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FIBONACCI SPIRAL IN SUNFLOWER WITH GEOGEBRA

Çiğdem Erol
Istanbul University, Department of Informatics
Istanbul, TURKEY
cigdems@istanbul.edu.tr

Şebnem Özdemir
Istanbul University, Department of Informatics
Istanbul, TURKEY
zsozdemir@istanbul.edu.tr

Zeki Özen
Istanbul University, Department of Informatics
Istanbul, TURKEY
zekiozen@istanbul.edu.tr

Emre Akadal
Istanbul University, Department of Informatics
Istanbul, TURKEY
emreakadal@gmail.com

Zerrin Ayvaz Reis
Istanbul University, Faculty of Education
Istanbul, TURKEY
ayvazzer@istanbul.edu.tr

Abstract

Mathematics, one of the ancient occupations through the history of humanity, is accepted as a discipline where abstract concepts are predominant and which contains generalities. When evaluated from the point of perception of abstract concepts and working with such concepts, it becomes evident that certain difficulties are experienced during learning and teaching process. One of methods used to overcome such difficulties is to correlate with everyday life and to present samples from real life to the individual. By this means, mathematical concepts can be materialised and lasting learning can be achieved. Even if we are not aware, almost every object or incident around us has a mathematical basis and a relation with mathematics. One of the most express examples to this relation is the Fibonacci numbers, observed in the order of plants, flowers, their leaves even their seed in the nature. This study includes the demonstration the compliance of relation between biology and mathematics, the order of seeds in the sunflower receptacle with the field of mathematics, taking the interdisciplinary study as basis, using Geogebra, one of the information technology tools developed for the field of mathematics and the evaluation of this practice developed by prospective teachers. Herewith it is aimed to emphasise the importance of interdisciplinary studies. In this study, the opinions of prospective biology and mathematics teachers are obtained and consequently it has been found out that they have positive opinion on the establishment of interdisciplinary relation. Furthermore, although it is not nominated as the main research question, it is understood that the information technology tools cannot be used only for materialisation of mathematics but also for establishment interdisciplinary relation.

Key Words: Fibonacci, Geogebra, Biology Education, Mathematics Education, Interdisciplinary Approach.

INTRODUCTION

The world we live in has always been a subject of curiosity for us. As such interest scaled up, our desire to explore the world and learn more about it increased accordingly. For us, as individuals, not only the world, but also our everyday needs and desire to satisfy such needs constitute factor increasing our motivation to learn. As regards to training and education concepts, such motivation has an important place regarding the interest of a student in the course and his/her achievement therein. When considered from this point of view, the math course is acknowledged as one of the disciplines, where problems are confronted during the learning and teaching process (Gersten, R.. et al., 2005; Keçeci, 2011).

Problems encountered in math course are listed, from the students' point of view, as perception of abstract concepts and some difficulties arising out of working with such concepts, during the course of learning process. (Umay, 1996; Zafran, 2010). From the teachers' point of view, it is defined as a course being difficult to teach (Cornelius, 1982; Hodgen, Askew, 2011). The student, who considers mathematics as a course which is unsympathetic, unattractive, needs to be memorised, is boring and contains long algebraic operations, refrains from learning and becomes biased (Ersoy, 1999; Baki, 2006).

Similar to the bias for math course, Gül and Yeşilyurt (2010) stated, regarding biology course, that with various studies they observed that biology is the leading course where the students have the greatest challenge, they fail and have difficulty to comprehend (Chuang and Cheng, 2003; Staeck, 1995; Yeşilyurt and Gül, 2008) and expressed that the students' attitudes may be influential on such problems encountered (Chuang and Cheng, 2003; Mutlu, 2006; Telli and Çakıroğlu, 2002). The studies indicate that the students' scores obtained for biology questions which have an important share, which is 7%, among the questions of university entry exam are at low level (Atav and Morgil, 1999), in other words it is observed that the students fail to attain sufficient level of success for biology course in university entry exam (Ekici and Hevedanlı, 2010).

