The Relationships between Pupils' Learning Styles and Their Performance in Mini Science Projects

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Abstract

This study aimed to investigate *(i)* the relationship between pupils' learning styles and their performance in mini science projects and *(ii)* the degree of enjoyment of pupils with different learning styles towards mini projects. A total of 80 pupils (7th grade-14 years of age) from two different primary schools participated in the study. The Grasha-Riechmann Learning Style Scale was used to determine the pupils' learning styles. Results showed that all categories of pupils except avoidant were stimulated to varying degrees by the mini projects. However, the pupils who were in the "independent," "competitive," and "participant" groups had relatively higher achievement scores in the mini projects than the pupils in the "avoidant," "dependent," and "collaborative" groups. Similar results also appeared for the degree of enjoyment. The implications of the results for teaching and learning science are discussed.

Key Words

Learning Style, Mini Projects, Science, Pupil.

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Kuram ve Uygulamada Eğitim Bilimleri / Educational Sciences: Theory & Practice
9 (1) • Winter 2009 • 31-49

Practical work is one of the most important and essential elements in teaching and learning science. In numerous studies related to practical work (e.g., Beatty & Woolnugh, 1982; Gunstone, 1991; Johnstone, & Al-Shuaili, 2001; Kapenda, Kandjeo-Marenga, & Kasanda, 2002), several attempts have been made to articulate the purposes. In all of these studies, researchers were in agreement that practical work verifies facts and principles already taught, encourages accurate observations and careful recording, promotes scientific methods of thought, develops manipulative skills, gives training in problem-solving, elucidates theoretical work so as to aid comprehension, arouses and maintains interest in the subject, and makes phenomena more real through actual experience. On the whole, students enjoy practical work and develop positive attitudes toward it; however, some research literature (e.g., Hodson, 1993) reported there is little to show that practical work is effective in helping students to learn scientific knowledge and some reports (e.g., Watson, Prieto, & Dillon, 1995) suggest that it is less successful than other methods. In addition, some students express a dislike for practical work (Head 1982) and enthusiasm for practical work declines with age (Lynch, & Ndyetabura, 1984). Woolnough and Allsop (1985) argue that there are different kinds of practical activities for different aims and kinds of practical work used are important for the students as well as teachers. Open kinds of practical work are seen by teachers as very motivating. Motivation is improved if students feel a sense of ownership of investigations and greater control is given to students (Jones, Simon, Black, Fairbrother, & Watson, 1992; Kempa, & Dias, 1990).

Mini-projects are practical problem-solving tasks (Hadden, 1991) or a kind of problem solving at the bench (Johnstone, & Al-Naeme, 1995). They are short and practical problem which requires for its solution the application of the knowledge and skills developed in previously completed set experiments (Vianna, Sleet, & Johnstone, 1999). They are designed to stimulate individual thought and creativity, to be solvable by several methods and to allow for more than one "correct answer" (Johnstone, & Al-Naeme, 1995). There are a number of studies in chemistry related to mini-projects (e.g., Al-Naeme, 1991; Cardenas, & Montealegre, 2001; Dunn, & Phillips, 1998; Hadden, 1991; Johnstone, & Al-Naeme, 1995) The common purposes in all these studies were, first, to propose the mini project as a way of improving experimental chemistry learning and secondly to show the usefulness of mini projects as a tool to promote independent work and commitment of students

to chemistry and chemistry learning. The results in all of these studies confirm these claims.

Because of the several characteristics of mini projects mentioned above, it is also thought some psychological factors such as individual differences might have an effect on the performance of students in mini projects. Some researchers (e.g., Al-Naeme, 1991; Johnstone, & Al-Naeme, 1995) tried to find out whether mini projects were catering adequately for the range of cognitive and motivational styles. The results of both studies show mini projects can appeal to some students more than others. Al-Naeme (1991) looked into the influence of various psychological factors (i.e. field dependence/independence, convergence/divergence and motivational styles namely curious, conscientious, achiever, social) on the performance (i.e. the achievement and the scores) of pupils in mini-projects. His findings demonstrated that the field dependent/independent factor is the most effective in influencing performance in mini projects. The motivation factor is second and finally that the convergent/divergent factor takes the third position. Moreover, when mean scores were calculated for various groups of pupils with various motivational styles, the curious groups were found to be the best and the conscientious groups were found to be the poorest. In their extensive study, Johnstone and Al-Naeme (1995) further examined the effect of these psychological factors on mini project in chemistry of the sample of 217 pupils (14-15 years old). Results indicated that those who do best in practical problem-solving of mini projects type were curious, field independent, and divergent pupils. However, the results also indicated that all categories of pupils were stimulated to varying degrees by the projects.

Learning styles: In last two decades, there are several studies in all fields of education related to learning styles. They are used widely in education and training to refer to a range of constructs from instructional preferences to cognitive styles (Riding & Cheema, 1991). Keefe (1991) describes learning styles as a combination of psychological, cognitive and affective issues that influence the way the learners perceive, interact with, and respond to the learning environment. According to Kolb (1984), learning style is the preferred way that the individual deals with given information and how she/he constructs meaning out of stimuli.

