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AN INQUIRY-BASED SCIENCE ACTIVITY: FLOATING-SINKING-STAYING BETWEEN THE SURFACE AND BOTTOM[1]

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ABSTRACT

The inquiry-based learning (IBL) approach is at the core of contemporary science education programs and aims to enable students to conduct research. In this study, an IBL activity was developed based on scientific concepts related to the respiratory systems of fish and scientific investigation skills. The developed activity was implemented for 2 hours in a 7th grade classroom of a public school. Data was collected through classroom observation, student worksheets, and semi-structured interview with the teacher following the lesson. Data analysis revealed that the activity was successfully implemented. The activity is a good resource for teachers who want to engage their students in IBL activities, seek materials that support students' scientific investigation skills, and want to support students' conceptual learning of scientific concepts. The general structure of this activity and how it involves inquiry-based learning provides an exemplary practice for the practitioners and researchers in the field.
Keywords: inquiry-based learning, respiratory systems, floating-sinking-staying in between surface and bottom.

SORGULAMAYA DAYALI BİR FEN ETKİNLİĞİ: YÜZME-BATMA VE ASKIDA KALMA

ÖZ

Sorgulamaya dayalı öğrenme, güncel fen eğitim sistemlerinin temelinde yer alan ve öğrencilerin bilim insanları gibi araştırmalar yapmasını hedefleyen bir yaklaşımdır. Bu çalışma, öğretmenlerin sınıf uygulamalarında kullanabileceği sorgulamaya dayalı öğrenme etkinliği geliştirmeyi ve bu etkinliklerin kullanımı konusunda öğretmelere örnek teşkil etmeyi amaçlamıştır. Bu amaç doğrultusunda balıkların solunum sistemleri ile ilgili bilimsel kavramları temele alan bazı araştırma becerilerinin bulunduğu bir etkinlik geliştirilmiştir. Geliştirilen etkinlik bir devlet okulunun 7. sınıf düzeyinde 2 ders saatinde uygulanmıştır. Uygulama sırasında elde edilen sınıf içi gözlemler, uygulamaya yönelik öğrenci çalışma kâğıtları ve uygulama sonrasında öğretmen ile yapılan yarı yapılandırılmış görüşme sonuçlarına göre etkinliğin başarı ile uygulandığı görülmüştür. Bu etkinliği; sınıflarında sorgulamaya dayalı öğrenme etkinlikleri yapmak isteyen, öğrencileri için araştırma becerilerini destekleyici materyaller arayan ve aynı zamanda öğrencilerin kavramsal gelişimlerini desteklemek isteyen öğretmenlerin uygulaması önerilmektedir. Etkinliğin genel yapısının ve sorgulamaya dayalı öğrenmenin sınıf içi uygulamalara nasıl dönüştürülebileceğinin açık bir şekilde verilmesinin uygulayıcılara ve alandaki araştırmacılara yol göstereceği düşünülmektedir.
Anahtar kelimeler: sorgulamaya dayalı öğrenme, solunum sistemleri, yüzme-batma-askıda kalma.

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INTRODUCTION

The concept of inquiry is based on Dewey, Bruner, Postman, and Weingarten's ideas on education (Craig, 2008). However, its association with science teaching as an educational approach started with Schwab's work (1962). Later, it was used for science teaching in the United States (US), following Schwab's research (1969, 1973). Today, contemporary science teaching programs (e.g., Ministry of National Education [MoNE], 2013; National Core Curriculum for Basic Education [NCCBE], 2004; Next Generation Science Standards [NGSS], 2013) recommend and use inquiry-based learning (IBL). In the National Research Council's (NRC) reports in 1996, 1997, and 2000, an inquiry was held into determining the standards of science education and determining the frameworks of science learning and teaching in US high schools. These reports played an essential role in increasing the use of IBL in the study of science. In the report prepared by Rocard et al. (2007), inquiry-based science education started with an emphasis on the need for science education today and in the future. In this context, many researchers have carried out studies focused on the use of IBL. These have often been experimental studies concerning the development of IBL in the context of concepts and skills, descriptive studies investigating the opinions, attitudes and knowledge levels related to this approach, and qualitative studies, focusing on the classroom and the use of the method.