All innovations of today's technology can be utilised to overcome the difficulties experienced in biology as well as mathematics. So much, according to Nicoll and Harrison (2003), it is possible to utilise the information technologies when attempting to overcome the difficulties in math education. Similarly, as regards to biology and science lectures where biology concepts are used predominantly, designing computer-aided teaching programs ensures that the students learn scientific concepts and opinions, which are hard to comprehend, more easily, as expressed by Taş et al. (2006) (Gorsky and Finegold, 1992). As to be seen, development and use of teaching activities, which would stimulate students' visual and intellectual systems, is quite important when teaching with abstract and hard-to-understand concepts (Ertepınar et al., 1998; Taş et al., 2006).

Several researchers have found out that the use of information technologies during presentation either biology or math concepts to students will considerably improve the achievement (Ferguson and Chapman, 1993; Akdeniz and Yiğit, 2001; Taş et al., 2006, Ayvaz Reis and Özdemir, 2010).

Further to referring to information technologies when during the teaching process of concepts, which lead to bias for the students, teaching approaches triggering the student's curiosity and eagerness for learning can also be employed. One of such teaching approaches is the interdisciplinary approach. The interdisciplinary approach, taking a certain concept or theme as basis, aims to enable the student to treat such concept from different points of view (Jacobs, 1989; Yıldırım, 1996). When construed from this perspective, the concept of "interdisciplinary" can be defined as the interaction between two or more disciplines (Moran, 2010) while it can be expressed as combining, and presentation, of traditional subject area around certain concepts in a significant manner also (Yıldırım, 1996).

In this study, the relation between mathematics and biology and the type of changes in opinion of the student it would lead has been explored, taking the interdisciplinary approach as basis and using an information technology (IT) tool. To this end, the relation between biology and mathematics is presented through sunflower, which is a sample from the real world. Main reason choosing sunflower is arising from its use as

example for various cases in biology and math coursees and the fact that it contains a mathematical mystery.

The existence of a mathematical rule is observed at the growth curve or physical appearance of many plants in the real world. The most frequently observed one among such mathematical rules is the golden ratio concept, also defined as a mathematical mystery, expressed via Fibonacci numbers. (Zheng and Wang, 2009). Each spiral of the sunflower plant indicates the existence of Fibonacci numbers, according to the number of seeds arranged outwards from centre (Boeyens, 2003).

METHOD

Pre-test – post-test method, one of the quantitative survey techniques, is used in this study, attempting to demonstrate the relation between mathematics and science course by means of Geogebra, an IT tools. The study group consists of students at Istanbul University, Hasan Ali Yücel Faculty of Education, Department of Elementary Education, Mathematics and Science Education, spring semester of academic year 2011-2012. Totally 54 students, 32 from Department of Mathematics Education and 22 from Department of Science, took place in the study.

First of all, a survey was conducted to take the opinions of the students on mathematics, science, relation established with everyday life, interdisciplinary relation, IT and the contribution of IT to interdisciplinary relation. First part of the survey, consisting of two parts, includes 13 questions on demographic data, computer and e-mail possession, membership to social media while second part has 53 questions of five point likert type.

In this study, it was decided to utilise sunflower plant to exemplify the relation between mathematics and science. For that purpose, a video (URL) is prepared containing the examples supporting the aforesaid relation. In a similar way, the sunflower is modelled by the researchers using Geogebra. Following the pre-test applied to the mathematics and science education students separately, they watched the video film about everyday life, relation between science and mathematics, mentioning the sunflower. Immediately after the video film, the geogebrical presentation emphasising the Fibonacci arrays of sunflower was shown. After the presentation of the chosen and prepared materials, the survey, containing the same questions posed to the study group, was conducted as post-test in order to discover whether or not there is a change in the students' behaviours.

Analysis of the data obtained was made applying independent t-test, by means of SPSS 18.0 program.

FINDINGS

The opinions of the students on establishing interdisciplinary relation, obtained through 53 questions included in the survey, are discussed under headings defined for establishing relation between everyday life and all disciplines, mathematics and everyday life, mathematics and other disciplines, IT and mathematics, IT and biology, IT and all disciplines, everyday life, IT, mathematics and biology. In this context, in accordance with the data obtained from pre-test and post-test indicate it has been found out that the opinions of mathematics and science education students was changed positively, compared to pre-test. Research results are given together with the result representing the group, as the evaluation of question group (Table 1-9).

