Chaos Theory and its Application to Education: Mehmet Akif Ersoy University Case[*]

Vesile AKMANSOY[a]
Burdur Provincial Education Department

Sadık KARTAL[b]
Mehmet Akif Ersoy University

Abstract

Discussions have arisen regarding the application of the new paradigms of chaos theory to social sciences as compared to physical sciences. This study examines what role chaos theory has within the education process and what effect it has by describing the views of university faculty regarding chaos and education. The participants in this study consisted of 30 faculty members with teaching experience in the Faculty of Education, the Faculty of Science and Literature, and the School of Veterinary Sciences at Mehmet Akif Ersoy University in Burdur, Turkey. The sample for this study included voluntary participants. As part of the study, the acquired qualitative data has been tested using both the descriptive analysis method and content analysis. Themes have been organized under each discourse question after checking and defining the processes. To test the data, frequency and percentage, statistical techniques were used. The views of the attendees were stated verbatim in the Turkish version, then translated into English by the researchers. The findings of this study indicate the presence of a "butterfly effect" within educational organizations, whereby a small failure in the education process causes a bigger failure later on.

Key Words

Chaos, Chaos and Education, Chaos in Social Sciences, Chaos Theory.

The term chaos continues to become more and more prominent within the various fields of social sciences (Farazmand, 2003). Currently the topic of chaos is being discussed in the social sciences, particularly in the domains of philosophy, sociology, management, and education. The application of chaos theory in the social sciences is advantageous since the theory broadens both the perspective and the influence of social sciences, thereby creating a new interdisciplinary paradigm that can be called "united science," characterized by its interdisciplinary approach (Yeşilorman, 2006). Although chaos theory is becoming increasingly more popular in the social sciences, as well as providing a valuable new viewpoint, Töremen (2000) states that chaos theory is only a recent addition to the social sciences and that it should be discussed more at the philosophical level than on the scientific level.

Chaos theory in the social science of education was adapted from chaos theory in physics and mathematics (Harshbarger, 2007). This theory was developed when scientists found that previously ignored random data was significant when it was taken into account over the long term.

In the field of education, chaos theory provides refreshing insights into an education system that consists of a mechanical world in which many individuals attempt to learn information under whatever philosophy of education is popular at the time. Education in any era, however, is based on the perceived needs of that era, where individuals must try to learn specific things within a specific amount of time while improving their understanding about a linear system on both the micro and macro level (Töremen, 2000). Yet such linearity cannot be the foundation for the education system we need in this information age. For example, Newton's linear research model has been applied to educational systems without questioning whether its foundations are suitable to meet today's needs. Absolute determinism has been forced to give in to structuralism, complexity and relative indeterminism. This deterministic mechanical model has blindly been accepted as the educational system of the information era. At this stage, however, it is critical to construct nonlinear models that facilitate learning (Ruelle, 1995).

Applying chaos theory to today's complex systems such as schools clearly provides a significant opportunity for change and transformation, since learning and thinking are not linear processes. Classroom managers should be aware that complexity and paradoxes provide an atmosphere that is very conducive to creativity. An organization's ability to maintain its dynamism and creativity is directly proportional to the effort it expends toward continuous improvement, organization, taking risks, transformation and development (Demirtaş, 2006). When Einstein said, "It is important that you keep asking questions," he was emphasizing the importance of perseverance. When it comes to an individual's personal education, it is important to remember that success is not constant, but sometimes it progresses more quickly than at other times. As such, chaos theory suggests that the education system should not eliminate "unsuccessful" students, because they may make significant progress at a later date. The data for chaos theory itself took a long time to collate. In the same way, students initially considered unsuccessful may become successful students after a period of

time (Loree & Stupka, 1993). In chaos theory, such a situation is called nonlinearity in chaos theory. According to Töremen (2000), successful education systems fluctuate between consistency and inconsistency, never achieving a state of balance. Therefore it follows that an individual's academic success may vary over time.

