

## **Case Study on Interdisciplinary Teaching Approach Supported by Project Based Learning**

(Proje Tabanlı Öğrenme ile Desteklenen Disiplinler arası Öğretim  
Yaklaşımına İlişkin Bir Durum Çalışması)

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**Abstract:** The aim of this study was to investigate an application of interdisciplinary teaching approach. It was a case study that supported by combination of qualitative and quantitative methods. Thirty-four 10th grade students who were attending a private school in Ankara were asked to develop projects in the line of interdisciplinary approach. To detect the effectiveness of this approach, a logical thinking skills test (GALT) was administered as pre-post test single-group experimental design fashion. To learn about students', teachers', and parents' ideas about the application, two interviews (before and after the application) were conducted. In addition, a questionnaire about interdisciplinary teaching approach was administered to all teachers at the school (N=36). The results obtained from pre-post test scores of students revealed that there was a significant difference in favour of the application. The interview data showed that teachers, students and parents had positive thoughts about the process. All of them agreed that interdisciplinary projects contributed to development of the ability of making connections between previously learned concepts, transferring what has been learned, and using the computer effectively as well as development of problem-solving, logical thinking, and communication skills.

**Key words:** Interdisciplinary teaching, project based learning, logical thinking skills

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**Öz:** Bu ara tırmada, disiplinlerarası öğretim yaklaşımına ilişkin örnek bir uygulamanın yapılması amaçlanmıştır. Ara tırma nitel ve nicel yöntemlerin bir arada kullanıldığı bir durum çalışmasıdır. Bu amaçla, Ankara'da özel bir lisede 10.sınıf öğrencilerinin disiplinlerarası öğretim yaklaşımı çerçevesinde projeler hazırlamaları sağlanmıştır. Disiplinlerarası yaklaşımın göre proje hazırlama sürecinin etkililiğini ortaya koymak için deneysel çalışma yapılmıştır. Deneysel desen olarak tek grup ön-son test seçilmiştir.

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ve ö rencilere (N=34) mantıksal dü ünme grup testi (MDGT) uygulanmı tur. Uygulama öncesi ve sonrasında sürece ili kin, ö renci, ö retmen ve velilerin görü lerine de ba vurulmu tur. Ayrıca okulda bulunan tüm ö retmenlere (N=36) disiplinlerarası ö retim yakla ımına ili kin anket uygulanmı tur. Ara tırmadan elde edilen sonuçlara göre, ö rencilerin mantıksal dü ünme grup testi puanları arasında uygulama lehine anlamlı fark bulunmu tur. Görü melerden elde edilen veriler nitel analizle çözümlenmi tir. Görü me bulguları ö retmen, ö renci ve velilerin sürecin etkilili ine ili kin olumlu dü üncelere sahip oldu unu göstermektedir. Görü meciler, disiplinlerarası proje çalı masının ö rencilerin ö renilen bilgiler arasında kavramsal ili ki kurma, ö renilenleri transfer etme, problem çözme ve mantıksal dü ünme, dili etkin kullanma, bilgisayarı etkin kullanma ve bilimsel çalı ma yapabilme becerilerini geli tirdiklerini ifade etmi lerdir.

**Anahtar kelimeler:** Disiplinlerarası ö retim, proje tabanlı ö renme, mantıksal dü ünme becerisi

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## **Introduction**

The basic aim of today's modern educational programmes is to raise individuals -the inputs of programmes- equipped with skills required by the society of knowledge. Individuals, who comprise the input, must acquire such basic skills as gathering knowledge related to various disciplines, bringing them together in an appropriate way, and meeting the needs with that knowledge in the processing period. All the discussions on this issue have always affected individuals firstly, and thus educational approaches. Educators have conducted studies on how to indoctrinate so many disciplines in individuals over time. Those studies may be classified under two headings: those in which disciplines are taught separately, and those in which disciplines are taught as a whole. In fact, teaching the disciplines in a holistic approach beginning with elementary education, through all level of education, is a method which has been used in education for a long time. However, today teaching rapidly changing disciplines with sub-branches in a holistic approach, gained more importance. According to Mathison and Freeman(1996, p. 6) knowledge was increasingly seen as a complex, interconnected system requiring new pedagogical methods for successful learning to take place. Situated cognition, thematic organizers, and concept mapping have been ways of developing more receptive and connected curricula for students.

Different designs are used to integrate disciplines which are disconnected in programmes. Robin Fogarty (1991) has identified ten models of curriculum integration, ranging from the fragmented disciplines (traditional) approach to a completely networked approach to curriculum planning. Between the fragmented and networked points of Fogarty's continuum, he identifies eight other models of curriculum integration (Kysilka,1998,p. 199):