As a result of the intense interest on learning styles, a number of models and scales were proposed to identify how a student learns: the

Gregorc model presented four learning styles (i.e. concrete sequential, abstract sequential, abstract random and concrete random; Ekici, 2001); the Myers-Briggs Type Indicator (Myers, & McCaulley, 1986); the Felder-Silverman Learning Style Model (sensing/intuitive, visual/verbal, inductive/deductive and active/reflective; Felder, & Silverman, 1988); Kolb's Model (active/reflective, abstract/concrete; Kolb, 1984); the McCarthy Learning Style Model (McCarthy, 1987); the Dunn-Dunn Learning Style model (Dunn, & Dunn, 1993) and the Grasha-Riechmann Learning Style Scale (GRLSS; Grasha, 1996) can be given as examples. At the base of all of these models, it can be said that there are data gathered about cognitive styles and research findings aimed to find out individual differences and varying evaluation of learning approaches (Keefe, & Ferrell, 1990).

Montgomery and Groat (1998) indicate that the Grasha-Riechmann learning style model is distinct from the other models in that it is based on students' responses to actual classroom activities rather than a more general assessment of personality or cognitive traits. Grasha argues that this situation-specific approach is more likely to be reliable and valid. Grasha (1996) sees learning styles as a blend or profile that resides within every student. Some students possess more of one style than another and it is typically the dominant qualities that are most easily seen in the class. Grasha (1996) described six learning styles as independent, avoidant, collaborative, dependent, competitive, and participant. Some obvious characteristics of these learning styles are: competitive (competes with other students in the class in order to perform better; wants to be recognized as the best student; is motivated generally by the rewards of recognition, and strives to the better than others) collaborative (learns by sharing ideas and talents and enjoys cooperating with teachers and other students) avoidant (not enthusiastic about learning; tends to be uninterested or overwhelmed by what is going on; components of this style include, a fear of failure, anxiety over receiving unfavorable evaluations from others, and feeling inadequate about one's knowledge and skills) participant (finds learning enjoyable and takes responsibility for getting the most out of any learning situation; approaches opportunity to learn with enthusiasm and attends as many meetings, conferences, rounds and other learning opportunities as possible) dependent (relies on authority and guidelines for how to perform; tend to seek specific answers and direction rather than formulating independent ideas and

approaches to problems), and independent (has a strong need to learn alone rather than relying on the teacher for answers; often goes beyond what is required to learn, and is willing to explore content and practice skills alone).

There are several research studies in which the GRLSS was used examine the effects of learning styles on students academic performance (Aripin, Mahmood, Rohaizad, Yeop, & Anuar, 2008; Bilgin, & Durmuş, 2003; Collison, 2000; Uzuntiryaki, Bilgin, & Geban, 2003). In all these studies, it was reported that the students' academic performance and/or their preference towards courses were affected by their learning styles by varying degrees. In other research studies related to learning styles, where different learning style scales were used, it was reported that learning styles affect students' attitudes towards courses (e.g., Bilgin, & Bahar, 2002; Mutlu, 2006) and alignment between students' preferences related to learning and learning environment can lead to increase their performance, however, the mismatch between the two can lead to decrease in performance (Andrews, 1990; Dunn, Griggs, Gorman, & Beasley, 1995; Klavas, 1994). Furthermore, alignment between students' learning styles and an instructor's teaching style leads to a better recall and understanding as well as more positive post-course attitudes (Felder, 1993). On the other hand, some researchers (Duff, & Duffy, 2002; Garner, 2000) questioned the reliability and stability of learning styles as they are unlikely to be accurate or correct and are not a fixed entity. Both the Kolb's learning styles inventory and the Honey and Mumford's learning styles questionnaires have been criticized on the grounds of item format, the use of norms, and poor reliability and validity (Bonham, 1988; Bostrom, Olfman, & Sein, 1990; Duff, 1997; Duff, & Duffy, 2002). Gunawardena and Boverie (1993) also reported that the pattern of learning indices; higher order thinking, metacognition, and efficient interaction did not differ significantly based on subjects' dominant learning styles.

Research Problems: As indicated in the Introduction section, studies related to mini projects were conducted mainly in chemistry and any indication could not be found regarding mini projects in science. Furthermore, learning styles (competitive, collaborative, avoidant, participant, dependent and independent) that might be one of the factors may affect pupils' performance in mini projects have not been studied. Therefore, the relationship between pupils' learning styles, their performance (i.e.

the achievement scores) in science mini projects, and their enjoyment of these activities deserve to be investigated. The specific questions for consideration are as follows: *(i)* What is the relationship between pupils' learning styles and performance in science mini projects? *(ii)* Is there a difference in terms of enjoyment of pupils with different learning styles towards science mini projects?

Method

Sample: This study was conducted during Spring 2007 in two different high schools in Bolu-Turkey. A total of 80 pupils (38 boys 42 girls) of 14 years of age at 7th grade participated in the study.

