regard, research is conducted to enhance the expertise of physics teachers in this subject (Fu & Clarke, 2019). According to the results of the bibliometric analysis of physics teachers in China, the main research hotspots of physics teaching are teaching, physics teaching aids, and educational evaluation (Wu et al., 2021). According to both studies, the teaching dimension is an essential idea for both researchers and educators. To organize relevant research, it is vital to determine the qualifications and level of teachers in this subject.

Self-efficacy, or belief in one's ability to complete a particular task, has been demonstrated to be positively associated with learning and motivation across domains (Bandura, 1997). According to Pajares (2003), self -efficacy is person's confidence in their ability to accomplish their goal. When these people become teachers, we can think of them as the belief that they have the necessary qualifications and skills to reach the goals they have set about teaching.

It is believed that educators who have strong ideas in their own competence put in more effort, participate more actively in informal learning activities, are more persistent, and experience less stress (Bandura, 1997; Lohman, 2006). Furthermore, the self-efficacy beliefs of teachers have been shown to be connected with the pedagogical practices of such teachers (Tschannen-Moran et al., 1998). Teachers who have high levels of self-efficacy are more likely to demonstrate effective classroom management (Woolfolk et al., 1990), use more innovative teaching methods (Ghaith & Yaghi, 1997; Guskey, 1988), set higher learning goals for their students (Ross & Bruce, 2007; Wolters & Daugherty, 2007), and encourage student autonomy (Woolfolk et al., 1990).

According to Zimmerman (2000), in terms of its substance, self-efficacy assessments place greater emphasis on performance capacities than on physical or psychological features. Self-efficacy has a multiple structure rather than a unique structure. Although there is a self-efficacy belief about teaching in general, there are self-efficacy belief scales that contain different aspects of teaching. For example, Haryanto et al. (2023) measured self-efficacy by associating it with the pedagogical content knowledge framework. In a research done by Ogan-Bekiroglu and Aydeniz (2013) on pre-service physics teachers, the self-efficacy of pre-service physics teachers at several phases of the teaching process, including planning, implementation, assessment, and general teaching, was measured. In the study conducted by Lekhu (2016), the self-efficacy of physics teachers in performing laboratory experiments was measured. As a result, data collection tools should be used to measure self-efficacy beliefs that include qualities suitable for research purposes. It is not possible to use a generally accepted measurement tool that is suitable for every teaching field.

The teaching strategy is the general application of teacher-determined methodologies to achieve learning objectives. When we think about it in the context of physics lessons, for example, it can be thought of as helping students to structure the concepts related to physics correctly in their minds (Grayson, 2004). According to Ukala (2018), teaching that is innovative takes a proactive approach to integrating new teaching ideas and methods into the classroom setting, where they may be used to benefit both the teaching and the learning that takes place there. Teachers are constantly being challenged to improve their own ways of thinking and the teaching strategies they use in the classroom. This is done with the goal of enhancing students' learning attitudes and abilities, thereby preparing them to meet the challenges posed by an increasingly complex and dynamic world (Gul & Rafique, 2017).

Many teaching strategies such as multiple intelligence teaching strategy (Gul & Rafique, 2017), project-based teaching (Siew et al., 2015), experiential teaching strategy (Bada & Akinbobola, 2017), reciprocal teaching strategy (Mafarja et al., 2022), and real problem solving (Lopez-Jimenez et al., 2021) have been applied in the field of physics education. "Innovative" is defined in the dictionary as featuring new methods; advanced and original (dictionary.cambridge.org). The innovative teaching strategy, on the other hand, can be defined as strategies that are out of the traditional teaching strategies and offer an innovative perspective to achieve teaching goals.

The creation of teaching content is an extremely important factor in the improvement of academic performance of students across all subject areas (Rios et al., 2018). The degree to which a teaching strategy or method supports learning outcomes is directly proportional to the success of the approach or technique. If the students' learning is adequately supported by the teaching methods utilized, it can be concluded that those teaching methods are effective. In the study done by Dwikoranto et al. (2020), a project-based laboratory learning strategy was utilized to enhance students' science process skills and levels of creativity. Because of the study, it is possible to conclude that the teaching employed is effective, as the anticipated growth in students' creativity and science process skills is realized. Effectiveness is not only determined by the teacher. The fact that students interpret the lesson's materials and approaches effectively is a success-enhancing aspect. In the study done by Klein et al.

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(2021), the efficiency of the university-level teaching delivered throughout Europe during the pandemic era was evaluated from the perspective of the students.

