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An Adaptation Study for the Measurement of Scientific Process Skills for Gifted Students in Science: The Diet Cola Test

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ABSTRACT
The Fowler Diet Cola Test (DCT) was originally developed to assess the scientific process skills of students in science classrooms. The use of the test is generally suggested for gifted students in science. There are considerable number of Scientific Process Skills (SPS) tests that the researchers developed for different student population. The necessity of a test that measure the gifted students' scientific skills in Turkey is the major reason to conduct this study. This study investigated the reliability and validity of the test for the Turkish context. The test itself contains two scientific problems as Form A and Form B. We examined and resulted the reliability estimates and translation procedures which are interrater reliability, equivalent forms and criterion validity. Also, we presented the validity results to show this test can be helpful and suited for gifted students in 5th and 6th grade science classes. The results suggest that DCT is a suitable instrument for assessing students' science process skills identified as talented in 5th and 6th grade students.

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Introduction

Scientific process skills (SPS) have been a concept that entered our country during the work of the World Bank (Çepni, Ayas, Johnson & Turgut, 1997). It was later integrated into science education programs (NME, 2005) and has stood out as a skill system that researchers and science educators rely on until today. SPS was first defined as "the ability to think" by the Educational Policies Commission (EPC) in 1961. The American Association for the Advancement of Science (AAAS) divided it into basic and integrated processes. Basic processes, observation, inquiry, measurement, communication, classification, and prediction; integrated processes are defined as variable control, operational definition, hypothesis making, data interpretation, experimentation, and modeling (Sanderson, 1971). Scientific Process Skills, which were handled within the scope of the studies carried out in cooperation with the Ministry of National Education and the World Bank, were in three categories: Basic, causal, and experimental. SPS, which is considered in this context and included in the science education curricula in our country, still stands out as the main subject of many studies and the most basic science education skills that are recommended to be acquired by students (Duruk, Akgün, Dogan & Gülsuyu, 2017; Ekici, & Erdem, 2020; Gunawan, Harjono, Hermansyah, & Herayanti, 2019; Harahap, Nasution, & Manurung, 2019).

Scientific process skills are the thinking skills used in creating knowledge, thinking about an existing or determined problem, producing solution suggestions/hypotheses for this problem situation, selecting the appropriate solution, modeling, and interpreting the problem results (Harlen, 1999). Many researchers have defined scientific process skills as the skills demonstrated by scientists and their characteristics, and they have focused on their transferability (Carin & Bass, 2001; Carin & Sund, 1989; Ewers, 2001; Padilla, 1986; Rutherford & Ahlgren, 1990). Scientific process skills are the essential skills that gifted students should acquire. Sternberg (1982) underlined that problem finding, problem-solving and scientific processes are the main focus in science education for gifted students. Scientific process skills are the basis of scientific thinking, scientific approach to a situation, and most importantly, thinking like a scientist. Researchers state that scientific process skills can be included as a development process for gifted students in differentiated science courses (Kutlu & Gökdere, 2015; Şener & Taş, 2017). In table 1 the SPS can be seen considered in this study. In gifted education, the importance of skill development has rigorous literature and should be nurtured using several experiences to shape student development (Day & O'Connor, 2017). This higher awareness of the importance of skill development and educational opportunities for gifted students has received more focus (Godor &Szymanski, 2017). However, the researchers should specifically focus on the unique needs of gifted students like scientific process skills to develop scientific inquiry or understanding of science. Literature suggested that the requirement of domain-specific educational activities/materials should be developed (Taber & Riga, 2016; Üzüm, 2017). These recommendations can also apply to measurement tools. The Diet Cola Test focuses on the measurement of scientific skills (Fowler, 1990; Adams & Callahan, 1995). But in Turkey, there are no or limited such instruments that the researchers or teachers can use. For this reason, the adaptation of the Diet Cola Test is seen as essential for the measurement of the SPS in science classes for gifted students.

