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Examining the differentiation in pre-service mathematics teachers' learning and studying approaches according to self-reinforcing, and persistence

Emine Nur Unveren Bilgic [1]*, Sahin Danisman [1]

[1] Department of Mathematics Education, Faculty of Education, Duzce University, Duzce, TÜRKİYE
*Corresponding Author: eminenurbilgic@duzce.edu.tr

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ABSTRACT

The aim of this study is to reveal the profiles of pre-service mathematics teachers in terms of learning and studying approaches by cluster-analyzing them on the basis of self-reinforcing and persistence. Learning and studying approaches inventory scale, self-reinforcing and persistence subscales were used to collect the data in the study, which was carried out with a descriptive research design. The participants of the study comprised of 487 pre-service mathematics teachers. According to the results, it was determined that the surface learning approach of the pre-service teachers did not differ according to gender while the strategic learning approach and the deep learning approach differed in favor of males. There was no significant difference in the learning approaches of the participants according to the grade level. According to the cluster analysis, it was revealed that pre-service teachers can be clustered as low motivation, high motivation, high self-reinforcing and high persistence.

Keywords: self-reinforce, persistence, mathematics teachers, teacher education

INTRODUCTION

One of the most fundamental characteristics that distinguish human beings from other living things is the ability to access, learn, interpret and use this information by evaluating the individual abilities. How people perceive the process of learning in question has been researched in detail for each discipline since the 1970s (Entwistle & Ramsden, 1983). Approaches to learning are described as the methods that an individual uses to focus on and retain new information (Sengodan & Iksan Zanotan, 2012). In addition the concept of learning approach also refers to how the student accomplishes his academic tasks and ultimately affects the nature of learning outcomes (Biggs, 1993).

The learners use the most effective approaches for themselves at the point, where they believe that they will be successful as a result of their efforts in the learning process (Alexander & Schwanenflugel, 1994). Adopting a deep approach to learning will enhance their awareness about learning processes (Evans et al., 2003). Starting from this point, using a deep approach to learning requires using strategies that accompany metacognitive outcomes (Son, 2004). Students with effective metacognition make self-assessments, record and monitor their learning, set goals and plan progress, manage time, participate in learning with their peers, show perseverance, persistence, and flexibility, are aware of their weak points, and determine and evaluate their methods. It is stated that they also adapt them to their future methods (Clark & Dumas, 2016; Zimmerman, 2001).

Marton and Saljo (1976) defined learning approaches in two different categories. These categories reflect the qualitative differences in the level of understanding obtained as a result of a combination of the intention of the student when starting the task and the process used to perform it (Entwistle, 1997). According to this categorization, the approach is defined as the in-depth approach, which is put forward by establishing a strong interaction with the content to be learned, focusing on associating new ideas with previous ones and daily life, examining the logic and related arguments of the content with the intention of understanding (Marton & Saljo, 1976). The other approach is the surface approach based on memorization for the content evaluation process in which the relationship between basic principles and examples is not fully distinguished, there is no integration between the elements of the content, and there is only the intention of completing the task requirements (Marton & Saljo, 1976). Soon after Marton and Saljo (1976), Ramsden (1979) defined the third approach as the strategic approach in which the students are interested in achieving the highest possible grades, use both deep and surface approaches when necessary, and have a competitive and professional motivation.

How pre-service teachers develop deep learning and association in mathematics and their impact on their development in their professional lives are important issues for the current higher education context (Akyeampong et al., 2013). In general, deep learning, job readiness, relevance, and analytical skills are valued by stakeholders in the international labor market (Organization for Economic Co-operation and Development [OECD], 2018). Today, it is stated that mathematics educators should improve the quality of learning through deep learning and the application of mathematics to daily life to adequately prepare prospective teachers for the solutions to complex problems encountered in schools (Ministry of Education [MoNE], 2018; National Council of Teachers of Mathematics [NCTM], 2000; OECD, 2018). From this point of view, it can be said that a strong interaction with the content and associating newly acquired ideas with previous ideas and daily life are important goals for the discipline of mathematics. In this context, Dweck and Leggett (1988) state that individuals in a discipline have an indirect effect on their academic achievement through deep cognitive involvement and effort in the process of achieving their goals. In this sense, it can be said that individuals with a deep learning approach show better mathematical performance, especially in the discipline of mathematics (Chamorro-Premuzic & Furnham, 2008; Postareff et al., 2015). Students' performance at the end of the learning process can be represented by measurable learning outcomes such as course evaluation grades/averages as a standard indicator of learning. Courses taken by prospective mathematics teachers require them to develop their mathematical knowledge and also apply the principles, concepts, and techniques they have learned to solve practical and abstract problems (Kilpatrick, 2020).