1. *Connected*: Ideas within each content area are related to each other and connections are made between prior knowledge and knowledge yet to be learned.
2. *Nested*: The emphasis is on learning skills and organizational skills needed within each discipline in order completely to understand the content of the discipline. In this model, the content area still remains as the major focus of the lesson, but the skills of thinking and organizing ideas are highlighted within the lessons.
3. *Sequenced*: Topics within a discipline are rearranged to coincide with those of another discipline.
4. *Shared*: Disciplines are “partnered” and units planned to focus on “overlapping ideas or concepts”.
5. *Webbed*: Themes form the base of the curriculum. Disciplines use the themes to teach specific concepts, topics and ideas within the disciplines. For example, the teachers may select ethics as a theme. Each teacher, then, within his/her own discipline will address ethics as it is appropriate to the subject matter.
6. *Threaded*: A “meta-curriculum” is designed around specific thinking, social or study skills and the content becomes the vehicle for these skills to be learned. At the same time, the classroom teacher infuses ideas about how one learns (multiple intelligences) and aids to learning (technology) which can help the students develop their metacognitive skills, i.e. they learn more about how they learn.
7. *Integrated*: Teams of teachers work together in all disciplines to find overlapping concepts and ideas around which they can plan units of study and implement them in common teaching time. This model is perhaps one that is currently used in many middle school curricula whereby interdisciplinary teaching teams work together to build units in which they share teaching responsibilities.
8. *Immersed*: A student becomes immersed in a field of study and filters information from content areas through his/her own lens. Integration becomes the responsibility of the student. This 'model' of curriculum integration is what is perceived to be the model of learning advocated by many doctoral programmes. The learner is in control of the knowledge learned, the strategies used and the sharing of that knowledge with other students, the faculty and the academic world.

Approaches described above can arise spontaneously in the learning process. Explanations and examples provided by teachers enable natural interdisciplinary integration. The models listed above can be observed naturally

during the learning process of students with the help of teachers and curriculum specialist who may try different ways to integrate the disciplines. As a matter of different disciplines taught to be in harmony is a priority. For this integration the harmony between the different disciplines should be the main issue to consider. There are some other models that integrate different disciplines.

Jacobs (1989) has also attempted to define curriculum options for an integrated curriculum. She has established five options from disciplined-based to complete curriculum integration. Between the two ends of her curriculum options are “degrees” of integration (Kysilka,1998, p.202):

1. *Parallel disciplines*: The disciplines maintain themselves as separate entities; however, teachers attempt to sequence topics so that related ideas are taught concurrently within the separate disciplines. (This is similar to Fogarty's sequenced model.)
2. *Multidisciplinary*: Related disciplines are brought together in a formal way for analysis and study, e.g. humanities, fine arts, political history. This type of integration supports the creation of a “new” course to be offered by finding relationships between existing disciplines.
3. *Interdisciplinary*: Specific units or courses of study are constructed to bring together all the disciplines within the school's curriculum. Units of study are designed around themes, ideas or issues which emerge from the regular curriculum. The units are taught for a specified period of time (two weeks, a month, a semester) determined by the teachers. Specific blocks of time are set aside in the daily or weekly schedule to accommodate the interdisciplinary units. However, the units do not supplant the existing disciplines, they are complementary to them.
4. *Integrated day*: A theme-based full-day programme focusing on student interests and needs.
5. *Complete integration*: Students determine their curriculum out of their life experiences, needs and interests.

These distinctions may help us understand the logic of interdisciplinary program applications. The most appropriate curriculum should be selected based on the analysis of the structure of the schools and characteristics of students and teachers. This theoretical structure cannot strictly differentiated. Interdisciplinary teaching approach theoretically includes the distinctions mentioned above.

### *Interdisciplinary Teaching Approach*

Interdisciplinary studies should go beyond the ordinary academic studies. When the school curricula of the European Union are examined closely in terms of overall structure, it will be found out that they are based on interdisciplinary teaching approach. The reason why interdisciplinary teaching approach has become important recently could be accounted for with the spread of two significant thoughts in the field of education. One of them is the fact that educators are increasingly dissatisfied with curricula thinking that they are away from life out of school. It is often suggested that skills learnt at schools should be applicable to real life problems. This could only be solved by re-structuring the integrated curricula. The second is the fact that educational approaches which could be called constructivism and which are liberalistic learning based on students' interests force the traditional structure to bring about changes in curricula (Nagel, 1996).

Jacobs (1989) defines an interdisciplinary curriculum as a knowledge view and curriculum approach that consciously applies methodology and language from more than one discipline to examine a central theme, issue, problem, topic, or experience. Squires (1975) defines an interdisciplinary course as one in which two or more disciplines are taught in conscious relation to one another (Cited in Mathison and Freeman, 1998).

The basic aim in this approach is to use knowledge coming from various disciplines for a certain purpose rather than simply transferring the knowledge of a discipline. Brand (1991) indicated that Jacobs defined knowledge as an integration of various courses that the content of the courses related to their daily lives. Because students can understand better in when they will become more enthusiastic about learning mathematic. (Mathison and Freeman, 1998; Thomas, 2000) Erickson (1995) defines interdisciplinary teaching as "a conceptual integration of a concept in differing disciplines" (Cited in Duman and Aybek, 2003). This concept is already a natural association with the program to be presented without differentiating the disciplines. Reed and Bergman (1995) defines integrated curriculum as an interdisciplinary concept as the integration of various disciplines around one single essence, especially an issue or problem. interdisciplinary approach enables students to see and discover the connections among disciplines and connections between disciplines and real life things; in addition to that, it also prepares them to critical thinking and creative problem-solving so that they could adjust to continuously changing needs of society and could develop skills required (cited in Özkök, 2005, p. 160).