In line with the data obtained, it is attempted to comment on establishing relation between everyday life and all disciplines. Table 1 shows the analysis of pre-test and post-test results of the mathematics and science education students regarding the establishment relation between everyday life and all disciplines, on group basis and independent from the group.

Table 1: Analysis of pre-test and post-test results of the mathematics and science education students regarding the establishment of relation between everyday life and all disciplines (MES: Mathematics Education Students, SES: Science Education Students).

	Groups	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Pre Test – Post Test		54	-,759	,845	,115	-6,600	53	,000
Pre-Test	MES	32	3,75	,718	,127	-1,188	52	,240
	SES	22	4,00	,816	,174			
Post-Test	MES	32	4,50	,622	,110	-1,907	51,995	,062
	SES	22	4,77	,429	,091			

As regards to establishment relation between everyday life and disciplines, statistically significant difference ($p<0.05$) is observed between the pre-test and post-test results of study group. The examination of average value of pre-test and post-test results reveals that the opinion about the probability that everyday life and all disciplines may be correlated with each other showed positive increase, independent from the group. However, at the examination of the same opinion on group basis, it is understood that there is no statistically significant difference between the groups. At this point, it is understood that mathematics and science education students equally believe in the necessity to correlate everyday life and any discipline and the difference of discipline is not determinant at this point (Table 1).

Table 2 shows the analysis of pre-test and post-test results of the mathematics and science education students regarding the establishment of relation between everyday life and mathematics discipline, on group basis and independent from the group.

Table 2: Analysis of results regarding the establishment of relation between everyday life and mathematics discipline (MES: mathematics Education Students, SES: Science Education Students)

	Groups	N	Mean	Std. Deviation	Std. Error Mean	T	df	Sig. (2-tailed)
Pre Test – Post Test		54	-,593	,659	,090	-6,605	53	,000
Pre-Test	MES	32	4,06	,669	,118	,097	52	,923
	SES	22	4,05	,575	,123			
Post-Test	MES	32	4,66	,545	,096	,137	52	,892
	SES	22	4,64	,492	,105			

As regards to establishment relation between everyday life and mathematics discipline, statistically significant difference ($p<0.05$) is observed between the pre-test and post-test results of study group. The examination of average value of pre-test and post-test results reveals that the opinion about the establishment of relation between everyday life and mathematics discipline showed positive increase, independent from the group. However, at the examination of the same opinion on group basis, it is understood that there is no statistically significant difference between the groups. At this point, it is understood that the pre-serve teachers in the study group, either mathematics education students or science education students, believe in the necessity to correlate everyday life and mathematics discipline (Table 2).

Table 3 shows the analysis of pre-test and post-test results of the mathematics and science education students regarding the establishment of relation between mathematics and other disciplines, on group basis and independent from the group.

Table 3: Analysis of results regarding the establishment of relation between mathematics and other disciplines (MES: Mathematics Education Students, SES: Science Education Students)

	Groups	N	Mean	Std. Deviation	Std. Error Mean	T	df	Sig. (2-tailed)
Pre Test – Post Test		54	-,630	,808	,110	-5,727	53	,000
Pre-Test	MES	32	3,97	,695	,123	-,593	52	,556
	SES	22	4,09	,811	,173			
Post-Test	MES	32	4,59	,712	,126	-,840	51,801	,405
	SES	22	4,73	,456	,097			

As regards to establishment relation between mathematics and other disciplines, statistically significant difference ($p<0.05$) is observed between the pre-test and post-test results of study group. The examination of average value of pre-test and post-test results reveals that the opinion about the establishment of relation between everyday life and mathematics discipline showed positive increase, independent from the group. However, at the examination of the same opinion on group basis, it is understood that there is no statistically significant difference between the groups. At this point, it is understood that the prospective teachers in the study group, either mathematics education students or science education students, equally believe in the necessity to correlate everyday life and mathematics discipline (Table 3).