Learning Style Scale: In this study, the Learning Style Scale developed by Grasha and Riechmann (Grasha, 1996) and validated for Turkish setting by Uzuntiryaki, Bilgin and Geban (2003) was used. The reliability values (Cronbach's alpha) of the six learning styles (i.e. competitive, collaborative, avoidant, participant, dependent and independent) were found to be .79, .63, .60, .65, .61, and .53, respectively. This instrument consisted of 60 items on a 5-point Likert type. Pupils were required to rate each item from "strongly disagree" to "strongly agree" and the pupils' *predominant style* according to the scores that were obtained from the learning style inventory were used to classify them.

Mini Projects: In order to shape the mini projects in science, the layout and procedure that were used by Johnstone and Al-Naeme (1995) in chemistry were taken as an example. Then, a similar procedure was used in this study in science mini-projects. In terms of administrating the mini project, every pupil worked individually on each project. It is important to mention that pupils were given instruction on how to approach the mini projects. First, they were asked to read the problem carefully. They, then, produced a plan for what they intended to do. After that, they tackled the problem, recorded their method and conclusion on the back of the sheet. A 45- minute period was allowed for three tasks. The tasks for the mini-projects were prepared by two teachers and the researchers. It was made sure that the topics covered the content area on which the mini-projects were based and that pupils were ready in terms of theoretical knowledge before the administration. In terms of scoring the performance of the pupils in the mini projects, a scoring

rubric was used. The performance of each student was scored independently by two researchers and the difference regarding the scores at each category on the scoring rubric was opened discussion. At the end of the discussion, a common score was awarded.

Questionnaire for pupils' opinions: A questionnaire was developed by the researchers to reveal the perceptions of the pupils who have different learning styles towards the science mini projects. This questionnaire was based on a 5 points Likert scale, and the students were required to indicate their opinions about mini projects by ticking the number between 0 and 4 that most accurately reflected their view.

Item 1- My perception toward the science mini project:

(1) strongly dislike (2) dislike (3) neutral (4) like (5) strongly like

Item 2- Mini projects made me more interested in science:

(1) strongly disagree (2) disagree (3) neutral (4) agree (5) strongly agree

Item 3- Mini projects helped me enhance and stimulate my own thinking skills:

(1) strongly disagree (2) disagree (3) neutral (4) agree (5) strongly agree

Item 4- Please write down your comments below regarding science mini projects.

Results

Learning style distribution

The learning styles of pupils were identified on the basis of their responses to the Grasha-Riechmann Learning Style Scale (GRLSS). The number of pupils and their percentages for each learning style group are given in Table 1.

Table 1.

Distribution of the Sample Divided on Learning Styles

Learning Style	Number and Percentage
Independent	18 (22.5%)
Avoidant	3 (3.8%)
Collaborative	12 (15%)
Dependent	21 (26.2%)
Competitive	12 (15%)
Participant	14 (17.5%)
Total	80

As shown in Table 1, pupils displayed relatively higher scores on the independent and dependent learning styles and lower scores on the avoidant learning style. The numbers of pupils in the competitive, participant, and collaborative learning styles in the sample are almost same. The number of avoidant pupils who feel inadequate about one's knowledge and skills appeared as the lowest. This result was expected. If they had appeared in large numbers they would have caused problems in terms of the results as they were uninterested or overwhelmed by what was going on.

Relationship between learning styles and mini project scores: One of the purposes of this study was to find the relationship between pupils' learning styles and their performances in science mini projects. First of all, descriptive statistics for pupils' mini project scores for each learning style were calculated (Table 2).

Table 2.

The Descriptive Statistics of Pupils' Mean Mini Project Scores by Learning Style

	Mini Project Scores	
Learning Styles	**Mean**	**SD**
Independent	13,11	1,08
Avoidant	7,17	1,26
Collaborative	10,04	1,81
Dependent	9,92	2,44
Competitive	12,41	2,20
Participant	12,32	1,42
Total (N=80)	11,35	2,40

As it can be seen from table 2, that there are differences between learning styles in terms of pupils' scores in the mini project. The mean mini project score of independent pupils is the highest, followed by competitive and participant pupils. On the other hand, the dependent and collaborative pupils' mean scores appeared as low, and avoidant pupils' mean scores appeared as the lowest. Secondly, MANOVA (Multivariate Analysis of Variance) was run to check these mean scores for statistical significance. According to MANOVA results, the effect of learning styles on pupils' scores in science mini projects was statistically significant (Type III Sum of Squares: 198,163; df 5; Mean Square 39,633; F:11,37; sig, 000). In order to determine which learning style group differed, a post hoc comparison test was performed using the Scheffe method. All pairwise comparisons among groups of learning styles are presented in Table 3.

Table 3.

