



FaSMEd

Raising Achievement through
Formative Assessment
in Science and Mathematics
Education



Heart Rate Investigation

Subject:

Science

Age of students:

12-13 years

Hardware:

Microsoft Surface or iPads, Heart Rate
Monitors

Software:

Educreations or Explain Everything,
Schoology

Functionalities:

Sending and displaying

Time:

2 class periods

FaSMEd partner:

Maynooth University

Short Abstract:

Investigating the effect of exercise on
heart rate



1. Content

Biology, heart rate.

2. Activity

2.1 Aims

Content Knowledge:

- Students will understand the effect of exercise on heart rate.
- Students will recall that the average pulse for an adult at rest is 70 b.p.m. Students will understand why exercise affects heart rate.

Process:

- Students will learn how to do a fair test.
- Students will become familiar with using a heart rate sensor.
- Students will associate increase in heart rate with the graph going up.

Skills:

- Information processing- recording, presenting information.
- Critical and creative thinking – examining evidence and reaching conclusions.
- Communicating
- Working with others

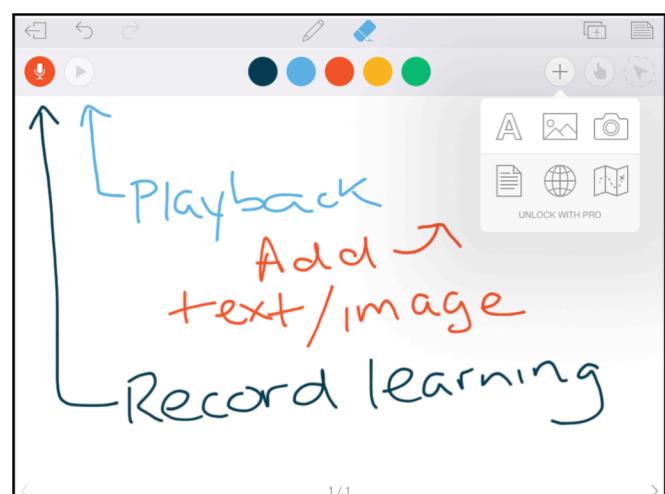
2.2 Structure / Methodology

Overview

This lesson unit is structured in the following way:

Class 1:

- Students will be divided into groups and the teacher will explain the rules of group work.
- Students will work in groups deciding how to measure their heart rate, recording their ideas on *Educreations* or *Explain Everything*¹.
- Teacher will analyse student responses to this task and use it to plan for class 2.



Educreations Application

¹ *Educreations* is an iPad application while *Explain Everything* is a Microsoft Surface application. These applications act as interactive screencasting whiteboards, whereby students can also record their thoughts audibly for the teacher to listen back to.

**Class 2:**

- A whole class discussion will allow for students to re-examine and modify (if needed) their original heart rate activity.
- Students will carry out their designed experiment working as a group.
- Students will answer the second question worksheet as a group again recording their ideas on *Educreations* or *Explain Everything*.
- Teacher will analyse student responses to the task.

Materials Required:

- iPads/Surfaces
- Heart Rate monitors
- *Educreations* app for iPad
- *Explain Everything* app for Surface
- Each student will need access to his or her individual *Schoology*² account.
- Worksheets 1 and 2 (you may adapt these to suit your class or another lesson)

Time needed:

Two forty minute classes. It is important that you do this activity in two separate classes so you have time to analyse the student responses to the first task and plan accordingly for the next lesson.

Before the Lesson:

- Ensure that you have the apps required for this activity installed on the tablets well in advance to avoid technical difficulties in class.
- Familiarise yourself with the technology before introducing it to the class.
- Print out worksheets 1 and 2.

Class 1 outline:

- Begin the class by discussing the importance of group work with your class.
- Explain to the students how successful group activities work and how to assign group roles.
- Allow students time to come up with rules for group work and to decide on group roles. Divide students into groups.
- Give students an iPad/surface per group and get them to answer worksheet 1 on the *Educreations/Explain Everything* app.
- Get students to save their work.
- Either get students to upload their work to *Schoology* or email them to the teacher so that you can analyse them and give them feedback in the next class.
- (If there is no Internet in the school analyse the worksheets from the iPads/Surfaces directly.)

² *Schoology* is an online learning environment that allows teachers to create and manage academic courses for their students. It provides teachers with a method of managing lessons, engaging students, sharing content, and connecting with other educators. For more information see the *Beginners Guide to Using Schoology*.

**Class 2 outline:**

- A whole class discussion or brainstorm at the beginning of class will allow for students to recap on the previous lesson.
- Teacher will use this discussion to give some feedback to students on their previous work on this task.
- Students will be put back into their original groups and try to modify or change their original method.
- Students will carry out their heart rate activities in groups recording their results as they work.