Finding linear solutions for the problems that education systems encounter can lead to a variety of issues. Such problems should be analyzed from various perspectives and solved by implementing other variables based on the principle of mutual causality. By analyzing problems in terms of multiple variables, one may discover a rich array of potential causes (Çobanoğlu, 2008). For instance, when a student's failure is analyzed in terms of multiple variables, not only is the student's ability analyzed, but also the school's climate, culture, and technological supplies. Such an analysis can provide schools with the opportunity to reform their selves, which may stimulate students and teachers to further develop new abilities and new concepts. In keeping with this, a linear thinking paradigm is being replaced in the educational system by the principle of mutual causality and the concept of multiple causes/multiple results (Erzan, 2005).

If education managers can pay attention to events and handle them with sensitivity, they can help prevent bigger problems from occurring (Altun, 2001). It is important that managers and teachers at schools know their students well and that they are attentive to existing and potential issues. If a student facing problems with one of his classes is expelled from that class, he may have further academic problems due to missing that class. This in turn acts to compound his level of failure, making it more difficult for him to escape the vicious cycle. This situation is an example of the "negative avalanche effect in education," and it is possible to consider the opposite to be true, where success leads to compounded success.

Concerning the literature on chaos theory in education, Loree and Stupka (1993) argue that it is impossible to obtain consistent results about the level of success of students using traditional evaluation tools. They instead suggest that new paradigms which develop independent learning abilities be implemented and followed. By analyzing the different aspects of chaos theory, Töremen (2000) attempted to establish a new viewpoint and to clarify chaos theory in terms of organization, education systems and today's managers. Altun (2001) and Ertürk (2012) investigated various

aspects of the application of chaos theory within education management. Bülbül and Erçetin (2010) concluded that there is a chaotic interaction between a student and his friends, family, society and school. Hunter and Benson (1997), conversely, argued that it is improper to use the principles of chaos in education, claiming that the complexity of people's behavior is not equivalent to the complexity in chaos theory. Erdoğan (2012) examined whether chaos theory, which sounds frightening to people, is actually a frightening theory.

Most papers written about chaos are theoretical in nature and few studies have been done that apply practice and observation on chaos. This is an indication that there is a need for more studies on chaos (Altun, 2001; Farazmand, 2003). As such, this study is among the few works which relate chaos to education and investigate the application of chaos theory to education. Chaos theory appeared at the end of the 20th century, claiming to do away with the dominant paradigm of determinism while finding new solutions for societal problems. The theory has begun to impact the social sciences, and consequently, educational studies. How this interaction will continue and whether this interaction will provide consistent solutions for problems faced in education are among the questions waiting to be answered.

This study first reviewed the existing literature and then examined chaos theory and evaluated its application to education. The primary goal was to state the views of faculty members at Mehmet Akif Ersoy University in Burdur, Turkey regarding chaos theory and its application to education. To this end, the following questions were asked to determine the views of the faculty members:

– How does failure affect one's future education?

– Does a negative experience in school affect a student's attitude toward school?

– What is the effect of chaos theory on success and the education process?

– How is the academic atmosphere affected by students with different levels of learning?

– What is the effect of a student's behavior on the rest of the classroom?

Method

Research Model

This research project is a qualitative study whose aim was to identify chaotic states according to the experiences and views of faculty members. Qualitative data was acquired during the research process from discourse questions tested by the descriptive analysis method.

Participants

The participants in the study consisted of 30 faculty members, made up of 10 members selected randomly from each of the faculties listed below during the 2011 school year at Burdur Mehmet Akif Ersoy University in Burdur, Turkey. The participants were selected from the Faculty of Education, the Faculty of Science and Literature, and the School of Veterinary Sciences.

Data Collection Tools

For this study, data was gathered using *standardized open-ended questions*. The survey consisted of a series of questions to be answered in a specific order, with each participant being asked in the same way. In order to gather data, eight questions were constructed to examine which examples of chaos were encountered in the education process, and to determine the impact of chaos on educational organizations. To prepare the survey questions, the literature was first reviewed after which standardized open-ended questions were developed based on the knowledge obtained. After consulting with a trained educator, four out of the twelve questions were eliminated and the remaining ones were then resubmitted for consultation. The questions were then finalized and implemented by contacting each faculty member in their respective faculty.

