



## Çizge Kuramının Sosyodinamik Kurama Adaptasyonu: Öğreřme Kavramı

### Adaptation of Graph Theory to Sociodynamic Theory: The Concept of Tearning

Mustafa Şahin BÜLBÜL<sup>1</sup>

<sup>1</sup>Kafkas Üniversitesi, Dede Korkut Eğitim Fakültesi, Sınıf Eğitimi Anabilim Dalı  
[msahinbulbul@gmail.com](mailto:msahinbulbul@gmail.com)

#### ÖZ

*Bu çalışma, eğitimde etkileşim biçimlerine örnekler üzerinden odaklanmayı amaçlamaktadır. Örnekte öğrenciler, aileler, öğretmenler, okul müdürleri ve akademisyenler arasındaki olası doğrusal, yüzeysel ve üç boyutlu etkileşim modelleri mümkün olduğunca ele alınmıştır. Analiz edilen örnek, öğrencileri sınavla kabul eden bir lisedir. Bu lisede bazı öğrenciler dersten sonra evlerine giderken bazıları pansiyonlarda kalıyor. Etkileşim biçimleri, ilgili ilkeler ve gözlemlenen sonuçları ele alan bu çalışma, 'öğreşme' adı verilen yeni ama önemli bir kavramı ortaya çıkarmaktadır. Öğretmenin ve öğrenmenin aslında tek bir kavram olduğu fikri, bazı eğitimsel varsayımları ve ilkeleri de beraberinde getirir. Eğitim bileşenlerinin 'öğreşme' kavramı üzerinden etkileşim yollarının yer aldığı bu çalışmanın tüm bileşenlere katkı sağlayacağı düşünülmektedir. Bu durum araştırması/etnografik çalışma, esasen bileşenler ve bileşenler arası etkileşimi arařtırmak için kullanılan çizge kuramı ile toplumdaki her bir bileşenin toplumun gelişiminin bir parçası olduğunu vurgulayan sosyodinamik kuramı birlikte ele almayı hedeflemektedir.*

**Anahtar Sözcükler:** Bilim/Fen Eğitimi, Çizge Kuramı, Sosyodinamik Kuram, Öğreşme.

#### ABSTRACT

*This study aims to focus on the forms of interaction in education through examples. Possible linear, surface and three dimensional models of interactions among students, families, teachers, school principals and academics are handled on the example as far as possible. The sample analyzed is a high school that accepts students by exam. In this high school, some students go home after class, while others stay in the dormitories of the school. This study, which deals with forms of interaction, related principles and observed results, opens up a new but important concept called 'tearning'. The idea that teaching and learning are actually one concept brings along some educational assumptions and principles. It is thought that this study, in which the ways of interaction of the components of education through the concept of 'tearning', will contribute to all compo-*

nents. This case / ethnographic study aims to deal with graph theory, which is mainly used to investigate the components and the interaction between components, and sociodynamic theory, which emphasizes that each component in society is a part of the development of society.

**Keywords:** *Graph Theory, Sociodynamic Theory, Science Education, Tearning.*

## INTRODUCTION

There are some defined roles in the field of education. It can be considered as if there is no training when these roles are excluded. However, sometimes inside, outside, sometimes both sides of the borders belong to educational activities, school can be a limit for teachers and students, but there are also learning opportunities outside of school. Academics, teachers, and students can lift this limit together. In this section, the design, implementation and development steps of science applications in a high school will be shared over the interaction network mentioned.

The word tearning is formed by combining the words teaching and learning and is used to mean to teach and learn mutually (Bülbül & Karaman, 2014). Although teaching and learning are perceived as two different concepts, it is the perception of a single concept differently by the teacher and the student (Bülbül, 2015). When the literature is examined, there are studies on mutual learning (Zhang, Xiang, Hospedales & Lu, 2018) or mutual teaching (Zhan & Niu, 2020), but there is no study on expressing the mutuality of both teacher and learning with a single concept. For this reason, teaching and learning will be dealt with mutually in this study and this interaction will be named as “tearning”. We will call the broader form of interaction “education”. If we think that education is insufficient, we need to choose a more comprehensive way of interaction by moving to the next steps according to the hierarchical structure to be mentioned later.

The concept used by those who examine the reflections of interaction in the social field is the concept of sociodynamics. This concept emphasizes that the interaction in social areas has a dynamic structure. This dynamic structure shows itself mostly in the areas of guidance (Peavy, 1997; Peavy, 2000). The sociodynamic theory explaining the interaction of societies has been around for 50 years; It tries to make the form and method of interaction examine and to examine the consistency of social sciences with mathematical representations (Mesquita & Boiger, 2014). Due to the long duration of friendships in the classroom, they have a dynamic and diverse dimension. This dynamic structure in the classroom gives students experience in how they can help each other learn (Murphey, Falout, Fukuda & Fukada, 2014). The fact that classmates know and accept each other has an important place in the planned projects to achieve more successful results. Classroom environments or school friendships are more suitable for developing diverse and long-term relationships (Weidlich, 2005). In this study, volunteer students who know each other and want to develop projects were chosen for the reason stated before.

Graph theory, developed to handle social interactions in mathematical form, is based on showing people as points and interactions as lines. Analyzes over these interactions, classification of possible relationship forms are included in the field of graph theory (Van Steen, 2010). In this study, we did not focus on how to teach graph theory to students (Niman, 1975). We tried to create a model in accordance with the sociodynamic theory by observing the interactions of students during the projects and seeing graph theory as a tool. Since we know that this theory will work in small groups (Chai, Le, Lee, & Lo, 2019), we prepared the model using graph theory in the light of the experiences gained during the process. We have reached a new presentation by making changes in the drawings, especially in the forms of interaction, since it is a study based on the real situation while using the known assumptions of graph theory and drawing principles (Tatsuoka, 1986). In the following parts, the previously studied case will be presented and the model will be shared with the data derived from this case.