Interdisciplinary teaching can also be defined as "presenting the fields of disciplinary topic by bringing them together around certain concepts or themes meaningfully" (Yıldırım, 1996). The aim in interdisciplinary teaching is "both learning the selected topic as a meaningful whole, and providing students with opportunities to examine the same issue from the perspectives of different

disciplines” (Yalçın and Yıldırım, 1998, p.147). In interdisciplinary teaching, a certain concept, problem or issue is concentrated upon, and knowledge and skills which might shed light on this issue from different perspectives are adapted from relevant fields and are integrated. Both learning the knowledge and skills of certain disciplines and integrating them in a meaningful way become possible through an interdisciplinary arrangement. “Interdisciplinary teaching may lead to problems such as coming up with meaningless knowledge, knowledge isolated from real life, and too abstract, difficult to apply knowledge” (Yıldırım, 1996, p.93). While teaching a concept in science course, a science teacher working in an elementary education school should present the relevant parts of the concept in Physics, Chemistry and Biology in a holistic way.

The three interdisciplinary strategies described by Nikitina (2006, p. 252) are as following:

The first strategy, *contextualizing*, is a method of embedding any disciplinary material in the fabric of the time, culture, and personal experience. For instance, while covering the history of science, the disciplines of history and medicine can be integrated to teach together.

The second strategy, *conceptualizing*, involves identifying core concepts that are central to two or more disciplines (e.g. ‘change’, ‘linearity’), and establishing a rigorous quantifiable connection among them. For example, the concept of change may connect evolutionary theory in biology with learning about the physics of compression, with the law of periodicity in chemistry, and ultimately with the mathematics of differential equations and number series.

The third strategy, *problem-centering*, involves enlisting the knowledge and modes of thinking in several disciplines (i.e. biology, chemistry, political science, economics) to examine messy real-life problems (such as water pollution, genetic engineering, or AIDS in Africa) that require more than one discipline to solve. The tenor of this strategy is that of an applied social science that pursues the goal of producing tangible results (i.e.products, technologies, policies, methodologies) aimed at improving the human condition. The goal of such fields is not as much to deepen understanding of the self or the natural world as it is in the humanities and the fundamental sciences, but to apply this understanding to action and social change.

Interdisciplinary teaching, which regards the specific methods and distinctions of each course but which enables students to see the whole through concrete learning experiences required by learning principles in the process of learning, facilitates comprehension, bearing in mind and transferring the knowledge. From the literature on cognition and instruction, it is possible to identify four cognitive abilities that interdisciplinary learning fosters. These include the ability to (1) develop and apply perspective-taking techniques; for

example discussion a topic , (2) develop structural knowledge of problems appropriate to interdisciplinary inquiry, (3) integrate conflicting insights (i.e., expert views) from two or more disciplines; for example talking in a newspaper article including interdisciplinary problems and (4) produce a cognitive advancement or interdisciplinary understanding of the problem; for example to produce and showing their own solution we could create appropriate classroom environment. (Repko, 2008, p.2). These abilities are related to students abilities to develop their own questions. Students could make connections across different disciplines when they work on the same projects or problems that naturally entail an integration of disciplines. Sometimes ideas and methods of disciplines could be conflict. In that case students could try to unify create different solutions for integration and could reach their own outcomes.

Naturally, developing an interdisciplinary curriculum will take longer than a disciplinary curriculum. Various activities such as obtaining information and skills likely to be relevant from differing fields, developing the lesson plans and materials, the relevant field teachers' coming together when needed in the process of curriculum development and teaching, and performing implementation and evaluation plans by considering different disciplines become important in an interdisciplinary curriculum. Therefore, planning stage, which is important in any type of curriculum development, becomes even more important in an interdisciplinary curriculum (Yıldırım, 1996).

In a school setting teachers of different courses should come together to investigate when and how they could collaborate while teaching a specific unit. Thus they could prepare their integrated plans for the academic year. The integrated lessons designed by the teachers could occur within existing time slots of the curriculum. However, in order for students to see how the teachers make connections between content areas, should devote time to discuss how they could achieve such connections. For instance they could allocate one-hour meeting weekly to share their ideas. "When students see how their teachers transverse the "artificial", but to the students "real", lines of content, they might find it easier to model their behaviour on that of their teachers." (Kysilka, 1998, p.205)

In order to be able to decide correctly as to which disciplines and in what form should be available in a programme draft that is designed on the basis of interdisciplinary approach, it is necessary to know the structure of this approach thoroughly. Ackerman (1980) analyses place of disciplines in an interdisciplinary approach (Mathison and Freeman, 1996). Accordingly, a discipline or disciplines must achieve interdisciplinary validity in terms of topic and setting up connections, and they must contribute to enrichment of teaching in content. Interdisciplinary topics must be composed of a collection of harmonious disciplines. Thus, a more superior understanding may be achieved in detailed topics. In-class activities or projects designed in accordance with the properties

of the topic may be used effectively in the application of the interdisciplinary teaching approach. More specifically, when class activities emphasize the development and implementations of an innovative project by integrating the topics not only will the subject content be easier to understand that also it will have greater relevancy. In this way, lessons will promote open for professional dialogue, creativity, and problem-solving skills better. Therefore, project-based learning is very appropriate for interdisciplinary teaching approach.

### *Project Based Learning*

Project based learning is an approach which requires interdisciplinary work, in which students take responsibility individually or in groups and perform research-based activities cooperatively on real life based problems about the content they form according to the topic in line with their interests and abilities, in which the teacher plays a facilitating and guiding role, which is resulted in realistic products and presentations, and which can combine differing approaches in its body (Demirhan, 2002). Whereas the curriculum is pursued, unit by unit progress is made, and a narrow and disciplined process is essential in traditional learning; monitoring students' interest, broad units composed of complex problems and topics, and an interdisciplinary approach is essential in project based learning approach.