The Results of Statistical Analyses for Mini Project Scores (MPS) by Learning Style

			MD (I-J)	**Std. Error**	*p*
Dependent Variable	**(I) L. Styles**	**(J) L. Styles**			
MPS	Independent	Avoidant	5,94	1,16	,000*
		Collaborative	3,07	,69	,001*
		Dependent	3,18	,59	,000*
		Competitive	,69	,69	1,000
		Participant	,79	,67	1,000
	Avoidant	Collaborative	-2,88	1,21	,294
		Dependent	-2,76	1,15	,286
		Competitive	-5,25	1,20	,001*
		Participant	-5,15	1,19	,001*
	Collaborative	Dependent	,11	,68	1,000
		Competitive	-2,38	,76	,039*
		Participant	-2,28	,73	,041*
	Dependent	Competitive	-2,49	,67	,007*
		Participant	-2,39	,64	,006*
	Competitive	Participant	9,524E-02	,73	1,000

The results reveal that there was a statistically significant difference between the mean scores of "independent pupils" and the mean scores of "avoidant", "collaborative" and "dependent" pupils. Similarly, the mean mini project scores of "competitive" and "participant" pupils were also significantly different from the mean scores of "avoidant", "colla-

borative" and "dependent" pupils. However, there was no statistically significant difference between the mean scores of "independent" and the mean scores of either the "competitive" and the "participant" group; and further, no statistically significant difference was found between the "achiever" group mean scores and the mean scores of either "collaborative" and the "dependent" group mean scores. Overall, the analysis of all pairwise comparisons in Table 3 indicate that the pupils who are in the groups of "independent", "competitive" and "participant" significantly outperformed the pupils who are in the groups of "avoidant", "collaborative" and "dependent" in the scores of mini projects.

Results for Questionnaire Items: Pupils' responses for questionnaire items (Item 1, 2 and 3) were also analyzed to find out the difference in terms of enjoyment of pupils having different learning styles towards mini projects. Table 4 shows the mean scores and standard deviations for three items for each learning style. The results of MANOVA (Multivariate Analysis of Variance) are also given in Table 5 which investigated whether an interaction between learning styles and pupils' mean scores in Questionnaire Items 1, 2 and 3 existed.

Table 4.

Statistics of Pupils' Mean Scores in Questionnaire Items by Learning Style

	Item 1		Item 2		Item 3	
Learning Styles	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Independent	3,39	,50	3,06	,73	3,72	,46
Avoidant	,33	,57	,33	,58	,33	,57
Collaborative	1,67	1,07	1,58	,90	1,75	1,05
Dependent	1,09	,94	1,52	1,21	1,19	,87
Competitive	2,75	,62	2,33	,65	2,67	,65
Participant	2,78	,43	2,43	,51	3,00	,55
Total (N=80)	2,21	1,21	2,11	1,09	2,35	1,26

Table 5.

Tests of Between-Subjects Effects (MANOVA)

Source	Dependent Variable	Type III Sum of Squares	df	Mean Square	F	*p*
L. STYLES	Item 1	73,36	5	14,67	25,83	,000*
	Item 2	38,13	5	7,62	10,10	,000*
	Item 3	85,77	5	17,15	31,39	,000*

The results showed in Table 5 clearly indicate that there was a significant effect of learning styles on pupils' scores in the questionnaire items 1, 2 and 3. In order to determine which learning style group means showed significant difference for scores in questionnaire items, a post hoc comparison test was performed using the Scheffe method. All pairwise comparisons among groups of learning styles reveal similar findings as in the results for the mini project scores. In other words, for all three items in the questionnaire, there was a statistically significant difference between the mean scores of "independent pupils" and the mean scores of "avoidant", "collaborative" and "dependent" pupils'. Similarly, the mean achievement scores of "competitive" and "participant" pupils were significantly different from the mean scores of "avoidant", "collaborative" and "dependent" pupils. However, there was no statistically significant difference between the mean scores of "the independent" and the mean scores of either the "competitive" and the "participant" group. Further, no statistically significant difference was found between the "achiever" group mean scores and the mean scores of either "collaborative" or the "dependent" group. On the basis of these results, it can be said that pupils in the "independent", "competitive" and "participant" groups enjoyed the mini projects more than the pupils in the "avoidant", "collaborative" and "dependent" groups.

Pupils' written comments towards biology mini project: As indicated, pupils were asked to write down their comments about biology mini projects in the questionnaire Item 4. It is not possible to give all the pupils' statements for each learning style. However, high levels as well as low levels of satisfaction were seen in the comments of pupils who had different learning styles. Generally speaking, the pupils' comments seem to be parallel to their scores in achievement tests as well as in the questionnaire items 1, 2, and 3. In other words, the comments of pupils in the groups of independent, competitive, and participant groups are usually positive; whereas the comments of pupils in the dependent, avoidant and collaborative groups are usually negative. It is also necessary to indicate that a small number of pupils in the dependent and collaborative groups expressed their comments of enjoyment and satisfaction, although they had lower scores in the achievement test. Some examples of pupils' opinions regarding mini projects are as follows:

"These kinds of practical activities made biology interesting because the results were not always what you expected… It amazed me more than growing seeds and watching them turn into grass which you knew was always going to happen." *Independent*

"I cannot say that mini projects really attracted me. I think the practical activities should encourage us to participate in groups, to work with our friends in seeking solutions for the problem. However, mini projects that were applied in this lab lack of sharing ideas and valuing working in groups." *Collaborative*

"Truly speaking, mini projects bored me… There are several reasons for this, but the most important one is the demand of the task required from me. I should do most of the things myself… Why do we have to do these kinds of activities." *Avoidant*

"In my opinion, mini projects were not organized as clearly as an experiment that we did normally do in the lab… I mean I feel better when I follow the instructions step by step and doing the things as they are required and told by the teacher..." *Dependent*