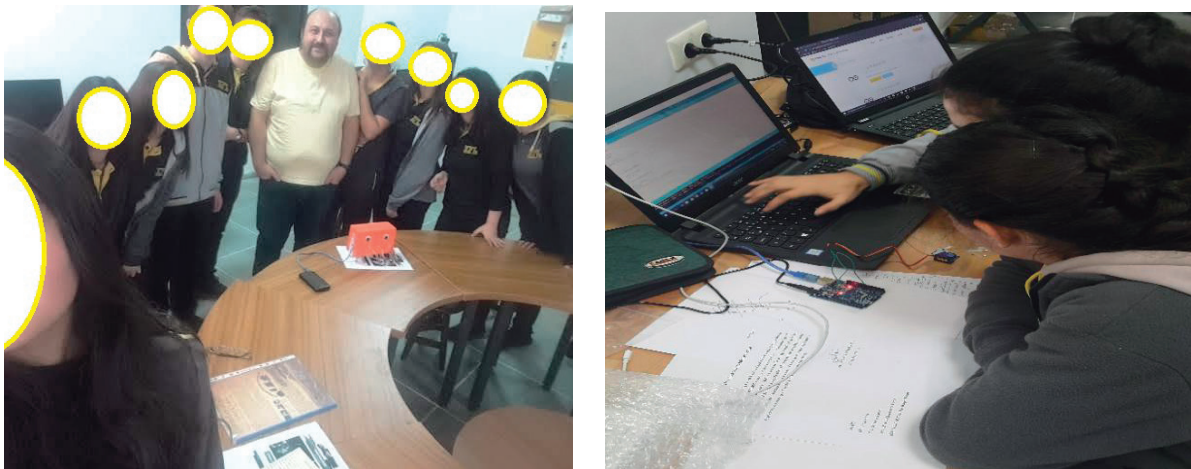
## METHOD

The method followed in this study; It is the way a situation is studied in depth. In the case study, not only were examined, but the forms of interaction in this situation were recorded during the projects. In this sense, it can be argued that the study is an ethnographic study. It is clearly seen that there is a sociodynamic study with a small group of ethnographic research types and a hierarchical interaction model has been reached at the end of participant observations and interviews. Beyond explaining a small group that produces a project, this study has a structure created with qualitative data completed with a short-term ethnographic method as a result of in-depth examination of interaction networks. These networks have ensured that the model presented has been tried many times and formed as a result of experiences.

### Introducing the case

This topic has been compiled in the light of unstructured interviews and observations made to introduce the environment of the case. Emphasis was placed on the participation of the students with volunteering. The created working groups were not included in the projects as a necessity. With the permission of the teachers, promotions that did not exceed 5-10 minutes were made during the lessons and projects were carried out with interested volunteer students. The starting points of the projects were determined by the writer, who is an academician, but was presented to the students by receiving the opinions and support of the teachers. While it was determined that students were not interested in some subjects (zero waste projects), students showed great interest in some subjects (such as Arduino Projects). The researched school is a school that accepts students by exam. Students in this school mostly choose medicine and engineering at universities. The courses generally progress in a content compatible with the question formats to be asked in the university entrance examination. The first priority of the students is not to make science, but to create a knowledge that can earn good universities.

A special class has been set up to work with students. This class is known as a design and skill workshop. Students who want to work in this field can work with the academician during recess, lunch breaks or during the lesson periods by getting permission from the teacher and the administration. The workshop has 3D printers, robotic material sets, wood carving sets and painting materials. The working environment is a large, spacious environment that is isolated from noise and suitable for illumination. The works were carried out as team works, not individually. The school where the research is conducted does not have warming, feeding and security problems and it can also provide accommodation services for students who need it.



**Figure 1.** Two photos from the working environment.

The first selected study topics are; technological supports and mechanization (biomimetic) of animal behavior in biodiversity, zero waste, earthquake and mountainous disasters. It is important to examine the subjects in depth and to work with product focus. It is aimed to form a natural curriculum by moving from simple to complex. Apart from learning, learning together is aimed. The flexible curriculum was shaped by students' ideas and experiences, and by the teachers' guidance. Some of the projects carried out without a time limit, a contest to be raised or anxiety concerns have progressed quickly and some are far behind. It is stressed that each component has the right to make equal decisions during the progress of the projects. The processes were recorded in a digital notebook and were followed up by everyone. Thus, it was possible to know the meetings that could not be met by everyone, by the whole team.

## FINDINGS

This section begins by explaining the types of interaction. Linear, surface and three dimensional interaction models are explained in the light of references and examples from the case. All models were re-evaluated by comparing them with another hierarchical interaction model presented at the end of this section. In this evaluation, the probability of realization and the power of influence were taken into account. The findings part of the research was completed with the information of the by-products that emerged in the process.

### Interaction Types

In the following sections, students are symbolized with "S", family with "F", teacher with "T", school principal with "P" and academician with "A". When we examine the interaction possibilities of the components in education, we encounter six different possibilities. If the two components are shown without lines, it indicates that there is no interaction between the two components yet. If a straight and single line is drawn between the two components, there is a neutral interaction between the two components. If two lines are inserted between the two components, this symbolizes the remote interaction that is not facing. Sometimes interactions are unidirectional and are indicated by " $\rightarrow$ ". Whatever direction the arrow points to, the component is recessive to the other. The dominant component has an effect on the component in the direction of the arrow. If the interaction is twofold, the symbol " $\leftrightarrow$ " is used. In this case, both components can affect each other.

The unwanted form of interaction is conflicts. Conflict is a negative interaction. This interaction is indicated by the symbol "X". In case of conflict, both components try to dominate each other. This dominant effort is closed to the influence of the other component. This closeness prevents interaction.