Validity and Reliability of the Research

In order to increase the level of persuasiveness (internal validity) of the study, a conceptual framework was developed after a review of the literature. During content analysis, themes were chosen that were broad enough to encapsulate relevant concepts but narrow enough to exclude irrelevant issues. In order to increase the external validity (transmissibility/generalization) of the study, the research process was described in detail. To this end, the research model, participants, means of data collection, data collection process, analysis and interpretation were defined in detail. For the research to achieve consistency (internal reliability), care was taken to ask the survey questions in the exact same way and order. Furthermore, the

findings were presented clearly with the support of the raw data, and care was taken to ensure that the research results were compatible with the hypotheses of the research question. In order to improve the internal reliability (consistency) of the research, all of the participants' views were stated verbatim in the Turkish version, then translated into English by the researchers themselves. Furthermore, the researcher, along with another experienced faculty member, independently coded the data and then compared their results in order to calculate the consistency level. In the results section of this paper, subjective judgment and assumptions were avoided, while facts and incidents were stated objectively.

Data Analysis

In this research project, themes were first identified for each question in order to gain a general opinion of the viewpoints that were gathered. Data that was found to be similar in the content analysis was collated according to these themes. Significant data units were then identified and coded, after which potential themes were selected and edited. The themes themselves constituted the basis of the questions. These themes were checked, clarified and organized into research questions. The researcher along with another researcher experienced with qualitative research then coded the themes independently. To achieve reliability for the coding, the following formula was applied: Reliability= Agreement/ Agreement + Disagreement x 100 (Miles & Huberman, 1994).The percentage of agreement between the two researchers was calculated to be 86.13%, and since an agreement percentage of 70% or more is considered to assure sufficient validity, the data analysis was found to be reliable. The participants' views were stated verbatim in Turkish, then translated into English by the researchers themselves, and then the participants' views were sampled, explained, and interpreted. The responses of the professors from the different faculties were evaluated and the differences between the faculties were noted. When views were expressed, participants were coded as follows: the Faculty of Education as EF (EF1, EF2, …, EF10), the Faculty of Science and Literature as FEF (FEF1, FEF2, …, FEF10) and the School of Veterinary Sciences as VF (VF1, VF2,…, VF10). The statistical methods of frequency (f) and percentage (%) were used to analyze the data.

Results

In this section of the paper, findings from the data analysis have been presented.

How Does One Incident of Failure Affect One's Future Education?

To research the effect of experiencing failure during the education process, participants were presented with the following situation: "The following statement describes chaos theory: A butterfly flapping its wings in Brazil may spawn a storm in the Indian Ocean. Similarly, a single instance of failure can affect the whole education process. For example, not understanding one unit makes it more difficult to understand the rest of the units, thereby causing the student to fail on exams and limiting their future job choices." Then the following open-ended questions were asked: "Can you give similar examples? What can be done to prevent such events from taking place?" Two different themes were gleaned from participants' answers: (1) "Because a failure affects the future, it is hard to correct them" and (2) "A failure affects the future but it can be corrected." All of the participants thought that a single instance of failure causes future problems. Of all participants, 86.67% held the belief that it is hard to correct a previous problem (and its subsequent effects), while only 13.33% believed that such problems should be dealt with individually and that they can be corrected. As stated above, each group of faculty members (EF, VF, and FEF) was comprised of ten participants. Nine participants (90%) from groups EF and VF as well as 8 participants (80%) from group FEF held the belief that one instance of failure in the education process was difficult to correct and that such problems breed more complex problems in the future.

In a similar manner, Baker (1995 as cited in Altun, 2001) examined the application of chaos theory to the educational system. According to his findings, schools and school systems are areas that are highly conducive to the butterfly effect. There are critical situations in daily life, as is the case in scientific study, where even small changes in successive events cause increasingly bigger problems. Chaos theory informs us that these situations are everywhere (Gleick, 2000). Based on these research findings, we can say that the butterfly effect provides us with indications about the future and that this effect can also be observed in education systems.

How Does a Negative Event in School Affect a Student's Attitude toward School?

