Nonlinear Effects of Performance-Avoidance on Self-Efficacy: A Cusp Catastrophe Model

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Abstract: *Background:* achievement goal theory provides an explanatory framework for students' academic behavior. Reports on performance-avoidance goal orientation have not always been consistent and satisfactorily interpreted.

Aims: This study aimed to explore the relation between students' performance-avoidance goal orientation and self-efficacy by fostering the nonlinear perspective.

Methods: In the empirical data cusp catastrophe analysis was applied.

Results: The nonlinear model was superior to the linear alternatives and the performance -avoidance goal acted as the bifurcation variable.

Conclusions: The behavior of peformce-avoidance is explained as bifurcation factor, signifying a nonlinear system and supporting the complex dynamical system theory (CDS).

Keywords: Complex dynamical system theory, Achievement goal theory, Peformce-avoidance goal orientation, Self-efficacy, Cusp catastrophe model, Bifurcation, Nonlinear phenomena.

INTRODUCTION

Research has shown that psychological constructs of achievement goal theory (AGT), such as mastery goals, performance-approach and performance-avoidance goals play crucial role in academic environments. Among them, mastery goals were proved to be the main predictor for students' self-efficacy, interest and achievement, while the effect of performance-avoidance, although not positive, it remains ambigous and mainly unexplored. This goal orientation creates negative emotions, as it is associated with the avoidance of showing an incompetence or having a negative comment [8]. Individuals with performance-avoidance goal try to avoid looking silly or having the worst performance, displaying a more vulnerable profile [39], and they feel fear and anxiety about failure combined with perception of low ability. Such a goal appears to have negative consequences and non-adaptive learning patterns [2, 13, 59].

Moreover, characteristics related to performance-avoidance goals include stress, low self-efficacy, superficial learning, limited use of cognitive strategies, low interest, low performance, low motivation, avoidance of help seeking, negative attitude towards learning, giving up and cheating behaviors [6, 10, 12, 16, 26, 27, 44, 45]. Students who adopt performance-avoidance goals show low performance and low interest, as the fear of failure prevails [10, 46]. Students who adopt this goal often give up when they face a demanding task or when they have to handle a task that they do not find it so enjoyable [24]. In addition, they find it difficult to work with other students and do not feel part of a group, so they do not use their social skills [23]. Students' failure in a task is often accompanied by negative emotions, such as stress and shame and negative thoughts [35, 36]. These students may feel that the rest of their classmates are a threat. Avoiding negative comments and judgments, as well as avoiding a poor performance, often requires a great deal of effort especially when the task seems difficult [50].

The huge literature existing for achievent goal orientations has illuminated the effects of these psychological constructs, however, for performance goal orientations and their ambiguous character, no reasonable theoretical explanations have been provided. Note also that in general, the effect sizes reported in the literature linking goal orientations to achievement and achievement related process are realtively small. Thus, seeking for additional more explanatory models is of paramount importance for theory development.

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Among other related to academic behavior constructs self-efficacy is one of the most influential factor. Beliefs about one's effectiveness in a particular subject play an important role in a person's academic success [4, 34]. Beliefs about self-efficacy are students' own views, individual judgments about their abilities or weaknesses towards learning. Self-efficacy affects student's motivation, learning style and outcome, and since it is associated with deep strategies followed, influences the effort, the persistence to achieve, as well as the goals set by an individual [1, 29, 40].

There are a large number of students who have knowledge about the subject, but they do not have high self-efficacy beliefs, which results in the possibility of abandoning the project [25]. When a person has lower self-efficacy beliefs, his/her self-destructive abilities are enhanced or they are often led to use certain strategies to avoid failure [49]. It is also worth mentioning that those students who avoid looking more stupid than those around them have a more negative self-image [39] and display also more negative emotions [5, 40].