Table 1

SPS and DCT Relation

Scientific Process Skills	SPS usage in the Diet Cola Test
Observation	Safety
Hypothesis Building	States problem or questıon
Prediction	Predicts outcome or hypothesizes
Classification	Arranges steps in sequential order
Saving Data	Lists materıals needed
Measurement	Plans to repeat testıng and tells reason
Determining Variables	Defines the terms of the experiment
Using Data and Modeling	Observe
Interpreting Data	Plans to measure
Experimentation	Data collection
Inference Decision-Making	Interpreting data
Establishing Number and Space Relations Changing	Conclusion based on data
and Controlling Variables.	Control variables

Resource: Çepni, Ayas, Johnson & Turgut, 1997; Adams & Callahan, 1995

In table 1 the SPS subjected in this study are given. SPS and the corresponding term on the Diet Cola Test rubric is given. The extent of the SPS and the test is found coherent. There are many BSB tests that can measure the properties specified in the literature. The analysis, especially considering the Turkish and the scales adapted to Turkish, is presented in Table 2.

Table 2

Comparison of SPS Scales/Tests

Scales/tests	Grade	SPS	Content	Type
Karatay ve Doğan, 2016	7th grade, middle school	1, 2, 3	7th grade General science content	Multiple choice
Türker, 2011	6th grade, middle school	1, 2, 3	General science content	Multiple choice

Aydoğdu ve Karakuş, 2015	3rd, 4th, 5th grades, primary school	1	General science content	Multiple choice
Karslı ve Ayas, 2013	Pre-service teachers	1, 2, 3	General science content	Multiple choice and open-ended
Kılınç, 2018	Pre-service and In-service teachers	1, 2, 3	General science content	open-ended
Aydoğdu, Tatar Yıldız ve Buldur, 2012	6th 7th 8th grades, middle school	1, 2, 3	General science content	Multiple choice
Kurnaz ve Kutlu, 2016	4th grade primary school	1	Subject Matter	Multiple choice
Şardağ ve Kocakülah, 2016	8th grade	1, 2, 3	General science content	Multiple choice and open-ended
Şahin, Yıldırım, Sürmeli & Güven, 2018	Pre-school, Early age	1	General science content	Multiple choice, open-ended and performance
Aktamış ve Şahin Pekmez, 2011	8th grade	1, 2, 3	General science content	Multiple choice and open-ended
Turan, 2014	4th 5th 6th 7th 8th grades, middle school	1, 2, 3	General science content	Multiple choice
Öztürk, Tezel & Acat, 2010	7th grade	1, 2, 3	General science content	Multiple choice
Özden ve Yenice, 2021	7th and 8th grade	1, 2, 3	General science content	Multiple choice

Table instruction: 1-Basic skills, 2-Integrated skills, 3- Experimental skills

The scales generally took primary school students as the target audience. Basic skills are based on students at lower education levels, while all SPS are defined as targets for higher education levels. The questions asked generally consist of multiple-choice, general science topics and are transferred from daily life. However, no specific use for gifted students was mentioned in any of the scales. Gifted students need activities, practices, models, programs and assessment that reflect their own development at their own pace. Gifted education field does not approve one-way approach to answer the students' need because of the extent of student characteristics and diverse needs (Brown, 2011). Brown (2011) added on the educational aspect of gifted students' needs that "typically gifted learners are performing at above-grade-level standards, and therefore the core instruction may not be responsive to these students because, for many of them, they have already mastered the core competencies (p.106)". We know that the test designed considering the grade or age norms do not match with the gifted students. Brown (2011) exemplified that "if students enter Grade 4 already scoring at the 95th percentile on an in-grade reading assessment, the learning result on that same measure will reflect minor, if any, growth gains at the end of the year, regardless of how effective the curriculum or instructional practices were because the problem rests with the assessment, not the learner (p.106)". Renzulli et al. (2010) advised that meeting the educational needs of gifted students who have been identified is most important task of gifted programs. And we know that the gifted programs have unique programs and models that meet the gifted students need like SACs in Turkey. Measurement is also one of the essential subjects that needs to be regulated according to the gifted students' characteristics and diverse needs. The DCT will be able to measure the development of gifted students' scientific process skills according to the students' own norms since it is open-ended in terms of its structure, reflects the student's own idea and development in the report, and most importantly, the student himself creates the experimental design to be evaluated. In addition, it is noteworthy that the number of tests consisting of open-ended questions is low in Table2. This need is stated in the literature by Adams and Callahan (1995). The fact that there is no test for this need in our country is also essential for meeting this need. In addition, the widespread use of SPS scales and the existence of different scales can be explained by the inadaptability of the scales that the researchers desire to provide scales suitable for the level of the sample group in their studies (Şardağ & Kocakülah, 2016).