"I hope more diverse techniques such as mini projects are used after this exercise. Although we made several mistakes, it gave us an opportunity to learn how to improve our ability to use them better." *Participant*

"In my opinion, a particular time of a lab session should be devoted to mini projects as they gave us an opportunity to apply the knowledge and the skills we got… Mini projects were better than group working in which everybody took similar scores." *Competitive*

Discussion

The differences among pupils regarding mini project scores as well as the preferences towards mini projects may indicate that there is a relationship between pupils' learning style and their performance in science mini projects. It is not logical to assume that learning styles are rigid and inflexible. Each style of learning has advantages and disadvantages for pupils, and one should not see any one characteristic as necessarily good or bad. However, it appears from this study that the display of one particular style may lead to more positive or negative outcomes. This might be the reason behind varying performances of pupils in this study. As stated in the results section, all categories of pupils except avoidant were stimulated to varying degrees by the mini projects. However, the pupils who are in the "independent", "competitive," and "participant" groups had significantly higher mean scores of mini projects than those

in the "avoidant", "collaborative" and "dependent" groups. Similar patterns also appeared in the responses for the questionnaire items 1, 2, and 3. All these patterns can be explained as follows:

- Independent pupils would prefer to work alone on course projects than to work with other pupils. They are less teacher-dependent for answers. By offering these opportunities, mini projects may give independent pupils opportunities to display their abilities and strengthen their confidence so that they had higher achievement scores and higher level of enjoyment.
- Pupils in the collaborative groups are characterized by their preferences for group work that was not offered in the mini projects because pupils worked individually on the mini projects. It is believed that not offering this opportunity to this group was a huge deprivation to them, which affected their performance in a negative manner.
- As the results showed, the performance of the dependent pupils was low and their attitudes towards mini projects, in which individual abilities are more stressed, were mostly negative. This is an expected finding because dependent pupils view teachers and peers as sources of structure and support and look to authority figures for specific guidelines on what to do. Their reliance on authority (the teacher) was also seen on their statements that were given on pupils' written comments.
- The number of avoidant pupils in the sample is the lowest (N=3). Their achievement scores and scores in the questionnaires were also the lowest. They are not enthusiastic about learning content and even attending class. Two of three avoidant students in the sample did not write any comments (Item 4 in the questionnaire) and one who did express his thoughts did it negatively.
- Competitive pupils tend to learn materials in order to perform better than others in the class. They compete with other pupils on any learning task for the rewards (i.e. the high scores in the mini projects) that are offered. They also like to receive recognition for their accomplishments in the class. The high performance of competitive pupils in the mini projects indicates that the mini projects appealed to competitive pupils by offering a chance to satisfy all these inner requirements.
- In the mini projects, seeing high scores of participant pupils who find

learning enjoyable and take part as much as course activities as possible was not surprising, as they take responsibility for getting the most out of any learning situation and approach opportunities to learn with enthusiasm

As indicated in introduction, even though all categories of pupils were stimulated to varying degrees by the mini projects, in terms of cognitive and motivational style, the results of the previous studies in chemistry showed that mini projects could appeal some pupils more than others (Al-Naeme, 1991; Johnstone, & Al-Naeme, 1995). The results obtained in this study may also confirm the findings of these studies as the pupils who are in the "independent", "competitive" and "participant" groups had significantly higher mean scores of mini projects than those in the "avoidant", "collaborative" and "dependent" groups.

Some may also argue that designing instructional procedures that mismatch the styles pupils possess may give a chance to experience to the less dominant qualities of pupils' learning styles. For instance, cooperative learning activities (e.g., Group investigation, Learning together, Jigsaw, Co-op Co-op, Teams-Games-Tournament) might be used to encourage pupils with a weaker collaborative and participatory style to develop skills working in teams. However, as it was seen in this study, the structure of the instructional method may affect the style applied in learning. As it was seen in pupils' comments as well as in the achievement scores, the mini projects did not appeal the dependent, collaborative, and avoidant groups. However, there were some pupils who were classified as dependent or collaborative (although their numbers were not high) and had high scores in the mini projects. These pupils might be called as "effective learners" as they appeared to have been able to adapt to the style that the learning situation required. Grasha (1996) argues that learning styles can be changed and modified depending upon the classroom procedures used. These are acquired characteristics shaped by a pupil's past experiences and educational settings. They can be further reinforced or even modified by the consistent application of educational practices.

The effect of learning styles on the performance of mini projects in the laboratory may also bring some questions regarding the effectiveness of the practical work done in the laboratory. Especially, as some researchers stressed (e.g., Borrmann, 2008; Johnstone, 1997; Johnstone, & Al-Shuaili, 2001) the following three questions could be asked concerning