Marston (1965) stated that the concept of self-reinforcing may be one of the few concepts that can provide a bridge between remedial orientations and the social learning approach. In addition, persistence grabs attention in the research. The reason for this is that every student who drops out will be considered a lost resource (Lastusaari et al., 2019). As mentioned before, the deep approach, which is one of the learning approaches includes intent to understand, linking ideas, and using evidence to form a general perception. The surface approach involves memorizing without understanding, not thinking, and accepting fragmented information. A student who uses the deep approach will often find a topic to be learned meaningful. Also, such a student will feel that learning is a positive challenge and will typically feel excited and satisfied with it. On the other hand, a student who uses the surface approach will often lack these positive emotions (Howie & Bagnall, 2013). Baeten et al. (2010) stated that the deep approach is associated with a good learning outcome and that students can be directed to use the deep learning approach more. From this point of view, Lastusaari et al. (2019) stated that deep learning approach can be encouraged by forcing an individual to think. At this point, the question "why are some students more successful than others even though they have similar learning backgrounds?" becomes more visible. This question can certainly be examined in many disciplines. However, mathematics is an academic subject that students perceive as particularly difficult and challenging (Haag & Götz, 2012). In this context, academia and the public believe that the discipline of mathematics requires more innate ability than others (Gunderson et al., 2017; Meyer et al., 2015). Domain-specific ability beliefs are essentially a domain-specific version of broader theories that intelligence is either fixed (entity theory) or malleable (incremental theory) and shape students' motivation and engagement (Yeager et al., 2016). From the malleable viewpoint, the examination of the related factors effecting students' mathematical ability and achievement such as their learning approaches as well as affective characteristics may contribute to the teaching of mathematics. The literature review also shows that self-reinforcing (Morris & Messer, 1978) and persistence (Battle, 1965), which are related to learning approaches, are related to motivation. Ball (1988) argues that ignoring what teachers know, what they do and how they learn in the relationship between mathematics didactics and perseverance and self-empowerment ruins efforts to change mathematics teaching. Research on pedagogical content knowledge, which can be considered in relation to teachers' thinking and development, reveals the importance of examining the teaching-learning processes of teachers and pre-service teachers (Shulman, 1987), as their preferences are of paramount importance in the teaching and learning processes. As the research reveals, teachers' affective characteristics such as their beliefs have an important impact on their practices (Buehl & Beck, 2014). Hence teachers' and pre-service teachers' preferences for learning and studying in relation to the motivation may contribute to the quality of teaching mathematics. Uncovering the relationship between cognitive and affective characteristics in terms of the learning approaches, self-reinforcing and persistence may further inform the stakeholders about the teaching process and student learning. What is more, as pre-service teachers being the future of our education, studying with them may acknowledge and lead us about the current teacher training system. Considering these, it seems important to examine the learning approaches of pre-service mathematics teachers in the teacher education process. This study aims to reveal the profiles of pre-service mathematics teachers in terms of learning and study approaches by performing cluster analysis on the basis of self-reinforcement and persistence.

METHOD

Research Design

Descriptive research design has been adopted within the research as it helps the researcher(s) to study and describe the distribution (Stangor & Wallings, 2014) of participants according to the variables of self-reinforcing and persistence. This research design is appropriate as this research aims to describe and classify the pre-service mathematics teachers based on their learning and studying approaches.

Participants

This research included 487 pre-service mathematics teachers, who were enrolled in different grade levels. The demographic characteristics of the participants are presented in **Table 1**.

Table 1. Demographic characteristics of participants

Variable	Category	n	%
Gender	Male	106	21.8
	Female	381	78.2
Grade level	1	173	35.5
	2	166	34.1
	3	104	21.4
	4	44	9.0

Note. GPA (Mean=2.84 & Standard deviation=0.79)

Data Collection

The demographic information has been obtained from the participants for the variables of gender, grade level, and achievement. The data collected through three measures: learning and studying approaches inventory, self-reinforcing, and persistence subscales.