Participants were presented with the following situation and were asked to answer an open ended question: "Chaos theory suggests that we focus on initial events. For instance, a student's attitude towards school and his/her entire academic life may be negative because of a bad experience on the very first day. What would such a student's attitude be towards his/her school, teacher, classmates and lesson materials?" The following three themes were gleaned from the responses to this question: (*1*) "One negative event at school can cause long lasting insecurity, a lack of self-confidence, and low motivation," (*2*) "A single negative event does not permanently shape the student's attitude and can be forgotten" and (*3*) "A negative experience can be an opportunity that triggers success."

With regard to these themes, 86.67% of the participants stated that a negative event at school may cause long lasting insecurity, lack of self-confidence and low motivation, while only 3.33% stated that a single negative event may not necessarily shape the student's attitude and may be completely forgotten. Moreover, 10% of the participants stated that a negative experience may actually be an opportunity for success. As seen in Table 2, 80% of EF respondents and 90% of both FEF and VF respondents held the belief that a negative event at school may cause long lasting insecurity, a lack of self-confidence, and low motivation. On the other hand, one participant (10%) from group EF expressed the belief that a simple negative event may not shape the student's attitude and may be forgotten, while one member from each of the three faculties said that a negative experience may be a trigger that leads to success.

Based on these findings, chaos theory may help us predict potential future results as well as chaotic features of the past and the future. In education environments, events constitute a negative or positive basis. An event that is perceived as being simple may actually cause irreparable damage.

Sensitive Dependence on Initial Conditions

In response to the issue of how a single negative experience may affect future events, the following situation and question was presented to the participants: "Chaos is expressed as sensitive dependence on initial conditions, as stated in a Turkish proverb:

"A nail saves a horseshoe, the horseshoe saves a horse, the horse saves a commander, the commander saves an army, and the army saves a homeland." Is it possible to observe this proverb in the context of education? If so, could you give any real life examples?"

The following two themes were gleaned from this question: (*1*) "A small positive event may cause an avalanche effect that affects other students positively" and (*2*) "An unsuccessful student may have a negative effect on all the other students around him."

Of all 30 participants, one from the FEF group did not express a view on this particular topic. As such, 96.6% (28 participants) expressed the belief that a small positive event can cause an avalanche effect and that one student's success may affect other students positively. One participant (3.4%) however, expressed the belief that an unsuccessful student may affect others negatively. Furthermore, 90% of group EF and 100% of groups FEF and VF expressed the opinion that the education atmosphere exhibits sensitivity to initial conditions.

The findings correspond with the Butterfly Effect in that a very small, trivial, overlooked effect in a complex system may bring about unexpected results that have a large impact. In daily life, as is true in scientific study, it is accepted that certain small changes result in large consequences (Öge, 2005). In education, repetitions (iterations) are one way that the effects of chaos theory have been observed. Chaotic systems can occur with iterations, as is the case in fractal examples. Negative or positive iterations in the academic process may repeatedly manifest themselves either negatively or positively. There are a large number of inputs in the education system, and failure in any one of them may cause a student to have incorrect perceptions, resulting in problems which only continue to increase (Bülbül, 2007).

The Application of Chaos Theory to the Education Process

Participants were presented with the following situation and asked the following question about whether or not the education process is linear: "The implication of chaos theory for the context of education is that unsuccessful students should not be eliminated because they may recover after a period of time. Chaos theory tells us that data gathered after a long period of time can undergo significant change. Thus, students considered to

be unsuccessful may become successful at a later date. Do you agree with this? Can you provide examples?" The following two themes were gleaned from this question: (*1*) "It is possible to see unsuccessful students become successful" and (*2*) "It is not correct to make generalizations."

Twenty-six of all participants (86.67%) responded that "unsuccessful students may become successful" based on intrinsic and extrinsic factors. Four participants (13.33%) stated that it is wrong to make generalizations and that academic success is not a key for other areas of success. As seen in the table, 90% of group EF, 70% of group FEF and 100% of group VF held the belief that unsuccessful students may become successful. On the other hand, 10% of group EF and 30% of group FEF expressed the opinion that it is wrong to make generalizations, while no VF respondents stated that view.