Table 4 shows the analysis of pre-test and post-test results of the mathematics and science education students regarding the utilisation of IT tools for math course, on group basis and independent from the group.

Table 4: Analysis of results regarding the utilisation of IT tools for math course (MES: Mathematics Education Students, SES: Science Education Students)

	Groups	N	Mean	Std. Deviation	Std. Error Mean	T	df	Sig. (2-tailed)
Pre Test – Post Test		53	-,604	,716	,098	-6,137	52	,000
Pre-Test	MES	32	3,88	,793	,140	-1,203	51	,235
	SES	21	4,14	,793	,173			
Post-Test	MES	32	4,53	,621	,110	-,798	51	,429
	SES	21	4,67	,577	,126			

As regards to utilisation of IT tools for math course, statistically significant difference ($p<0.05$) is observed between the pre-test and post-test results of study group. The examination of average value of pre-test and post-test results reveals that the opinion about the utilisation of IT tools for math course showed positive increase, independent from the group. However, at the examination of the same opinion on group basis, it is understood that there is no statistically significant difference between the groups. At this point, it is understood that the mathematics and science education students equally believe in the necessity to correlate everyday life and mathematics discipline (Table 4).

Table 5 shows the analysis of pre-test and post-test results of the mathematics and science education students regarding the positive effect of utilisation of IT tools on math course, in relation to the establishment of relation between everyday life, mathematics and biology, on group basis and independent from the group.

Table 5: Analysis of results regarding the positive effect of utilisation of IT tools on math course, in relation to the establishment of relation between everyday life, mathematics and biology (MES: Mathematics Education Students, SES: Science Education Students)

	Groups	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Pre Test – Post Test		53	-,755	,806	,111	-6,814	52	,000
Pre-Test	MES	32	3,78	,870	,154	-1,190	51	,240
	SES	21	4,05	,669	,146			
Post-Test	MES	32	4,63	,554	,098	-,264	51	,793
	SES	21	4,67	,577	,126			

As regards to the positive effect of utilisation of IT tools on math course, in relation to the establishment of relation between everyday life, mathematics and biology, statistically significant difference ($p<0.05$) is observed between the pre-test and post-test results of study group. The examination of average value of pre-test and post-test results reveals that the said opinion showed positive increase, independent from the group. However, at the examination of the same opinion on group basis, it is understood that there is no statistically significant difference between the groups. At this point, it is understood that the mathematics and science education students equally believe in the necessity to utilise IT tools in relation to the establishment of relation between everyday life, mathematics and biology (Table 5).

Table 6 shows the analysis of pre-test and post-test results of the mathematics and science education students regarding the positive effect of utilisation of IT tools on biology course, in relation to the establishment of relation between everyday life, mathematics and biology, on group basis and independent from the group.

Table 6: Analysis of results regarding the positive effect of utilisation of IT tools on biology course, in relation to the establishment of relation between everyday life, mathematics and biology (MES: Mathematics Education Students, SES: Science Education Students)

	Groups	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Pre Test – Post Test		53	-,679	,701	,096	-7,055	52	,000
Pre-Test	MES	32	3,84	,677	,120	-1,429	51	,159
	SES	21	4,10	,539	,118			
Post-Test	MES	32	4,59	,560	,099	-,489	51	,627
	SES	21	4,67	,483	,105			

As regards to the positive effect of utilisation of IT tools on biology course, in relation to the establishment of relation between everyday life, mathematics and biology, statistically significant difference ($p<0.05$) is observed between the pre-test and post-test results of study group. The examination of average value of pre-test and post-test results reveals that the said opinion showed positive increase, independent from the group. However, at the examination of the same opinion on group basis, it is understood that there is no statistically significant difference between the groups. At this point, it is understood that the mathematics and science education students equally believe in the necessity to utilise IT tools in relation to the establishment of relation between everyday life, mathematics and biology (Table 6).

Table 7 shows the analysis of pre-test and post-test results of the mathematics and science education students regarding the utilisation of IT tools for all disciplines, on group basis and independent from the group.