Learning & studying approaches inventory

Turkish adaptation of the scale developed by Hounsell et al. (2002) was made by Topkaya et al. (2011). The scale has a five-factor structure with three approaches, which are surface approach with four items, deep approach with 10 items and strategic approach with four items. The Turkish adaptation of the scale showed satisfactory results for reliability coefficients (.60, .75, .85, .45, and .74) for each of five factors (Topkaya et al., 2011). Cronbach's alpha reliability coefficient of the scale has been found to be .85 in the current study.

Self-reinforcing

This is a subscale of self-control and self-management scale, which is developed by Mezo (2009) and adapted into Turkish by Ercoskun (2016). This subscale with five items has a reliability coefficient of .81. Cronbach's alpha reliability coefficient of this sub-scale has been found to be .85 in the current study.

Persistence

This is a subscale of self-regulated online learning questionnaire, which is developed by Jansen et al. (2017) and adapted into Turkish by Yavuzalp and Ozdemir (2020). This subscale with five items has a reliability coefficient of .79. Cronbach's alpha reliability coefficient of this sub-scale has been found to be .82 in the current study.

Analysis Procedures

Cluster analysis was used to profile the learners based on their scores on the the measures of self-reinforcing and persistence. Ward method with the squared Euclidean distance technique was chosen for cluster analysis, because this procedure tends to combine clusters with a small number of observations and tends to produce clusters with approximately the same number of observations (Hair & Black, 2000). This technique is often considered useful to improve the underlying data structure (Atlas & Overall, 1994). Therefore, it is considered particularly effective in revealing the underlying structure of the data. The number of meaningful clusters was decided by considering large changes in clustering distances and characteristics of the resulting clusters and taking dendrogram into consideration. The dendrogram is a graphic representation of the clustering process. It shows the steps in which individual participants start as small clusters and are combined into larger clusters until the whole group forms one cluster. Discriminant function analysis has been conducted to assure the validity of the cluster solutions. Skewness and kurtosis values have confirmed the normality of surface approach (S=-0.34, K=-0.40), strategic approach (S=0.50, K=-0.14), and deep approach (S=1.19, K=1.22) mean scores. ANOVAs, MANOVAs, dependent and independent sample t-tests were conducted on learning and studying approaches. All the analyses were conducted with SPSS 21.

RESULTS

Learning and studying approaches of the pre-service mathematics teachers were examined in terms of gender, grade level and achievement in the first place. Thereafter, the participants were classified using cluster analysis based on the differences in self-reinforcing and persistence subscales. Finally, the clusters have been analyzed in terms of differences between and within the clusters.

Preliminary Analysis

The independent samples t-test results, which were conducted to determine whether learning and studying approaches differ according to the gender are presented in **Table 2**.

Table 2 indicates that surface approach mean scores do not significantly differ between female (mean [M]=3.47, standard deviation [SD]=0.81) and male (M=3.35, SD=0.89) participants ($t[485]=1.33$, $p>.05$). As a result of the analysis, a statistically significant difference was found between the female (M=2.39, SD=0.87) and male (M=2.64, SD=0.89) participants' strategic approach mean scores in favor of males ($t[485]=-2.56$, $p<.05$). Furthermore, there was also statistically significant difference between the female (M=2.07, SD=0.82) and male (M=2.38, SD=0.96) participants' deep approach mean scores in favor of males ($t[485]=-3.07$, $p<.01$).

Table 2. Independent samples t-test results according to gender

	Gender	n	Mean	Standard deviation	t	df
SA	Female	381	3.47	0.81	1.33	485
	Male	106	3.35	0.89		
STA	Female	381	2.39	0.87	-2.56*	485
	Male	106	2.64	0.89		
DA	Female	381	2.07	0.82	-3.07**	485
	Male	106	2.38	0.96		

Table 3. ANOVA results according to grade level

Subscales	Source of variances	Sum of squares	df	Mean square	F
SA	Between groups	1.16	3	0.39	0.56
	Within groups	334.28	483	0.69	
	Total	335.45	486		
STA	Between groups	3.13	3	1.04	1.34
	Within groups	376.55	483	0.78	
	Total	379.68	486		
DA	Between groups	5.70	3	1.90	2.56
	Within groups	358.06	483	0.74	
	Total	363.77	486		