Students with high self-efficacy put more effort, are more motivated, set higher goals [33], while a supportive environment and a history of success help them to enhance their self-efficacy [3]. Still, students who exhibit higher levels of self-efficacy are those who acknowledge, when it happens, that teachers promote mastery goals in their classroom [15]. It is worth mentioning that students who adopt a mastery goal and a performance-approach goal to a large extent have higher beliefs of self-efficacy [38]. Thus, self efficacy is associated and can be predicted by the above achievement goals, however, on the contrary, a definite relationship between beliefs in self-efficacy and performance-avoidance goals has not been establish [9].

To this end, the current literature highlights that the performance-avoidance construct has an atypical behavior and needs special attention. Since earlier times interdisciplinary research fostering the complex dynamical system framework (CDS) has shown that constructs involved in approach-avoidance conflicts are associated with nonlinear phenomena [21, 17]. Recent works, within achievement goal theory, have provided empirical evidence that the peculiar role of performance-avoidance can be understood as a splitting variable in a cusp catastrophe structure [55]. This paper reports on the role of performance-avoidance, building on the CDS perspective.

Complex Dynamical Systems

Complex dynamical systems (CDS) theory has introduced a new paragigm, with the Kuhnian sense, in social and behavioral sciences. During the past decades, the conceptualization of psychological processes as dynamical complex and nonlinear systems, has been demarcated in many publications and different research areas. Indicative are collective volumes [19, 22] or papers focusing on the application of nonlinear methodologies to cognitive psychology [30], creativity and proplem solving [52], educational psychology [20], organizational psychology [31], decision making [56], to mention a few. It is pertinent however to emphasize that this methodological shift is apparent in applied areas appealing to evaluation of intervention sciences such as Psychotherapy, where scholars have demonstrated the role of chaotic dynamics in such processes. Theoretical models that integrate joint factors of psychotherapeutic change including motivation, emotions, information processing and regulation, have gained empirical support and provided a better understanding of the change processes in question [37, 42, 43]. The characteristics of a system comprised by many interacting parts and evolving in time in a nondeterministic fashion, lead to an ontology known as *compelx adaptive systems* [41]. Their description and exploration are realized via concepts and tools, such as attractors, entropy, fractal dimension, exponents, catastrophes, etc., which belong to a different epistemological framework. Also, these systems are inherently nonlinear and demand modeling approaches that can reveal potential behaviors, such as sudden shifts and transitions between states/atractors or behavioral modes. These could be unexpected gains or losses, sudden successes or failures, and in general, phenomena where the proportionality between the hypothetical cause and effect is absent.

Complex dynamical systems appealed to developmental and cognitive sciences because outcomes, such as learning, problem solving or attitudinal adjustment could be understood better as emergent phenomena, which are created via a nonlinear dyamcal process [53]. Similarly, the interpretation of otherwise mystifying empirical matters in psychotherapy can be construed from complexity theory and related fields, such as Synergetics [42]. Extending this view to other psychological process the application of CDS has flourished to a powerful interpretative framework, which has provided better answers to perpetual questions and better explanations to recurrent contradictory empirical findings.

A popular nonlinear modeling procedure is the application of catastrophe theory [58], which is presented next and it is fostered in the present data analysis.

The Cusp Catastrophe Model

The cusp model is the most applicable in behavioral sciences; it is expressed by the potential function F (y/a, b):

$$F (y / a, b) = ay + 1/2by2 - 1/4y4 \qquad (1)$$

where **a** is the asymmetry factor and **b** is the bifurcation factor. F(y/a, b) describes a dynamical system, which seeks to optimize some function [14]. This optimization process implies that there are two antagonistic factors or processes and adopts the notion of equilibrium, which is expressed by setting the first derivative of the equation (1), df(y)/dy =0. The result is expressed by equation (2) which is graphically represented by a three dimensional equilibrium response surface:

$$df(y)/dy = -y3 + by + a \qquad (2)$$

The graphical representation of the cusp response surface is depicted in Figure **1** that is used for model interpretation [18]. The system's behavior is linear in some region of the surface, however, when the bifurcation factor exceeds a critical value the surface, which is fold, suggests that changes occur only as transitions between two attractors (modes of behavior). The existence of two attractors implies that the behavior oscilates between two modes, an effect that introduces uncertainty and chaos in the system.