The best desired form of interaction is the mentioned bidirectional interaction. This bidirectional interaction, which is the indicator of maximum interaction in all linear, superficial and three dimensional interaction models, is called "tearing". In order for learning to occur, all components must have the potential to affect each other. It is a two-way interaction of all components expected in all linear, surface or three dimensional interactions. Non-interactive, neutral or negative interactions mean that the expected efficient and successful interaction does not occur. One or more of the components should try to persuade other components to improve interaction.

As an example, let's take a student from the sample according to our own experience and observations (Figure 2). In this example, his family interacts with the student from a distance. The teacher is also neutral with the family, but interacts remotely. The teacher has a neutral face-to-face interaction with the academic while the student is dominant. A similar neutral relationship exists between the teacher and the principal. In this example, the student has a negative interaction with the principal. Despite other oppressive interactions, the student conflicts with the principal. If there is a conflict, other components should work to compromise the components.

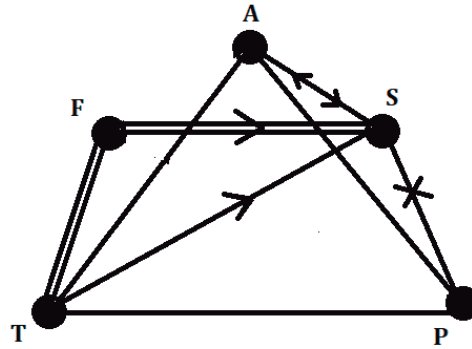


Figure 2. Presentation of interaction types.

There is no interaction between the academician and the family. The lack of interaction weakens the structure. Whether the interaction is face-to-face or remote can change the degree of influence, but lack of interaction, unidirectional and / or conflict-building is dangerous and needs to be resolved.

### Linear Interaction Model

When we examine interactions on a student basis, we need to talk about primary (SF, ST, SP and SA) and secondary interactions (FT, FP, FA, TP, TA and PA). Secondary interactions must be of a nature that nourishes and strengthens the primary interaction. Weakness of secondary interactions is also reflected in primary interaction. When strong secondary interactions are humanist, the healthy development of the student will be paved.

Student-Family (SF) interaction is the most important and primary interaction for students' mental and physical development. Conflicting and negative family interactions are known to increase anxiety in the child and negatively affect student success (Hudson & Rapee, 2001). For this reason, this interaction, which is the most basic and continues from the beginning of life, is the interaction that should be reviewed first in problem situations.

Student-Teacher (ST) interaction is the most studied topic. Even if the student started her learning in her family, she has a learning-oriented relationship with her teacher. This relationship continues conceptually, even if the teacher changes individually for many years. Said interaction is an interaction that can continue remotely in electronic environments compared to other interactions (Bloch, 2002). In fact, a clearer and clearer path of interaction can be created by using digital platforms on issues that cannot be discussed face to face. It is known that as students' interactions with each other and their teachers increase, success will increase and more permanent learning will take place (Lindblom-Ylänne, Pihlajamäki & Kotkas, 2003). It is also known that the interaction of students and teachers is influenced by the gender of the parties (She, 2000) and their physical and personality traits (Adams & Cohen, 1974).

Teacher and student interaction is actually very complex. For example; students' attitudes towards the course depend on the learning environment as well as the teacher's behavior (Lang, Wong & Fraser, 2005). Therefore, correcting problematic interactions can sometimes result from outside components. Interaction models are designed to solve systemic problems quickly and permanently. The presence of spatial problems outside of human interaction will be considered the weakness of interaction models when they cannot be resolved by the components. While the interaction problem was solved during the studies, cases where the target problem was not solved were not encountered.

During the research, another interaction that was not included in the model but similar to student-teacher interaction was observed. Interactions between responsible and counselor teachers and student teachers, those who will teach when they graduate, can be evaluated in the relationship between professional learning and te-

aching, and success depends on the presence of bi-directional interaction (Hamman, Fives & Olivarez, 2007).

Student- Principal (SP) interaction is a rare interaction although they are in the same school. In rare cases, which are generally considered positive or negative, the student interacts with the principal. The principal draws a boundary between the student and tends to reduce interaction. During the projects, students did not have any trouble getting permission from the school principal. The fact that some of the demands of the school principals who meet the demands of the students were met by the students shows that the interaction is two-way.

Student- Academician (SA) interaction is the rarest interaction that a student can establish. Either the student should be very curious or a research subject that would cause the academician to interact should be formed. This form of interaction of the academician working outside the school, which does not include the components in the school and at home, was observed during the project. Some students have consulted their own ideas and projects with the academician. As with other linear interactions, more complex interactions can occur after student-academic interaction. The number of interactions needed grows as the discussed project grows. For example; As a result of the project, students and academics traveled together. Before the trip, it was necessary to obtain permission from the school principal and the family of the student and inform the relevant teacher.

While linear interactions can expand to more dimensional interactions, multidimensional interactions can affect linear interactions. For example; the culture of societies, the perception of the teacher and the principal of the school at the scientist may affect the student's perception of the scientist (Farland-Smith, 2009). Depending on the level of impact, the student may want to interact with a scientist. Thus, the possibility of interaction between the student and the academician occurs.

Family-Teacher (FT) interaction is usually initiated by the teacher. It is an interaction without the knowledge of the student to congratulate the family on the success of the student or to ask the family for the reasons of his failure. The teacher who interacted with the student before may have threatened to meet with the family. Then the content of the interview is curious by the student and the family usually shares the content of the interview with the student. According to the content, the student reviews his attitude towards the teacher. In some cases, the family wonders the student's situation and interacts with the teacher. If these interactions occur regularly and frequently, the family will not encounter surprises. Very rare and irregular family teacher interactions are often event-centric. Therefore, the interaction of the teacher with the family is also very important.