Latent profile analysis (LPA) is a categorical latent variable method that identifies latent subpopulations within a population based on a particular set of characteristics. LPA thus presupposes that individuals may be categorized with variable degrees of probability according to their personal and/or environmental characteristics (Spurk et al., 2020). The objective of all mixture models is to give a probabilistic categorization of individuals into latent classes based on a statistical model, where each class is one of K discrete latent variable categories c. In contrast to conventional component analysis or IRT modeling, the latent variable is hence categorical as opposed to continuous (Bauer, 2022). Using the means of continuous observable variables, latent profile analysis attempts to recover hidden groupings (Oberski, 2016). In many educational research studies, latent profile analysis is employed. For instance, research has been undertaken on teacher burnout during the COVID19 epidemic (Răducu & Stănculescu, 2022), teacher attitudes and practice while using technology in the classroom (Thurm, 2018), and the identification of future secondary school teachers (van Rooij et al., 2020).

This study aimed to explore teachers' self-efficacy, innovative teaching, and comprehensive teaching approach levels in the context of physics education, with a particular focus on the Chinese educational system, where physics is considered as a vital subject (Fu & Clarke, 2019; Wu et al., 2021; Zhang et al., 2020). To address this aim, the following research questions were posed:

- What are the levels of teachers in terms of self-efficacy, innovative teaching, and comprehensive teaching approach?
- What are the correlations among sub-dimensions of self-efficacy, innovative teaching, and comprehensive teaching approach?
- What are the latent profiles of teachers in terms of self-efficacy, innovative teaching, and comprehensive teaching approach?

Research Methodology

The study employed a quantitative approach, conducting exploratory analyses for data interpretation. The measurement tools were directly applied to the sample population for data collection. The research was initiated at the beginning of the 2022-2023 academic year.

Sample

The research involved two separate samples: one for a pilot study and the other for the main study. The pilot study engaged 120 teachers who completed questionnaires. Of these, 107 participants provided complete responses, which were subsequently utilized. The pilot study aimed to secure a minimum sample size of 100 participants, as suggested by Hair et al. (2010). Notably, no demographic data related to the participants was collected during the validity and reliability assessment of the scale. Following the completion of the validity and reliability processes for the scales in the pilot study, the same tools were administered to the main study sample. This sample consisted of 320 physics teachers from Jiangsu Province. Of these teachers, 241 returned the scales without missing data, and their responses were utilized for the main study analysis.

Data Collection Tools

To acquire the scales, an extensive literature review was performed, identifying potential scale items for use in self-efficacy, innovative teaching, and comprehensive teaching approach within physics education domains. The scale items were subsequently evaluated by a panel of specialists, including two physics educators and two assessment and evaluation experts. A separate sample, possessing similar attributes but not included in the primary study, was chosen to validate and assess the reliability of the scales used in the research.

Self-efficacy

According to the exploratory factor analysis result, KMO value was calculated as .828 and Bartlett's Test of Sphericity result was calculated as ($\chi^2 = 1898$, $df = 66$, $p < .01$). As a result of the Exploratory Factor Analysis, item

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9 was removed from the scale. A two-factor structure was obtained. In the first factor, there are 2nd, 5th, 10th, 12th, 3rd, 6th items and this factor is named as "teaching self-efficacy". The factor load is between .72 - .98. In the second factor, there are 8th, 4th, 1st, 7th, and 11th items. The factor load is between .99 and .72. The second factor is named as "affective domain ". The first dimension can explain 39.5 percent of the variance of the scale. The second dimension explains 32.4%. In total, 71.9 of the scale variances can be explained by these factors. As a result of confirmatory factor analysis; The first model calculated χ^2/df (417/43 = 9.69), CFI = .806, TLI = .752, SRMR = .093 and RMSEA = .282. Since the indices were not sufficient, the modifications suggested by the program were made. In the second model, χ^2/df (37.5/40 = .937), CFI = 1, TLI = 1, SRMR = .0615 and RMSEA = .0. In the third step, the reliability values were calculated. Cronbach's α = .967, McDonald's ω = .969 for Teaching self-efficacy, Cronbach's α = .938, McDonald's ω = .940 for self-efficacy to handle psychological factors, Cronbach's α = .914, McDonald's ω = .918 for the whole scale. As a result, a valid and reliable scale was obtained to measure the self-efficacy of physics teachers.