Table 7: Analysis of results regarding the utilisation of IT tools for all disciplines (MES: Mathematics Education Students, SES: Science Education Students)

	Groups	N	Mean	Std. Deviation	Std. Error Mean	t	df	Sig. (2-tailed)
Pre Test – Post Test		53	-,642	,736	,101	-6,343	52	,000
Pre-Test	MES	32	4,03	,695	,123	-,823	51	,414
	SES	21	4,19	,680	,148			
Post-Test	MES	32	4,72	,457	,081	-,342	51	,734
	SES	21	4,76	,436	,095			

As regards to the utilisation of IT tools for all disciplines, statistically significant difference ($p<0.05$) is observed between the pre-test and post-test results of study group. The examination of average value of pre-test and post-test results reveals that the said opinion showed positive increase, independent from the group. However, at the examination of the same opinion on group basis, it is understood that there is no statistically significant difference between the groups. At this point, it is understood that the mathematics and science education students equally believe in the utilisation of IT tools for all disciplines (Table 7).

Table 8 shows the analysis of pre-test and post-test results of the mathematics and science education students regarding the utilisation of IT tools for biology course, on group basis and independent from the group.

Table 8: Analysis of results regarding the utilisation of IT tools for biology course (MES: Mathematics Education Students, SES: Science Education Students).

	Groups	N	Mean	Std. Deviation	Std. Error Mean	T	df	Sig. (2-tailed)
Pre Test – Post Test		53	-,415	,719	,099	-4,204	52	,000
Pre-Test	MES	32	4,13	,660	,117	-1,496	51	,141
	SES	21	4,43	,811	,177			
Post-Test	MES	32	4,59	,615	,109	-,1,164	50,622	,250
	SES	21	4,76	,436	,095			

As regards to utilisation of IT tools for biology course, statistically significant difference ($p<0.05$) is observed between the pre-test and post-test results of study group. The examination of average value of pre-test and post-test results reveals that the said opinion showed positive increase, independent from the group. However, at the examination of the same opinion on group basis, it is understood that there is no statistically significant difference between the groups. At this point, it is understood that the mathematics and science education students equally believe in the utilisation of IT tools for biology (Table 8).

Table 9 shows the analysis of pre-test and post-test results of the mathematics and science education students regarding the opinion “Teaching a course by establishing interdisciplinary relation promotes learning”, on group basis and independent from the group.

Table 9: Analysis of results regarding the opinion "Teaching a course by establishing interdisciplinary relation promotes learning" (MES: Mathematics Education Students, SES: Science Education Students).

	Groups	N	Mean	Std. Deviation	Std. Error Mean	T	df	Sig. (2-tailed)
Pre Test – Post Test		53	-,340	,586	,081	-4,216	52	,000
Pre-Test	MES	32	4,28	,581	,103	-1,178	51	,244
	SES	21	4,48	,602	,131			
Post-Test	MES	32	4,66	,483	,085	-,809	51	,422
	SES	21	4,76	,436	,095			

As regards to the opinion "Teaching a course by establishing interdisciplinary relation promotes learning", statistically significant difference ($p<0.05$) is observed between the pre-test and post-test results of study group. The examination of average value of pre-test and post-test results reveals that the said opinion showed positive increase, independent from the group. However, at the examination of the same opinion on group basis, it is understood that there is no statistically significant difference between the groups. At this point, it is understood that the mathematics and science education students equally believe in the opinion "Teaching a course by establishing interdisciplinary relation promotes learning" (Table 9).

DISCUSSION AND CONCLUSION

Mathematics, when considered from the viewpoint of teachers and students, is recognised as a course where the parties encounter difficulties within the course of learning and teaching process. Efforts made to overcome such difficulties comprise various teaching approaches, material designs and presentation of abstract concepts through materialisation and supporting with examples. Main objective for performing all such studies is to convert the student's negative attitude into positive and to improve the interest in course.

At the literature review, studies were found stating that difficulties are experienced also in biology course, which are equivalent to those emerging in math course. From this viewpoint, the effort to create student's interest and positive attitude becomes applicable also for biology course and science course, its extension in elementary school.