The identification of variables that can act as bifurcation factors is of paramount importance and an interesting inquiry. The spiliting role of some factors can explain contradictory empirical findings and provides a deeper understanding and supports theory building [53, 54]. Note that equations (1) and (2) are deterministic, nonetheless the contemporary stochastic catastrophe theory offers the possibility to apply statistical models to empirical data and infer about these nonlinear effects. There are modeling procedures based on the probability density function of equation (1) or on the first derivative (equation 2), while for optimization procedure the maximum likelihood [7] or the least squares approach [18] can be used. A lucid review of the methods could be found in [53].

In educational psychology and particiulary in achievement goal theory, empirical research examining the role of goal orientations within the CDS perspective have fostered catastrophe theory to model and explain students' achievement in varous disciplines [47, 48, 54]. In these models performance goals played a crucial role as splitting variables, inducing chaotic behavior. Similarly, classroom's performance motivational discourse has been associated with sudden, unpredictable, and discontinued changes in students' reading performance [49]. This paper builds on the previous works and extents the validity of achievement goal theory within the CDS framework, by exploring the relationships between self-efficacy and performance-avoidance.

MATERIALS AND METHODS

Study Design

The study design is a cross-sectional research and part of a wider project aiming to explore the applicability of the complex dynamical systems framework (CDS) in educational psychology, and presents selected findings from two independent studies, both focusing on achievement goal theory constructs and their determinant roles in language learning and teaching.

Sample and Procedure

Two independent samples of different age groups were involved; one group comprised of 14 years old students (N=124), and the other group comprised of 16 years old (N=61), respectively. The students were from public schools of Macedonia, Northern Greece, attended mandatory courses in Modern and Ancient Greek language. The data collection involved the completion of the PALS scale (Patterns of Adaptive Learning Surveys; [28]), adopted for this study and took place during a regular class. The measurements included students' goal orientations: mastery, performance-approach, and performance-avoidance goals and students' self-efficacy [11, 26]. The three-factor factorial validity of PALS and the unidimentioanality of self-efficacy have been supported by confirmatory factor analysis [57]. Reliability analysis delivered Cronbach's alpha values of 0.83, 0.84, and 0.63 for mastery, performance-approach, performance-avoidance goal orientation, while for self-efficacy the interanal consistency coefficient was 0.86 (Table **1**).

Ethical Considerations

The study followed all ethical consiterations including the written informed consent and keeping anonymicity of the participants. The project was

approved by the Ministry of Education Ethics and Deontology committee.

Data Analysis and Results

Table **1** shows the correlation matrix with Pearson correlation coefficients, descriptive statistics and reliability measures for the four pssychologial constructs. Mastery approach is positively correlated to performance-approach (r= 0.19, p< 0.01) and self-efficacy (r= 0.49, p< 0.001). Performance-avoidance is also positively correlated to performance-approach (r= 0.37, p< 0.001) and negatively to self-efficacy (r= -0.13, p< 0.01).

Subsequently, cusp analysis was performed aiming to reveal potential nonlinear effects. The modeling procedure that was followed, employs the probability function, *pdf*, of the stochastic cusp catastrophe (equation 1), which is derived from the empirical data. The direct method for cusp model was followed which is described in [18].

$$pdf(y) = \xi \, exp\left[-\frac{1}{4}y^4 + \frac{1}{2}by^2 + ay\right] \qquad (3)$$

Instead of the raw data, y, the normalized scores *z* were used, corrected for location and scale (y→z). Where location was set at the minimum value of y and for scale the ordinary standard deviation was used. The method employs the least squares optimization procedure and includes comparisons with the linear alternative models evaluating them in terms of variance explained (R^2) and the statistical significance of the coefficients. In the cusp analysis self-efficacy was introduced as the dependent measure (z), Mastery goal

orientations was introduced as the asymmetry factor (***a***), while performance-avoidance as the bifurcation (***b***).