the claims that indicated in the curriculum as well as in textbooks: *(i)* Are the pupils really enjoying the practical work the way it is currently done (the cook way) in the schools? *(ii)* Is it really effective in terms of the expected learning outcomes? *(iii)* Is it really equally attractive for all pupils who have different psychological characteristics? The results of several research show that the practical work is often dull and teacher-directed (Hodson, 1990); it is purposeless and the noise (unimportant) information often swamps the signal (i.e. the important information in terms of understanding) during instruction (Johnstone, 1997) and often the explicit aim of the practical task does not coincide with the purpose of the practical experience (Hart, Mulhall, Berry, Loughran, & Gunstone, 2000). In fact, the practical works in the laboratory should promote meaningful learning and should be seen as a potential for the development of creative thinking. This can happen if pupils are not always told how to do things. It might not be illogical if it is expressed that there is only a slim opportunity for being creative, because there is so much spoon-feeding in the society today regarding how-to-do-it instructions in school, at home, and at work (Johnstone, 1997). As Hodson (1996) indicates motivation of the pupils is not guaranteed by simply doing practical work. We need to provide interesting and exciting experiments and allow learners a measure of self-directed investigation learners need an interest in. Commitment to the learning tasks that conventional laboratory work frequently does not provide is also a necessity. That commitment, he says, comes from personalizing the experience by focusing on the conceptual aspects of the experiment, by identifying for oneself a problem that is interesting and worth investigating.

In conclusion, the results of this study indicate that the individual differences in learning style can have an effect on the performance of pupils depending on the instructional procedures. What messages do the results of this study convey to educators?

(i) As a stand point, teachers need to acknowledge that pupils are different and ensure that the instructional procedures applied in the classrooms and in the laboratory take such diversity into account. To do this well, more information about pupils' and teachers' learning styles should be known. Being aware of pupils' learning styles and teachers' leaning styles make the teacher aware of his/her teaching styles, because if learning styles determine teacher's teaching styles (teaching in a way of learning), this gives advantages to some pupils who match their lear-

ning styles with the teacher's. There are some studies that support these claims (Rassool, & Rawaf, 2007; Shulman, 1990)

(ii) Another message is for the curriculum writers. There is a necessity for a balanced curriculum that would provide learning tasks and different instructional techniques to fit all categories of pupils who have different personal traits and allow all these pupils achieve to the best of their ability.

(iii) Pupils are thought to have mixture of learning styles but they display a bias towards one in particular. In this study, mini projects do not seem to suit collaborative and dependent pupils. However, many science curricula state the importance of working in groups and developing social skills in their objectives. Therefore, this limitation of mini projects might be lessened by performing the tasks at least in peers rather than individually.

References / Kaynakça

Al-Naeme, F. F. A. (1991). *The influence of various learning styles on practical problem solving in Scottish secondary schools***.** Unpublished doctoral thesis, Glasgow University, Glasgow, Scotland.

Andrews, R. H. (1990). The development of a learning styles program in a low socioeconomic, underachieving North Carolina elementary school. *Journal of Reading, Writing, and Learning Disabilities International*, *6*, 307-314.

Aripin, R., Mahmood, Z., Rohaizad, R., Yeop, U., & Anuar, M. (2008, July). *Students' learning styles and academic performance.* Paper presented at 22nd Annual SAS Malaysia Forum, Kuala Lumpur Convention Center, Kuala Lumpur, Malaysia.

Beatty, J. W., & Woolnough, B. E. (1982). Why do practical work in 11-1 3 science? *School Science Review*, *63*, 758-770.

Bilgin, İ. & Bahar, M. (2002). Öğretmen adaylarının öğrenme stilleri ve fen bilgisi dersine karşı tutumları arasındaki ilişki. *Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi*, *2* (4), 53-67.

Bilgin, İ. & Durmuş, S. (2003). Öğrenme stilleri ile öğrenci başarısı arasındaki ilişki üzerine karşılaştırmalı bir araştırma. *Kuram ve Uygulamada Eğitim Bilimleri Dergisi*, *3* (2), 381-400.

Bonham, L. A. (1988). Learning style use: In need of perspective. *Lifelong Learning*, *11* (19), 14-17.

Borrmann, T. (2008). Laboratory education in New Zealand. *Eurasia Journal of Mathematics, Science and Technology Education*, *4* (4), 327-335.

Bostrom, R. P., Olfman, L., & Sein, M. K. (1990). The importance of learning style in end-user training. *MIS Quarterly*, *14* (1), 101-120.

Cardenas, F. A., & Montealegre, R. R. (2001). Mini projects: An alternative to improve general chemistry teaching in higher education. *Journal of Science Education*, *2* (2), 102-105.

Collison, E. (2000). A survey of elementary students learning style preferences and academic success. *Contemporary Education, 71,* 42-49.

Duff, A. (1997). Validating the learning styles questionnaire and inventory of learning processes in accolinting: A research note. *Accounting Education*, *6* (3), 263-272.

Duff, A., & Duffy, T. (2002). Psychometric properties of Honey & Mumford's learning styles questionnaire (LSQ). *Personality and Individual Differences*, *33* (1), 147-163.

Dunn, R., & Dunn, K. (1993). *Teaching secondary science students through their individual learning styles: Practical approaches for grades 7-12*. Alyn and Bacon: USA.

Dunn, R., Griggs, S. A., J., Gorman, B., & Beasley, M. (1995). A meta-analytic validation of the Dunn and Dunn model of learning-style preferences. *Journal of Educational Research*, *88*, 353-361.

Dunn, J. G., & Phillips, D. N. (1998). Introducing second year chemistry students to research work through mini projects. *Journal of Chemical Education*, *7* (75), 866-870.