In this study, a material is designed to bring positive opinion to both coursees, using one of the IT tools, namely Geogebra. By using this material, which can be presented for both biology and math coursees in conformity with the interdisciplinary approach, it is endeavoured to add a different line of vision to prospective elementary mathematics and biology teachers. Through surveys made before and after presentation of the video film, with the content to support the material and the idea of interdisciplinary approach it comprises, the way of perception of the concepts "Everyday life and courses", "Everyday life and math course", "math and biology coursees", "Everyday life, math and biology coursees" by the study group and their way of evaluation of the effects of IT tools on said relations.

As conclusion of the study, it is identified that both prospective mathematics and science teachers have positive opinion regarding the establishment of interdisciplinary relations and that such positive opinion was improved after observing a model application in the course of study. Information technology tolls are regarded by prospective mathematic and biology teachers as an important tool, to serve as a bridge, for the purpose of establishing interdisciplinary relation. Consequently, supporting interdisciplinary studies with information technology tolls is of importance with regards to present interdisciplinary relation and to visualise it perceptibly, beyond being of abstract nature.

According to findings of the research; there is statistically significant difference in the positive attitudes of both mathematics and science pre-service teachers between pre and posttest. The positive attitudes of working

group increased after the application, which was prepared with IT tools. Mathematics and science pre-service teachers differently reacted to geogebric representation of sunflower's receptacle. According to observation of that reaction,

- The Mathematics pre-service teachers respectively realized the point sets, the golden ratio, fibonacci numbers and finally realized the sun flower
- The science pre-service teachers firstly thought as a meaningless figure and then they realized to sunflower's receptacle. Finally they realized to point sets.

As it is seen in those reactions, both students of those disciplines had enough concepts to find that relationship. Besides they had not any opinions about how to build that relationship.

The interdisciplinary approach is important in order to build relationships between courses/subjects/concepts, and to analyze them with different perspective. It is also important for multi-dimensional thinking. İn order to present those approach with the support of IT tools, the pre-service teachers, new-generation teachers, should have new visions, such as how to build that relationship, what kind of IT tools should be used. Especially those teachers should also be informed about the learning behavior of the net generations (digital natives). Nowadays, the technologic devices, such as tablet PCs, smart boards, are started to integrate into primary education program. Therefore the courses, such as "educational technologies and material development", "principles and methods of teaching", should be taught with the support of IT tools. It should be also shown that how to use them with which educational approaches and methods.

In this study, the role of IT tools in interdisciplinary approach and the positive attitudes of the pre-service teachers is presented. Consequently the IT tools can be used not only for abstract concepts of mathematics or science, and attracting students but also can be used for building relationship between those courses/subjects/concepts. In this context the IT tools has an important role in order to show that educational process is a whole process.

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REFERENCES

Akdeniz, A. R. & Yiğit, N. (2001). Fen Bilimleri Öğretiminde Bilgisayar (Logo) Destekli Materyallerin Öğrenci Başarısı Üzerine Etkisi: Sürtünme Kuvveti Örneği. *Yeni Binyılın Başında Türkiye'de Fen Bilimleri Eğitimi Sempozyumu, 7-8 Eylül 2001*, Maltepe Üniversitesi, İstanbul.

Atav, E. & Morgil, F. İ. (1999). 1974–1997 yıllarında ÖSYM sınavlarında sorulan biyoloji sorularının değerlendirilmesi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 15: 24–29.

Ayvaz Reis, Z., & Özdemir, Ş. (2010). Using Geogebra As An Information Technology Tool: Parabola Teaching, *World Conference on Learning, Teaching and Administration*, Procedia - Social and Behavioral Sciences, 9: 565-572.

Baki, A. (2006). *Kuramdan uygulamaya matematik eğitimi*. Trabzon: Derya Kitabevi, ISBN 9789758053797.

Boeyens, J. C.A. (2003). Number patterns in Nature. *Crystal Engineering,* 6(4): 167–185.

Chuang, H.F. & Cheng, Y. J. (2003). A study on attitudes toward biology and learning environment of the seventh grade students. *Chinese Journal of Science Education*, 11(2), 171–194.