Table 4. Agglomeration schedule coefficients according to self-reinforcing & persistence variables

	Coefficient	Former coefficient	Subsequent differences
1. Level	1291.03	682.07	
2. Level	682.07	496.19	
3. Level	496.19	373.22	
4. Level	373.22	326.31	
5. Level	326.31	282.69	
6. Level	282.69	248.82	

Table 5. Mean & standard deviation values of quadruple clusters

Clusters	n	f	Self-reinforcing		Persistence		
			Mean	Standard deviation	Mean	Standard deviation	
Cluster 1	104	21.4	2.96	0.79	3.03	0.81	L-L
Cluster 2	196	40.2	4.21	0.59	6.14	0.55	H-H
Cluster 3	121	24.8	4.16	0.46	4.18	0.68	H-L
Cluster 4	66	13.6	2.79	0.55	5.18	0.46	L-H
Total	487	100.0	3.74	0.87	4.86	1.38	

A one-way ANOVA was performed to analyze the differences on learning and studying approaches of pre-service mathematics teachers in terms of grade level. ANOVA results are presented in **Table 3**.

ANOVA results suggest that there is not a significant difference on surface approach (F[3, 483]=0.56, p>.05), strategic approach (F[3, 483]=1.34, p>.05), and deep approach (F[3, 483]=2.56, p>.05) of pre-service mathematics teachers according to grade level.

Determination of Clusters

Pre-service mathematics teachers were grouped according to self-reinforcing and persistence using a cluster analysis. Using Ward's minimum variance hierarchical cluster technique, primary clusters were created to reduce the differences among the clusters (Ward, 1963). The data for grouping variables of self-reinforcing and persistence were analyzed in the form of a graphical representation as dendrogram (see **Appendix A**).

Examination of the cluster combinations in dendrogram suggests us two, three or four cluster solutions for the groupings of participants. To assure this inference from dendrogram, the cluster coefficients in agglomeration schedule have been examined to reveal the differentiations and to support the cluster solutions obtained from dendrogram (**Table 4**).

Tabel 4 indicates that the coefficients do not show a significant difference after the fourth level. This result implies that participants can be examined under two, three or four clusters according to the grouping variables. Each cluster solution was evaluated, and clusters of these potential solutions were created separately in order to find the most meaningful clustering solution theoretically. A suitable number for the cluster was obtained via observation of large gaps between the cluster sets. Taking dendrogram and agglomeration schedule coefficients into consideration the quadruple cluster solution has been chosen to better present the differentiations among the participants regarding the purposes of this study. When the member numbers for different cluster solutions are compared, it is seen that the quadruple cluster solution exhibits a balanced distribution compared to the others. To ensure the subsequent validity of the cluster solution, a discriminant function analysis was conducted on the whole sample. The quadruple cluster solution predicted cluster membership by 92.6%.

The mean and standard deviation values of the quadruple cluster solution obtained for the subscales of the pre-service mathematics teachers are presented in **Table 5**.

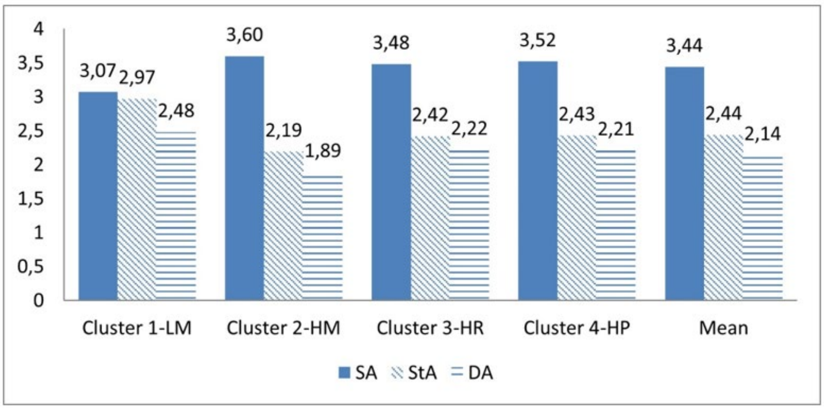

Figure 1. Cluster comparisons (Source: Authors' own elaboration)

