

4.1 Case study 1 (CS1 Turkey)

Concept focus	Introduction to the concept of speed
Activities implemented	Activity A
Inquiry skills	Planning investigations Working collaboratively
Scientific reasoning and literacy	Scientific reasoning (collection of data, identification of variables)
Assessment methods	Classroom dialogue Teacher observation Worksheets
Student group	Grade: 7 th grade (lower second level) Age: 14-15 years Group composition: mixed ability and gender; 24 students Prior experience with inquiry: Some prior experience (collecting data, teamwork and conducting an experiment)

In this case study, one activity from the Speed SAILS unit was implemented with a class at lower second level. Skills chosen for assessment were *planning investigations*, including carrying out the experiment, and *working collaboratively*, in particular teamwork. *Scientific reasoning* capabilities were also assessed, looking at ability to identifying variables and to collect scientific data. The teacher assessed these skills during the lesson, when student groups were working on their inquiry process.

(i) How was the learning sequence adapted?

The **Speed** SAILS inquiry and assessment unit was implemented during a single 45-minute lesson. Activity A was investigated and the learning sequence followed the steps described in the unit with no modifications. This unit was implemented with group working (6 groups, 4 students in each group, Figure 1). The students have some experiences with inquiry, but always using structured inquiry activities like laboratory experiments. Therefore *planning investigations* was an unusual situation for them.

At the beginning of the lesson, teacher gave out the students' worksheet (Figure 2) and explained what was required during the activity. First of all, students read the worksheet and afterwards all groups planned own investigation and conducted experiments. The **Speed** unit was constructed with two main tasks. The first task was to plan an experiment to measure how far the students would walk in 5 seconds. The second task asked students to plan an experiment to measure how long it would take to walk 5 metres. The teacher implemented the activities in that order, because she considered the first stage to be very important for understanding speed. When the students finished the first task, teacher then said that students could conduct second task. At the end of the activity, groups presented their results and processes. Then a whole group discussion was made because teacher wanted to provide clarification for all of students.

Student: **Teacher, we will measure distance via meter. Because 5 seconds is very short time period to measure. Do we use meter?**

Teacher: **All right. How do we determine how much time passes?**

Student: **Via meter.**

Teacher: **You measure distance via meter. Ok, do you measure time when you use meter? I am walking now and how do I know what time is passing?**

Student: **Ok. I use stopwatch to measure time.**

Figure 3: Examples of responses to teacher questions for planning investigations

For collecting and interpreting data, teacher looked into group’s worksheet during and at the end of the activity. Teacher used students’ worksheet as an instrument for assessment of inquiry skills. Also she used rubrics to assess whether or not students recorded data. *Working collaboratively* was very difficult to assess, because generally the students look as if they are studying together. However some students were more active than their teammates. Moreover the teacher did not distinguish which stages should be done together and which stage done individually.

Table 1: Teacher rubric for assessment of inquiry skills

Inquiry skill	Emerging	Developing	Consolidating	Extending
Planning investigations	Research plan to be feasible. <i>(Are their plans investigable?)</i>	Choose materials according to plan. <i>(Students group choose accurate materials to conduct their plan)</i>	Relationship between plan and variables <i>(Plans whether have some variables or not)</i>	Alternative plan for possible problem when it may arise research process. <i>(We can change other variables if our plan doesn’t work)</i>
Identifying variables	Variables mentioned	Relevant variables mentioned (speed, time, distance etc.)	Relationship between variables and measurements	Relates to control of variables <i>(They should consider some variables that are controls)</i>
Collecting and interpreting data	Collect some findings at the end of the implementation process (they don’t collect data). <i>(e.g., “We find something about our research”)</i>	Collect data <i>(Data must relate to research question or variables)</i>	Relationship between data and research question <i>(Students should explain that relation between data and research question)</i>	Use data and interpret to answer research question. <i>(Their interpretations must base on evidence/data)</i>
Working collaboratively (teamwork)	Work individually in groups	Work together in planning an investigation	Work together in both planning and conducting an investigation	Work together in planning, conducting, and evaluating an investigation

(iii) Criteria for judging assessment data

To assess inquiry skills developed in the **Speed** SAILS unit, teacher used the rubric in Table 1 when she assessed students’ working and she decided group levels/stages. Then she gave appropriate feedback according to the group’s performance levels. The teacher evaluated inquiry skills step by step.