During the project, parents and teachers met twice to discuss general issues. In the meeting, it was observed that the families wanted exam-based lessons and thought that the time spent on the projects was wasted. This approach has been impressive in determining the direction of students' other interactions. It has been observed very clearly that in cases where the family and student bonds are strong, the student can participate in the project work if it can affect the family (bilateral interaction). There were also situations where the family did not allow but the student wanted to participate. This highlights the one-way interaction between the student and his family.

Family-Principal (FP) interaction usually takes place when the teacher cannot solve the family. For example, during the project, he wanted to take a family student from school and the teacher could not persuade the family. In this case, the school principal came into play and solved the problem. In addition, very short-term interactions were observed between the parents and the school principal during the project, but these are greetings. Families generally prefer to learn and solve the situation related to their students primarily by discussing with teachers.

Family- Academician (FA) interaction is usually carried out secretly from the teacher and the principal to solve problems that the family cannot solve at school if the academician has not contacted the family for

research purposes. When the knowledge that the family receives support by interacting with the academician secretly is learned by the teacher and the school principal who cannot solve the problem, they can take negative or unimportant attitudes towards the family. Interaction of families with academician may lead to the next student-family-academician or student-academician interaction.

Teacher-Principal (TP) interaction is a common interaction in the school system and has an impact on the solution of problems. Sometimes the school principal interacts with the teacher for information or supervision, while sometimes the teacher can interact with the school principal for information or permission purposes. When the frequency and content of the interaction are examined, inspiring, allowing and empowering interactions are observed (Szeto & Cheng, 2018). If there is no confrontational interaction and the school principal is both encouraging, inspiring and supportive leadership to the teachers, a teacher-principal interaction can be mentioned that causes a positive change in the success of the school (Edgerson & Kritsonis, 2006).

Teacher- Academician (TA) interaction that will strengthen the learning in secondary / supportive interactions and which is reflected on the student very quickly if it is an interaction takes place voluntarily and naturally. The interaction between the academician, whose theoretical and current knowledge is considered to be more than the teacher, and the practice and experience knowledge of the teacher, who is thought to be more than the academician, reveals a current and realistic content. Throughout the research, physics, chemistry, biology, mathematics and technology teachers were studied. Teachers' experiences of students contributed to determining the subjects of study and making the presentation more effective.

Principal-Academician (PA) interaction is the interaction that is observed later than the teacher-academician interaction, but the effect will be throughout the school. While teacher-academician interaction changes some methods and techniques, the principal-academician interaction means such as setting up a new lab or updating the library. Throughout the project, the academician and the school principal interacted over the problems of the workshop place.

### **Surface Interaction Model**

There are three important skills. These are cognitive skills, behavioral skills, and social skills. Teachers are responsible for helping students develop these skills. Teachers feed on three important sources to help develop these skills. These are academicians as a theoretical resource, families as a practical resource and administrators as a social resource. Academics have the opportunity to follow the current developments more than the teacher. It is thought that learning will know the theoretical background better. The family, which is the first source of student's practices, has more accurate and realistic information about how these practices can change faster and permanently. School principals are responsible for the school's interaction with other social structures as well as for the functioning of the school system. Therefore, he is a specialist in social environments inside and outside of school and the interaction of these social environments. The teacher has a higher influence on social structures (other classes, teachers and other staff, etc.) within the school. The teacher will be more successful in helping his student when he keeps his relations strong with these three resources. The greatest help that the teacher will do; is to keep these resources on the agenda of students' self-access and how to achieve a healthy interaction.

The one-to-one interaction of the two components is a linear interaction. Surface interaction occurs as a result of the interaction of the three components around a table. This interaction is stronger than linear interaction because it contains three linear interactions. In the case that at least one of the linear interactions is healthy, harmonious and realistic, the surface interaction can be affected by this linear interaction.

As it is known, there are two kinds of currents; direct current and alternative current. The first discovered current in nature is direct current. Lightning flows linearly from the sky to the earth. In the opposite direction,

that is, no flow from ground to sky is observed. If there was a flow from ground to sky and then from sky to ground, we would call it alternating current. In fact, alternating current was found later, and it was an invention that caused the spread of electricity. In alternating current, the electric current changes its direction continuously. According to direct current, this high efficiency current forms the basis of the electrical and electronic age.

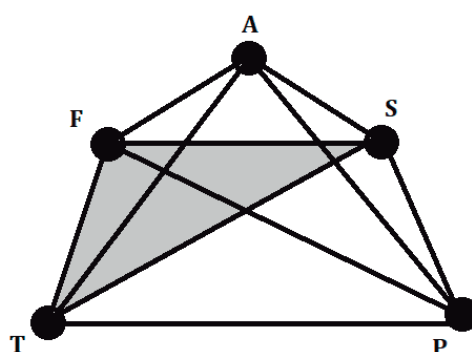
Learning and teaching is also a one-way effect. Therefore, similar to the alternating current, the bidirectional effect (interaction/tearing) is more important. According to the linear interaction with dominant components, the three-component surface interaction model, which has “tearing”, has double-sided linear interactions, and the direction of the interaction is constantly changing, is more constructive, strong and problem-solving.

Interactions in the surface interaction model can be divided into two in terms of student. These are the primary interactions that the student is in (SFT, STP, SFP, SFA, STA and SPA) and secondary interactions (FTP, FTA, FPA and TPA) that are not in the student but created with the student in mind. These interactions are handled in order of natural occurrences, in descending order.

Surface interactions are divided into triangle and rectangular (SFTP) interactions, considering the number of components. The rectangular interaction between these two surface interactions is a stronger structure that makes finding the solution easier. However, continuous use of this structure can weaken the power to reach a solution. It is important to try other interaction models. Components should try to activate sub models as well, instead of constantly trying to unite. As the number increases, it is easier to find / understand the solution, but the probability of meeting and reconciliation becomes difficult. Therefore, it is preferred to use linear interaction models for small problems before surface interaction models.