Innovative Physics Teaching

According to the exploratory factor analysis results, the KMO value was calculated as .911 and the Bartlett's Test of Sphericity result was calculated as (χ^2 = 2329, df = 153, p < .01). As a result, a three-factor structure was obtained. In the first factor, there are 5th, 14th, 8th, 7th, 12th, and 9th items, and the factor is named "multiple teaching". The factor load is between .64 - .93. In the second factor, there are 2nd, 3rd, 4th, 6th, 11th, and 15th items. The factor load is between .67 and .92. The second factor is called "self-directed learning". In the third factor, there are 1st, 10th, 13th, 16th, 17th, and 18th items. The factor load is between .56 and .90. The third factor is named "student-centered". The first dimension can explain 25.4 percent of the variance of the scale. The second dimension explains 24.6% and the third dimension is 23.8%. In total, 73.8% of the scale variance can be explained by these structures. As a result of confirmatory factor analysis, χ^2/df (197/132 = 1.49), CFI = .972, TLI = .968, SRMR .0505, and RMSEA .0673 are calculated. No modification was applied because the indices were sufficient. In the third step, reliability calculations were made. Cronbach's α = .932, McDonald's ω = .943 for multiple teaching, Cronbach's α = .935, McDonald's ω = .940 for self-directed learning, Cronbach's α = .934, McDonald's ω = .940 for students-centered, Cronbach's α for the whole scale = .946, McDonald's ω = .949.

Comprehensive Teaching Approach

According to the exploratory factor analysis, the KMO value was .901 and the Bartlett's Test of Sphericity result was calculated as (χ^2 = 2186, df = 190, p < .01). A two-factor structure was obtained. In the first factor, 10 items (1, 2, 3, 6, 7, 9, 10, 11, 18, 19) were collected. The factor is named "planning". The factor load is between .53 - .96. The remaining 10 items (4, 5, 8, 12, 13, 14, 15, 16, 17, 20) for the second factor were collected. The factor load is between .59 - .98. The second factor is named "implementations". The first dimension explains 31.5 percent of the scale variance. The second dimension explains 31%. In total, 62.5 percent of the scale variance can be explained. The first model indices formed at the end of the confirmatory factor analysis were calculated as χ^2/df (404/169 = 2.39), CFI = .892, TLI = .879, SRMR .0656, and RMSEA .113. Since the values were not local, the indices were calculated as χ^2/df (259/160 = 1.62), CFI = .955, TLI = .946, SRMR .0579 and RMSEA .0752 after the modifications suggested by the program were made. In the third step, reliability calculations were made. Cronbach's α = .935, McDonald's ω = .943 for the Planning dimension, Cronbach's α = .937, McDonald's ω = .943 for the implementation dimension, Cronbach's α = .939, McDonald's ω = .943 for the whole scale.

The scales, whose validity and reliability processes were completed, were applied to 320 physics teachers working in Jiangsu Province. In the scales, 241 of them were returned completely.

Data Analysis

It was planned to make a classification based on the average scores obtained by the teachers in the variables. Latent Profile Analysis was used because the measurement variables were continuously variable. In the study, the snowRMM package was used in the Jamovi (2.3.21) program.

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Research Results

The self-perceptions of teachers were explored. Two subdimensions comprise the self-efficacy scale. In both subcomponents, teachers perceived themselves to be very skilled. As indicated in Table 1, the average for the teaching self-efficacy sub-dimension, which measures teachers' self-efficacy in the overall teaching field, is 4.28, indicating that teachers viewed themselves as very competent in this sub-dimension. The mean for the sub-category affective domain, which teachers deemed sufficient to overcome students' reluctance to learn about the emotive component, was 4.31. Comparison to all other sub - dimensions, teachers perceive themselves to be most competent in this one.

The innovative physics teaching scale is composed of three dimensions. Teachers considered themselves adequate ($\bar{x}$ = 3.91) on the multiple teaching sub - scale, which measured the utilization of a variety of teaching aids and resources for learners who have different learning styles. Teachers believed they are adequate ($\bar{x}$= 4.01) in guiding students toward self-directed learning and selecting the most effective teaching technique. In addition, teachers believe themselves competent ($\bar{x}$ = 3.91) in favoring student-centered methods and tactics in the classroom. Thus, teachers perceived themselves to be skilled in innovative teaching.

There are two sub-dimensions on the comprehensive teaching approach scale. In the "planning" sub-dimension, which measured the planning and organization of successful teaching, teachers believe they do adequately ($\bar{x}$ = 4.12). The second sub-dimension, "implementations," assessed how teachers viewed their plans' implementation. The mean on this dimension is 4.01, and teachers felt themselves adequate.