Efforts to improve teacher practices have also gained value by proposing to expand the use of IBL in classrooms. This requirement and the need to increase the quality of using IBL approach in the classroom are clearly emphasized in the findings of many of these studies. For example, in research by Kaya and Yılmaz (2016), it is emphasized that teachers should pay attention to the type of inquiry being led and increase the responsibility of the students in the inquiry processes as much as possible.

As stated in Windschitl (2002) and Kaya and Yılmaz (2016), there are different levels when applying the IBL approach. These levels are classified according to the responsibilities and roles that are given to teachers and students. Sadeh and Zion (2009) draw up this classification according to how free the student is left to ask questions in the lesson. For example, *confirmatory inquiry*, which is the simplest level of this classification, confirms a set of scientific principles by the learners following a given process, as in a recipe in a cookbook (Windschitl, 2002). The highest level is the *open inquiry*, whereby the teacher allows the students to form their own research questions and processes (Brown & Melear, 2006). One of the other two levels concerns research questions, with students following a *structured inquiry*, where the teacher leads the process. The last level is the *guided inquiry*, which is used in this study, where the teacher creates the research question, and the next steps are carried out by the students (Bell et al., 2005).

The levels of inquiry used in classrooms are related to the availability of teaching opportunities at school; this is a controversial issue among educators. Some teachers prefer structured and guided inquiry, while others claim that any level of inquiry other than open inquiry is not appropriate considering the educational perspectives underlying this method (Kaya & Yılmaz, 2016). Guided inquiry advocates claim that guided IBL helps students understand scientific contents, high-level scientific skills, and the nature of scientific knowledge (Blanchard et al., 2010; Quintana et al., 2005). They also state that guided inquiry reduces both students' wasted time and fear of a sense of failure when not achieving a result (Trautmann et al., 2004). The current study utilized a guided inquiry approach drawing on these ideas shared in the related literature.

No matter what level of IBL activities are used, five basic structures are required. These structures, which are stated in the NRC (2000) report, are:

1. A scientifically-focused question.
2. The need to develop and evaluate explanations to explain the question by giving priority to the evidence.
3. The formulation of explanations to answer scientifically-oriented questions based on the evidence.
4. The evaluation of scientific meanings in the light of alternative explanations.

5. The need to explain and defend/justify the explanations obtained.

These features form the basis of IBL activities and provide essential clues to practitioners for classroom practice. Çavaş et al. (2011) discussed the applications of IBL activities in the classroom, focusing on three main stages: Initiating an inquiry, focusing on the investigation, and sharing understanding. Using a similar approach, Kaya and Yılmaz (2016) planned their classroom activities with an open inquiry-based learning approach to include three stages. In these stages, the primary purpose of the *initiating an inquiry* is to create a relationship between the learner's curiosity and the planned course content. At this stage, the student is expected to examine the materials, make observations and ask questions. This stage is completed with the research question being created by the students under the guidance of the teacher (Çavaş et al., 2011). In the next stage, *focusing on the investigation*, the students, in small groups, research the questions created through the process of initiating an inquiry and developing ideas on how to produce solutions (Kaya & Yılmaz, 2016). One of the most important activities at this stage is to produce materials. The final stage, *sharing understanding*, is the process that enables groups to make presentations to share their experiences with their friends (Zhang & Krajcik, 2005). Here, peer learning allows them to reconsider their ideas (Kaya & Yılmaz, 2016).