When the literature was examined, many SPS scales were found (Dwianto, Wilujeng, Prasetyo & Suryadarma, 2017; Erkol & Ugulu, 2014; Nasution, Harahap & Harahap, 2018). The SPS scale, suggested for the gifted, is the Diet Cole (DCT) scientific process skills test developed by Fowler (1990). The main starting point in developing the test is that performance and skill assessments are not allowed to be measured in standard science tests (Adams & Callahan, 1995). As a result of their study, Adams and Callahan (1995) did not approve of the use of the test to identify giftedness. Still, they suggested that it should be used to measure scientific process skills in gifted students. In Table 1 the SPS scales and tests were frequently developed specialized grades or subjects that there were not for gifted students. Also, the open-ended structure of the tests properly measures the gifted students SPS that the literature frequently suggested open and guided inquiry approach which is parallel with the SPS open ended measurement. In the literature, the use of the DCT is frequently encountered in studies on giftedness (Han, 2017; Kim & Kang, 2014; Robinson, Dailey, Hughes & Cotabish, 2014; Yang & Park, 2017). Therefore, this study aims to introduce a test that can measure the SPS of gifted students to the Turkish science education literature.

Methodology

Fowler Diet Cola Test Scale (FBSB), developed by Fowler (1990) and later updated by Adams and Callahan (1995), can reveal which scientific process steps are used effectively or not. It has been recommended to use for gifted students' samples. Present study is the adaptation of this test and scale adaptation methodology was followed. The Turkish translation of the scale was made and then used by the researcher. In consultation with two language experts, the translation of the text was finalized, and the test was completed after being examined by two language experts. The scale consists of two forms (Form A and Form B). Students are asked to develop a scientific plan that can solve the problem in any form. The plans prepared by the students were then evaluated according to the rubric developed by Adams and Callahan for the analysis of the DCT results. The analyzes were made on the total scores in the pre-test and post-test. The rubric includes the steps, safety, problem, hypothesis, material list, test repetition, observation, measurement, data collection, interpretation, inference about data, and control variables. Students must include each step in the given forms. If there are additional operations with detailed information about the steps, (2) points are given. If there are operations related to the steps, (1) points, and if there are no operations related to the steps, (0) points are given.

The Translation Processes

In the adaptation process of the test, firstly, it was translated from English to Turkish. The test and rubric were first translated by the researcher and then given to both the field educator and the language expert researchers for review during the translation process. In line with the suggestions of Coster and Mancini (2015), the translation was examined by two researchers, compared with the original version, and made ready for pilot study after some minor corrections. The first, second, third and fourth instructions' words has changed; in form A and form B in the second problem sentences we used two words to explain better in Turkish context in response to one word.

Pilot Study

The test, which was prepared for the pilot study, was applied to two different gifted student groups: Form A and Form B. The teacher asked the students questions about the test, and the researcher made minor changes according to the results. In particular, changes were made in a few points that could not be understood in the instructions.

Last Translation and Documentation

As a result of the changes made according to the results obtained from the pilot study, the language experts have consulted again. After the back translation process, the text approved by the experts was made ready for implementation. The situation that should be noted about the test is that the translation process is more understandable than other tests and scales since it is a short and open-ended test consisting of two questions. The fact that it did not require any special studies on cultural equivalence facilitated the translation process. For this reason, taking into account the recommendations of Jesus and Valente (2016), this adaptation process was carried out in translation, expert opinion and pilot application, feedback, and review.