Although interactions are generally present with other components, surface interactions may apply to a single subject. If the same surface interaction is used for each subject, a holistic environment cannot be created. For this reason, all dimensions of the interaction should be carried out in double-sided for certain intervals and reasons.

Student-Family-Teacher (SFT) interaction is basic and the most common form of surface interaction (Figure 3). Also, Interaction SFT is generally attempted when linear interactions fail. The purpose of the interaction may be the problems of the student’s family, the problems of his / her lessons, or problems with school compliance.



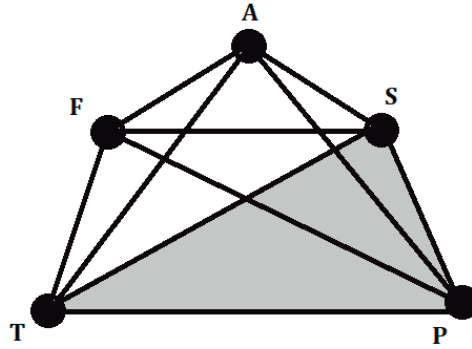
**Figure 3.** Presentation of SFT interaction.

The interaction mentioned during the project was observed twice. In the first one, the family came to school and while the teacher was in the garden, the teacher called the student and the three-component interaction naturally occurred. The student was praised by both her family and her teacher. The subject of the interview is generally the lessons. Some expectations regarding the future were expressed and the student was asked to set his goals more clearly. Another example of interaction is the conversation with the student who wants to go to



the doctor while the student is there with the teacher. The teacher informed the family and questioned if they had any information about the situation.

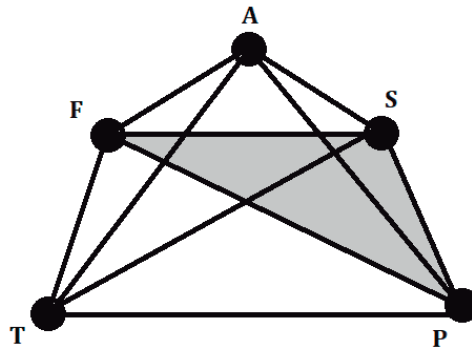
Student-Teacher-Principal (STP) interaction can take place in situations where the teacher and the student cannot solve, and in cases related to school rules or for support from the school principal (Figure 4). Before this interaction, the teacher and the principal should also have a pre-interview. In some cases, this surface interaction can be performed for the last time to warn the student before interacting with the family.



**Figure 4.** Presentation of STP interaction.

They said that the students were called and warned together with their teachers because of the decrease in the success of the two students during the project and that their families would be informed if their non-study behavior continued. Such warnings come before the rectangular interaction. When the student interactively observes that the interaction network is growing, he perceives that the problem is growing easier and tries to change his thoughts and behaviors, which are the most important source of the solution.

Student-Family- Principal (SFP) interaction is a very dangerous interaction because there is no teacher in this interaction (Figure 5). If it happened with the knowledge and guidance of the teacher, or if it was completely related to the operation of the school and upon the invitation of the principal, there is no problem but if not, the teacher may perceive this situation as ignoring the student or his family, and the problem may become even more unsolvable.

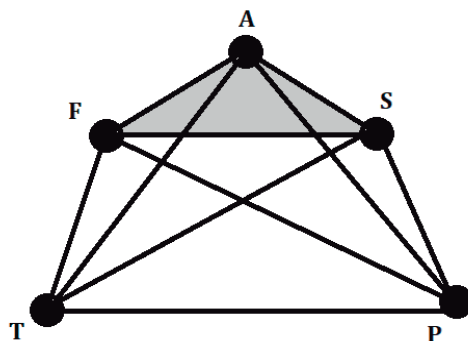


**Figure 5.** Presentation of SFP interaction.

During the project, this kind of interaction was observed during the enrollment of a new student. The student and her family talked to the principal about how to make the school adaptation process easier.

Some interactions can occur independently of the school, for example; the principal can be a relative or neighbor of the family. Therefore, even though such relationships affect school relations positively or negatively, they were not addressed during this study.

Student-Family- Academician (SFA) interaction refers to a school that cannot produce solutions because it occurs outside of the school components (Figure 6). Often it is the search outside the school for the development of the child, led by the family. It is obligatory to have teachers in projects carried out in high schools. Therefore, it is impossible for the student to apply with a project without a teacher. The family expects to consult the academician either to give private lessons or to support matters under his responsibility.

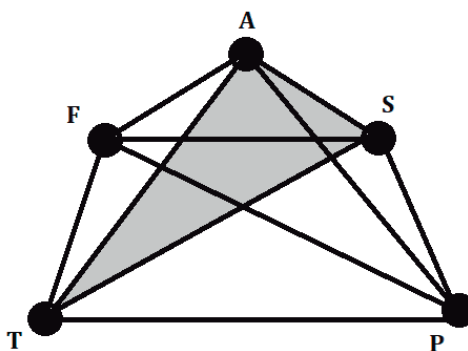


**Figure 6.** Presentation of SFA interaction.

SFA interaction was observed once during the project. The family asked the academician to train her child on setting up a circuit. This training, which is intended to be held outside the school and exclusively, has not been realized due to the workload of the academician.

Due to the agreement of the academician with the school, the academician can attend classes at the school. In this case, the academic should now be coded as a teacher. During the semester, the academician who gave lectures and exams at the school lost the quality of the external observer outside the school system. During this project, the academician voluntarily participated in some courses, but did not take responsibility for the course.

Student-Teacher- Academician (STA) interaction is the most important and most effective surface interaction (Figure 7). It reflects the modern education vision. In a healthy and natural learning environment, the student gets along well with the family and the teacher and the school principal have a good interaction with each other. In this case, STA is an important surface interaction where all components are present, even if they are representative. Therefore, it should be called golden interaction. It is a form of the three-dimensional interaction model mentioned later that can produce similar effects when performed with three components.