When we use the interdisciplinary approach, we have to find common topics across the curricula. To show connections between the disciplines teachers have to draw borders of a project that is appropriate for the interdisciplinary links in terms of its content, required skills and outcomes. "In project based learning, the project is the central teaching strategy; students encounter and learn the central concepts of the discipline via the project." (Thomas, 2000 p. 3)

The stages of project based learning approach, as defined by Moursound (1999), are:

1. setting the objectives,
2. determining and describing the work to be done or the issue to be handled,
3. forming the teams,
4. determining the features of the final report and the way of presenting it,
5. forming the working calendar,
6. determining the checkpoints,
7. determining the evaluation criteria and levels of proficiency,
8. gathering information,
9. organising and reporting the information,
10. presenting the project (Quoted by Erdem and Akkoyunlu, 2002).

In the project work students have to be clear about their aims to be able to determine the steps to follow in their research steps. Students have to be arranged as compatible teams. Then they need to be drawing limitations for their final aims and report. Students have to use their time management skills in order to form project calendar. They need to make some decisions to determine working their preferences. In the project process they need self-control points at regular intervals for the quality of their project. In the stage of information gathering, they need to use different scientific sources that can be verified for the synthesis of information. A project is in depth investigation of a topic worth learning. In research, a small group is formed in class by students, and responsibility is taken sometimes as a class sometimes individually. The key feature of a project is that it focuses on seeking answers to questions on a topic with students' efforts or through joint work of students and the teacher. The aim of a project is to learn more about a topic rather than find answers to the questions about the topic put forward by the teacher (Katz and Chard, 1989; Quoted by Demirhan, 2002).

Research available in literature provides evidence as to the fact that project based learning affects students' upper level thinking skills such as critical thinking, creative thinking, reflective thinking, problem solving, and scientific and logical thinking. The skill of logical thinking -one of the upper level thinking skills containing problem solving skill- is defined as the skill of performing judgement of preservation-mass length, volume, proportional judgement, controlling variables, connective judgement, judgement with probability, and relational judgement (Aksu, Berbero lu, Martin and Paykoç, 1990). When using logical thinking skills explained above, learners go through various mental practices or processes by doing some abstraction and generalization and solving the problem. Whenever students use the logical thinking skills, they integrate processes such as identifying and controlling variables, and hypothesizing in the problem solving steps.

### ***Purpose of the Research***

A close examination of the general structure of the EU school curricula demonstrates that they are based on interdisciplinary teaching approach. Interdisciplinary teaching approach enables students to transfer what they have learnt into different fields, to see the relations between knowledge of various topic fields, and thus to develop upper level thinking skills. This research is conducted so as to investigate interdisciplinary teaching approach in various dimensions at secondary education level. Secondary education was chosen because of students' interdisciplinary project management skills develop during that level. Also the instrument used in this research contains at some of the concepts that are more related to logical thinking skills (eg, preservation, proportional judgement etc.) at this level.

This research aims to study the interdisciplinary teaching approach and to demonstrate a sample application of the approach. For this purpose, 10<sup>th</sup> grade students (N=34) were randomly selected. They prepare projects in line with the interdisciplinary teaching approach, and efforts were made to determine the effects of this application on the learning process and on students' logical thinking skills. The teachers' (N=15) and parents' (N=17) views concerning the effects of the application and the interdisciplinary teaching approach were requested. Answers to the following questions were sought in this context:

1. What are the effects of interdisciplinary teaching approach supported by project based learning on 10<sup>th</sup> graders' logical thinking skills?
2. What are the students', teachers' and parents' views concerning the application of interdisciplinary teaching approach supported by project based learning?

## **Method**

### ***Research Design***

This research, in which a sample application of interdisciplinary teaching approach along with project based learning is performed, is a case study with qualitative and quantitative components. Case study is defined by Yıldırım and Şimşek (2000, p.290) as an empirical research method in which a current fact is studied in its content, and is used when certain boundaries between the fact and the content are not evident, and more than one single source of evidence or data is available.

Single case design one inside another, one of the case study designs, was used in this research. In such a design, mostly, there may be more than one sub-layer or unit within a case. Therefore, more than one unit of analysis is available (Yıldırım and Şimşek,2000). The components analysed are accumulated. The data was obtained from school and more than one sub-component within a case is studied. The students, teachers and parents in the school organisation are regarded as sub-units. The school organisation is regarded main unit. The students, teachers and parents in the school organisation are regarded as sub-units. To support the case study research, a quantitative study was also conducted. To examine the effectiveness of interdisciplinary teaching approach supported by project based learning, a scale (GALT) was used as pre-and post-test application.

### ***Study Group***

The research sample was composed of 36 teachers employed in a state high school in Ankara, 34 students and 29 parents. Research was conducted with 15 teachers (1 art, 1 music, 2 history, 1 biology, 1 chemistry, 1 physics, 1 geography, 1 maths, 2 literature, 2 English, 1 computer, 1 psychology teacher). 17 parents had a college degree, 10 with high school diploma and 2 with primary school diploma.