The activity used in this research was prepared with a similar configuration, and it was planned and implemented following the level of guided inquiry. The aim of the activity, which has been prepared according to the structure mentioned in the literature, is to design a model that shows how fish can swim on the surface, at the bottom and in the middle of a body of water. The activity's conceptual bases are "classifying living creatures according to their similarities and differences." and "showing the structures and organs that make up the respiratory system of the model." The skills targeted for acquisition were based on scientific process and research skills, such as data collection, observation, inference, predicting, defining and controlling variables, communication, designing an experiment, and establishing a hypothesis.

ACTIVITY IMPLEMENTATION

The activity carried out in the study aims to understand what the function of a fish's swim bladders and how a fish can swim. The activity, which is based on guided inquiry, is appropriate to apply at the middle school level in terms of both subject and cognitive competence. The study's scope was carried out in 2 class hours with 28 students (in groups of four) in the seventh grade in a public school in Kastamonu province of Turkey. The study was checked for ethical consideration, and it was found ethically appropriate with the decision of the Hacettepe University Ethics Committee on 15 May 2018 with number 35853172-619.

The implementation of the activity was carried out by the second author, a teacher in an educational institution, who has experience in IBL. In advance, scientific and technical trials were carried out in the preparation phase to determine the activity stages. Also, some of the model examples expected to be created in the activity were prepared by the teacher before the activity.

Although the activity is founded in biology for its target learning outcome, it has an interdisciplinary structure. Data collection, observation, inference, estimating, defining and controlling variables, communication, interpretation, designing experiments, and forming hypotheses are required scientific skills. The activity is based on the swimming, sinking, and suspension activities used in the Fibonacci (http://www.fibonacci-project.eu/) and PRIMAS (https://primas-project.eu/) projects, and associated with the IBL approach. Unlike the activities for teaching the concepts of swimming, sinking, and hanging, it has been associated with the respiratory systems of living things. It has been planned and implemented in a guided inquiry cycle. As mentioned in the introduction, it consists of the stages of initiating an inquiry (introduction), focusing on the investigation, and sharing understandings (conclusion).

Tools and Equipment

The materials needed for the activity are as follows:

- worksheets,
- 500 ml plastic bottles,

- marbles,
- straws,
- plaster or tape,
- a screwdriver,
- scissors,
- balloons,
- play dough,
- large plastic box (buoyancy pool),
- water, and
- color pencils (optional).

The teacher can also create a model in advance based on the student level in the classroom. However, no model was used in the current study. Care should be taken when allowing students to use cutting and piercing tools. If necessary, these procedures can be performed by the teacher to the extent that the students wish.

The activity process is outlined in Appendix 1. The details of the implementation process are given in Appendix 2. The swimming process of fish and the role of swim bladder are explained in Appendix 3. Finally, the activity worksheet is given in Appendix 4.

Implementation Process

The activity was implemented in three stages:

1. Initiating an Inquiry (Warm-up Questions)

At this stage, the students were asked, "How do living things swim in the water?", "How can you keep motionless on the surface of the water when you are in the sea or a pool?" and "How do divers stay under the surface of the water?" The questions were asked to check the students' prior knowledge. During the warm-up question time, there was no feedback indicating if anything was correct or wrong. The goal here was to see what the students knew and to find out any misconceptions about the content.

In this section, the answers from the students were more related to their background. The vast majority of students raised examples of fish when talking about how living things swim and stated that they used their fins. Nothing was mentioned about the amount of air a fish might have in it or the function of its swim bladder. The question of how do living things stay on the surface of water helped the students recognize the role of air in swimming. When asked the question: "How do divers stay beneath the surface of the water?", the students mentioned about the use of air tubes. In addition to this, two groups stated that divers wear weights to sink deeper into the water, allowing other groups to start to look at the swimming process differently. Through this initial discussion, imaginations were created for the activity by allowing students to relate to the subject and call on prior learning. The practitioner's role in the process was not to transfer information but to allow the students to reveal their knowledge and provide them with opportunities to connect the new knowledge with the existing knowledge. The students were encouraged to express their opinions in an environment of open discussion. The most crucial thing at this point is that the teacher does not convey his/her ideas or thoughts.