Table 6. Dependent sample t-test results on learning & studying approaches

	Approach combinations	95% Confidence interval of difference	t	df
Cluster 1	SA-STA	-0.13-0.33	0.87	103
	SA-DA	0.35-0.84	4.79*	
	STA-DA	0.33-0.65	6.10*	
Cluster 2	SA-STA	1.21-1.61	13.94*	195
	SA-DA	1.51-1.92	16.41*	
	STA-DA	0.21-0.41	6.03*	
Cluster 3	SA-STA	0.87-1.25	11.10*	120
	SA-DA	1.04-1.47	11.38*	
	STA-DA	0.06-0.33	2.82*	
Cluster 4	SA-STA	0.81-1.36	7.78*	65
	SA-DA	1.00-1.61	8.62*	
	STA-DA	0.68-0.37	2.89*	

Table 5 shows that the average of self-reinforcing scores varies between 2.79 and 4.21, and the average of persistence scores varies between 3.03 and 6.14. The standard deviation values of both scales vary between 0.46 and 1.38. When the self- reinforcing and persistence score averages were coded according to their sizes and paired with each other, four different pairings were obtained for each of the four clusters. The four groups that emerged from the cluster analysis are distinguished by their unique traits, as shown in **Table 3**. The results shown in **Table 3** support the classification's accuracy for pre-service mathematics teachers. The groups were named examining their characteristics:

1. Cluster 1-Low motivated (LM): This cluster includes pre-service mathematics teachers who scored low in both self-reinforcing and persistence subscales. As these two variables can be thought as indicators of motivation, this cluster is entitled as low motivated.
2. Cluster 2-High motivated (HM): This cluster includes pre-service mathematics teachers who scored highest in both self-reinforcing and persistence subscales. Hence, this cluster is entitled as high motivated.
3. Cluster 3-High reinforcing (HR): This cluster includes pre-service mathematics teachers who scored high in self-reinforcing and low in persistence subscales compared to other clusters. Hence, this cluster is entitled as high reinforcing implying the low persistence of participants.
4. Cluster 4-High persistent (HP): This cluster includes pre-service mathematics teachers who scored low in self-reinforcing and high in persistence subscales compared to other clusters. Hence, this cluster is entitled as high persistent implying the low self-reinforcing level for participants.

Cluster Comparisons

After the clusters were identified, comparisons between and within the clusters were made using the learning and studying strategies used by pre-service mathematics teachers. Four clusters have been examined according to their mean scores in learning and studying approaches, which has been presented in **Figure 1**.

Figure 1 indicates that strategic approach mean scores are the highest amongst and within all clusters, while deep approach mean scores are the lowest.

Intra-cluster comparisons are used to describe the differentiations between the paired approaches within the clusters. Considering three learning and studying approaches, three dependent sample t-tests are used for each cluster. Test results are presented in **Table 6**.

Table 6 indicates that there is a significant difference (t[103]=4.79, p<.001) in surface approach mean scores (M=3.07, SD=0.78) compared to the deep approach mean scores (M=2.48, SD=0.74) in cluster 1. Also, strategic approach mean scores (M=2.97, SD=0.76) significantly differ (t[103]=6.10, p<.001) from deep approach mean scores (M=2.48, SD=0.74) in cluster 1. Surface approach mean scores in cluster 2 (M=3.60, SD=0.89), cluster 3 (M=3.48, SD=0.73), and cluster 4 (M=3.52, SD=0.71), and strategic approach mean scores in cluster 2 (M=2.19, SD=0.95), cluster 3 (M=2.42, SD=0.78), and cluster 4 (M=2.43, SD=0.67) significantly differ from each other (t[195]=13.94, t[120]=11.10, t[65]=7.78, respectively, p<.001). Surface approach mean scores in cluster 2 (M=3.60, SD=0.89), cluster 3 (M=3.48, SD=0.73), and cluster 4 (M=3.52, SD=0.71), and deep approach mean scores in cluster 2 (M=1.89, SD=0.94), cluster 3 (M=2.22, SD=0.80), and cluster 4 (M=2.21, SD=0.72) significantly differ from each other (t[195]=16.41, t[120]=11.38, t[65]=8.62, respectively, p<.001). Strategic approach mean scores in cluster 2 (M=2.19, SD=0.95), cluster 3 (M=2.42, SD=0.78), and cluster 4 (M=2.43, SD=0.67), and deep approach mean scores in cluster 2 (M=1.89, SD=0.94), cluster 3 (M=2.22, SD=0.80), and cluster 4 (M=2.21, SD=0.72) significantly differ from each other (t[195]=6.03, t[120]=2.82, t[65]=2.89, respectively, p<.001). Thus, significant differences are identified for all pairwise combinations of approaches in cluster 2, cluster 3, and cluster 4.