Table 1
Descriptive Statistics of Participants

Dimensions	$\bar{x}$	*SD*
Teaching self-efficacy	4.28	0.511
Affective domain	4.31	0.497
Multiple teaching	3.91	0.868
Self-directed learning	4.01	0.875
Student-centered	3.91	0.910
Planning	4.12	0.782
Implementations	4.01	0.783

Pearson correlation value, as shown in Table 2, was calculated for the relationship between sub-dimensions. The highest correlation was between self-directed learning and multiple teaching sub-dimension. The level of correlation between teaching self-efficacy and multiple teaching and teaching self-efficacy and self-directed learning were not statistically significant. Again, the relationship between implementations and multiple teaching and implementations and self-directed learning were not statistically significant. The level of relationship between other sub-dimensions was statistically significant.

Table 2
Correlations Among Dimensions

Dimensions	(1)	(2)	(3)	(4)	(5)	(6)
Teaching self-efficacy (1)	—					
Affective domain (2)	.640***	—				
Multiple teaching (3)	.102	.135*	—			

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Dimensions	(1)	(2)	(3)	(4)	(5)	(6)
Self-directed learning (4)	.095	.133*	.892***	—		
Student-centered (5)	.139*	.130*	.769***	.796***	—	
Planning (6)	.429***	.443***	.156*	.165*	.180**	—
Implementations (7)	.32***	.332***	.057	.052	.222***	.693***

Note. * $p < .05$, ** $p < .01$, *** $p < .001$

For each model parameterization, one, two, three, four, or five latent profiles were evaluated. To analyze the performance of the 15 combinations of models and the number of profiles, we conducted an analytic hierarchy approach based on the following five generally used information criteria: AIC, AWE, BIC, CAIC, CLC, KIC, SABIC, ICL, and Entropy, as shown in Table 3. A smaller number for each information criterion indicates a superior model, and Entropy should be close to 1. The matrix produced from the three models' IC, AWE, BIC, CAIC, CLC, KIC, SABIC, ICL, and Entropy values was analyzed. The analytical hierarchy technique recommends using model 2 parameterization with five latent profiles (varying variances and covariances kept to zero). In addition, model 2 with five profiles got the lowest scores for each of the information criterion.

Table 3
Latent Profile Analysis

Model	Class	LogLik	AIC	AWE	BIC	CAIC	CLC	KIC	SABIC	ICL	Entropy
1	1	-1853	3733	3899	3782	3796	3707	3750	3738	-3782	1
1	2	-1707	3458	3719	3535	3557	3416	3483	3465	-3545	0.916
1	3	-1399	2858	3215	2962	2992	2800	2891	2867	-2978	0.94
1	4	-1294	2664	3117	2796	2834	2590	2705	2676	-2810	0.954
1	5	-1219	2529	3078	2690	2736	2439	2578	2544	-2699	0.973
2	1	-1853	3733	3899	3782	3796	3707	3750	3738	-3782	1
2	2	-1561	3181	3526	3282	3311	3125	3213	3190	-3288	0.949
2	3	-1273	2635	3160	2788	2832	2549	2682	2649	-2803	0.938
2	4	-1127	2371	3076	2577	2636	2255	2433	2390	-2589	0.956
2	5	-1056	2260	3144	2518	2592	2114	2337	2284	-2532	0.957
3	1	-1339	2747	3164	2869	2904	2679	2785	2758	-2869	1
3	2	-1307	2699	3212	2849	2892	2615	2745	2713	-2860	0.913
3	3	-1196	2494	3103	2672	2723	2394	2548	2511	-2681	0.958
3	4	-1158	2434	3138	2640	2699	2318	2496	2452	-2651	0.955
3	5	-1118	2370	3170	2603	2670	2238	2440	2391	-2616	0.959

Note: Model 1: Equal variances and covariances fixed to zero; Model 2: Varying variances and covariances fixed to zero; Model 3: Equal variances and equal covariances

According to the groups, their distribution according to each variable is seen in Figure1. In the 5th group, innovative physics teaching dimensions are seen to be partially low. Different visualization tools were used to present the situation of the groups according to each variable in more detail.