Implementation

Sample

In the process of selecting the students to participate in the study, attention was paid to the fact that they were students who were diagnosed as gifted. The researcher kept a list of the students participating in the study. The researcher kept this list confidential, and then each student was given a code and removed their name. Students who took science courses in the Individual Talent Recognition (ITR) groups of Science and Art Centers (SACs) were selected as participants. These students are students who are successful in the field of general mental ability and support education programs. Therefore, it is assumed that students have gained communication, cooperation, group work, learning to learn, problem-solving, scientific research, entrepreneurship, critical and creative thinking, effective decision making, technology literacy, social responsibility, and effective use of resources.

Of the 74 students who participated in the study, 61 completed both tests, while the other 13 students could not complete the test due to absenteeism. The number of the sample is seen sufficient for an open-ended test when considering the population (Swami & Barron, 2019; Ulger & Cepni, 2020). The participant group consists of 32 female and 29 male students. While 44 students are at Grade 5 level, 17 students are at Grade 6. The ITR groups generally consist on 5th and 6th graders and they learn and study the general science content (physics, chemistry and biology) in this group. Because of that we sampled ITR groups. 7th and 8th graders generally take the courses in Special Skills Development group (SSD) in SACs and they learn and study the special science contents like physics, chemistry or biology. So the ITR groups suited better for this study.

Results

We first wanted to prove that gender did not play a role in the test results and that one group did not score higher or lower than the other group. Accordingly, no significant results were found according to the one-way ANOVA results based on mean scores (p_{pre}=.658, p_{post}=.965). Table 3 shows the mean score results.

Table 3

DCT Mean Scores by Gender

		Test round	
		pre	post
Gender	n	Mean (SD)	Mean (SD)
Male	29	4,83 (1,77)	8,10 (1,66)
Female	32	4,63 (1,77)	8.13 (2,13)

According to the one-way ANOVA analysis, the results were performed to show that the test did not differ considering the grade level. Also, there was no significant difference between the grades according to the mean scores. (p_{pre}=.781, p_{post}=.295). Table 4 shows the mean score results.

Table 4

DCT Mean Scores by Grade

		Test round	
		pre	post
Grade	n	Mean (SD)	Mean (SD)
5th grade	44	4,68 (1,78)	8,27 (1,86)
6th grade	17	4,82 (1,74)	7,71 (1,93)

Reliability

Equivalent forms: Half of the students were selected in the first test process, and Form A was applied, and Form B was applied to the other half of the students. The results were collected by the researcher. In the post-test period, Form B was applied to the students who had applied Form A in the first test, and Form A was applied to the other students. The interval between the first and last tests is 11 weeks.

Interrater reliability: 30 of the completed tests were randomly selected and sent to two different researchers for interrater reliability. The results obtained were compared with the researcher's scoring.

Reliability estimates: Pearson product moment correlation was used to determine the equivalent forms reliabilities. The correlation obtained at the end of the 11-week period was .78 ($p<.01$). Interrater reliability values performed with two different researchers were .89 for the first researcher and .87 for the second researcher, respectively.

Validity

After the pretest application, the students created the activities and experiments related to the given topics according to the given problem situation and collected data during the application process. After analyzing and interpreting the data they collected, the students also carried out the reporting. In the groups before ETF, students came with knowledge about the steps of scientific research. In addition, the teacher reminded the students about the instructions on this subject. Students' reports were analyzed using the DCT rubric.

Criterion validity: According to Baykul (2010), when a measurement tool with accepted validity and reliability is used as a criterion, the correlation coefficient between the scores obtained from this scale and the scores obtained from the applied scale approaches +1, leading to high criterion validity, but being close to 0 indicates that the test has a low level of criterion validity (Şardağ & Kocakülah, 2016). For this reason, in the criterion validity analysis, the Diet Cola Test and the SPS scale developed by Şardağ and Kocakulah (2016) were applied to 18 gifted students excluded from the study sample. According to the correlation coefficient results obtained, it was determined that the test had moderate (.41) criterion validity between the two scales. This correlation, which is close to average, shows a difference between the test administered to gifted students and the tests developed for the general student population. This result also supports the necessity of this test for gifted students.

Limitations

This study is limited to 61 5th and 6th grade students who are gifted. The reason is for that the ITR groups were consisted on these grades. In another study the sampling range and grade can be increased. The students who are in special talent development program in SACs can be addressed that they also took the scientific process course in support group before ITR. Another limitation is that there is two problems which consist the test questions. It is unlikely to mention about the construct validity. We suggest that in another study field expert should also evaluate the content.