### ***Procedure***

The following procedures were done in the research:

- A 6-hour training on interdisciplinary teaching applications and project based learning was given to the teachers prior to the application. That course contained theoretical information about project based learning and showed examples of the applications of interdisciplinary teaching. Of the total, 1 hour was allocated to introducing the approach, 1 hour to studying the application examples, and 4 hour to team work. Training was given by researchers.
- Work teams were formed with teachers prior to the application, and each group worked with teachers of other categories in a field related with their team. Students and teachers formed the teams together. Teachers were assured to follow the process closely with this activity.
- The participating teachers' views were consulted at the beginning and end of the process.
- The students in the research group were informed of scientific research techniques, preparing and presenting projects based on interdisciplinary teaching approach, for 2 weeks (12- hour instruction) prior to the application. The internet, computer and power point using skills of students to take part in project work were determined through information forms and their insufficiencies were handled. A 4-hour presentation on conducting research and preparing projects was given to the students prior to the application. Then they were asked to choose a topic of project and to form a project work group of 2-3 people. A teacher was appointed to each group as an advisor. The topics selected by students were checked by the teachers and were confirmed if they were appropriate for project work. The working hours for teachers of different branches were determined for each project prepared by the students. Each teacher guided the students in accordance with their fields of discipline.

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- The students' views were requested at the beginning and end of the process.
- "Logical Thinking Group Test" was applied to the students at the beginning and end of the process.
- A questionnaire on the current applications concerning the approach of interdisciplinary teaching was given to all the teachers working in the school of application and participating in the seminar held at the school.
- Documents were sent to the participant parents to inform them of the project prior to the application, and their opinions concerning the effects of project activities based on interdisciplinary learning approach on the students were requested after the application.

### ***Instruments***

#### ***Pre-test & post-test***

Group Assessment of Logical Thinking Scale, developed by Roadranga, Yeany and Padilla (1982) and adapted into Turkish by Aksu, Berbero lu, Martin and Paykoç (1990), was employed so as to determine the effects of the application on students' logical thinking skills. The test, which is composed of 21 items, was constructed by selecting items of high validity and reliability among the ones developed previously in this field which were to measure various reasoning abilities. The test measured 6 logical procedures. They were: preservation-mass, length, volume (4 items), proportional judgement (6 items), controlling the variables (4 items), connective judgement (3 items), judgement with probability (2 items), and relational judgement (2 items). These items were configured to measure some features: to identify a suitable operational definition of the described variable to give a description of a problem to identify a suitable hypothesis; to give a description of an investigation and obtain data, to identify a graph that represents the data, or give a graph of data from an investigation, and to identify the relationships between the variables; to give a hypothesis, to select a suitable design for investigation, to test it, give a description of an investigation, to identify the independent, dependent and controlled variables (Hsu, 1991) As shown above the test can be applied to student groups in the period of concrete and abstract processing. The reasons for answers were given in the form of multiple-choice. Following the adaptation into Turkish, the test was applied to 1298 students of secondary education and high school level. The reliability coefficient (KR 20) was found to be 0.68 (Aksu, Berbero lu, Martin and Paykoç, 1990).

### ***Interview***

Open-ended interview form was used for interviews. In order to obtain the students' and teachers' views on the process, 4 teachers and 10 students who joined the application were interviewed through focus group interview technique before and after the application. The teachers were asked 6 open-ended questions. The interview form containing the same questions was also applied to the students. The parents' views were obtained through a questionnaire of 8 open-ended questions. The content validity of the interview forms was achieved through expert opinions. In order to receive teachers' views concerning interdisciplinary learning approach in greater detail, 36 teachers teaching in the same school were given a 28-item questionnaire form about interdisciplinary teaching approach. All of the teachers completing the questionnaire form had participated in the seminar course which is related to interdisciplinary project implementations such as identifying the aim of the project time allocated for weekly meetings and the assessment given by the researcher prior to the application. A minimum of 2, a maximum of 6 alternatives were given for the answers to the questions.

### ***Data analysis***

In order to determine whether or not there exists significant difference between the pre-test and post-test scores took of GALT. T test was used for related groups. A content analysis was performed on the data obtained from interview questions, and the themes concerning the contributions of the process were determined. Interview data were recorded by two researchers. Later these records were analyzed mutually. Common concepts and facts are encoded in the interview to ensure interreliability check.

### **Findings**

#### ***1. Findings and Interpretations on the 1. Sub-Problem***

The effects of interdisciplinary teaching approach that was applied through project based learning on students' logical thinking skills was questioned in the first problem statement; and in order to find answers, the difference between first and final scores students received from "Logical Thinking Group Test" was compared with t test; and the results are shown in Table 1.

*Table 1: Results of Logical Thinking Group Test*

LTGT	N	X	S	Sd	t	P
Pre-Test	34	6,97	3,99	33	-3,824	0,01
Post-Test	34	10,71	4,02			.

As is evident from Table 1, the average score that students received from the test is 6.97 in the pre-test and 10.71 in the post-test. The standard deviation is 3,99 for the pre-test and 4.02 for the post-test, respectively. A significant difference is available between the pre and post applications of Logical Thinking Group Test [ $t_{(33)}=3,824, p<.01$ ]. Based on the findings, it could be said that the application affected students' logical thinking skills in a positive way.

The teaching-learning process aims at facilitating students a holistic comprehension and interpretation power; enabling them to understand the problem statement, to read and encode the data, to form a hypothesis; and exposing them to an experience in which they will display their scientific and analytic reasoning abilities. Considering the properties such as proportional judgement, controlling the variables, connective judgement and relational judgement that are measured by the test of logical thinking skills the process may be said to be effective in terms of these variables.