A review of similar findings reveals that Loree and Stupka (1993) make the following suggestion regarding chaos in the education process: student success should not be evaluated over a short period of time. Despite the complexity of the education process coupled with its nonlinear and repetitive character, there is a sufficient amount of order present in this process (Biesta & Osberg, 2010). According to Töremen (2000), because successful education systems exhibit little balance between consistency and inconsistency, any given student's level of success may vary over time. Gunter (1995) points out that the butterfly effect enables us to understand that a student can make a difference, and that schools should make use of all of the abilities that their students have (Çobanoğlu, 2008). The findings of this study lead us to the conclusion that the education process is not linear and exhibits variance. A student's level of success may vary over time, becoming markedly different from a previous point in time.

The Application of Chaos Theory to Success

In reference to the expanding effect that initial changes have according to chaos theory and how chaos theory can be applied to education, the following situation was presented to the participants and the following question was asked: "According to ancient Ionian philosophy, everything in nature turns other materials into itself. For instance, when ice is put into water it transforms the water into ice, while water tries to melt the ice and turn it into water. Can you give similar examples?" From this question, two themes were gleaned: (*1*) "Successful

students are driving forces and students take each other as examples" and (*2*) "The situation changes depending on the character of the group."

As is evident from Table 5, twenty-eight participants (96.55%) responded that successful students are driving forces and that students take each other as examples, whereas one participant (3.45%) responded that this issue depends on the specific group's character and that such students do not always exist. Furthermore, one participant did not give an answer for this category. In addition, as is evident from the table, 90% of respondents in group EF and 100% of respondents in groups VF and FEF held the belief that successful students are driving forces, that students take other students as examples, and that if unsuccessful students are in the minority, they may become successful by taking successful students as role models. On the other hand, one participant from group EF expressed the opinion that student interaction depends on the character of each individual group.

The general view of participants is that students affect each other, making them become more like each other when they share a given academic environment. Similarly, under the right conditions, random events that occur in certain social situations may trigger *self-organization* if positive and negative feedback is present (Çobanoğlu, 2008). A few unsuccessful students may be assimilated if they spend time in a group full of successful students. Success snowballs under the influence of group psychology. As a consequence, we can conclude that a dominant group of students will continue to affect the other students either positively or negatively during the academic process.

How is Education Affected by Students Having Different Levels of Learning?

With regard to how the education atmosphere is affected by varying levels of learning, participants were presented with the following situation and asked the following question: "Traditional education is based firstly on a centralized system, secondly on teachers who are aware of regional differences, and lastly on students. Just as all students have different learning abilities, each student is at a different level of learning. This means that each educational setting has different learning situations. Inflexible rules that are "set in stone" are therefore not valid. As such, how should the academic environment be organized?" The following two themes were gleaned from this question: (*1*) "Education methods

should be used that take into account individual differences (multiple intelligences, individual learning, etc.),” and (2) “Homogeneous groups of students should be formed and learning should be reinforced through repetition.”

With regard to these two themes, twenty-four (80%) participants said that the same level of learning cannot be expected of every student, so education methods should be used that take into account individual differences (such as multiple intelligences, individual learning, etc.). Six participants (20%) responded that homogeneous groups of students should be formed in which learning should be reinforced through repetition. Additionally, as seen in the table, 90% of group EF, 80% of group FEF and 70% of group VF held the opinion that personal differences should be taken into account when organizing the education atmosphere. On the other hand, 10% of group EF, 20% of group FEF and 30% of group VF were of the opinion that homogeneous groups should be constituted and that learning should be reinforced with the traditional learning method of repetition.

Based on the majority of the views given by respondents, differences between students should be taken into account when organizing the academic environment. Since students cannot be pigeonholed into a single category and each is a separate, individual person, education should be organized in such a way as to take into account each student’s distinctive characteristics.

Preventing Communication Hindrances Caused by Different Attitudes that Students Have

Participants were presented with the following situation and asked the following question: “Chaos Theory allows us to make predictions. If students with aggressive, shy or self-confident communication styles can be identified before they come to class would that prevent communication hindrances from occurring?” The following two themes were gleaned from the responses: (1) “Yes, a teacher should be prepared for the behavior their students can potentially exhibit,” and (2) “No, it does not prevent such miscommunications since students have varying responses in different circumstances.”