Cornelius, M.L.(1982).Teaching Mathematics.Britanya Kütüphanesi Basılı Katalog Yayınları, ISBN 0-7099-0714-1.

Ekici, G. & Hevedanlı, M. (2010). Lise Öğrencilerinin Biyoloji Dersine Yönelik Tutumlarının Farklı Değişkenler Açısından İncelenmesi. *Journal of Turkish Science Education*, 7(4), 97 - 109.

Ertepınar, H., Demircioğlu, H., Geban, Ö., & Yavuz, D. (1998). Benzeşme ve Bilgisayarlı Öğretimin Mol Kavramını Anlamaya Etkisi. *III. Ulusal Fen Bilimleri Eğitimi Sempozyumu Bildirileri*, *23-25 Eylül 1998*, KTÜ, Trabzon.

Ferguson, N. H. & Chapman, S. R. (1993). Computer-Assisted Instruction for Introductory Genetics. *Journal of Natural Resources and Life Sciences Education*, 22, 145-152.

Gersten R, Jordan NC, & Flojo JR. (2005). Early Identification and Interventions for Students With Mathematics Difficulties. *Journal of Learning Disabilities*, 38(4), 293-304.

Gül, Ş. & Yeşilyurt, S. (2010). Secondary Education Students' Attitudes Towards Biology And Biology Lesson (Pilot Study). *Mehmet Akif Ersoy Üniversitesi Eğitim Fakültesi Dergisi*, 10(20), 28-47.

Gorsky, P., & Finegold, M. (1992). Using Computer Simulations to Re-Structure Students' Conceptions of Force. *Journal of Computers in Mathematics and Science Teaching*, 11(2), 163-178.

Hodgen, J. & Askew, M. (2011). Emotion, Identity and Teacher Learning: Becoming a Primary Mathematics Teacher. New Understanding of Teacher's Work, Emotions and Educational Change, Ed. Day, C., Lee, C. H. K.. Springer. ISBN: 978-94-007-0544-9.

Jacobs, H. (1989). *Interdisciplinary Curriculum: Design and Implementation.* Alexandria: Association for Supervision and Curriculum Development.

Keçeci, T. (2011). Matematik kaygısı ve korkusu ile mücadele yolları. *2nd International Conference on New Trends in Education and Their Implications* (ICONTE), pp 55-64.

Moran, J. (2010). *Interdisciplinarity*. Second edition, New York: Routledge. ISBN: 0-203-86618-5. Pg.14

Mutlu, M. (2006). The relation between the learning styles of the students in Anatolian high schools, Anatolian teachers' high schools science high schools and their attitudes towards biology course. *International Journal of Environmental and Science Education*, 1(2), 148–162.

Nicoll, K., & Harrison, R. (2003). Constructing the good teacher in higher education: The discursive work of standards, *Süregelen Eğitimde Çalışmalar Dergisi,* 25(1), 23–35. DOI:10.1080/01580370309289.

Staeck, L. (1995). Perspectives for biological education-challenge for biology instruction at the and of the 20th century. Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 11, 29-35.

Taş, E., Köse, S., & Çepni S. (2006). The Effects of Computer-Assisted Instruction Material on Understanding Photosynthesis Subject. *Internatinal Journal of Environmental and Science Education*, 1(2), 163-171.

Telli, S. & Çakıroğlu, J. (2002). Biyoloji sınıfındaki öğrenme ortamının öğrencilerin biyolojiye yönelik tutumlarına etkisi. *V. Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi*, *16-18 Eylül 2002*, ODTÜ Kültür ve Kongre Merkezi, Ankara.

Umay, A. (1996). Matematik eğitimi ve ölçülmesi. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 12: 145-149.

URL, Nature by Numbers, http://www.youtube.com/watch?v=kkGeOWYOFoA&feature=player_embedded [Visited Date: January 18, 12].

Yeşilyurt, S. & Gül, Ş. (2008). Ortaöğretimde daha etkili bir biyoloji öğretimi için öğretmen ve öğrenci beklentileri. *Kastamonu Eğitim Dergisi*, 16(1), 145-162.

Yıldırım, A. (1996). Disiplinler Arası Öğretim Kavramı ve Programlar Açısından Doğurduğu Sonuçlar. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, 12, 89-94.