The analysis revealed a cusp structure in the empirical data, predicting students' self-efficacy in language, both Modern and Ancient Greek. Table **2** shows the results from the direct method based on probability density and least squares, along with the multiple regression slopes, standard errors, t-tests and model fit for the cusp models and the linear counterparts. For the first group (8th grade – Modern Greek language) the linear model is statistically significant and explains 21% of the variance, while the cusp model, having all the coeficients statistically significant explaines 72% of the variance. For the second group (10th grade – Ancient Greek language) the linear model is statistically significant and explains 16% of the variance, while the cusp model, having also all the coeficients significant explains the lion share of 76% of the variance. The cusp models, based in the statistical significance of the coefficients and the R^2 values, are proved superior to the linear alternatives, thus the main hypothesis is supported.

DISCUSSION

The utilization of cusp analysis, even though it has an inductive character in this research, it is concominately theory driven, since an accumulated knowledge on avoidance type constructs, suggests that underlying conflict processes associated with it, can induce nonlinear phenomena [21, 17]. The results showed that such effects are present and it is in line with epistemological assumptions that conform with the complexity and the dynamical nature of psychological processes. Figure **1** describes the nonlinear features of

Table 1:   Correlation Matrix and Descriptive Statistics for the four Phsychologial Construts

	Master Approach	**Performance Approach**	**Performance Avoidane**	**Self- Efficacy**
Master Approach	1.00			
Performance Approach	0.19**	1.00		
Performance Avoidance	-0.02	0.37***	1.00	
Self-Efficacy	0.49***	0.21**	-0.13**	1.00
Cronbach's alpha	0.83	0.84	0.63	0.86
Mean	4.30	4.14	3.58	4.81
Std. Deviation	1.29	1.41	1.31	1.25
Skewness	-0.106	-0.580	-0.185	-0.422
Kurtosis	-1.409	-0.852	-1.343	-.0467

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

Table 2: **Predicting Students' Self-Efficacy in Language. The Direct Method Based on Probability Density and Least Squares: Multiple Regression Slopes, Standard Errors, *t*-tests and Model Fit. Cusp Models and the Corresponding Linear Alteranative Models Respectively**

	Model	Adj R^2	b	se(b)	t	Model F
8th Grade: Moder Greek	**Linear Model**	0.21				208.07***
	Mastery Approach		0.413	0.023	17,95***	
	Performance Avoidance		-0.120	0.022	-5.45***	
	Cusp Model	**0.72**				876.3***
	Z^4		0.334	0.019	17.58***	
	(Performance Avoidance), bZ^2		0.027	0.008	3.18***	
	(Mastery Approach), aZ		0.195	0.048	4.06***	
10th grade: Ancient Greek	**Linear Model**	0.16				196.52***
	Mastery Approach		0.302	0.046	6.56***	
	Performance Avoidance		-0.157	0.049	-3.17**	
	Cusp Model	**0.76**				
	Z^4		0.299	0.019	15.6***	956,7***
	(Performance Avoidance), bZ^2		0.031	0.014	2.21*	
	(Mastery Approach), aZ		0.261	0.059	4.42***	

* p < 0.05, ** p < 0.01, *** p < 0.001

the system's behavior in a three dimensional space. When the bifurcation has low values (the back of the surface), the changes in behavior is smooth and a linear relationship between the state variable (self-efficacy) and the asymmetry (mastery-approach) holds. In the middle of the surface, beyond the *cusp point* the surface folds and two regions appear, the upper and the lower mode, which correspond to two different states or behaviors, representing high and low self-efficacy levels. At this region, the probability density function of the dependent variable exhibits bimodality, whereas the area between the two modes is called the inaccessibility area, where the behavioral points are unlikely to exist. Thus, in this region of the surface, changes in the dependent variable occur only as sudden jumps or transitions between the two behavioral attractors. This is a discontinuity and a dynamic effect which introduces uncertainty in the systems' behavior, when the bifurcation factor takes values beyond a critical point [14].

