

## KAOSUN KEŞFEDİLMESİ VE SORGULANMASI: MAKARALARIN HAREKETİ

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### ÖZET

Bu çalışmanın amacı içerik olarak kaos teorisinin ve yöntem olarak araştırma temelli öğrenmenin kullanıldığı bir etkinlik oluşturmaktır. Bu çalışmada açıklanan etkinlik, kaotik sistemlerin araştırma temelli öğrenme yöntemiyle incelenebileceğini de göstermesi açısından önemlidir. Etkinlik kapsamında, öğrenciler makaraların kaotik hareketinin nedenlerini tartışmıştır.

**Anahtar kelimeler:** Kaos teorisi, araştırma temelli etkinlik

## CHAOS EXPLORATION AND INQUIRY: THREAD CONES' MOTIONS

### ABSTRACT

This study aims to explore an activity to teach chaos theory. For this purpose, we used inquiry-based learning as a method. The activity explicated in this paper demonstrates how chaotic systems can be studied using the inquiry-based learning method. As a part of the activity, students discussed the reasons of the chaotic motions of the thread cones.

**Keywords:** Chaos theory, inquiry activity

### INTRODUCTION

With nonlinear conceptualizations, Chaos theory has potentialities for generating some of the strongest explanations

for the motions and entities in our universe. In the pursuit of answers to questions related to such phenomena, models are constrained by idealized or essentialized

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perspectives. For instance, we often employ studies focusing on the gravity between two bodies. But, how would we situate billions of other stars and their planets while observing these two bodies? Within chaos, we find systems that are nonlinear, dynamic, and complex. The initial conditions have significant influence on the life of such systems which are always affected by multiple factors (Kellert, 1993). For example, if we assume a controlled setting in which we would solve a basic problem about a car's motion on a road with constant velocity, this would be easy. However, in the real world we find different types of frictions, cavities, and other unknown factors that may affect a car's motion.

Another chaotic system is education. Central curricula, policy, and books fail to predict the behavior of students who have varying developmental trajectories in educational spaces (Erçetin & Bülbül, 2011). The achievement of an instructional objective may be targeted with different methods and these methods may interact in different ways in diverse settings (Bülbül, 2007). Chaos theory addresses these multiple interactions. For prospective teachers, system awareness is crucial in the journey towards becoming a teacher (Karaman, 2010).

In education, teachers' work used to be defined by the 'delivery of content'. More recently, emphasis has been put on centrality of students' autonomous learning. Both characterizations of education are constrained by a one-way direction in the process. Simply put: teaching would be associated with the transmission of knowledge and learning would be described as receiving the specified knowledge in this paradigm. These framings do not adequately reflect the nature of interaction between teachers and students. For instance, it is not uncommon in learning environments to observe the emergence of a reversal of expected roles. In other words, there may be moments when a student may teach and a teacher may learn thanks to this teacher-student interaction. Therefore, there is a need for a term that conveys the chaotic nature of educational processes. In this study, we propose the term *tearning*.

Merging teaching and learning, *tearning* signals two-way interactions. If, as educators, we target creative work in our classes, *tearning* actions should not follow constantly predictable patterns. While some level of structure may be desirable, *tearning* spaces need to promote surprise, curiosity, and discovery. In this regard, inquiry would be an appropriate means for doing nonlinear dynamic *tearning* activities. While guided inquiry is underscored, scientists often use

open ended inquiry. As Weinbaum et al. (2004) remind us, “inquiry groups provide a place for both experienced professionals and those in the earlier stages of their career to hone their craft and support one another” (p. 17). In this study, while focusing on the subject of chaotic systems, we utilize inquiry as a method (Amrein & Berliner, 2003). In particular, we explore how a team of prospective physics teachers make decisions and study a chaotic system.

## THE APPLICATION OF THE ACTIVITY

For this inquiry, the chaotic system we focus on consists of two main parts; thread cones with rope and a pencil to reel up the rope. For one thread cone it is possible to observe predictable motion while one is reeling up the rope. But, with ten thread cones, the motion becomes chaotic (Figure 1). A video which demonstrates the chaotic motion of thread cone is available at: [http://youtu.be/FKkzsRBR\\_8w](http://youtu.be/FKkzsRBR_8w)



Figure 1. *Chaotic Motion of Thread Cones*

In our study, five preservice physics teachers had a group discussion focusing on factors that affected the motion of thread cones as well as those that had no effect. The volunteer team members met at the physics laboratory at the School of Education. The participants generated various ideas about factors that had an effect on the motion of thread cones. We categorized those ideas based on a decision making procedure. Figure 2 shows the procedure followed in choosing factors that had an effect on motion.

First, participants expressed their own ideas. We included ideas that were proposed for group discussion in a list. The group had the option of excluding some of these

suggested ideas; but, all suggested ideas were tested by the team. Red lines in Figure 2 represent areas that did not lead to any group learning due to team members' silence. Blue lines, on the other hand, show the procedural steps followed while deciding on a factor that had an effect on motion. As Figure 2 demonstrates, students either tested an idea while deciding on whether it was a factor that had an effect on motion or they decided to code it as a factor without testing based on group agreement. The decision making in this system was chaotic due to the nature of group discussion and peer influences associated with what is known as butterfly effect (Lorenz, 1995).

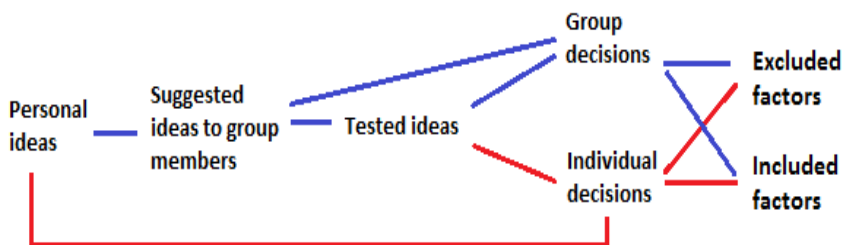


Figure 2. *Decision Making Procedure for Factors.*

The preservice teachers agreed on eleven factors (Table 1) that had an effect on motion. Some more factors could be added to the list, but it is not the aim of this study to develop a precise

formula to describe the event. Instead, we draw attention to how focus on a chaotic system facilitates discussion and identification of a number of factors within an inquiry project.

The low number of factors selected for testing in Table 1 can be interpreted as participants' uncertainty related to those particular areas. As shown in Table 1, team members decided to test Factors 1, 5, and 3. For the remaining factors, the team members

agreed that there was no need to test and decided to include these as plausible. There were no factors that the team members disagreed on.

Table 1. List of Factors That Had an Effect on Motion of Thread Cones

		<b>Tested factors</b>	<b>Agreed factors</b>	<b>Disagreed factors</b>
1.	Motion of hand while reeling up	+	+	
2.	Interaction among ropes		+	
3.	Speed of reeling rope up		+	
4.	Structure of floor		+	
5.	Number of thread cones	+	+	
6.	Style of reeling up		+	
7.	Number of reeling up		+	
8.	Distance from floor to the hand while reeling up	+	+	
9.	Type of rope		+	
10.	Weight of thread cone		+	
11.	Shape of thread cone		+	

## CONCLUSION

We found that the *tearning* opportunity furthered the participants' interest in doing more decision making procedure. Specifically, the inquiry-based activity facilitated prospective teachers' reflections on chaotic systems. Furthermore, the decision-making procedure prompted participants' discovery learning

and collaboration within the team. In conclusion, we suggest that teacher educators can explore prospective teacher inquiry processes in particular with team explorations of chaotic systems.

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