## 2. Findings and Interpretations on the 2. Sub-Problem

The data obtained from by interviews were used for conceptual patterns created. *“establishing conceptual associations, transferring what has been learnt, using the language effectively, and problem-solving/logical thinking, computer using and doing scientific study”*. As a result of the literature review and interview analysis above mentioned themes emerged. They are related to students' achievements obtained at the end of the process. For example, transferring means that the use of sources has changed after the application. Using the language effectively means, is this application have develop their skills? Another example of problem solving skills, concept of problem with the limited concept of mathematic lesson or after process has changed as a concept of everyday life problems, are they feel fear of making mistakes when they solving a problem. The data concerning the questionnaire were analysed using percentage and frequency.

### 2.1 Findings Obtained through Interviews with Students

*Establishing conceptual associations:* Students stated in the initial interview that they could set up associations between topics and concepts only

with the teachers' help and that they chose to memorise those relations. S3: "I'm usually using a way of memorizing. Memorization is not useful. When I memorize, I generally forget." S2: "I do not have problems in mathematics but in the verbal lessons I have a memorization problems. They also said at the end of the process that they felt the need to look for holism in topics and that they desired to understand the complex structures (especially in social events), thus they tried to understand by associating different topics. S4: "All courses are actually associated. This is more meaningful for me." S2: "Our text books should show the relationship between interdisciplinary connections as our projects do."

*Transferring what has been learnt:* At the beginning of the process the students said that they did not make conscious efforts with their current knowledge to use the new knowledge, but that they could establish associations between disciplines close to each other. And at the end of the process, they stated that they used knowledge transfer consciously, and that they related especially the topics in history with today's events. . S2: "In fact, every subject is related to each other but it is important to see that relationship. I was very surprised when the teacher established a connection between math and history. After that I took him as an example" That the students worked with differing disciplines and differing teachers along the process and they focussed on detailed research topics enabled them to transfer knowledge of differing fields. S6: "For example, human rights and the Nazi camps, project: "... so the issue of human rights, and we connect it to our literature courses." S8: "Terrocota project: "... Our ceramic statues are made of the best of. " At this point, especially for students of history teachers can contact their preferred examples have been effective. In addition, students with teachers from different branches of a theme throughout the work of the different dimensions of students to be more careful about information transfer may have caused.

*The skill of using language effectively (self-expression):* When the students were asked for their opinion in the initial interview, they said that they could not use language effectively. They thought that improving their linguistic skills or self-expression skills was the objective of Turkish language course only. At the end of the process, the students stated that they became aware of using the language effectively. It might be said that the project the students prepared and presented in front of an audience at the end of the process was influential in this awareness. S5: "Asik Veysel project: "... Emphasis, and tones work well but I guess it requires talent. X teacher especially wanted it. " S8: "In the showroom I was excited. My voice was trembling. When I start to explain our project my excitement has passed."

*Problem solving/Logical thinking skills:* At the beginning of the process, the students pointed out that those skills were limited to problems about daily life and numerical courses, that they could use those skills in the case of concrete problems (such as shopping, simple experiments and maths problems), and that they did not need to/have a desire to use the skills in the solution of more complicated events. S9: *"We are doing research in science classes, I m solving a problem in math lesson but do not deal with problems in the history lesson"* At the end of the process they stated that they tried to use those skills in solving the problems related with their neighbourhood and that along the process (especially while doing research) they made efforts to analyse and interpret the relations. S7: *"From The Sahara desert project" "I think every issue can be studied. If we mark in teams we can solve by examining. We have even solved the problem of water."* The students made interpretations signalling that they were aware of the elements of problem solving process such as examining the variables related with a situation, questioning, and interpreting the problems. S2: from "the bees help us for cleaning mines project" sheet *"Our experiment continues. I think the results of observations support our hypothesis. "*

*Skills of computer using:* At the beginning of the process, the students' involvement with computers was limited to playing games, listening to music and writing papers. S2: *"Computer teacher must help us get used to powerpoint. I cannot use it very well"* , S11: *"I'm using the computer. But I do not know how it gets in the project."* The students thought they had general knowledge of computers but they did not consider it sufficient at the beginning of the process; whereas at the end of the process they stated that they tried to be conscious computer users, they used the internet in line with a purpose, they were able to prepare presentations on computer, and that they used computers more often for research purposes. S11: from The Speaking of the map project. *"... Without a computer project would not be so effective."* S12: *My school web page project: "... page appeared and began to go more and more like I learned ASP."* S2: *"Well. I think I am quite good at using powerpoint."*

*Being able to perform scientific study:* At the beginning, the students thought that scientific study could only be done in science. However, at the end of the process they pointed out that scientific study could be done in any course/topic that they were interested in. In the same vein, it was found at the beginning of the process that the course load affected students' desire for research in a negative way; but at the end of the process they believed they found scientific study fun if they studied systematically, and they said they wanted to

allocate more time to that. S6: *“History, music, physics, all of them can be studied. There are many issues to research.”* Besides, at the end of the process, it was noteworthy that they were willing to participate in scientific institutions and competitions with their projects. S2: *We participate in research project competitions and I hope we will get a degree.”*

## 2.2 Findings Obtained Through Interviews with Teachers

*Establishing conceptual associations:* At the beginning of the process the teachers pointed out that the level of students’ perception was insufficient in establishing associations between topics learnt, and that it would be difficult to instil the skill in students in secondary education. T4: *“Lycee is early for this kind of work I think. Except University entrance exam they are not interested in anything”* T6: *They cannot establish a connection between lesson topics.”* This view of teachers’ changed at the end of the process, and they began to think that establishing conceptual relations could be considered a basic skill. They also pointed out that giving examples from day to day life would be useful to facilitate it. T3: *“Information is not disconnected from each other in life. I think students should learn to establish this link at an early age.”*

*Transferring what has been learnt:* The teachers were observed to hold similar views at the beginning and end of the process. T3: *“There should be more transition, between lessons and issues. We need a guide or curriculum to create connections”* They emphasised that efficient learning activities should be prepared and that students should be provided with the skill of analysing and interpreting the knowledge.