The implications of the findings are primarily epistemological, advocating the paradigm shift towards CDS, since such behavior is merely due to the complexity and the dynamics of the system [32]. Thus, is was shown that there are circumstances where the traditional linear models are inadequate to describe and interpret psychological processes. The results are in covenant with other research findings exploring the predictive roles of the achievement goal theory constructs in academic behaviors of students [46, 49, 54].
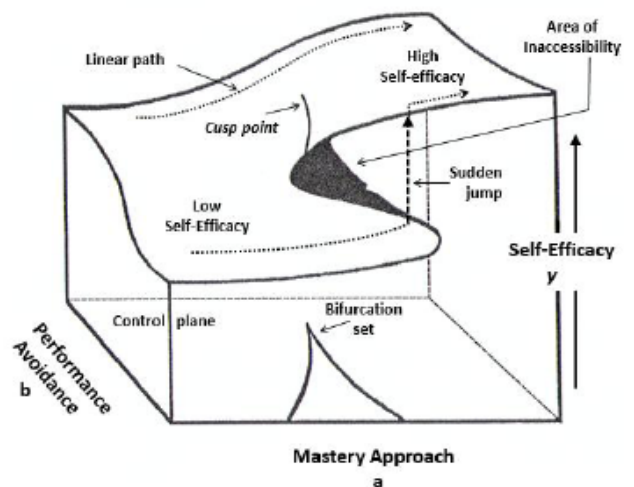

Figure 1: A three-dimensional display of the cusp catastrophe response surface of *self-efficacy* as a function of *mastery-approach* (asymmetry) and *performance-avoidance* (bifurcation).

Since the trichotomy of Elliot and Church (1997), performance approach and performance avoidance goals were aggregates of a single construct. This type of research supports their distinction, and it should be stressed that although this paper reports on the role of performance avoidance goals, it is known that under various settings performance approach goals for which their role has been strongly debated, can also act as splitting variable [47, 55]. Moreoever, in other reports evidence has been provided that linear combinations of both performance goals contribute to the asymmetry and bifurcation factors [45, 55]. The performance type of goals -approach or avoidance- are associated with nonlinearity. This is theoretically anticipated and explained by considering force-field dynamics and opposed processes, which are commonly present in any human decisiom making or actions [19, 45].

Note, that cusp catastrophe and its fundamental function is by definition the appropriate mean to model the outcomes of such conflicting dynamics in the presence of two antagonistic processes. The identification of potential bifurcation factors improves our conceptual understanding about unanticipated situations resulting out of the complex nonlinear interactions of protagonist factors. The findings of this research inform theory about the peculiar behavior of the performance-avoidance goal, which is mainly a non-adaptive factor [2, 13]. This goal orientation beyond a critical point affects self-efficacy believes in an unpredictable fashion, which in turn can have analogous influence on academic behavior. From a practical point of view, it is essential that teachers need to know about the origin of those potentially sudden changes in students' behavior, which might be due to the operation of a bifurcation effect. Moreover, teachers are definitely urged to support mastery goals and elude performance avoidance, while keeping the latter below the bifurcation point.

Besides the specific implications for the achievement goal theory, this work and the relevant cusp catastrophe research, have an impact on a contemporary problematization and on going endeavors attempting to answer research questions on the nature of psychological constucts. That is, whether a latent variable is categorical (a kind) or dimensional (continuous) [61]. This crucial question seeks to predict if changes can occur as smooth shifts in a continuous scale or as transitions between stages. Cusp catatrophe models advocate the discontinuous changes and this has important implications in defining measuring and treating latent constructs. Examples might be developmental variables [60] or issues and factors of psychotherapy processes [37, 42].

The present research has certain limitations originating from the use of an opportunity sampling and the incomplete exploration by implementing merely motivational variables, while other individual differences, such as cognitive factors, are known to be also associated with nonlinear phenomena [51, 52]. Nevertheless, informing theory and practice, this study continuous an ongoing discussion on the nature of pshychological processes involved in language learning, and further about the methodological issues and developments that allow better exploration of the phenomen under study.

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