The Fowler Diet Cola test is as follows.

DIRECTIONS FOR SCIENCE SKILLS PRETEST

1. Distribute one copy of the test to each child.
2. Read these directions out loud:

   Today you are going to take a test to see how well you can design an experiment.
   Look at your paper while I read the problem aloud:

(Form A) Are earthworms attracted to light? In other words, do earthworms like light? Tell how you would test this question. Be as scientific as you can as you write about your test.
Write down the steps you would take to find out if earthworms like light.
You may begin.
(There is no time limit, but most will be through in 10-15 minutes)
Note: Students might ask if they may draw a picture of the experiment. If so, tell them they may, but they still need to explain their experimental design in words.

DIRECTIONS FOR SCIENCE SKILLS POSTTEST

3. Distribute one copy of the test to each child.
4. Read these directions out loud:

   Today you are going to take a test to see how well you can design an experiment.
   Look at your paper while I read the problem aloud:

(Form B) Are bees attracted to diet cola? In other words, do bees like diet cola? Tell how you would test this question. Be as scientific as you can as you write about your test.
Write down the steps you would take to find out if bees like diet cola.
You may begin.
(There is no time limit, but most will be through in 10-15 minutes)
Note: Students might ask if they may draw a picture of the experiment. If so, tell them they may, but they still need to explain their experimental design in words.

As you can see the diet cola test is simple and include two open-ended problems. Students will design an experiment step-by-step using SPS in both Form A and Form B as pretest and posttest. The instructions are expressed clearly for students. The language and field experts stated it is understandable in Turkish culture too or very similar that it is appropriate as it is in the final translation. The Turkish version of the test is given in the Appendix 1. The Fowler Diet Cola Test rubric is as follows.

Table 5

The Fowler Diet Cola Test Rubric

Fowler Science Process Skills Assessment Pre-Test/Posttest Scoring Sheet
Score one point on student paper for each item incorporated into design. Score two points if more than one sub-item is listed for a specific item.

Pre			Post
	plans to practice **SAFETY**		
	states **PROBLEM** or **QUESTION**		
	PREDICTS outcome or **HYPOTHESIZES**		
	lists more than **3 STEPS**		
	arranges steps in **SEQUENTIAL** order		
	lists **MATERIALS** needed		
	plans to **REPEAT TESTING** and tells reason		
	other items listed by student but not on list		
	DEFINES the terms of the experiment: "attracted to" "likes" "bees" "Diet Cola"	**DEFINES** the terms of the experiment: "attracted to" "likes" "earthworms" "light"	
	plans to **OBSERVE**		
	plans to **MEASURE**: (e.g., linear distance between bees, and/or cola, number of bees, time involved)	plans to **MEASURE**: (e.g., linear distance between worms, and/or light, number of worms, time involved, amount of light)	
	plans **DATA COLLECTION**: graph or table; note taking; labels		
	states plan for **INTERPRETING DATA**: comparing data; looking for patterns in data; in terms of definitions used; in terms of previously known information		
	states plan for making **CONCLUSION BASED ON DATA**: (e.g., time to notice drinks; bees may not be hungry; distances to sodas are equal; time involved for two samples is equal; temperature, light, wind, etc, are equal)	states plan for making **CONCLUSION BASED ON DATA**: (e.g., time to notice light; distances to light and shade are equal; time involved for two samples is equal; temperature, wind, etc, are equal)	
	plans to **CONTROL VARIABLES**: (e.g., bees not hungry; bees choose diet or regular soda; distances set equally; amounts of soda equal; number of bees tested are equal; temperature, light, wind, etc, are equal)	plans to **CONTROL VARIABLES**: (e.g., worms choose dark or light; distances set equally; number of worms tested are equal; time involved is equal; temperature, wind, etc., are equal)	

Pretest Score: _______ Name of rater: ___________________ Date:________
Post test score: _______ Name of rater: ___________________ Date:________

The rubric included the SPS in every step that the students' experimental designs are proper or not. Every step has a scoring instruction given the top of the table. It should be noted that every student who take the test should be exposed to the scientific processes like mentioned before. Additionally, the SPS are universal that they are all measured using this rubric so that the language experts agreed on the translation and field experts approved on the SPS content of the rubric. The Turkish version of the rubric is given under Appendix 2.