Ekici, G. (2001). *Öğrenme stiline dayali biyoloji öğretiminin analizi.* Yayımlanmamış doktora tezi, Gazi Üniversitesi, Eğitim Bilimleri Enstitüsü, Ankara.

Felder, R. M. (1993). Reaching the second tier: Learning and teaching styles in college science education. *Journal of College Science Teaching*, *23*(5), 286-290.

Felder, R. M., & Silverman, L. K. (1988). Learning and teaching styles in engineering education. *Engineering Education*, *78*, 674-684.

Garner, I. (2000). Problems and inconsistencies wifh Kolb's learning styles. *Educational Psychology*, *20* (3), 341-348.

Grasha, A. F. (1996). *Teaching with style: A practical guide to enhancing learning by understanding teaching and learning styles***.** San Bernardino, CA: Alliance Publishers.

Gunawardena, C. N., & Boverie, P. E. (1993). *Impact of learning styles on instructional design for distance education*. (ERIC Document Reproduction Service No. ED359926).

Gunstone, R. F. (1991). Reconstructing theory from practical experience. In B. E. Woolnough (Ed.),

Practical science (pp. 67-77). Milton Keynes: Open University Press.

Hadden, R. A. (1991). *Problem solving at the bench, 100 mini-projects in chemistry for 14-16 years olds*. Glasgow: Centre for Science Education, University of Glasgow.

Hart, C., Mulhall, P., Berry, A., Loughran, J., & Gunstone, R. (2000). What is the purpose of this experiment? Or can students learn anything from doing experiments? *Journal of Research in Science Teaching*, *37*, 655-675.

Head, J. (1982). What can psychology contribute to science education? *School Science Review*, *63* (225), 1-42.

Hodson, D. (1993). Rethinking old ways: Towards a more critical approach to practical work in school science. *Studies in Science Education*, *22*, 85-142.

Hodson, D. (1996). Laboratory work as scientific method: three decades of confusion and distortion. *Journal of Curriculum Studies*, *28* (2), 115-135.

Johnstone, A. H., & Al-Naeme, F. (1995). Filling a curriculum gap in chemistry**.** *International Journal of Science Education*, *17*, 219-232.

Johnstone, A. H. (1997). And some fell on good ground. *University Chemistry Education*, *1* (1), 9-13.

Johnstone, A. H., & Al-Shuaili, A. (2001). Learning in the laboratory: Some thoughts from the literature. *University Chemistry Education*, *5* (2), 42-51.

Jones, A., Simon, S., Black, P. J., Fairbrother, R. W., & Watson, J. R. (1992). *Open work in science: Development of investigations in schools*. Hatfield: Association for Science Education.

Kapenda, H. M., Kandjeo-Marenga, H. U., & Kasanda, C. D. (2002). Characteristics of practical work in science classrooms in Namibia. *Research in Science and Technological Education*, *20* (1), 53-65.

Keefe, J. W. (1991). *Learning style: Cognitive and thinking skills*. Reston, VA: National Association of Secondary School Principals.

Keefe, J. W., & Ferrell, B. G. (1990). Developing a defensible learning style paradigm. *Educational Leadership*, *48* (1), 57-61.

Kempa, R. F., & Dias, M. M. (1990). Students' motivational traits and preferences for different instructional modes in science education. *International Journal of Science Education*, *12*, 195-216.

Klavas, A. (1994). In Greensboro, North Carolina: Learning style program boosts achievement and test scores. *The Clearing House*, *67*, 149-151.

Kolb, D. A. (1984). *Experiential learning: Experience as the source of learning and development*. Englewood Cliffs, N.J: Prentice-Hall.

Lynch, P. P., & Ndyetabura, V. L. (1984). Student attitudes to school practical work in Tasmanian schools. *Australian Science Teachers Journal*, *29* (2), 5-9.

McCarthy, B. (1987). *The 4MAT system: Teaching to learning styles with right/left mode techniques***.** Barrington: Excel, Inc.

Montgomery, S. M., & Groat, L. N. (1998). *Students' learning styles and their implications for teaching* (CRLT occasional papers, No.10). The Center for Research on Learning and Teaching, University of Michigan.

Myers, I. B., & McCaulley, M. H. (1986*). Manual: A guide to the development and use of the Myers-Briggs type indicator* (2nd ed.). Palo Alto, CA: Consulting Psychologists Press.

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

Rassool G. H., & Rawaf, S. (2007). Learning style preferences of undergraduate nursing students. *Nursing Statidard*, *21* (32), 35-41.

Riding, R. J., & Cheema, I. (1991). Cognitive Styles: An overview and integration. *Educational Psychology*, *11* (3-4), 193-215.

Shulman, L. (1990). *Aristotle bad it right: On knowledge and pedagogy (Occasional paper no.4)*. East Lansing, M: The Holmes Group.

Uzuntiryaki, E., Bilgin, I., & Geban, O. (2003, March). *The effect of learning styles on high school students' achievement and attitudes in chemistry.* Paper presented at Annual meeting of National Association Research in Science Teaching, Philadelphia, Pennsylvania, USA.

Vianna, J. F., Sleet, R. J., & Johnstone, A. H. (1999). The use of mini-projects in an undergraduate laboratory course in chemistry. *QUİMICA NOVA*, *22* (1), 138-142.