Twenty-seven of the respondents (90%) said that the teacher should be prepared and should plan for the potential behavior of their students, whereas three (10%) replied that such preparation and planning does not prevent communication

problems since the students’ responses are difficult to determine and vary depending on the situation. Moreover, 100% of group EF, 80% of group FEF and 80% of group VF held the opinion that teachers should be prepared for students’ behaviors. On the other hand, 20% of group FEF and 20% of group VF stated that student responses may vary based on the situation and that it is therefore not profitable to plan for such behaviors, whereas no respondents from group EF espoused this view.

These findings lead to the conclusion that education should be understood as a process in which alternative plans should be prepared. When an organization drifts into chaos, the system may transform into something previously not encountered. The difficulty here for education management is to make small changes that move a system in the desired direction (Çobanoğlu, 2008). Education is a process that calls for foresight. It needs to predict problems and also to conceive of alternative plans in the event that they are needed to handle chaotic situations. Since schools are complex social systems that have many nonlinear variables, being aware of the different ways that students communicate will increase the quality of the academic environment.

The Effect of a Student’s Behavior on the Whole Classroom

Participants were asked the following question: “Imagine an unstable atomic nucleus. It could disintegrate at any moment. When this occurs, it may destroy another atom. Does a student’s behavior in the classroom affect other students in a similar way, and if so, how?” The following two themes were gleaned from these questions: (1) “Yes, it has an effect and one student’s behavior does affect the other classmates,” and (2) “It may not always have an effect.”

With regard to these themes, twenty-six participants (86.67%) responded that “a student’s unusual behavior has the ability to affect his/her classmates in both positive and negative ways.” Four respondents (13.33%) said that “although it may not affect the whole classroom, it may affect their friends.” Additionally, as seen in the table, 90% of both groups EF and VF along with 80% of group FEF were of the opinion that students’ behaviors affect each other. On the other hand, 10% of groups EF and VF together with 20% of group FEF believed that behaviors do not always affect other students. As such, there is difference of

opinion between members of FEF and members of the other two faculties.

The view of the participants was that unusual behavior on the part of students does have the effect of drawing other students into that behavior. According to chaos theory, when a system begins to go out of balance, strong attractors pull it in a certain direction (Töremen 2000).For example, one student's laughing may produce a domino effect, provoking other students to laugh. When this situation occurs frequently in a classroom environment, this causes obstacles for learning.

Discussion and Suggestions

This study investigated the application of chaos theory to the academic environment, finding that when a student experiences a single instance of failure in the education process, this can cause bigger problems in the coming years that are difficult to resolve. A single negative event at school can cause long-lasting attitudes such as insecurity, a lack of self-confidence, and low motivation depending on the influence of that event. The behavior of students affects other students, reinforcing this behavior. The Butterfly Effect informs us that just as a very small, trivial and easily overlooked effect may bring about unexpected results in the education process, negative or positive repetitions in education can result in similar outcomes. It is also evident that a student's level of success exhibits nonlinearity (variability) over time. Successful students are a driving force and other students may take them as role models for themselves. Consequently, if unsuccessful students are in the minority, they may become successful by taking successful students as role models. Education methods (such as multiple intelligences, individual learning, etc.) that take individual differences into account should be used since it is evident that each student's distinctive characteristics shape their education. Education is an activity that requires foresight, which involves predicting problems beforehand and preparing alternative plans. Knowing the communication differences students have creates a higher quality academic environment. It is clear that the butterfly effect occurs in educational institutions and that a small failure experienced during one's education can cause a bigger failure later on. From this it can be concluded that the butterfly effect gives indications about the future and that education systems are sensitive to initial conditions. Moreover, it is evident that the education system is not linear.