A one-way between subjects ANOVA was conducted to compare the effect of cluster membership on learning and studying approaches. Inter-cluster comparisons using one-way ANOVA, indicate that all the learning and studying approaches significantly differ according to the cluster memberships (surface approach: F[3,483]=10.04; p<.001, η^2=.06; strategic approach: F[3,483]=19.63; p<.001, η^2=.11; deep approach: F[3,483]=12.26; p<.001, η^2=.07]. Post hoc comparisons using the Tamhane test indicates that the mean score for surface approach (M=3.07, SD=0.78) and strategic approach (M=2.97, SD=0.76) in cluster 1 was significantly different than all the other clusters. Surface approach scores are lower than all the other clusters, while strategic approach scores are higher than all the other clusters. However, surface and strategic approach mean scores in other clusters do not significantly differ from each other. Post hoc comparisons using the Tukey HSD test reveals that the mean score for deep approach (M=1.89, SD=0.94) in cluster 2 was significantly lower than all the other clusters. However, deep approach mean scores in other clusters do not significantly differ from each other.

An additional one-way ANOVA was performed to analyze the effect of cluster membership on achievement scores of pre-service mathematics teachers. One-way ANOVA results suggest that there is a statistically significant difference in achievement scores among clusters (F[3, 483]=3.40, p<.05, η^2=.01). Post hoc comparisons using the Tamhane test indicates that the achievement scores (M=2.78, SD=0.59) in cluster 1 is significantly lower than the achievement scores (M=3.08, SD=0.53) in cluster 4. Although the achievement scores increase from the first cluster to the fourth cluster, this increase is not statistically significant except for cluster 1 and cluster 4.

DISCUSSION

This research aimed to reveal the profiles of pre-service mathematics teachers in terms of learning and studying approaches by cluster-analyzing them on the basis of self-reinforcing and persistence.

According to the results of the research, surface approach means of the students are higher than those of strategic and deep approach. This may stem from the fact that assessments and grades are geared toward surface learning, as the surface-type of learning approach is more suitable for exam success (Bengtsson & Teleman, 2019). Another finding suggests that the surface learning approach preferences of pre-service teachers does not differ according to gender. This result can be explained by the fact that pre-service teachers studying in the same department show similar characteristics. There are studies supporting this finding, as they found no difference in learning approaches according to gender (Balam, 2015; Rutherford et al., 2016). In addition, strategic learning approach and deep learning approach scores differed significantly in favor of males. It is supported by many studies that men perform higher than women in mathematics and science disciplines (Carnoy, 1971; Steegh et al., 2019). Since these two approaches conceptually support student achievement, it can be said that the result obtained is supported by these studies. In addition, the gender gap in mathematics achievement persists in some countries, while it is absent in others. On the other hand, it is revealed that while female students have a strategic and deep learning approach, male students exhibit a surface learning approach (Bulut et al., 2020; Sithole, 2018; Smith et al., 2005).

Based on the findings of the study, it was determined that there was no difference in the learning approaches of the pre-service teachers according to the grade level. In other words, pre-service teachers use similar approaches according to their grade levels. Rutherford et al. (2016) similarly revealed that undergraduate students' approaches to learning do not differ according to grade level. Metin et al. (2011) also found that the pre-service teachers' learning styles do not change across the grade levels. This situation may have arisen as a result of the fact that pre-service teachers did not receive training on learning strategies or that their study habits did not change across the grade levels. As a matter of fact, Turan et al. (2020) stated in their study that training activities at the higher education level are effective on students' learning approaches. Lack of such kind of trainings in the undergraduate education may be the reason for the non-differentiation.

As another result of the research, according to the clustering analysis based on self-reinforcing and persistence subscales, it was seen that teacher candidates can be divided into four different groups. These clusters were named as low motivation (both averages are low), high motivation (both averages are high), high self-reinforcing (low persistence), and high persistence (low self-reinforcing). Self-reinforcing and persistence are two important concepts associated with motivation (Brophy, 1983). In this respect, the concept of motivation was preferred in cluster names to meet both variables of self-reinforcing and persistence.