Watson, J. R., Prieto, T., & Dillon, J. (1995). The effect of practical work on students' understanding of combustion. *Journal of Research in Science Teaching*, *32* (5), 487-502.

Woolnough, B., & Allsop, T. (1985). *Practical work in science*. Cambridge: Cambridge University Press.

Ek 1. *Mini Projelerin Sınıf İçerinde Uygulamasını Gösteren Örnek Bir Sayfa*

No/Sınıf: İsim:

1. Problem

Öğretmeniniz size iki ayrı kapta beyaz bir toz özelliği gösteren iki madde verdi. Sonra da bunlardan hangisinin un, hangisinin şeker tozu olduğunu tespit etmenizi istedi. (Not: Tatlarına bakarak ayrım yapmanız yasaktır!)

2. Planınız

Problemi dikkatli olarak tekrar okuyun.

Ne yapabileceğinize dair planınızı aşağıdaki boşluğa yazın.

Eğer aklınıza bir şey gelmiyorsa öğretmeninize danışın. Size bazı ipuçları verecektir.)

3. Kullanacağınız malzeme, araç ve gereçler

Etkinliği yapabilmeniz için gereken malzeme, araç ve gereçleri düşünerek öğretmeninizden bunları isteyiniz.

Şimdi etkinliğe başlayınız

Sayfanın arka kısmını yönteminizi, etkinlikte elde ettiğiniz bulguları ve sonuçları yazmak amacı ile kullanın.

Not: Ders kitaplarınız, dergi, ansiklopedi gibi her türlü kaynağı kullanmakta serbestsiniz.

Ek 2. *Mini Proje İçin Rubrik*

Problemi anlama	**2** Problemi açık ve net biçimde anlamış.
	1 Problemi kısmen anlamış.
	0 Problemi anlamamış.
Olası çözümleri planlama	**5** Uygulanabilir bir başlangıç planına sahip, uygun malzeme, araç ve gereç seçilmiş, etkilik adımları net olarak ifade edilmiş.
	4 Uygulanabilir bir başlangıç planına sahip fakat uygun malzeme, araç ve gerecin seçilmesi konusunda küçük problemler var, etkinlik adımları net olarak ifade edilmiş.
	3 Uygulanabilir bir başlangıç planına sahip, uygun malzeme, araç ve gereç seçilmiş,etkilik adımları net olarak ifade edilmiş fakat etkinliğin yapılmasını içeren adımlar karıştırılmış.
	2 Uygulanabilir bir başlangıç planı ile ilgili küçük de olsa problemler var, uygun malzeme, araç ve gereç seçilmesinde ve etkinlik adımların ifade dilmesinde bazı karışıklıklar var.
	1 Planlamaya ilişkin çeşitli sorunlar var, uygun malzeme, araç ve gereç seçilmemiş.
	0 Fikir beyan edilmemiş, plan yok.
Etkinliği yapma	**5** Etkinliğe ilişkin uyarılara dikkate alınmış, etkinlik adım adım doğru biçimde yapılmış, uygun malzeme, araç ve gereçler kullanılmış, veriler toplanırken gerekli notlar alınmış.
	4 Etkinliğe ilişkin uyarılara dikkate alınmış, etkinliğin adım adım doğru biçimde yapılmasında bazı sıkıntılar var, uygun malzeme, araç ve gereçler kullanılmış, veriler toplanırken gerekli notlar alınmış.
	3 Etkinliğe ilişkin uyarılara dikkate alınmış, etkinliğin adım adım doğru biçimde yapılmasında bazı sıkıntılar var, uygun malzeme, araç ve gereçler kullanılması konusunda karışıklıklar var, veriler toplanırken gerekli notlar alınmış.
	2 Etkinliğe ilişkin uyarılara dikkate alınmış, etkinliğin adım adım doğru biçimde yapılmasında önemli eksiklikler var, uygun malzeme, araç ve gereçler kullanılması konusunda karışıklıklar var, veriler toplanırken gerekli notlar alınmış.
	1 Etkinliğe ilişkin uyarılara dikkate alınmamış, etkinliğin adım adım doğru biçimde yapılmasında önemli eksiklikler var, uygun malzeme, araç ve gereçler seçilmemiş, veriler toplanırken önemli notlar alınmamış.
	0 Etkinliğin yapıldığına dair bir işaret yok.

Rapor etme	**3** Bulgular düzenli biçimde açıklanmış, bulguları destekleten şekil, çizim kullanılmış, sonuç açık biçimde ifade edilmiş, anlaşılır bir dil kullanılmış.
	2 Bulgular düzenli biçimde açıklanmış, bulguları destekleten şekil, çizim kullanılmış, sonuç açık biçimde ifade edilmesinde bazı sorunlar var, anlaşılır bir dil kullanılmış.
	1 Etkinlikte uygulanan adımlar birbirine karıştırılmış, sonucu ifade edilmesinde sıkıntılar var, anlaşılır bir dil kullanılmamış.
	0 Uygun bir rapora ilişkin hiçbir kanıt yok.

Not: Alınabilecek en yüksek puan 15'tir.