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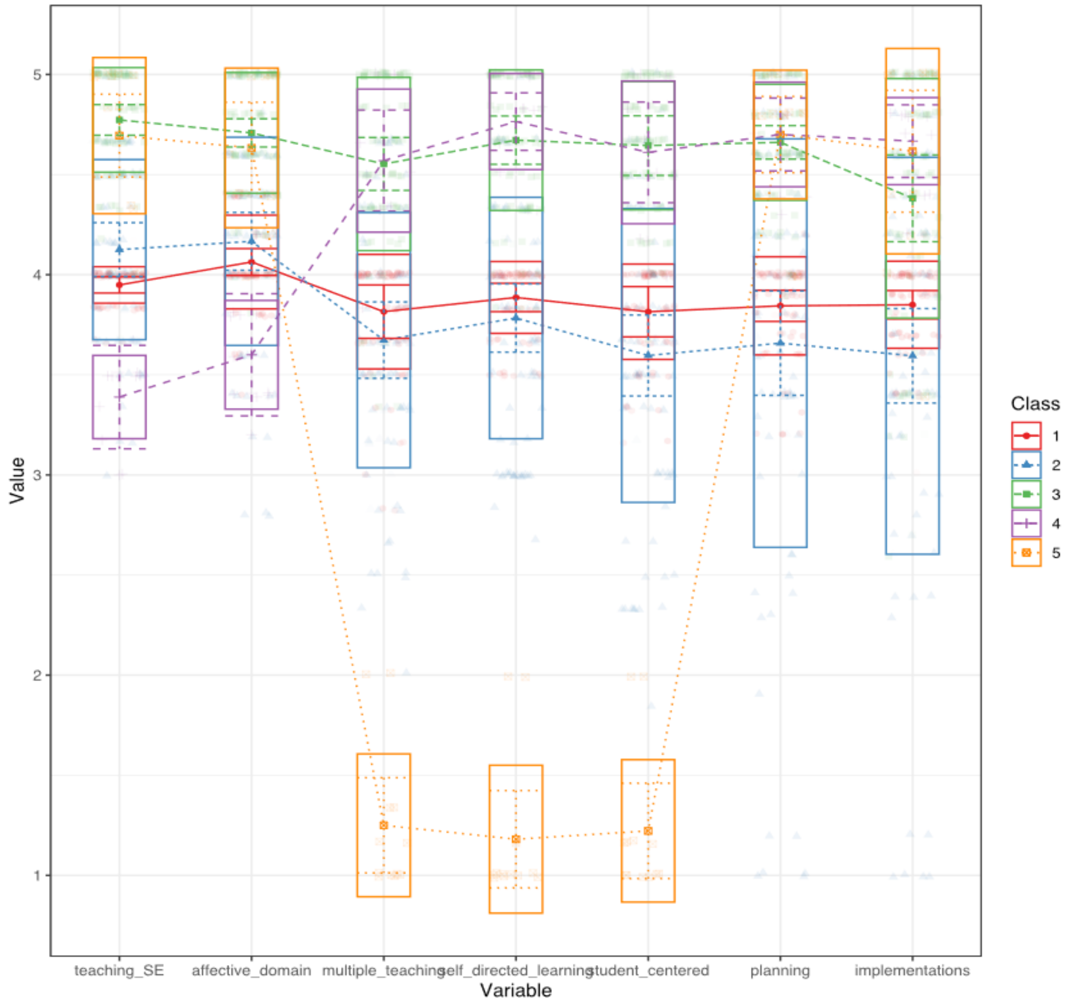
Figure 1
Distribution of Variable Based on Profile



Based on LPA findings, as shown in Figure 2, teachers were categorized into five distinct groups. The first category was known as moderately competent. They perceived themselves to be average in all aspects relative to other groups. Moreover, all sub-dimension averages were near one another. It may be considered that the teachers in this category to be those who believe they can use my knowledge. There are 64 teachers in the first group, which accounts for 26.6% of the total.

The second set of teachers was labeled "Low self-efficacy - moderate teaching skills." The judgments of self-efficacy of the teacher in this group were slightly above average, but only on the innovative teaching and comprehensive teaching approach scales, as revealed by assessing other teaching skills. There were 77 teachers in this category, or 32 percent of the total membership.

Thirdly, teachers in the Very High Competent category believed they were proficient in all subject areas. The scale averages were significantly higher than those of the other categories. The number of educators in this category was 76, making up 31.5 percent of the total.

Non-High self-efficacy - High teaching skills characterized the fourth group of educators. This group had the lowest judgments of self-efficacy compared to other groups. Nonetheless, these teachers scored exceptionally well on measures of creative teaching and effective education. The teachers in this category considered themselves to be humble. This group of twelve individuals represented 5% of the entire group.

The fifth group of teachers had high self-efficacy but inadequate innovative teaching skills. This group of teachers had a high level of self-efficacy but chose a traditional approach and was deficient in innovative teaching. There were five teachers in this group, or 5% of the total membership.

