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THE EFFECT OF INSTRUCTIONAL METHODS ON THE PERFORMANCE OF THE STUDENTS HAVING DIFFERENT COGNITIVE STYLES

ÖĞRETİM TEKNİKLERİNİN FARKLI BİLİŞSEL STİLLERE SAHİP ÖĞRENCİLERİN BAŞARILARINA OLAN ETKİLERİ

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ABSTRACT: This study reports i) the effect of traditionally designed teaching method and the group work on students' performance in a topic related to biology and, ii) the difference between the performance of students who have field dependent and field independent cognitive styles. Second year science teacher students (N=80) in primary teaching department were participated. Students in the control group (N=40) were given a traditional lecture whereas in the experiment group (N=40) discussion-based group work was adopted. To measure Field dependence/Field Independence, (FD/FI) Group Embedded Figures Test and to measure students' achievement before and after instruction an achievement test were applied. The results showed i) the students in the experiment group showed significantly higher performance than control group students in the achievement test and ii) may be the most importantly, the group work in the experiment group favoured both FD and FI students whereas FI students benefited more than FD students in traditional teaching method in control group.

Keywords: teaching techniques, cognitive styles, student achievement.

ÖZET: Bu çalışma da i) biyoloji ile ilgili bir konuda, geleneksel ve grup çalışmasına dayalı öğretim tekniklerinin, öğrencilerin başarısına etkisi ve ii) alana bağlı/alana bağımsız bilişsel stile sahip öğrencilerin başarıları arasındaki fark rapor edilmiştir. İlköğretim bölümündeki seksen fen öğrencisi çalışmaya katılmıştır. Kontrol grubundaki öğrencilere geleneksel yöntem, deney grubuna da tartışmaya dayalı grup çalışma tekniği uygulanmıştır. Alana bağlı olma/alandan bağımsız olma özelliği Gurup Saklı Şekiller Testi ve öğrencilerin öğretim öncesi ve sonrası başarı düzeylerini ölçmek amacı ile de bir başarı testi uygulanmıştır. Sonuçlar, i) başarı testinde, deney grubundaki öğrencilerin kontrol gurubundaki öğrencilerden anlamlı düzeyde daha yüksek başarı gösterdiğini ve ii) belki de en önemlisi, grup çalışması tekniğinin Alana Bağlı/Alandan bağımsız bilişsel stilinin her ikisini de hitap ettiğini ama geleneksel öğretim yönteminden alandan bağımsız öğrencilerin daha fazla faydalandığını göstermiştir.

Anahtar Sözcükler: öğretim teknikleri, bilişsel stiller, öğrenci başarısı

1. INTRODUCTION

In any teaching, learning or examining situation information is being processed by teachers and students. The teacher tries to present material which he/she understands in a way in which students will also understand. However it is unlikely that anyone can transmit material from his understanding to the understanding of another person intact. The current view is that knowledge has to be *reconstructed* as it passes from one person to another. In this process, the factors such as prior knowledge, cognitive styles, attitudes, teaching styles etc. play an important role.

Cognitive styles:

There are several definitions of the term "cognitive style" in the literature. Messick's (1984) definition of cognitive style as consistent individual differences in preferred ways of organising and processing information and experience has been cited widely. Saracho (1997) indicates that cognitive styles identify the ways individuals react to different situation and they include stable attitudes, preferences, or habitual strategies that distinguish the individual styles of perceiving, remembering, thinking and problem solving.

There are two fundamental cognitive style families: wholist-analytic and verbal-imagery. The verbal-imagery style dimension of cognitive style can be summarised as a dimension of whether an individual is inclined

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to represent information during thinking verbally or in mental pictures. The most prominent style label for wholist-analytic dimension of cognitive styles is field dependence/field independence (FD/FI). FD/FI originated in Witkin's work (Witkin, 1974; Witkin *et al,* 1977; Witkin and Goodenough, 1981). It is extensively studied by several researchers and has had wide application to educational problems. Witkin and Goodenough (1981) describe an individual as field dependent (FD) if he/she has difficulty in separating an item from its context. An individual is field independent (FI) if he/she can easily break up an organised field and separate relevant information from its context or discern 'signal' (what matters) from 'noise' (the incidental and peripheral) in a confusing background (Johnstone and Al-Naeme, 1991). According to Witkin (1974) an analytical/global way of thinking may be the best criterion to differentiate the interests of FD/FI learners. Basically, FI learners perceive and process information analytically, while FD learners do it in a global, holistic and passive way.