2. Focusing on the Investigation

In this section, the students were asked the research question: "How can you make a fish model that can swim both on the surface of the water, at the bottom of the tank and also hang in the middle of the water?" Referring to a fish model related the activity to scientific concepts. The model does not need to be described in this way – it can just be referred to as the “model.” At this stage, the students were introduced to the materials and were told that they needed to design a model that could float, suspend, and sink. They were also told that they did not have to use all of the materials. In this section, it was thought that first drawing the group design would make it easier to create the final model. Accordingly, the first question on the worksheet asks students "Draw the design of the fish model you intend to make." It was expected that the design would come from the students with no teacher input. The teacher was expected to give the students enough time, and to encourage them to create a design.

In the second phase, the design process of the groups came to the fore. When the design processes of a sample group (the second group) were taken into account, it could be seen that the first step was the sharing of ideas and their presentation within the group. In the next phase, it was observed that the group formed a scientific basis to their ideas by discussing them. They then turned to the materials and created designs for production. The members of the group agreed upon the idea that having a single air intake in the bottle would facilitate movement. They also placed their weights at the opposite end to the air intake. At this stage, the students were most challenged by where the air should enter and, at this point, the place where they hesitated was hanging in the middle of the water position. The teacher acted merely as an observer and was not involved in the design or creation of the models. The only help offered in this phase was when the use of cutting and piercing tools was required. Sample drawings of the students' designs are given in Figure 1.

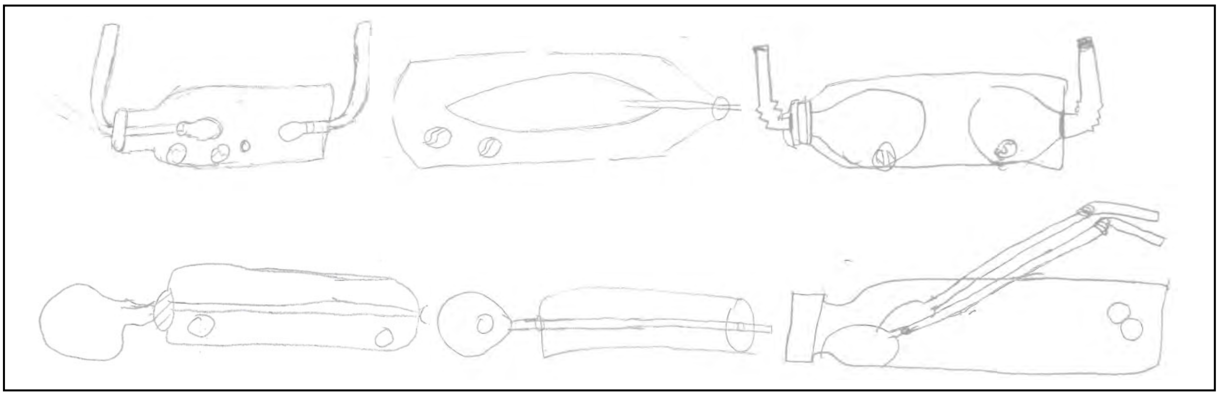

Figure 1. Design Examples by Students

The students' drawings exhibited a range of different designs. In some designs, the students tried to use all the materials they had been given, and different methods were tried to facilitate the air input and output. In all the models, straws were used; in some models, the balloon was located inside the model, while in others, it was located on the outside. A wide variety of models is encouraged to enrich the discussion and the process of evaluation of the different results. At this stage, the teacher did not interfere with the designs, and acted only as a guide for the students' questions.

The students were given time to work with the model designs they had drawn. During this time, they worked in groups, updating their models and collecting data to answer the research question. The teacher was an observer at this stage, only assisting students in the use of cutting and piercing tools. During the lesson, the teacher performed cutting and drilling operations at the students' request.