Lastusaari et al. (2019) suggested that persistence will have a positive effect on learning approaches. While the surface learning approach has the highest average in all clusters, the deep learning approach has the lowest average in all clusters. Accordingly, it can be said that the learning approaches that teacher candidates have or prefer are independent of self-reinforcing and persistence. This situation is compatible with the fact that students' learning approaches are mostly in line with the surface learning approach in the literature (Chan & Elliot, 2004; Hattie & Donoghue, 2016). Besides, although pre-service teachers are supposed to exhibit strategies, which align with deep learning including the development of holistic and broad understanding of a subject (Rutherford et al., 2016), the research often revealed that this was not the case (Riding & Rayner, 1998). Moreover, this finding contradicts with the expectation that adopting a deep learning approach would be dominant in line with the transformation between subject area content knowledge and pedagogical content knowledge across the grade levels. A teacher will be able to address some standards about how to teach a concept that he/she knows in depth (Grossman, 1990). Accordingly, the aims of teaching the subjects in teacher training programs should be addressed in the context of the learning outcomes targeted for each subject and pre-service teachers' understanding of the projections of the mathematics courses' contents on professional life should be shaped. On the other hand, based on the results of the study by Negash et al. (2022), students preferred deep and strategic learning approaches over surface-based learning approaches. A deep approach to learning encourages students to take an active role in their own learning and be internally motivated to learn the material.

In the first cluster, where self-reinforcing and persistence are low, there is a differentiation between surface and strategic learning approach and deep learning approach. In this context, it is seen that pre-service teachers prefer the surface learning approach and the strategic learning approach compared to the deep learning approach. In addition, there is no differentiation between the surface learning approach and the strategic learning approach in this cluster. In this respect, it can be said that the deep learning approaches of the low-motivated students are lower than the other two approaches. This situation can be explained by the fact that pre-service teachers with low motivation prefer surface learning instead of learning the subjects conceptually (McManus et al., 1998). As Dasari (2009) puts forth, the surface approach focuses on rote learning or memorizing facts to meet minimum standards. Deep learners, on the other hand, study the content carefully in details and strive to comprehend the content completely. That may be the reason of the surface approach preferences of the low-motivated students, as they look for ways of passing exams instead of learning the content deeply (Lucas & Meyer, 2005). Teoh and Yap (2015) also reveals that surface approach has been correlated positively with surface motivation, while there is no correlation between surface approach and strategic or deep approach. Biggs (2012) states that the regulation of cognitive activities related to performing appropriate activities is determinative for a student with a deep learning approach to achieve a task with an appropriate result. In addition, he states that a student with a surface learning approach exhibits low cognitive activities that cannot explain the results of knowledge. From this point of view, the deep learning approach requires not giving up in cognitive activities compared to the surface learning approach. In this context, it can be said that the deep learning approach can be achieved with higher persistence and self-reinforcement.

Research results also suggested that there was a significant difference between the strategic learning approach and the surface learning approach preferences in the other three clusters in favor of the surface learning approach. In addition, there was a significant difference in favor of the surface learning approach between the surface learning approach and the deep learning approach in these clusters. Finally, it has been revealed that there is a significant difference in favor of the strategic learning approach between the strategic learning approach and the deep learning approach in these clusters. There are a number of studies suggesting that the students are mostly surface rote learners, as when it comes to classroom discussion, they are more teacher-directed, less self-directed and lack self-autonomy (Goh, 2005; Kember, 2000; Leung et al., 2007; Ziguras 2001). It is stated that students generally prefer to get passing grades through strategic learning by focusing on routine issues at a superficial level rather than understanding the basic subjects in depth (Bengtsson & Teleman, 2019; Cox, 1994; LoGiudice et al., 2022). This explains the highest scores in surface learning approaches across all the clusters.