(iv) Evidence collected

Teacher opinion

This research process related to not only measuring distance and time but also how to “plan” to measure distance and time. I think this is important point for inquiry-based learning, because we generally give the research process and ask for some findings from students. So my students had difficulties during the *planning investigations* stage. I gave some prompts and feedback related to planning of investigations. Then my students planned their investigation.

I was unaccustomed to using rubrics during my lesson so I had difficulty. Thus, I preferred group assessment than individual assessment. You can organize to use two assessment tools – one for group assessment and another for individual assessment. Thus teacher can choose one of them.

During the activity, I think my students showed success about inquiry skills developed in the **Speed** unit. For example, I asked a question about margin of error and appropriate measurement “Are your results accurate?” and “How can we get hypercorrect answers?” Students said that “We measure several times and we take the mean of these measurements.” I was very surprised when I heard the answer, because we haven’t talked about margin of experimental error. This student answer provides very good evidence for his/her inquiry skills.

Observer notes

We recorded the activity lesson via one camera and one voice recorder that was on teacher’s clothes. In this case there was evidence of inquiry skills (*planning investigations, working collaboratively*) and *scientific reasoning* (identification of variables, collecting and interpreting data), because this activity both targets few skills and these skills were integrated within it. The teacher preferred group assessment more than individual assessment (teacher said that she used group assessment because it is easier). The teacher used rubrics to assess group’s study for each skill. Also she assessed inquiry skills when students complete some task as an inquiry stage. For example, teacher evaluated students’ plan when groups finished their investigation plan. If whole group’s discussion related to planning was finished, groups could start their experimental process. Thus assessment processes related to each inquiry skills both were easier and timely.

Sample student artefacts

Student groups generally used two different methods for their investigation plan. The first method related to measuring step size and finding the distance travelled. The second method was interested in measuring time and finding the distance travelled. In example 1 (Figure 4), students state, “We will use meter to find out how far a man can walk in 5 seconds. If our length of step size is large or our speed is high, we will walk further than the others.” When we evaluate this plan, we say that the correct equipment was chosen and the group has identified variables. These criteria have shown that this student group is in the consolidating category for the inquiry skill *planning investigations*.

Also in this example, for collection and interpretation of data, students wrote, “3.80-4.25 meter is our results. Our results answered the research question. Results are different because the first group [*they formed two sub-groups in their team*] walked slowly and we found 3.80 m, the second group walked fast and we found 4.35 m.” When we look this explanation, we can see data and some variables that have affected their results. Also this explanation has at the end a decision whether groups found an answer or not related to research question. There is evidence of targeted skills when evaluated from this perspective.

<p>Aşağıda yer alan soruların cevaplarını bulmak için nasıl bir ölçüm yaparsınız.</p> <p>Soru 1: 5 saniyede ne kadar yol alacağınızı nasıl ölçeriniz?</p> <p>Araştırma planınız: Bu araştırma sürecinizi nasıl yapacağınızı anlatmanız gerekmektedir. Bunu you veya çizim ile anlatabilirsiniz. Planınızın uygulanabilir olmasına dikkat ediniz.</p> <p>Bin aradan 5 saniyede ne kadar gittiğini metre ile ölçünüz. Birini adımıyla ve hızıyla ne kadar hızlıca 5sn gitmişse o kadar çok olur.</p>  <p>Kullanılacak Materyaller: Kronometre ya da metre</p> <p>Uygulama süreciniz: Planınızı uygulayıp ne tür sonuçlar aldığınızı yazmanız beklenmektedir. Elde ettiğiniz veriler/deliller araştırma sorusuna cevap verebildi mi?</p> <p>3.80 4.25 > 1. hız farklı, herkesin farklı adımları 2. grup yavaş yürüdü 3.80 m çıktı biz hızlı yürüdük 4.25 m çıktı.</p> <p>Elde ettiğiniz verileri başka birine anlatmak için nasıl organize edersiniz veya özetlersiniz? Bazılarımız yürümek için adımların 5sn ne kadar hızlı olduğunu, hızlı ne kadar yürüdüğü ve hızlı adımlarla ne kadar yürüdüğünü o nokta için açıklık yaptık.</p>	<p>Research Question 1: How far you can walk in 5 seconds and how do you measure it?</p> <p>Planning of investigation: We will use meter to find out how far a man can walk in 5 seconds. If our length of step size is large or our speed is high, we will walk further than the others.</p> <p>[sketch of experiment]</p> <p>Equipment: Stopwatch and metre</p> <p>Experimental Process: Conduct your plan and write your results.</p> <p>3.80-4.25 meter is our results. Our results answered the research question. Results are different because the first group walked slowly and we found 3.80 m, the second group walked fast and we found 4.35 m.</p> <p>Can your data address the research question? How can you organise your data for presenting?</p> <p>To explain our process we would use a person. The person would act this process within two different variables (fast walking and big steps) to measure distance for 5 seconds. Thus I can abstract this process with this demonstration.</p>
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Figure 4: Example 1, student artefact for research question 1