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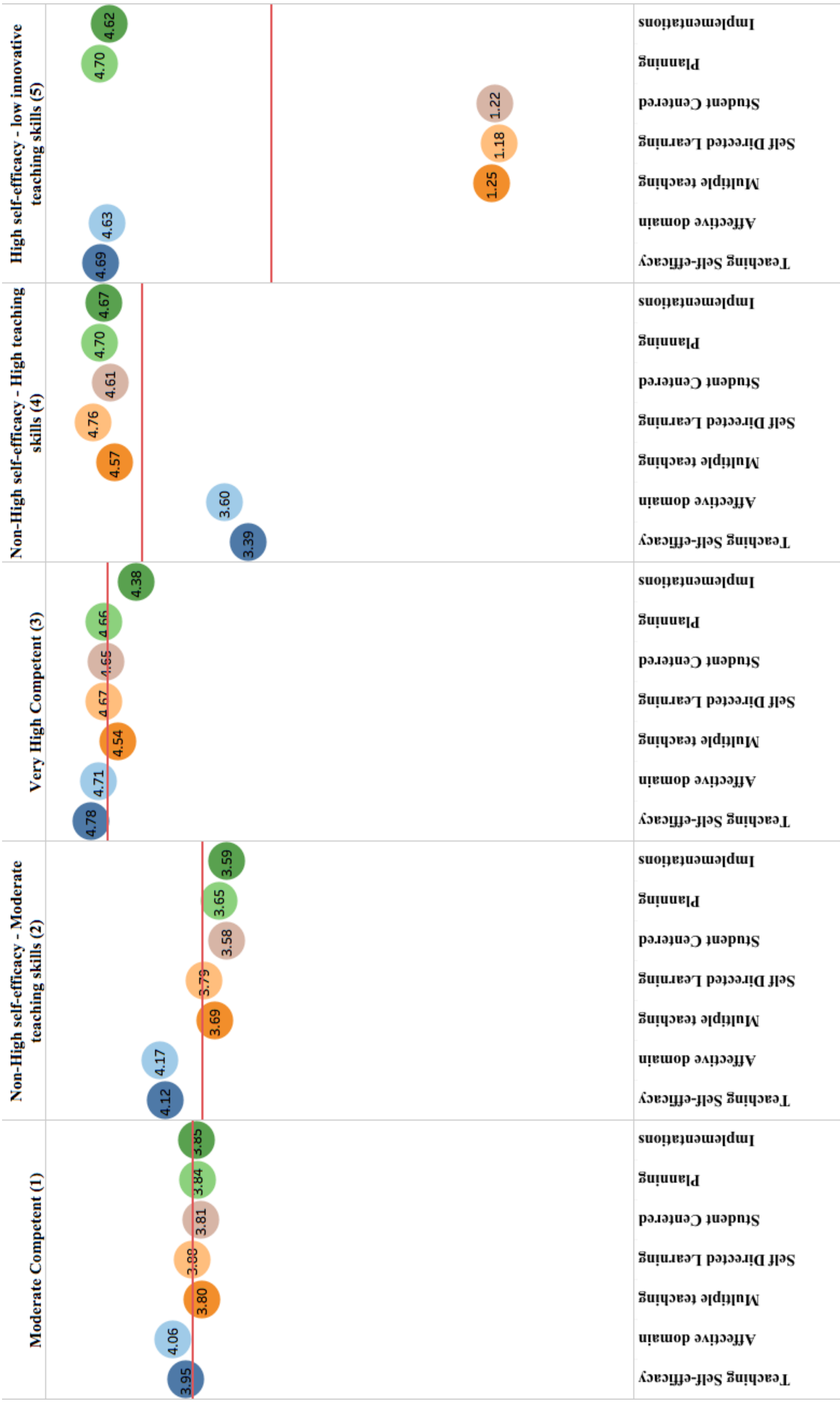
Figure 2
Mean of Variables Based on Profile



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Discussion

Teachers' self-perception is crucial to a comprehensive teaching approach and student performance (Clark et al., 2021). The purpose of this study was to examine educators' self-perceptions on many dimensions, such as self-efficacy, innovative teaching, and comprehensive teaching approach. The focus of this work was on the two sub-dimensions of self-efficacy, the three dimensions of creative teaching, and the two sub-dimensions of comprehensive teaching approach.

Self-efficacy is a person's confidence in their capacity to accomplish particular activities successfully (Pajares, 2003). In the context of teaching, self-efficacy refers to a teacher's confidence in their capacity to educate successfully. According to this study, teachers perceive themselves as highly competent in both teaching self-efficacy and the affective domain. The emotional domain refers to a teacher's capacity to manage the emotional components of education, such as addressing student misconduct and inspiring students. Findings from the present study indicate that teachers feel they are adept at controlling the emotional components of teaching, a crucial feature of good teaching. These results are consistent with other studies (Chan, 2008; Hiğde et al., 2014; Lekhu, 2016).