3. Sharing Understanding (Concluding Activity)

In this section, the students were asked to share their designs and results. First, the children showed their models in a tank of water, where everyone could see them. They had to explain what they had paid special attention to in their designs. In this context, they were allowed to experiment and further develop their designs. It was important in the intergroup interaction process that the groups could see the development of ideas and the possibility of other solutions.

At this stage, the students were asked to follow the group presentations to see each other's models and explain each group's thoughts and ideas when designing them after experimenting with them in the water tank. The teacher took on the mantle of moderator, but did not evaluate the models. Inter-student interaction was promoted, and solution methods were discussed and compared through the success of their models. Some of the trials of the students are given in Figure 2.

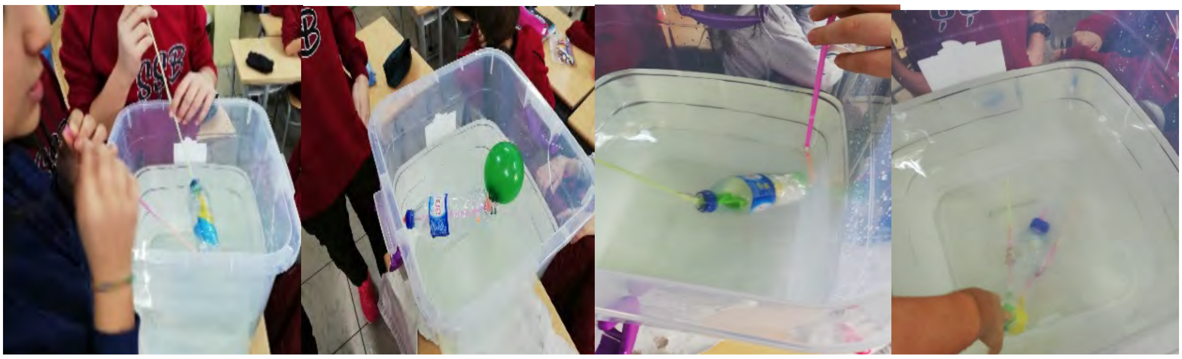

Figure 2. Models Made by the Groups

Students' designs and models were mostly similar but some of them involved revisions. After the student presentations were completed, the overall evaluation of the activity and a whole class discussion were initiated. When the students were asked to show the desired three characteristics (swimming, sinking, hanging) of the models they had made, three of the groups stated that the model they had made in the first stage only floated, while the other two groups stated that their model sank. One group said their model could swim and stay in the middle of the water. They later stated that they had improved their design and only then were able to perform the two different movements.

When asked what problems they had faced during the activity they responded by saying they had experienced problems with sinking, and that they had increased the weight by drilling more holes to make it sink more. The groups who were unable to perform the sinking task and bring the fish model back to the swimming position on the water stated that they needed to have inflated the balloons more. When asked "What parts or organs do the parts in the model represent in the fish?" all the groups answered the question by explaining that the plastic bottle represented the fish, the gills corresponded to the straws, and the swim bladder to the balloons. The answer to the question shows that the students now understood the respiratory systems of the fish, and the roles of the gills and the bladder. The questions asked after this stage are similar to the questions asked at the beginning of the activity to make connections to the initial knowledge and consolidate learning of the new knowledge.

Responding to the question "What scientific knowledge did you use in designing the model?", the students stated that if the bottle was filled with water, it would sink to the bottom, and if the balloons were filled with air, it would go up. This answer was the required and expected one needed to explain the scientific activity involved in the swimming and sinking of the fish. They determined that the swim bladder was essential for the movement of the fish. Regarding the question "What did you gain from doing this activity?", the students stated that they had designed and produced a model similar to a submarine. They also explained why the swim bladder was essential and related it to filling the lungs with air to stay on the surface of the water while swimming in the sea. The students expressed the view that they wanted to continue doing such activities.