Zafran, L. (2010). Why Math Tutoring May Not Have the Expected Results, and Why It Is Hard for Students to Catch Up. *America's (Math) Education Crisis*, 151-162. USA ISBN: 978-1-45-361995-7.

Zheng, L., & Wang, G. (2009). Modeling Golden Section in Plants. *Progress in Natural Science*, 19 (2), 255-260, Abstract. ISSN 1002-0071.

APPENDIX

Questionnaire

1. Relation between everyday life and all disciplines can be established.
2. Establishing relation between everyday life and a discipline improves attendance to course.
3. Teaching a course giving examples from everyday life ensures that the course is learned much better.
4. Establishing relation between everyday life and a discipline improves the efficiency of that course.
5. Most remembered examples given in a course are those supported with everyday life.
6. Everyday life and mathematics discipline are correlated.
7. Establishing relation between everyday life and mathematics discipline improves attendance to course.
8. Teaching mathematics by giving examples from everyday life ensures that the course is learned much better
9. Establishing relation between everyday life and mathematics discipline improves the efficiency of the course
10. Most remembered examples given in math course are those supported with everyday life
11. It is possible to establish relation between mathematics and a lot of disciplines
12. Establishing relation between mathematics and other disciplines improves the efficiency of math course
13. Establishing relation between mathematics and other disciplines improves the efficiency of the course
14. Teaching a course by establishing interdisciplinary correlation promotes learning
15. Courses taught by establishing interdisciplinary relation may overcome the bias against the interrelated disciplines
16. During my student days, I liked math course
17. During my student days, I had a bias against math course
18. During my student days, I liked biology course
19. During my student days, I had a bias against biology course
20. The discipline which is most closely related with everyday life is biology
21. In biology course, plenty of examples may be given from everyday life
22. It is possible to establish relation between mathematics and biology disciplines
23. Establishing relation between mathematics and biology disciplines yields a positive effect with regards to math course
24. Establishing relation between mathematics and biology disciplines yields a positive effect with regards to biology course
25. Giving an example from biology course when teaching mathematics improves the interest in course
26. Giving an example from biology course when teaching mathematics arouses the idea for the student that mathematics is correlated with biology
27. Giving an example from math course when teaching biology improves the interest in course
28. Giving an example from math course when teaching biology arouses the idea for the student that biology is correlated with mathematics
29. The triple of mathematics, biology and everyday life can be correlated
30. Teaching course/giving examples by establishing relation between mathematics, everyday life and biology arouses the idea for the student that biology is correlated with mathematics
31. Utilising information technology tools improves attendance to course.

32. Utilising information technology tools ensures that the course is learned much better.
33. Utilising information technology tools improves the efficiency of that course.
34. Utilising information technology tools improves the interest in course
35. Most remembered examples given in a course are those given using information technology tools
36. Utilisation of information technology tools for math course ensures the development of a positive attitude for course
37. Utilising information technology tools for math course improves attendance to course
38. Utilising information technology tools for math course improves the interest in course
39. Utilising information technology tools for math course ensures that the course is learned much better
40. Utilising information technology tools for math course improves the efficiency of that course
41. Utilisation of information technology tools for biology course ensures the development of a positive attitude for course
42. Utilising information technology tools for biology course improves attendance to course
43. Utilising information technology tools for biology course ensures that the course is learned much better
44. Utilising information technology tools for biology course improves the efficiency of that course
45. Utilising information technology tools for biology course improves the interest in course
46. Relation between mathematics, biology and everyday life can be demonstrated using an information technology tool
47. Relation between mathematics, biology and everyday life can be established using an information technology tool
48. Relation established between mathematics, biology and everyday life generates positive effect on math course
49. Relation established between mathematics, biology and everyday life improves the interest in math course
50. Relation established between mathematics, biology and everyday life generates positive effect on biology course
51. Relation established between mathematics, biology and everyday life improves the interest in biology course
52. Interdisciplinary relations can be demonstrated using information technology tools
53. Utilising information technology tools facilitates the establishment of interdisciplinary relation.