In comparisons between clusters, it was revealed that pre-service teachers' learning approaches differed significantly according to persistence and self-reinforcing. Accordingly, pre-service teachers in cluster 1 have lower surface learning approach scores than all other clusters, and strategic learning approach scores are higher than all other clusters. However, the mean scores of these two approaches of pre-service teachers in other clusters do not differ from each other. This can be interpreted as low persistence and self-reinforcement affect students' determination in their cognitive efforts and students prefer strategic learning approach regardless of deep or surface learning approach. As a matter of fact, it is suggested that strategic learners prefer the appropriate learning approaches, deep or surface, depending on the situation (McManus et al., 1998). In addition, it was determined that the deep learning approaches of the pre-service teachers in cluster 2 were significantly lower than the other three clusters. This result contradicts with the results of the studies claiming that pre-service teachers with high persistence and self-reinforcement have commitment to cognitive efforts (Elliot et al., 1999; Zimmerman & MartinezPons, 1990).

Although the success grades got higher from cluster 1 to cluster 4, it was determined that there was a statistically significant difference only between achievement scores of cluster 1 and cluster 4 in favor of cluster 4. In this context, it can be said that the high determination of pre-service teachers has a positive effect on achievement (Simons et al., 2004; Zimmerman et al., 1992). Considering that the number of mathematics and mathematics education courses is higher than other courses in the program of teaching mathematics, it can be said that these courses make the greatest contribution to the achievement scores of teacher candidates. Xiao and Sun (2021) put forth that the students with high motivation are more involved in mathematics activities and more persistent when facing challenges. Furthermore, mathematics achievement and persistence are positively correlated. This result may explain the differences in achievement scores among clusters.

Limitations & Implications for Future Research

Some issues that can be accepted as limitations of the study are mentioned hereby. The first issue that can be accepted as a limitation is that the data were collected from prospective mathematics teachers working at three state universities. If additional participants from other universities are selected, the findings of the study may be extended. Another limitation of the study is the measurement tools used in the data collection process. Since the data collection process was carried out with the help of these instruments, the findings of the study are limited to the interpretation of the items of these instruments. The findings of the study may be supported use of other related scales. Teachers' thoughts and preferences behind their behaviors should be investigated specifically and simultaneously in addition to the pre-service teachers. In this study, pre-service mathematics teachers' approaches to learning and studying were examined in the context of self-reinforcement and persistence. It is widely accepted that two factors, teacher knowledge and affective domain, are more closely and directly related to teachers' teaching practices (Escudero-Ávila et al., 2021; Ernest, 1989; Schoenfeld, 1998). In terms of teacher knowledge, it is accepted that teachers' affective domain is a multifaceted structure (Ernest, 1989). For this reason, it is highly recommended that pre-service teachers' learning and studying approaches should be interpreted in the context of teacher knowledge and addressed within the scope of other affective domains. As an extension of this study, longitudinal studies can be carried out to see the change in the profiles of pre-service mathematics teachers. In addition, the relationship between the learning and teaching preferences, and affective traits of teachers can be examined through mixed method studies.

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Ethical statement: The authors stated that, in this study, all rules specified in "Higher Education Institutions Scientific Research and Publication Ethics Directive" were strictly followed. Actions specified under the title "Actions Contrary to Scientific Research and Publication Ethics" were not carried out. In addition, ethical permission required to carry out the study was obtained from Sakarya University Social and Human Sciences Ethics Committee (16.02.2021/ E-61923333-050.99-11492).

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APPENDIX A

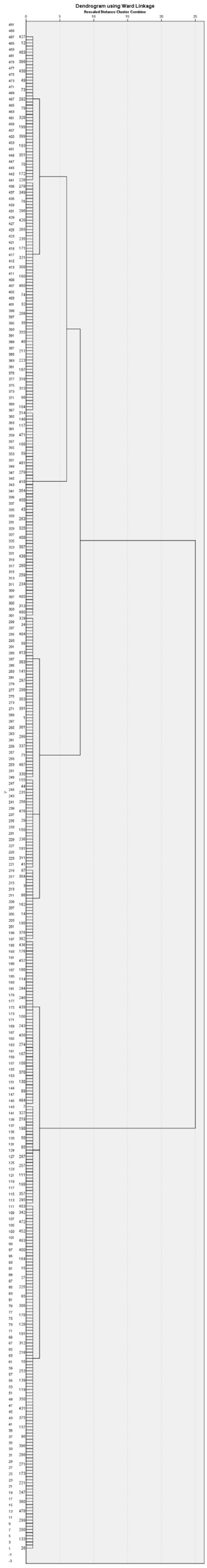

Figure A1. Dendrogram for self-reinforcing & persistence variables (Source: Authors' own elaboration)