The students' worksheets were two-sided. The second side had the other research question (how do you measure the time it would take to walk 5 metres?) Some of the groups compared new data and previous research data or they improved their first investigation plan and they used the new data. In example 2 (Figure 5) for *planning investigations*, students wrote: "First we will determine 5 meter length. Then we will use stopwatch to measure time. We will conduct experimental and mathematical process as we done previously. We will use ratio and proportion to calculate time and distance. For example: If we walk 1 meter in 2 seconds, we may walk 5 meter in 10 seconds." Students' explanation is quite clear and they say that which equipment they will use, but they didn't mention variables that affect their results. They did not exclude variables, but they realised this when they wanted to apply their plan. Students wrote something about this situation: "Our speed and number of step changed when we applied the plan. First measurement showed 7 seconds and second measurement showed 5 second."

<p>Soru 2: 5 metreyi ne kadar sürede alacağınızı nasıl ölçersiniz?</p> <p>Araştırma planınız: Bu araştırma sürecinizi nasıl yapacağınızı anlatmanız gerekmektedir. Bunu yazı veya çizim ile anlatabilirsiniz. Planınızı uygulanabilir olmasına dikkat ediniz.</p> <p>5 metreyi belirleyiz. Sonra kronometre tutarız. Diğer yaptığımız etkinliklere</p> $\frac{5m}{880m} \times \frac{500m}{10s} = 7$ <p>1 metreyi 2 saniyede alarak 5 metreyi 10sn alırsak</p> <p>Kullanacağımız Materyaller: kronometre, metre</p> $\frac{100m}{2s} \times \frac{500m}{10s}$ <p>Uygulama süreciniz: Planınızı uygulayıp ne tür sonuçlar aldığınızı yazmanız beklenmektedir. Elde ettiğiniz veriler/deliller araştırma sorusuna cevap verebildi mi?</p> <p>Şu anki hız ve adım sayımızda değişiklik oldu. Beklemediği yöne gidiyor</p> <p>İlk başta 7s'ye gidiyordu daha sonra 5sn'ye gidiyordu. İnan ortası olarak 6s aldık.</p> <p>Elde ettiğiniz verileri başka birine anlatmak için nasıl organize edersiniz veya özetlersiniz?</p> <p>Oran oranı kavrak ve bulduğumuz sayıyı yuvarladık ve 7'ye dedik. Daha sonra 1 metreye 2 saniye gidiyalık 5m'de kaç sn alınıca diye oranı kavrak ve 10s çıktı. Daha sonra deney yaptık ve medymini bulduk. İlk önce 7sn çıktı, daha sonra 5saniye çıktı ve biz de ortasını 6'yı aldık.</p>	<p>Research Question 2: How far you can walk in 5 seconds and how do you measure it?</p> <p>Planning of investigation: First we will determine 5 meter length. Then we will use stopwatch to measure time. We will conduct experimental and mathematical process as we done previously. We will use ratio and proportion to calculate time and distance. For example: If we walk 1 meter in 2 seconds, we may walk 5 meter in 10 seconds.</p> <p>Equipment: Stopwatch, metre</p> <p>Experimental Process: Conduct your plan and write your results.</p> <p>Our speed and number of step changed when we applied the plan. First measurement showed 7 seconds and second measurement showed 5 second.</p> <p>Can your data address the research question? How can you organise your data for presenting?</p> <p>We used ratio and proportion to find a number that was 7. Then we did proportion that is how second does it take for 5 meter if we get over 1 meter within 2 second. After that, we conducted experiments. First measurement showed 7 seconds, second measurement showed 5 seconds. Thus we decided to use median that was 6.</p>
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Figure 5: Example 2, student artefact for research question 2

(v) Advice for teachers implementing the unit

We applied the activity in our classroom. I wished I could do inquiry activity out of the classroom, because if we applied the activity out of the classroom it would have been easier. For this reason I advise that teachers should do this activity out of the classroom.