Discussion and Conclusion

The statistical analysis and expert opinions suggest that this test is sensitive to student responses. When the SPS is taught, teachers or researchers can use this test to investigate how the skills were developed. As Adams and Callahan (1995) suggested, the test has no significance between gender and groups, so that it can be used in class. The teachers who focus on SPS teaching and are interested in determining whether the teaching process is effective on students should use it at the beginning and end. The results suggested the use of the DCT to measure the SPS of gifted students. Similarly, Dailey and Robinson (2017) used the test accordingly to assess the SPS of gifted students' science teachers that how they understand experimental design and they supported the content validity as well.

We saw that even the students were high achievers in science and gifted in terms of skills in support group program in SACs, they achieved low scores from a test that evaluate the process of experimenting using scientific inquiry. They did not achieve in both Form A and Form B even the scores decreased at the post test (Table3; 4). It is thought that students who are gifted and want to improve their skills in scientific processes should be given more opportunities and especially exposed to daily life problems. Sağat and Karakuş (2019) similarly suggested that gifted students reflect their ideas on the results, apart from the experimental processes, to complete the activity, so they indicated the development of their research and knowledge-oriented skills.

The test starts with a problem situation and asks students to develop an experiment to explain the problem. Initially, Fowler (1990) wondered how students design and conduct experiments? When we examined the whole procedure, we understood that the experimental design and the activity itself are compatible with the nature of the inquiry-based approach. Especially integrating the lesson plans with guided inquiry and preferably open inquiry makes it more valid and reliable. Literature also suggests using the inquiry-based approach in science for gifted students (Buerk, 2021; Özgür & Yılmaz, 2017; Ülger & Çepni, 2020; Yang & Kang, 2020). The best way to measure the development the skills is performance-based assessment which clearly represents an indispensable approach for assessing gifted student learning (VanTassel-Baska, 2014). The DCT was used in the studies assess the students' performance on scientific process skills while solving the problems given (Dailey & Robinson, 2017; Ju & Kim, 2013; Kim & Shin, 2006). It should be noted that students should not be expected to get high scores for this scale unless they are applied to scientific processes together with the science content. Because not only choosing or finding one answer but also asking for producing their work is essential to develop their skills at their own pace.

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APPENDIX 1

Bilimsel Beceri Ön-Testi Yönergesi

1. Her öğrenciye testin bir kopyasını dağıtın.
2. Aşağıdaki yönergeyi sesli okuyun:

    Bugün bir deneyi ne kadar iyi tasarladığınızı görmek için test edileceksiniz.
    Ben problemi sizlere sesli bir şekilde okurken, size dağıtılan kâğıdınıza dikkat edin.

(Form A)

Toprak solucanları ışıktan etkilenirler mi? Diğer bir deyişle, toprak solucanları ışığı severler mi? Bu soruyu nasıl test edeceğinizi/deneyselleştireceğinizi açıklayın.
Testiniz/deneyiniz hakkında yazarken olabildiğince bilimsel olun.
Toprak solucanlarının ışığı sevip sevmediği ile alakalı olarak oluşturduğunuz testin basamaklarını maddeleştirerek yazın.
Başlayabilirsiniz.

(Zaman limiti yoktur, fakat en fazla 10-15 dk. Sürecek bir çalışmadır) Not: Öğrenciler deneylerinin resimlerini çizmek istediklerine yönelik soru sorabilirler. İsteyen öğrenciler çizebilirler fakat yine de kendi cümleleriyle deney tasarımlarında ne yapacaklarını açıklamaları gerekmektedir.

Bilimsel Beceri Son-Testi Yönergesi

1. Her öğrenciye testin bir kopyasını dağıtın.
2. Aşağıdaki yönergeyi sesli okuyun:

    Bugün bir deneyi ne kadar iyi tasarlayabildiğinizi görmek için test edileceksiniz.
    Ben problemi sizlere sesli bir şekilde okurken, size dağıtılan kâğıdınıza dikkat edin.