EVALUATION of the ACTIVITY

In this section, the evaluations regarding the activity taught, the problems encountered, and suggestions for practitioners are discussed based on the student feedback and the findings obtained from the semi-structured interview with the teacher who carried out the activity. In the whole group discussion with the students following the implementation process, the students emphasized that the activity was different from the traditional lessons and that it brought them both scientific and practical experiences. Some students stated that they found the implementation part of the activity quite enjoyable. Some other students emphasized that it was more valuable to present their solution-oriented models. When the students' learning outcomes through the activity are taken into account, the activity may be considered to have been more successful compared to traditional classroom activities.

The practitioner teacher stated that the activity was generally successful and was implemented without problems. This is evident in his response to a question asked during the interview: "The activity was not challenging in general. It was carried out with ease. The students participated eagerly. They came up with ideas and tried to do it themselves. As they tried, they had a chance to go one step further." It has been seen that the activity is generally applicable in the format presented in the plan, and the different parts of the activity were implemented by following the instructions. When the teacher was asked to summarize the general course of the lesson during the semi-structured interview, the lesson's stages were reflected in the teacher's response.

> First of all, I asked students engaging warm-up questions. With these questions, I enquired about the students' knowledge of the subject. I gave no feedback regarding whether the answers were right or wrong. Then I asked them the research question, and told them what kind of things I expected from them. They first made a drawing of their model and then created their models. They answered questions about the activity during and after their trials. Lastly, we discussed the process and models together.

It can be seen that the answer given by the teacher includes the stages of (1) the initiation of the inquiry, (2) the focus of the investigation, and (3) the sharing of understanding. This shows that the activity can be implemented in the classroom as designed.

Regarding the question about describing what the most challenging parts of implementing the activity were, the teacher stated that it was the discussion part in the last part of the activity: "The discussion, which is the last part, was challenging. It was because the students' scientific background knowledge was not adequately prepared. Because of problems arising from our education system, they cannot present different perspectives. They cannot produce original ideas." He attributed this challenge to the current education system.

In the evaluation part of the implementation of this activity, in terms of the advantages and disadvantages, the teacher emphasized that time may be a disadvantage because the two recommended course hours were filled with the activity. The practitioner teacher evaluated the advantage in terms of the benefits to the students. This situation was stated as follows:

> As an advantage, children gaining different thinking skills will enable them to produce different ideas in other lessons and subjects. Mainly, the development of design skills contributes to the design of different things and innovative thinking skills. The skills developed in this activity will impact other lessons as well.

As the teacher stated, the activity was planned by targeting scientific concepts and aimed to develop certain skills. The teacher's views about the implementation show that the planning and the process of the activity complement each other.

For the implementation process of the activity, and for those who will apply it in future, the teacher made a self-assessment with suggestions about the time allocated to the parts of the activity. He said "I would try to make the last part, the discussion part, longer. There was not enough time. The time spent on the design could be shortened. There was no problem in the other sections."

The student worksheets and models could be designed to assess student learning. During the lesson, all of the groups came up with ideas for the given task. The models accurately reflected the solution proposals which serve their purpose and the worksheets included explanations about the model development process. For example, the point that was considered in the model developed by the third group was how the model would behave at different levels in the water. This highlighted that the students understood the activity goals. In the process of observing and developing the behavior of the model they had made, they noted: "Our model is floating but not sinking." They realized that they were missing their goals and said, "We increased the number of the holes and the weight of the model and made it sink and swim." In line with what they said, it can be claimed that the students understood the role of a swim bladder and realized that the weights were essential for sinking the object.

Group 4 said: "It needs water to sink and air to go up. When we fix the straw, if we have too much water, we blow into the balloon through the straw and inflate the balloon to make it go up." They expressed the importance of swim bladders by summarizing the process. This shows that there are different stages of learning. The students said that the activity was unusual. They explained that, by encouraging them to think, it enabled them to produce different ideas. They also stated that it was essential to respect all the different ideas and develop the ideas of friends by creating harmony within the groups. In terms of permanence of learning, the statement "Something I will never forget." summarizes the situation.