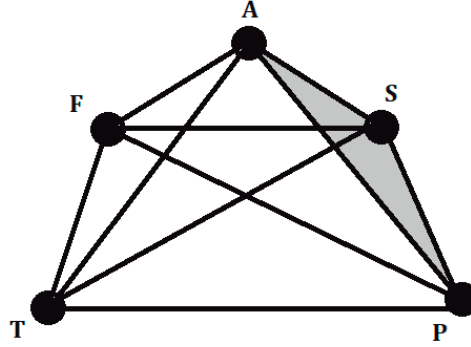


**Figure 7.** Presentation of STA interaction.

It can be said that all the works discussed in the project come out of this interaction. The principal and the family played a supportive role. The emergence, development and regulation of ideas STA interaction was carried out. It was conveyed to families and students and principals through teachers through linear interaction. It can be said that all linear and surface interactions except STA contributed to STA interaction. STA is a core

surface interaction and an adequate interaction when it receives formal, financial and motivational support from other components.

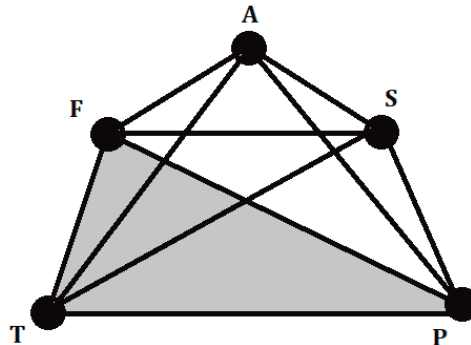
Student-Principal-Academician (SPA) interaction is also a form of interaction that has the potential to be dangerous (Figure 8). This is because there is no teacher in interaction. In the high school where the study is carried out, each class has a responsible teacher. Even if an extra-curricular subject will be discussed, the teacher should be informed and invited. Interactions where the teacher is not invited or informed may be the cause of new problems.



**Figure 8.** Presentation of SPA interaction.

The teacher has a central role in the school system. However, the academician does not have a defined role in the school system yet. If the school principal organizing the interaction does not invite the home teacher and does not provide information about the interaction, this may disrupt the balance of the school system. In some modern educational practices, academics work as a school principal. In this case, the roles change and interaction becomes non-hazardous. The purpose of the interaction is already to change roles and to eliminate all levels. In a physical sense, the interaction continues until it becomes the same, and the moment when the interaction stops is the moment when the sameization and change ends.

Family-Teacher-Principal (FTP) interaction is not seen as a problematic interaction even if the student is not included (Figure 9). This interaction, which takes place with the organization of the school principal, takes place once or twice in the period under the name of “parent meeting”. All teachers and parents are expected to attend the meeting. Here, as well as surface interaction, linear interactions are observed in subjects that do not concern the community. The main goal of these meetings is the student’s individual development and / or success in the community.

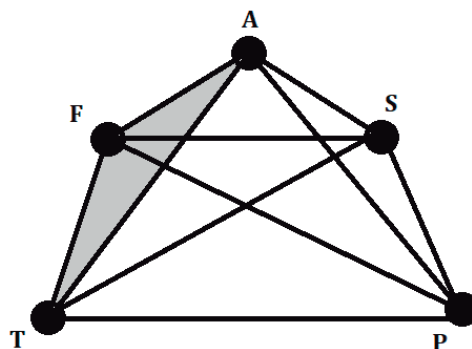


**Figure 9.** Presentation of FTP interaction.

The principal, who wants to hold a stronger and extraordinary parent meeting, may invite an academician to the meeting and ask him to speak on a short-term and needed topic. In addition, students can be invited to organize activities such as picnics, excursions or meals, where success is not spoken but human relations are

strengthened. In such a meeting, a lot of interactions take place and a good observer gets the opportunity to observe many problems pushed under the rug.

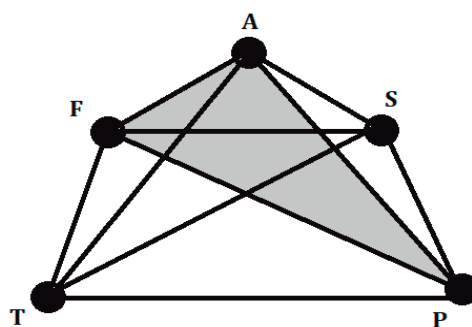
Family-Teacher- Academician (FTA) interaction may vary depending on who is leading, if the scholar is not intended to conduct a research (Figure 10). The family may set up a meeting environment to see the teacher inadequate and get support from the academician, or the meeting can take place under the leadership of the teacher to support the family as inadequate. When evaluating the interaction as positive or negative, factors such as interaction time, previous and subsequent interactions, and dominance should also be evaluated.



**Figure 10.** Presentation of FTA interaction.

The fact that the interaction has an external component / dimension and the student is not included makes the interaction extraordinary. The most powerful and most beneficial interaction for the student among the surface interactions that the student is not in is FTA interaction.

Family-Principal-Academician (FPA) interaction is an interaction that lacks two basic components such as teacher and student (Figure 11). It is also very difficult to succeed because of this disability. Even if the family directs the student and the principal to the teacher through linear interaction, it will not affect the student-teacher interaction effectively.

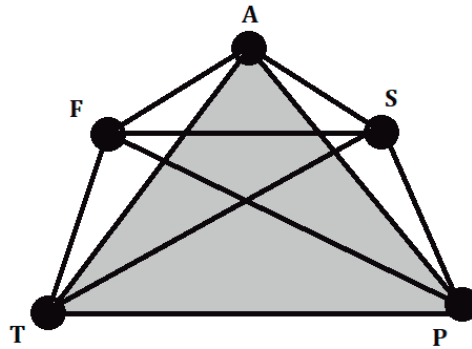


**Figure 11.** Presentation of FPA interaction.

This model may have a positive effect; The conflict between the student and the teacher can be an effort to resolve. The reconciliation environment prepared by the teachers and students who cannot solve the problem among themselves, the instructions of the academician and the meetings of the family and the school principal can be effective.