*The skill of using language effectively (self-expression):* In interviews at the beginning of the process, the teachers said that families and neighbourhood were influential in language skills and that they made efforts to instil this skill in students in their classes. And at the end of the process they emphasised that they must follow students’ interests closely to ensure the development of those skills, those skills must be included in the objectives of all the courses, and that linguistic skills might be improved through various activities. T4: *“University entrance exam is blocking those skills. Students just spend their time answering questions. Activities such as project or theatre to improve their language skills are seen as a waste of time. During these projects they notice that they really improved themselves”*

*Problem solving/Logical thinking skills:* At the beginning of the process the teachers pointed out that problem solving and logical thinking skills were necessary for personal development, most children were affected by various stimulants in our time and thus problem solving became more important. At the end of the process, they stated that the experiences out of school affected the

students' personal development, but that the skills might be provided through in-school activities, especially with project work. T3: *"..scientific products are formed by students. It is really important. They learned how to create and test their hypotheses, they learned to set a problem"* T5: *Some projects require much effort and abstraction skills ...and they did."*

*Skills of computer using:* In relation to the skills of computer using the teachers said that the process brought about positive changes in the students. They also stated that they were insufficient in such skills and that they needed in-service training in that matter.

*Scientific study skills:* At the beginning and end of the process, the teachers' views on scientific study skills concentrated on the Centre for Student Selection and Placement (ÖSYM, the centre which selects and places students into higher education in Turkey). T1: *"Because of the exam, nothing else interests them and this exam does not measure the skills of scientific skills"* T3: *"We must evaluate what they have learned in their work practice... not only test their knowledge"* The teachers believed that scientific study skills were necessary but the current system of education did not encourage students to do scientific study. However, following the application, they said that the students were more willing to prepare projects, and that introducing the projects they had prepared to the society encouraged both the teachers and the students and their families. T5: *"If they do not have test anxiety they will more successful as these projects"*

### *2.3. Findings that were obtained from the Questionnaire which were done the teachers who participated in the application.*

Survey research has been applied participating teachers (N=15) and other teachers (N=40) before the application. Accordingly, 61% of the teachers thought that the students could not use what they had learnt in a course in a different course; 56% said they could not arrange the curriculum according to students' needs, 53% said the curriculum did not facilitate students to acquire knowledge related to the neighbourhood in which students lived, 69% stated that the topics available in the curriculum did not complement each other conceptually.

In a similar vein, the teachers' knowledge about interdisciplinary applications was also insufficient. For instance, to the question of "should the topics about different courses be integrated within the process or at the end of the process?" 69% said that they should be integrated at the end. However, interdisciplinary teaching applications should be spread into the whole of learning process, and they should be explained to students as learning objectives and interdisciplinary skills to be used from the very beginning of teaching.

The objectives of interdisciplinary teaching should also be of the type students are likely to encounter in real life and they should also be up to date. However, 67% of the teachers said they could not arrange activities to make students think about social activities and cultural differences; 50% of the teachers stated that while preparing daily lesson plans they did not allocate place for activities related with different courses. Moreover, it may also be said that teachers do not make efforts to provide students with basic skills to use in all fields of learning. For instance, 61% of the teachers said that they did not consider students' gaining universal behaviour forms (map reading skills, skills of using symbols of various field, etc.) important, 39% said they could not teach students the knowledge to help them find solutions to the problems they were probable to face in real life, 53% said they could not include activities in their lessons activities to develop problem solving skills, 47% said they did not give students multi-component problems and ask for solutions. Skills compatible with interdisciplinary objectives should be facilitated to students through activities within the process. The activities must be related to various fields and be up to date.

Besides, teachers are disqualified in inter-group cooperation, which forms the backbone of interdisciplinary teaching. To the question "do you cooperate with other teachers in terms of teaching the courses?" 64% answered negatively. In a similar vein, to the question "do you think shared evaluation concerning the course programme you apply should be made together with teachers of other groups?" 72% gave negative answers.

Additionally, arrangements for educational environment (such as aids, equipment, teaching materials) needed in interdisciplinary teaching applications are also thought to be insufficient. For instance 64% of the teachers think that the course books they are teaching are insufficient in integrating knowledge of differing fields into daily life; 75% said they could not supply classroom library with books through which students could reach knowledge of various fields.

Teachers were found not to be able to use evaluation methods compatible with the interdisciplinary teaching approach. A close examination of responses given to the questions showed that to the question "do you make evaluations apart from exams (oral, written, short-answer, multiple-choice etc.)?" 58% of the teachers gave negative answers. In a similar way, to the question "are you able to make evaluations containing all the processes of learning?" 64%, to the question "do you enable students to do self-assessment?" 50% gave a no answer. In addition to that, it is also believed that "evaluations made do not contain knowledge and skills that students can transfer into daily life". For example, 56% of the teachers gave negative answers to the question "are you able to evaluate what your students have learnt in an environment very similar to real life circumstances?" Besides, 69% said that they could not "give their students

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opportunities to transfer knowledge of different disciplines (courses)” in their evaluation. And to the question “do you discuss with your students after examinations how they feel mentally, emotionally and socially during the exam?” 47% of the teachers gave negative answers.