CONCLUSION and SUGGESTIONS

When the data obtained from the student worksheets and the semi-structured interview with the teacher is taken into account, the activity can be considered as successful in terms of achieving the desired goals. Practitioners may use the activity in their classrooms considering the success of the activity plan and the teaching process as well as the opinions of the teacher. Aligned with the related literature (Gencer, 2015; Özçelik & Akgündüz, 2018; Yılmaz et al., 2017), it was observed that the practice of students expressing their ideas increased the quality of learning.

In terms of IBL, the study revealed that generating solution methods, discussing ideas, and achieving results in search of a common goal are essential for students' social and cognitive development. Also, the availability of materials and the teacher's preparedness, scientific knowledge, and the ability to manage the process are essential for using the IBL approach (Bayram, 2015). Although concepts related to biology are targeted in the activity, it is structured so that it can be adapted for different disciplines. For example, this activity can be used to teach physics topics related to buoyancy, swimming, sinking, and suspension. At the same time, it can be used to design a submarine or a vehicle to facilitate the action of swimming in the water as part of STEM applications.

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Appendix 1

Overview of the Activity

Let's Float the Fish

In this activity, students will design a model that shows how fish can swim on the surface, bottom, and in the middle of the water.

Overview

Type of activity: Guided inquiry activity

Level: 6^{th} or 7^{th} grade

Unit: Explore the world of living things / *Systems in our body*

Subject: Getting to know the living things / *Respiratory system*

Purpose

- To understand how fish's swim bladder work, how fish can swim, and how fish's respiratory system functions.

Learning outcomes

- Learners can classify living things according to their similarities and differences by giving examples.
- Shows the structures and organs forming the respiratory system on the model.

Inquiry skills

- Data collection, observation, inferences, making a prediction, defining and controlling variables, designing an experiment, formulating hypothesis.

Materials and equipment

- Plastic bottles (500 ml)
- Marbles
- Straws
- Tape
- Screwdriver (or a bradawl)
- Scissor
- Play dough
- A large plastic container
- Water
- Colored pen (optional)
- Balloons

Teacher preparation

- The teacher can create a model in advance against the possibility that your activity cannot reach the desired result according to the student level. Students should be careful about using cutting and drilling tools. If necessary, the teacher can do the process to the extent desired by the students.

Appendix 2

The Process of the Activity

Let’s Float the Fish –Process of the Activity

1. Warm-up Activity/ Initiating an Inquiry

The following questions are asked to the students upon entry to the activity, but the students’ answers are not judged as correct or incorrect. The aim here is to see what the students know and to reveal the misconceptions in the classroom.

- How do living things swim in the water?
- How can you ensure that you remain immersed in the water when you are in the sea or pool?
- How can divers dive into the water?

After these questions are answered, the main activity starts.

2. Main Activity/ Focusing on the Investigation

The activity worksheets are distributed to students. A student reads the following question on the worksheet "How can you make a fish model that can swim both on the surface of the water, at the bottom of the tank and also hang in the middle of the water?"Following that, the teacher waits for the learners' thinking process before he presents the materials. The teacher shows the equipment table and requests a model that has to perform the three different conditions: float, sink, and stay in the middle of the water. It should be emphasized that students are not obliged to use all of the materials provided and are free to decide what materials they want to use. Students are asked to first make a drawing for their model and then create the model.

3. Closing Activity/ Sharing Understanding

Once students prepare their models, the teacher asks them to share their models for the classroom in a place where everyone can see the process. Groups present their models one at a time and explain how their model works. During this sharing, both the group and the whole class can be asked the following questions:

- Was the model able to show the three desired features? (Swimming, sinking, hanging)
- What scientific information did you use when designing the model?
- What problems did you encounter during the activity and how did you resolve them?
- Which organs of a real fish do the parts in your model represent?
- What should you do if you want to swim more in-depth into the sea?
- Which groups’ model did you like the most? Why?
- What did you learn as a result of completing this activity? Why is it important to do this activity?