In many studies (Al-Naeme, 1991; Johnstone and El-Banna, 1986; Tinajero and Paramo, 1997; Witkin et al., 1977) the correlation between FD/FI and academic performance in science (and in other fields) has been studied. The results indicate that FI students score significantly higher than FD students in most of the academic fields of science. Johnstone and El-Banna (1986) reported that there is significant positive correlation between students' degree of FD/FI and their scores in chemistry examinations. In addition, they indicated that students who are FI perform better than the students who are FD in all groups of working memory capacity. Ziane (1990) pointed out that field dependency was found to play an essential role in students' success; FI physics students obtained higher scores in solving physics problems than the students who have FD cognitive style. Al-Naeme (1991) also indicated that FD/FI cognitive style is very important and may play a crucial role in chemistry mini-projects laboratory problem solving procedures. In another study Tinajero and Paramo (1997) also found that FD/FI is related to the overall achievement and results indicated that FI boys and girls in secondary school level performed better than FD ones in all of the subjects considered.

1.1 The research problems

There is not any study in the literature in Turkey in terms of the effect of FD/FI cognitive style in students' performance related to science disciplines namely, biology, physics and chemistry. In this study it is aimed to explore the effect of FD/FD cognitive styles on the students' performance in a topic related to biology The following research questions are addressed:

1) Is there a difference between the achievement test scores of the students who took traditionally designed instruction (Control group) and discussion-based group technique? (Experiment group)

2) Is there an interaction effects between the instructional techniques and cognitive styles of students?

2. METHOD

2.1 Sample of study

The subjects participated to this research consisted of a total 80 students attending science teaching, in primary teaching department in Abant Izzet Baysal University. The number of girls and boys are almost equal in the sample (37 boys 43 girls).

2.2. Assessment Instruments

Test for FD/FI: Measurement of FD/FI tendencies is assessed by the Road and Frame test, the Body Adjustment Test, and the Group Embedded Figures Test (or it is called Field Dependent/Field Independent test). All of these measures involve the disembedding of a shape from its surrounding field. In this study to

determine students' level of field dependency, Field Dependent/Field Independent test (FD/FI Test) was used. This version of FD/FI test used in this study was devised and calibrated by El-Banna (1987) from Witkin's (1977) original tests material. It includes 20 complex figures, apart from another 2 figures as examples. Simple shapes are located in the last page of the FD/FI test booklet as a specimen of the type to be found. Students were required to recognise and identify a hidden simple shape in each of the set of complex figures and outline it in pen or pencil on the lines of the complex figure. The more sample figures correctly found, the better the student is at this process of separation of a figure from a confusing background and is said to be FI, and vice versa for FD. There is, of course, a continuum between these two extremes and those of intermediate ability are classified as field intermediate (FINT). Students were given 15 minutes to complete the test. Before starting the test, they were briefed about the testing procedure.

A formula was used by the researcher to create the three categories, that is FD, FINT and FI. Several researchers also used the same formula (eg. Alamolhodaei, 1997; Bahar and Hansell, 2000). According to this, students scored more than one-quarter of a standard deviation (SD) above the mean score were classified as FI, while students who scored under one-quarter of a SD below the mean score were classified as FD, and between a score of plus or minus one quarter of a SD around the mean were considered as FINT. In this study, as several researchers done before, the FINT students in the FD/FI tests were neglected so as to expose the extremes.

The version of FD/FI used in this study was also used by several researchers and its validity and reliability had already been established (Alamolhodaei, 1997; Bahar and Hansell, 2000; Johnstone and Al-Naeme, 1991). Also in this study, by using split-half theorem, the reliability of FD/FI test was computed. The reliability coefficient was found to be 0.812 that indicates high reliability of the test.

Achievement test: An achievement test was prepared to assess the degree of students' understanding in the topic "proteins". It contains 20 multiple choice questions in which the response has to be justified. To develop this test, firstly the instructional aims were determined by the researcher and then in the light of the several textbooks and handout that were prepared for the students, the test items were developed by the researcher with three experts in biology and in evaluation. Here is an example:

Question 1. Which of these fertiliser given below is the best for plants?

a) Urea

b) Ammonium nitrate

c) Ammonia

d) Ammonium sulphate

Please give your reasoning (The right choice is b. Partly because the nitrogen is present in two forms- as ammonium ion, and as the nitrate ion. Plants take up Nitrate ion rapidly, the ammonium ion providing a long-term fertiliser)

Both the control and the experiment group students were given the achievement test at the beginning of the instruction session (ie. pre-test) and they were also given the achievement test when the instruction session was completed (post-test). The reliability of the test was found to be 0.75.