#### 2.4 Findings Obtained from Interviews with Parents

At the end of the process the parents stated that the students' language using skills had improved, they made more successful presentations, they learnt to use the time correctly, they began to see computers as learning instruments, their group work skills as well as computer using skills developed, they became more willing to participate in project work and other activities in school, and they were making efforts to discover and share original thoughts.

#### Discussion and Conclusion

The conclusions reached in this research are summarised as in what follows:

1. According to research results, interdisciplinary teaching approach which was supported by project based learning affected the students' logical thinking skills in a positive way. The logical thinking pre-test and post-test results showed that interdisciplinary teaching approach which was supported by project based learning stimulated the process of students' processing the knowledge and thus they could use such properties as making logical inferences, understanding hypotheses, interpreting and analysing the data which enabled scientific thinking.
2. In general, the teachers, students and parents stated positive views on the effectiveness of the process. The teachers and students said that the application developed such skills as "*establishing conceptual associations between the learnt knowledge, transferring what has been learnt, problem-solving and logical thinking, using the language effectively, using the computer effectively, and doing scientific study*" in students. The parents also held similar views.
3. According to the findings, the teachers thought that the currently used educational programmes should be made more flexible. The teachers' negative views concerning the project work in which interdisciplinary teaching approach may be applied stemmed from the structure of the programmes. The teachers stated that they were in a hurry to cover the topics of teaching according to the programme. Besides the teachers needed to be informed of the application in greater detail.
4. It became clear in the research that teachers do not know much about the teaching of topics outside their field, that cooperation between teacher groups was not adequate, and that the application changed the points of view concerning the process of evaluation in a positive way.

5. It was observed in the research that the students were willing to do research in different topic fields, that they liked preparing projects and presenting them in front of an audience, that they did not have difficulty in determining the topic of projects, but that they had difficulty in bringing the data obtained together.

The research done by Yalçın and Yıldırım (1998) emphasises the positive learning environment occurring in the process of interdisciplinary teaching application. Kleiman (1991) suggests that projects prepared by students should be put into practice in order for mathematics teaching to be successful. In a similar vein, Aschbacher (1992) consults students', teachers', managers' experts' and parents' opinions following the application of interdisciplinary teaching approach, and reaches positive conclusions about the effects of the approach on students. And in the study performed by Gardner and Boix (1994), different disciplines were used in combination, and it was concluded that it brought about positive consequences in students in terms of comprehending the whole and seeing the relations.

In research conducted by Demir (2008), fourth grade courses of Science and Technology, Mathematics, Social Sciences, and Turkish Language in primary education were integrated under the theme of "energy". The curricula of those courses were applied through traditional educational cases in the control group, and they were applied through integrated curriculum in the experimental groups. The curricula were applied through traditional educational cases in the first experimental group, through Jigsaw II- a learning technique based on cooperation in the second experimental group, and through project based learning activities in the third experimental group. The research findings demonstrate that applying integrated curricula in combination with cooperation based learning techniques and project based learning approach generates efficient results in terms of academic achievement, self-reliance, and students' sensorial and social development. Do an (1993) in Science, Budak (2000) in Foreign Language, and Dervi o lu and Soran (2003) in Biology obtained positive results in relation to the applicability of interdisciplinary teaching approach.

Parallel to previous literature, the research results show that well-planned interdisciplinary teaching activities supported by project based learning affect cognitive and sensorial learning products in a positive way. Therefore, in order for programmes to be flexible and dynamic in structure, teachers of various disciplines fields must be able to do team work and scientific study skills must be emphasised more often in classes. Apart from that, there should be more relation between the other courses and they must be made more up to date and functional. In this research, most students stated at the beginning of the process that they did not know much about setting up relations between courses and that they

experienced problems of making sense of the whole of what was learnt at school – which was a consequence of the fact that courses were independent of one another. And at the end of the process, it was noteworthy that student made efforts to relate between basic sciences at least and that they regarded this case as a way facilitating learning. Secondary education students in particular will be advantageous in the rest of their lives and in preparing for the next stage by using what they have learnt at school.

Students use technology actively in daily life. Transferring and using their technological skills and knowledge into school learning might be facilitated through interdisciplinary activities. In order for programmes to be flexible and dynamic in structure, teachers of differing fields must be able to do team work and scientific study skills must be emphasised more often in classes. The group work performed by teachers in schools should not remain on paper, but should be put into practice, and working with different groups should be encouraged because this will enable interdisciplinary teaching applications. This, in turn, may enable teachers to do joint work on how to relate courses setting out from one or more disciplines and on how to form blocks. Teachers must be informed of interdisciplinary teaching approach and in-service training activities must be held. Considering that the new programmes are re-structured with interdisciplinary thoughts, teachers must possess the skills and competencies needed for those programmes to be more effective.

Interdisciplinary teaching should gain more importance in application as an approach to develop students' skills of curiosity, research, discovery, associating, synthesis, and concluding. In this context, the renewed primary education programmes have undergone significant changes in terms of relating within the course and with other courses and sub-disciplines. However, the extent to which the changes have been adopted by teachers- appliers of the programme- is an issue of further research.

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