You can find explanations on how students can develop their models in this section.

This part is provided to inform the teacher about the construction of the fish model. Teachers may have tips from here to support the groups' progress.

1. It is the swim bladder that allows the fish to swim deep in the water (Figure A). Another name of it is air bladder.

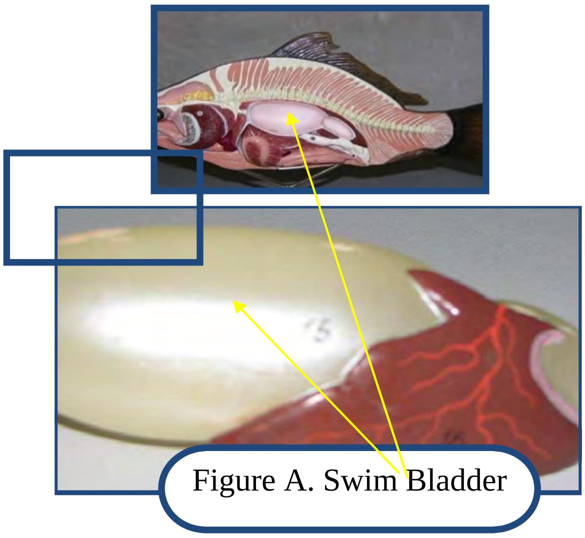

Figure A. Swim Bladder

2. Students should design a system in which air can be pumped into and out of the water using bottles and straws. The learners must open holes in some parts of the bottle to ensure that the water enters or exits to help the bottle sink and float. If necessary, it can be connected to the balloon in the bottle. After the instrument is installed, the air should be emptied when the object is to be sunk, and air should be blown to move the bottle up. To stay in the middle of the water, air and water balance should be provided inside the bottle.

Appendix 3

Background Information

Let's Float the Fish –Background Information

What is the swim bladder? What is the role of the swim bladder?

The swim bladder is a vital organ that plays a role in adjusting the vertical levels of fish in water and stabilizing them. It is an addition of thin intestine and has a skinny membrane-like shape. It is similar to the lung cavities of some vertebrates due to the air being full. These organs sometimes function as a respiratory organ alone. The working style closely resembles the principle of submarines. Just as a submarine can drain water in its ballast so that it can stay at specific depths or pour water into its ballast, the fish will empty the gas in the swim bladder or fill it so that it can stay in the water at a constant level.

The bladder must be filled with air to be able to perform its normal function. Thus, for the fishes with closed swim bladders, the air is sucked or refilled through capillary vessels. The glands, which have come to the forepart of the swim bladder, fulfill this function by arranging them with the reflexes which are automatically affected by the water pressure. Most of the fishes living on the ground do not possess swim bladders at the adult stage.

Appendix 4

Worksheet

Let's Float the Fish– Students' Worksheet

Research Question: How can you make a fish model that can swim both on the surface of the water, at the bottom of the tank and also hang in the middle of the water?

1. Draw the design of the fish model.

[Various drawings]

2. What did you pay attention to when designing your model?

[Sample Answer: We have noticed how an object can remain on the water and can be affected by the water's force to sink when desired.]

3. What kind of materials did you choose?

[Sample Answer: Bottle, straws, scissor, sticky tape, and screwdriver.]

4. Which of the desired movements can your fish exhibit? Write your observations.

[Sample Answer: Our fish model can sink to the underneath of the water and float between the surface and bottom of the water container.]

5. What kind of results do you infer from the model you have done and the data you have obtained?

[Sample Answer: Fish must fill swim bladder with air to swim on the water surface. If they want to sink into the water, they have to evacuate air from the swim bladder.]

6. Which organs of a real fish do the parts in your model represent? Show it on your drawing.

[Sample Answer: Pet bottles: fish; straws: capillaries; empty space in the bottle/ balloon: swim bladder.]