The data that was obtained from pre- and post-test was analysed by ANOVA techniques to compare the means of the groups.

2.3 Procedures in the control and in the experiment group

As indicated before, students in the control group were given a lecture in a conventional way. That is, the researcher gave a talk about the information of proteins. This information was the same as the information sheets that were given to the students in the experiment group. The lecture that was given to control group was teacher-based however, students were free to ask any questions that were need to be clarified

about the proteins. Furthermore, during lecture some discussions were occurred between students and the researcher about the topics that were open to discussions.

The instruction method in the experiment group was student-centred. Firstly, the students were randomly grouped as five. One student in each group acted as a chairman. This chairman was chosen from the volunteers among the group. Each of the other four in the group were given a sheet of information related with proteins. All the sheets are different. The task was to share and to discuss this information. Here are the topics covered on the four information sheets:

Sheet A: The nitrogen food cycle; production of Ammonium, Nitrate.

Sheet B: Essential amino acids; balancing protein diets; fertiliser shortages.

Sheet C: Amounts of protein in foods; improving protein quantities.

Sheet D: Protein requirements for humans; new ways to produce proteins; rich and poor countries regarding protein consumption; misuse of proteins in the world.

The information on the sheets was in the form of facts and figures. They were few opinions or suggestions. In group discussions students were required to use these facts and figures to suggest ways of solving the world protein shortage. In each group the following procedures were followed:

1- Fifteen minutes were given for the group to read and to understand the information on their sheets.

2- They worked through the questions listed "Information Questions" (See Appendix 1) and each member of the group gave the answer on his/her information sheet and then the group members shared their ideas with each other. It is necessary to indicate that there is a letter(s) after each question that shows which group member should have the answer (See Appendix 1). After this information questions students in the class were also given a listed "General Questions" (See appendix 2). These questions were open-ended, and students were able to speak freely to state their opinions and share the counter arguments.

3. RESULTS AND DISCUSSIONS

The descriptive statistics of the control and the experiment group in terms of pre- and post-test are given in Table 1.

Table 1. Descriptive statistics about the achievement test scores of the Control and the Experimental Group

		Pre-test		Post-test	
Group	N	$\overline{X}$	S	$\overline{X}$	S
Control	40	1.65	1.03	13.95	2.23
Exp.	40	1.73	0.78	16.27	1.62

X= mean scores S= Standard deviation

As can be seen from Table 1 the achievement test mean scores for both groups were near to each other. The results of ANOVA show no statistically significant difference between pre-test means of the control and the experiment groups ($F=0.135$; $p=0.71$). This indicates that both groups were similar regarding the level of prior knowledge they had about the protein. When it is looked into the results of post-test there is an improvement in the mean scores of both groups. However, the results of analysis show a statistically significant difference between two groups in favour of experiment group ($F=28.5$; $p=0.000$). That is, the students who were applied student-centred discussion-based group work had higher scores in the achievement test than the students who were conventionally taught.

One of the purposes of this study was to find out the possible effects of the instruction method (i.e. conventional teaching and discussion-based group work) on the achievement test scores of students having field dependent or field independent cognitive styles. Table 2 shows the

distribution of FD/FI students in the sample. The distribution of FD/FI students in the control and in the experiment groups and their descriptive statistics are also given in Table 3. As indicated in Method section, the FINT students in the FD/FI tests were neglected so as to expose the extremes.

Table 2. Classifications of the whole sample regarding FD/FINT/FI

	C. Style		
	FD	**FINT**	**FI**
N	33	9	38
%	41.3	11.2	47.5

Table 3. Descriptive statistics for FD/FI in the post-test for the control and the experiment group

	C.Style	N	$\overline{X}$	S
Control gr	FD	14	11.57	1.02
	FI	21	15.48	1.50
Exp. gr	FD	19	16.05	1.39
	FI	17	16.82	1.67