During the project, the principal asked for help from the academician and organized a meeting to persuade the families. It was thought that it would be effective for the academician to voice the issue when the families did not allow their children, although they asked them to direct their children to out-of-school activities. Some families were convinced by this model.

Teacher-Principal-Academician (TPA) interaction is an interaction that sometimes strengthens the teacher and sometimes brings additional tasks (Figure 12). This interaction, which strengthens teaching, may bring unrealistic approaches as it will strengthen the theoretical dimension of teaching. The school principal and academician, who are out of the application, can raise expectations regarding the course content and lecture.

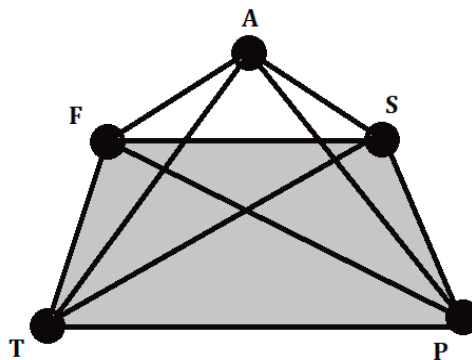


**Figure 12.** Presentation of TPA interaction.

During the project, after the STA interaction, the most used interaction model was TPA. This interaction model allowed changes to be made in the functioning of the school (such as the curriculum, syllabus and exam schedule) for the development of the student.

TPA interaction took place either during breaks or remotely using the phone. Although effective, there were short-term and problem-oriented interactions. Generally, it was observed that the school principal had made the decision for the teachers, but in cases where the teacher was not satisfied, problems occurred in the applications. For this reason, in this interaction model, the academician should follow a strategy that eliminates the authority over the teacher.

Student-Family-Teacher-Principal (SFTP) interaction is the strongest interaction that can be established within the school, but is generally only seen at graduation or memorial ceremonies (Figure 13). In terms of age, experience and role, the most hesitant component is the student in the environment where four components interact. Although all roles are defined through students, they are in environments where they have difficulty in expressing themselves and remain quieter. Components other than the student should emphasize the fact that they are gathered for him or her and should be asked his or her opinion from time to time.



**Figure 13.** Presentation of SFTP interaction.

Even if increasing the number of interactors helps to see many dimensions of the problem, if a democratic and motivating communication language is not developed, interaction may bring other problems. Therefore, there is a need for leaders in multiple interactions that focus interaction on resolution, reduce conflicts and support reconciliation. These leaders are not elected; they are usually spontaneous. The leader of the intera-

ction does not have to continue his leadership continuously. As long as the solution is focused, constructive transformational leadership studies should be conducted. In this case, solutions that are not valid may also arise. As a requirement of democratic communication, it may be considered to try the proposed solution rather than refute it. The components can take the initiative and choose the way of persistence at the point where the student believes that he will be harmed.

### Three Dimensional (3D) Interaction Model

There is only one interaction for 3D interaction model and it is called as Student-Family-Teacher-Principal-Academician (SFTPA) interaction (Figure 14). SFTPA interaction is the most ideal one, but unfortunately it is the least seen one. It is so rarely observed that if all possible surface interactions occur in a healthy and frequent way, the 3D interaction model can be considered as happening.

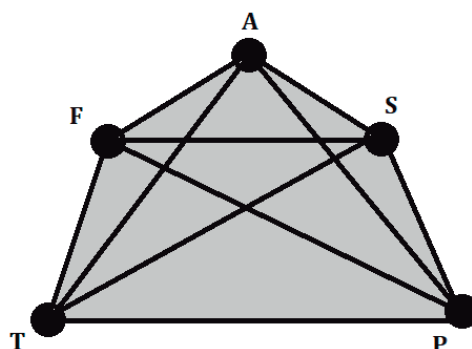


Figure 14. Presentation of SFTPA interaction.

All schools and non-school institutions should work to realize this 3D interaction. This interaction is the model that can find the last solution. The failure of this model to find a solution means that it cannot be resolved until the components change. Therefore, the components must come together in a consensus and focus on the solution. If the problem cannot be solved with the 3D interaction model and the problem can be solved in simpler structures, it may be thought that there is a communication problem between the decoding structure and the external component. Some of the model may have developed an attitude towards another part. Then the components at the intersection must strive to create integrity.

### Interaction hierarchy

All interactions are important. All healthy and sincere interactions will contribute to the solution. In addition, all interactions can be part of the solution in the background in certain situations. However, interactions must also have a ranking, order and / or system.

A hierarchy was tried to be created in order to compare interactions with each other and to guide educators about interaction. This hierarchy helps us understand interactions than the strongest of interactions, the least likely to occur (Figure 15). According to the power and possibility graph, as the component of the interaction increases, the power increases but the possibility of realization decreases.

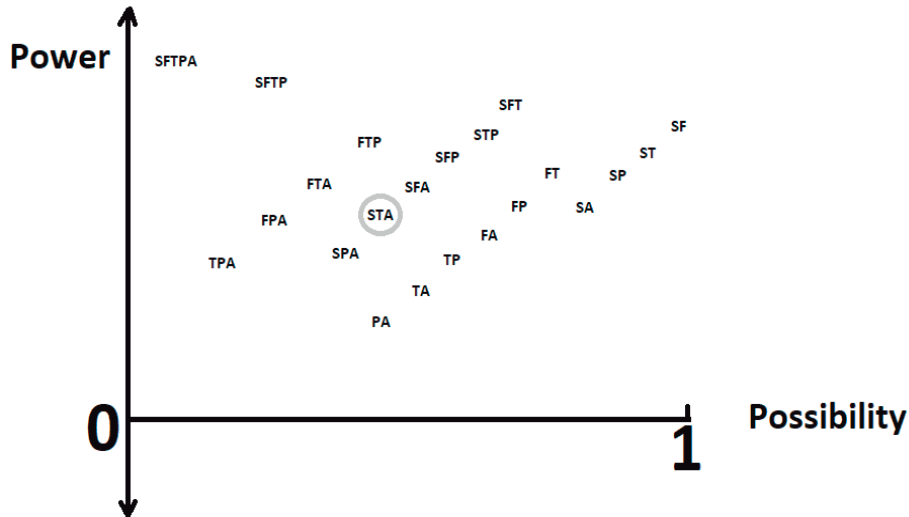


Figure 15. Power and Possibility graph of interaction hierarchy.