Innovative teaching refers to techniques of teaching that are innovative and encourage active student learning (Ukala, 2018). Multiple teaching, self-directed learning, and student-centeredness comprised the three variables utilized to assess innovative teaching in this study. According to the data, teachers believe they perform acceptably in all three categories. Multiple teaching methods relate to the use of a variety of strategies to target students with distinct learning styles.

The use of multiple representation systems by teachers also supports multiple teaching in a sense. Teachers' use of multiple representation systems differs. For example, in the study conducted by Masrifah et al. (2020), it is stated that the proficiency of physics teachers in using multiple representations is at a moderate level. However, following professional development for physics teachers, these educators have started using multiple representations more effectively (Conceição et al., 2021).

Self-directed learning refers to fostering student autonomy and accountability for their own education. Student-centeredness refers to pedagogical practices that prioritize the interests and needs of students. Observational data from a study of physics teachers confirmed that the teacher's approach shifted from a controlling, teacher-dominated style to one that fostered more autonomous learning opportunities for independent student learning, teacher-student interactions, and student-student interactions (Zhang et al., 2020).

A comprehensive teaching approach is the capacity of a teacher to plan and conduct successful education. The present study utilized a scale with two sub-dimensions to assess a comprehensive teaching approach: planning and implementation abilities. The results indicate that teachers regard themselves as satisfactory in both subdimensions. Planning abilities refer to a teacher's ability to create lesson plans that are aligned with teaching objectives and suit the requirements of students (Van Dusen et al., 2021). Implementation abilities refer to a teacher's ability to effectively implement lesson plans and change education to meet the requirements of students (Haryanto et al., 2023). Comprehensive teaching approach is related to pedagogical content knowledge (Ogan-Bekiroglu & Aydeniz, 2013). According to Wang et al. (2016), as the basic education reform sweeps across mainland China, teachers are faced with the problem of continually enhancing their professional literacy in order to accomplish their jobs well. Teachers' qualifications and abilities often increase throughout their careers due to participation in professional development courses.

The most robust association was found between self-directed learning and the subdimension of multiple teaching. This suggests that these two subdimensions have a strong positive linear connection. This result is significant because it demonstrates that when multiple teachings are provided, self-directed learning increases as well. Self-directed learning refers to a large number of individual and group activities performed by students in the classroom and at home, without the direct involvement of the teacher (Kovalenko & Smirnova, 2015). To achieve this, teachers must have high multiple teaching competencies.

According to the study's findings, there are five unique categories of teachers based on their self-reported self-efficacy and teaching abilities. The first group is deemed moderately competent, suggesting they perceive themselves to be average in all categories relative to the other groups. The second group has low self-efficacy and mediocre teaching skills, except for innovative teaching and comprehensive teaching approach, where they score above average. The third group, termed 'very competent,' thinks themselves proficient in every subject area. The fourth group has low self-efficacy but outstanding teaching abilities, which is somewhat unexpected but demonstrates that low self-efficacy does not necessarily equate to bad teaching ability. The last group pos-

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sesses high levels of self-efficacy but lacks unique teaching skills. While the findings are intriguing, the study has several limitations. The evaluation of self-efficacy and teaching skills, for instance, is reliant on self-reported data, which may be vulnerable to biases and mistakes. In addition, the study does not describe the criteria or measurements used to evaluate teaching skills, making it impossible to judge the validity and reliability of the findings. Moreover, the study did not examine the elements that lead to the variations in self-efficacy and teaching skills between the five groups, such as teacher training, experience, or motivation. Yet, the study's findings may be useful for informing teacher training and professional development initiatives. Teachers in the second category, for instance, may benefit from training that focuses on boosting their self-efficacy in areas other than innovative teaching and comprehensive teaching approach. To complement their already high levels of self-efficacy, the fifth group may benefit from training that stresses the creation of creative teaching strategies. In conclusion, the data reveal substantial variations in teacher self-efficacy and teaching skills, highlighting the need for treatments that address the unique strengths and limitations of individual teachers. In the literature review, no latent profile analysis study based on the competencies of Physics teachers was found. In the study conducted by Heuling et al. (2021), latent profile analysis was performed depending on the digital competencies of pre-service science teachers. According to the results of the study, 4 profiles were formed according to information & digital literacy, communication & collaboration, digital content creation, safety, and problem-solving competencies. Latent profile analysis was conducted by Tondeur et al. (2017) based on the level of technological pedagogical content knowledge of pre-service science teachers. According to the results of the analysis, pre-service teachers were gathered in two profiles as high and low proficiency.