(Form B)

Arılar diet koladan etkilenirler mi? Diğer bir deyişle, arılar diet kolayı severler mi? Bu soruyu nasıl test edeceğinizi/deneyselleştireceğinizi açıklayın.
Testiniz/deneyiniz hakkında yazarken olabildiğince bilimsel olun.
Arıların diet kolayı sevip sevmediği ile alakalı olarak oluşturduğunuz testin/deneyin basamaklarını maddeleştirerek yazın.
Başlayabilirsiniz.

(Zaman limiti yoktur, fakat en fazla 10-15 dk. Sürecek bir çalışmadır) Not: Öğrenciler deneylerinin resimlerini çizmek istediklerine yönelik soru sorabilirler. İsteyen öğrenciler çizebilirler fakat yine de kendi cümleleriyle deney tasarımlarında ne yapacaklarını açıklamaları gerekmektedir.

APPENDIX 2

Fowler Bilimsel Süreç Becerileri Ölçeği

Ön test/ Son test Puanlama Anahtarı

Öğrenci adı: ________________ Okulu: ________________
Tasarıma eklenene her bir madde için öğrenciye bir puan verilir. Eğer her bir alt madde ile ilgili listelenen belirli maddeler için ise 2 puan verilir.

Ön	Form A	Form B	Son
	GÜVENLİK ile ilgili planlar		
	PROBLEM veya **SORU CÜMLESİ**		
	Sonuç tahmini veya **HİPOTEZ**		
	3 ADIMDAN fazla basamak		
	Adımların **SIRASIYLA** düzenlenmesi		
	Gerekli **MATERYAL LİSTESİ**		
	TEST TEKRARININ planlanması ve gerekçesi		
	Listede olmayan fakat öğrenci tarafından belirtilen diğer basamaklar		
	Deneydeki terimlerin **TANIMLANMASI**: "hoşlanma", "diet cola", "arılar", "ilgi çekmek"	Deneydeki terimlerin **TANIMLANMASI**: "hoşlanma", "ilgi çekmek", "toprak solucanları", "ışık"	
	GÖZLEME dair planlar		
	ÖLÇMEYE dair planlar: (Örn; kolalar/arılar arası uzaklık, , arı sayısı, zaman)	**ÖLÇMEYE** dair planlar: (Örn; ışık/solucanlar arası uzaklık, ışık miktarı, solucan sayısı, zaman)	
	VERİ TOPLAMAYA ilişkin planlar		
	VERİ YORUMLAMAYA ilişkin planların ifadesi: veri karşılaştırma, veride bir model arama, ön bilgi kullanımı, tanım kullanımı)		
	VERİYE İLİŞKİN SONUÇ ÇIKARMA ifadeleri: (Örn; içecekleri fark etme zamanlarını not etme, arılar aç olmayabilir, kolalar arası mesafe eşittir, her iki örnekleme ait zaman miktarı eşittir, sıcaklık, ışık, rüzgar vb. eşittir)	**VERİYE İLİŞKİN SONUÇ ÇIKARMA** ifadeleri: (Örn; ışığı fark etme zamanlarını not etme, gölgeye ve ışığı olan mesafeleri eşittir, her iki örnekleme ait zaman miktarı eşittir, sıcaklık, ışık, rüzgar vb. eşittir)	
	KONTROL DEĞİŞKENLERİ ile ilgili planlar: (Örn; Arılar aç değil, arılar normal veya diet kolayı seçtiler, uzaklıklar eşit dağıtıldı, test edilen arı sayısı eşit, sıcaklık, ışık, rüzgar vb. eşit)	**KONTROL DEĞİŞKENLERİ** ile ilgili planlar: (Örn; solucanlar ışığı veya gölgeyi seçtiler, test edilen solucan sayısı eşit, ölçülen zaman eşit, sıcaklık, ışık, rüzgar vb. eşit)	

Öntest Puanı: ______ Puanlayıcı Adı: ________________ Tarih: _______
Son test Puanı: ______ Puanlayıcı Adı: ________________ Tarih: _______