Educators can try all interaction models in the hierarchy. STA (gold interaction) interaction, which is the optimum value of these interaction models, is the interaction that should be supported most. While preparing this hierarchy, the student was taken to the center and the components are listed as S, F, T, P and A away from the center. This hierarchy has always been used when naming interactions and placing them on the graph.

### Some outputs of the project

During the one-year project, some designs and ideas were reached as a result of the interaction of students, teachers and academicians (Figure 16). The development of the products was not sudden, it took time. Students' realization that science and technology are developing over time will enable them to be patient in subsequent design processes. An idea that emerged in the meeting turned into design over time. After determining the purpose of following the nature without harming the nature, bushes were made using similar pipettes. A design has emerged that will move constantly in the wind and use motion energy to collect data with piezoelectric and send data. When the idea of helping people under the rubble in the news after an earthquake in the project process was opened to discussion, snakes with a wheel and a smartphone were designed. Telephones, which can be a lamp in the mouth of the snakes, give and receive sound and images, can be controlled remotely. The snake contains water wrapped in sachets. With the teacher bringing up small insects sticking to his car after a trip, a mechanism was designed to save a bug by attaching a propeller in front of the car and hitting the insects with the driving force of the air.

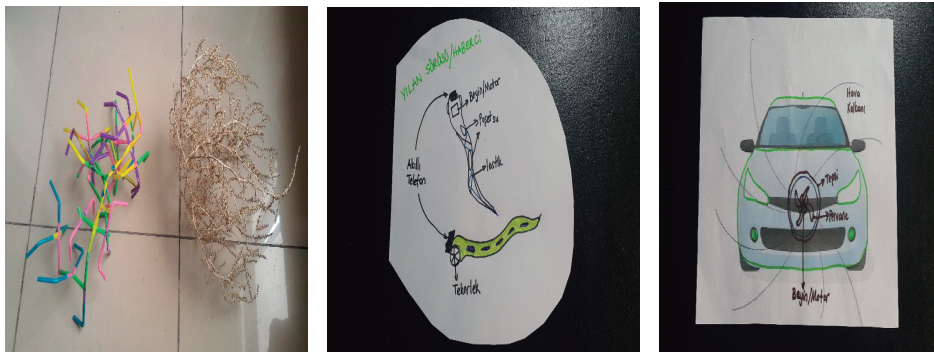


Figure 16. Some outputs of the project.

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## CONCLUSION

It is very difficult to evaluate this original study examining the interaction of educational compounds and to compare it with other studies. Nevertheless, at the end of this study, it is clear that education has five known important components. Four of them are classic and constitute school functioning. There are different combinations of these five components, and the strength of interaction increases with the number (Dennis & Martin, 2005). Considering the different interaction possibilities of all components, a hierarchy emerges. According to this hierarchy, while linear interactions occur more, three-dimensional interaction is almost never observed. Educators should try all interaction models when they have problems.

During the project, we saw that many products were designed and implemented with the interaction of students, teachers and academicians. The crab body is placed on the motor and feet, which are provided to move randomly (Figure 1). By placing a pencil on this body, an “artist crab” emerged. The concept of “tearning” from the first coding moment until it is operational brings an important philosophical opening. During the project, teacher and student roles were mixed. Everyone constantly interacted by making use of each other’s knowledge. Instead of learning and / or teaching with students, teachers and academics, there have been mutual “tearning”.

Education is interaction (Xiao, 2017). Training becomes stronger and more qualified when the interaction is bi-directional (mutual) and occurs between all components (tearning). The purpose of all components should be to increase the number of this interaction and to improve its type.



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## **EXTENDED SUMMARY**

### **Purpose**

*The aim of this study is; It is trying to understand the dynamic structure of the classroom environment through students gathered around a project. It is thought that effective guidance, solution generating strategies and developmental stages needed in science education will be more understandable when examining the form and orientation of interactions in the process and shared with researchers as a model.*

### **Method**

*The method followed in this study; It is the way a situation is studied in depth. In the case study, not only were examined, but the forms of interaction in this situation were recorded during the projects. In this sense, it can be argued that the study is an ethnographic study. It is clearly seen that there is a sociodynamic study with a small group of ethnographic research types and a hierarchical interaction model has been reached at the end of participant observations and interviews. Beyond explaining a small group that produces a project, this study has a structure created with qualitative data completed with a short-term ethnographic method as a result of in-depth examination of interaction networks. These networks have ensured that the model presented has been tried many times and formed as a result of experiences.*

### **Findings, Conclusion and Discussion**

*This section begins by explaining the types of interaction. Linear, surface and three dimensional interaction models are explained in the light of references and examples from the case. All models were re-evaluated by comparing them with another hierarchical interaction model presented at the end of this section. In this evaluation, the probability of realization and the power of influence were taken into account. The findings part of the research was completed with the information of the by-products that emerged in the process.*

*Education is interaction. Training becomes stronger and more qualified when the interaction is bi-directional (mutual) and occurs between all components (tearing). The purpose of all components should be to increase the number of this interaction and to improve its type.*