Conclusions and Implications

The study explored educators' self-perceptions, comprehensive teaching approach, and innovative teaching skills in physics. The findings revealed that teachers view themselves as very competent in both teaching self-efficacy and the emotional domain. They also consider themselves to be acceptable in the areas of multiple teaching, self-directed learning, and student-centeredness. In terms of comprehensive teaching approach, teachers feel that their planning and implementation skills are acceptable. However, there were no statistically significant correlations between Teaching self-efficacy and Multiple teaching and Teaching self-efficacy and Self-directed learning, as well as between Implementations and Multiple teaching and Implementations and Self-directed learning. Additionally, the study categorized teachers into five groups based on their self-perceptions and teaching skills. The groups ranged from moderately competent to extremely competent. The findings indicated that some teachers had low self-efficacy but excellent teaching skills, while others had high levels of self-efficacy but lacked innovative teaching abilities. These results provide valuable insights into teachers' self-perceptions, teaching efficacy, and innovative teaching skills in physics, which can inform the development of effective professional development programs for teachers.

According to the findings of the study, latent profile analysis provided teachers with relevant classification results. Future researchers could implement latent profile analysis using a variety of measuring instruments. In contrast, self-report data collecting instruments were utilized in this investigation. Classroom observations can be leveraged to develop measuring instruments for assessing teachers' teaching skills.

Declaration of Interest

The authors declare no competing interest.

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Appendix

Self-efficacy

1. I could induce students' interests in physics learning.
2. I have sufficient professional physics teaching knowledge and competence to cope with students' learning problems.
3. My earnest teaching is the most important factor in promoting students' learning outcome.
4. I could create a harmonious and happy learning climate in physics education.
5. I am capable of using different teaching methods for students in different levels.
6. I know how to rapidly control class order.
7. I am capable and confident of improving students' learning attitude towards physics education.
8. I am confident of improving students' emphasis on physics education.
9. Physics teachers present better influence on guiding physics learning
10. I feel that I am capable of changing students' incorrect physics knowledge.
11. The effect of family environment on students could be overcome through education.
12. I can develop the teaching effectiveness under existing environment and equipment.

Innovative physics teaching

1. I would often provide novel and stimulating materials.
2. I would allow students freely select assignment topics related to the course.
3. I often encourage students preceding self-evaluation.
4. I would often arrange self-directed learning activities.
5. I would often arrange diverse learning activities beyond physics teaching.
6. I would utilize actual contingency for opportunity education.
7. I would often teach with similes or analogy.
8. I would provide diverse solutions to respond to students' questions.
9. I would ask questions to guide students' multiple thinking.
10. I would normally accept students' points of view.
11. I often encourage students to accept others' opinions.
12. I would particularly cultivate students' responsibility, humor, and openness of mind when planning teaching activity.
13. I would often guide students to think with images.
14. I would normally introduce diversified teaching facilities.
15. I would normally allow students to apply various methods or media.
16. I would often plan different physics topics to train students' ability development.
17. I often encourage students through discussion and interaction.
18. I would normally plan diverse lessons and teaching activities.

Comprehensive Teaching Approach

1. Understanding students' physics knowledge before lesson.
2. Investigating students' security before lab instruction.
3. Making teaching records before instruction to cope with special situation.
4. Practicing physics teaching according to teaching plan and schedule in the instruction.
5. Providing definite action demonstration and explanation in the lab instruction.
6. Systematically presenting materials from simplicity to complication in the instruction.
7. Effectively distributing teaching time in the instruction to maintain fluent teaching-learning process.
8. Providing adequate practice time in the instruction for students familiarizing material content.
9. I would make different evaluation standards according to students' individual differences.
10. I would precede evaluation with diverse methods.
11. I would inquire whether students really understand teaching content from simplicity to complication.
12. I would adjust the teaching schedule or method according to students' evaluation results.
13. I would precede self-evaluation according to teaching content.
14. I would express goodwill and assistance to students with learning difficulty or special needs.

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15. I would appreciate and encourage students with the learning progress.
16. Providing students with opportunities for peer cooperation and interaction in the instruction.
17. I would provide students with opportunities for expression and decision making with a democratic education style.
18. I would avoid sarcastic and negative words to criticize students.
19. Establish teaching rules and procedures before instruction and ask for students' compliance.
20. Maintaining good class order in the instruction.

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