A number of suggestions can be given based on these findings. This study could be carried out in different faculties at different universities, and more general results could be identified. Moreover, this study could be carried out at schools in different provinces and districts in coordination with public education authorities. By taking the butterfly effect into account, pre-emptive solutions could be sought for problems in the education process. Opportunities could be created to induce a positive avalanche within education in the direction of desired student behavior. In view of the fact that the education process is not linear and that a student's success varies over time, flexible programs could be developed and implemented. The distinctive qualities of different students could be taken into account when creating educational programs. Finally, the disorder caused by chaos in education should not frighten educators; on the contrary, it should be used as an opportunity to seek order from chaos and then reorganize the system to adapt to this new situation.

References/Kaynakça

Altun, S. A. (2001). Kaos ve yönetim. *Kuram ve Uygulamada Eğitim Yönetimi Dergisi, 28*, 451-469.

Biesta, H., & Osberg, D. (Ed.). (2010). Complexity theory and the politics of education. In H. Biesta, & D. Osberg (Eds.), *Complexity, education and politics from the inside-out and the outside-in: An introduction* (pp. 1-3). UK: Sense Publishers.

Bülbül, M. Ş. (2007). *Kaos ve eğitim*. Ankara: Beyazkalem Yayıncılık.

Bülbül, M. Ş., & Erçetin, Ş. (2010). Chaos and analogy of education. *Middle East Journal of Scientific Research, 5*, 280-282.

Çobanoğlu, F. (2008). Değişim mantığını anlamak: akış ve dönüşüm olarak örgüt. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi, 23*, 110-119.

Demirtaş, H. (2006). Yönetim kuram ve yaklaşımları eğitiminin ilköğretim okulu öğretmenlerinin sınıf yönetimi paradigmalarına etkileri. *Eğitimde Politika Analizleri ve Stratejik Araştırmalar Dergisi(INASED), 1*(1), 49-70.

Erdoğan, H. (2012). Karmasa, karmaşıklık ve eğitim ilişkisi. *Tarih Kültür ve Sanat Araştırmaları Dergisi, 1*(2), 87-136.

Ertürk, A. (2012). Kaos kuramı: yönetim ve eğitimdeki yansımaları. *Kastamonu Eğitim Dergisi, 20*(3), 849-886.

Erzan, A. (2005). Bilimden kaçış mı? *Günce (Türkiye Bilimler Akademisi) Dergisi, 32*, 4-8.

Farazmand, A. (2003). Chaos and transformation theories: A theoretical analysis with ımplications for organization theory and public management. *Public Organization Review: A Global Journal, 3*, 339-372.

Gleick, J. (2000). *Kaos* (Çev. F. Üçcan, 10. bs.). İstanbul: Tübitak Popüler Bilim Kitapları.

Harshbarger, B. (2007). Chaos, complexity and language learning. *Language Research Bulletin, 22*, ICU.

Hunter, W. J., & Benson, G. D. (1997). Arrows in time: The misapplication of chaos theory to education. *Curriculum Studies, 29*(1), 87-100.

Loree, T., & Stupka, E. (1993, November) *Teaching and learning in a student success course: A discussion concerning the development of the internal locus of control using fuzzy logic, TQM, and chaos theory of education*. Paper Presented at The National Conference On Teaching And Learning, Arlington, Virginia.

Miles, M. B., & Huberman, M. A. (1994). *An expanded sourcebook qualitative data analysis* (2nd ed.). London: Sage.

Öge, S. (2005). Düzen mi düzensizlik (kaos) mi? Örgütsel varlığın sürdürülebilirliği açısından bir değerlendirme. *Selçuk Üniversitesi Sosyal Bilimler Enstitüsü Dergisi, 13*, 285-303.

Ruelle, D. (1995). *Rastlantı ve kaos* (4. bs). Ankara: Tübitak Popüler Bilim Kitapları.

Töremen, F. (2000). Kaos teorisi ve eğitim yöneticisinin rolü. *Kuram ve Uygulamada Eğitim Yönetimi, 22*, 203-219.

Yeşilorman, M. (2006). Kelebek kanadını kimden yana çırpıyor? Birleştirilmiş bilimin kıyısında kaos ve sosyal bilimler. *İstanbul Kültür Üniversitesi Yayınları, 3*, 77-86.