The interaction effects between instructional techniques and cognitive styles were examined by using two-way ANOVA techniques. Summary statistics for this analysis are given in table 4. As can be seen from table 4, there were statistically significant interaction effects between instructional techniques and cognitive styles of students. In other words, FD students in the experiment group where discussion based teaching was applied benefited more than FD students in the control group where conventional teaching method was applied. On the other hand, the students who were field independent appeared to have higher scores in both instructional techniques. As mentioned in introduction, in all studies related to FD/FI cognitive styles and academic performance, FI students appeared to be superior to FD students. In this study, the findings also confirm these studies. However, the mean scores of FD and FI students in the experiment group were not very different. In other words, discussion-based teaching method appeared to give the equal chance to FD as well as FI students. The reason of this result can be explained as follows: when do students approach a mass of information they respond in various ways with a view to making sense of it. During learning a topic or during class session some of the signs are essential to this process and some of them are not important. However, as a novice learner, when students are faced first time with a new topic they think that everything said by teacher is important and therefore have to be learned. That is why they try to take note anything said by teacher. Nonetheless, field independent students have ability to break up an organised field and separate relevant information from its context or discern 'signal' (what matters) from 'noise' (the incidental and peripheral) in a confusing background. This could give an advantage to FI students in a conventional way of teaching

Table 4. Two-way ANOVA table for instructional techniques/C. Styles interaction effects

Source	Type III Sum of Squares	Df	Mean Square	F	Sig.
Corrected Model	244,535	3	81,512	30,242	,000
Intercept	15578,381	1	15578,381	5779,847	,000
Instructional technique	147,382	1	147,382	54,681	,000
Cognitive styles	94,844	1	94,844	35,189	,000
Instructional technique * C.Styles	42,607	1	42,607	15,808	,000
Error	180,585	67	2,695		
Total	16792,500	71			
Corrected Total	425,120	70			

because the essential, vital information is not obvious all the time. However this advantage disappear in the experiment group. Because i) students shared their meaning of understanding by talking to each other, ii) they concentrated on the answer of the questions that were the most important to acquire the meaning and, iii) each student was responsible only from one information sheet that reduces to load on the memory. All these gave an opportunity to avoid the unnecessary (i.e. noise) information in which the FD students were not good at. That might be the reason behind the high scores FD students as FI students in the achievement test.

4. CONCLUSIONS AND TEACHING IMPLICATIONS

The results show in this study that students who participated discussion-based group work gained higher scores in the achievement test than the students who were conventionally taught. In addition, in terms of the effect of instructional technique on cognitive styles, on the basis of students' scores in the achievement test it can be said that the conventional way of teaching favoured more FI students than FD students whereas discussion-based group favoured the both group of students.

It is certain that like some other factors cognitive styles have also effect in students' performance in any topic that is learnt. Teachers should be aware these cognitive characteristics of the students and should take into consideration when he/she is presenting the new material to them. It is impossible to find an instructional technique that suits every student in the class. However, as it was done in this study, by adopting new teaching, learning and assessment techniques teachers can minimise the effect of one particular psychological characteristic. As von Glaserfield stated, who is a major exponent of the ideas in constructivism, teaching and learning are not synonymous; we can teach, and teach well, without having the students learn.

This research can be thought as a preliminary study and can be repeated with wider samples by including other variables such as convergence, divergence; verbal, imagery; motivational styles etc. In addition, the effect of different method of instruction and the match between cognitive styles of students and instructors can be addressed for further studies.

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Appendix 1- Information questions

1- How do plants and animals get their protein (A)
2- How do humans get their protein? (A)
3- What are amino acids? (B)
4- What are essential amino acids? (B)
5- What type of food tend to be high in protein content?-give percentages (C)
6- What type of food tend to be low in protein content?-give percentages (C)
7- How much protein do we need each day? (D)
8- How much usable protein do we need each day? (D)
9- Which are the rich countries, which are the poor (D)
10- How much usable protein do rich and poor people get? (D)
11- How do our requirements and what we get actually differ? (D)
12- Why do we need fertilisers? (A)
13- Which is the best fertiliser and why? (A, B)
14- Why are fertilisers increasing in price? (A, B)
15- How much protein is present in wheat flour and soya flour? (C)
16- How do these two sources compare in the essential amino acid content? (B)
17- What does balancing a protein diet mean? (B)
18- Suggest one or two ways to improve protein production? (C)
19- What three new sources of protein are most useful? (D)
20- Should we breed more cattle for animal protein? Why? (D)

Appendix 2- General Questions

1- How can we reduce the rich countries dependence on wasteful animal protein?
2- How can we persuade people (rich and poor) to try new forms of protein?
3- Should we, in Turkey, bother to help poorer countries? After all, if we need them, their populations will grow further, causing more food problems later.
4- Why are countries in the rich west selfish with protein supplies?
5- Should more emphasis be placed on “family planning” in poor countries, and less on producing more food?
6- Suggest three practical steps that we could take now in this country to help solve world protein problems?