Students Engaged in their Heart Rate Activity

You should let the students use the heart rate monitors³ for this activity where possible.

- Give the students worksheet 2 to do on their iPad/Surface.
- Get students to save their work.
- Either get students to upload their work to *Schoology* or email them to the teacher so that you can analyse them and give them feedback in the next class.
- (If there is no Internet in the school analyse the worksheets from the iPads/Surfaces directly.)

After the lesson:

You should analyse responses to worksheet 2. If there are still misconceptions or difficulties with this topic they should be addressed by the teacher in the next class.

You should upload your comments or any picture from the activity to the FaSMEd *Schoology* page.

³ Heart Rate Monitors available at: <http://www.vernier.com/products/sensors/heart-rate-sensors/>



2.3 Technology

Sample procedure for using the heart rate monitor:

- Attach heart rate monitor to computer via Bluetooth.
- Start logger pro on computer.
- Either set length of data collection for 100 s or get students to stop data collection at 100 s – depending on their level of comfort using the equipment.
- At rest: student standing. Hold handgrips following palm and finger positions. Start data collection. Stop collection at 100 s. Store run.
- Walking on the spot. Start data collection as student starts to walk on the spot. Stop collection at 100 s. Store run.
- Running on the spot. Start data collection as student starts to run on the spot. Stop collection at 100 s. Store run.
- Show all runs to see the three results together.
- Save graph for effect of exercise on heart rate of a particular student.



Heart Rate Monitor

Precautions/tips:

- The maximum distance the handgrips can be from the receiver is 80 cm.
- Mobile phones and wireless laptops can interfere with the signal.
- The receivers can pick up a signal from other handgrips so groups should be at least 2m apart.
- For some people there will be a delay of about 15 s before the heart rate start data starts to be collected (particularly if hands are cold).

2.4 Aspects of Formative Assessment

Within this series of lessons the teacher tried to increase and improve students' participation in co-operative work in order to engage them in learning tasks that elicit evidence of student understanding. Students were to work collaboratively to design and carry out a heart rate investigation. While the lesson was successful in increasing student collaboration and getting students working co-operatively, it was noticed how the teacher's feedback practices had improved during this series of lessons.

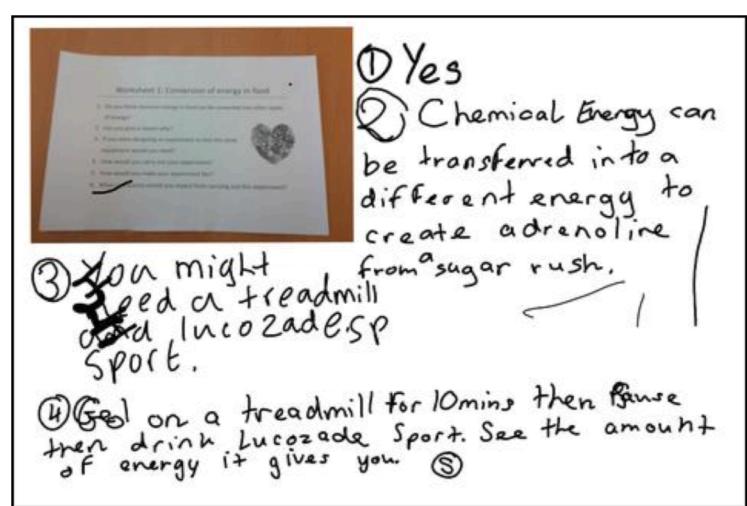


Figure 11: Sample of student work on Educreations (A4)



In the initial lesson on A4 the teacher had innovatively made use of the application *Educreations* to build structured group feedback. This fits neatly into the cuboid framework whereby the teacher was providing feedback that moves learners forward through technology functioning in the sending and displaying of student information. Within the application student's thoughts about their heart rate activities were recorded onto their iPads and the teacher used the student thinking to inform her next lesson. Figure 11 illustrates a sample of student work on the application. The questions posed by the teacher that the students have to explore as a group appear in the picture to the left and the students then have the space to write down their ideas on the right (Appendix C contains the questions that the students explored). Their comments during the task were also audio recorded through the application. Prior to the second lesson, the teacher analysed the student's work on this task and used it to build structured group feedback. In the following lesson it was observed that she made time for identifying and responding to any conceptual difficulties that the students were having about the circulatory system and addressed these misconceptions at the beginning of the lesson as displayed in Figure 12. This was particularly of benefit to low achieving students as their misconceptions may have gone unnoticed prior to integrating this technology into the lesson.

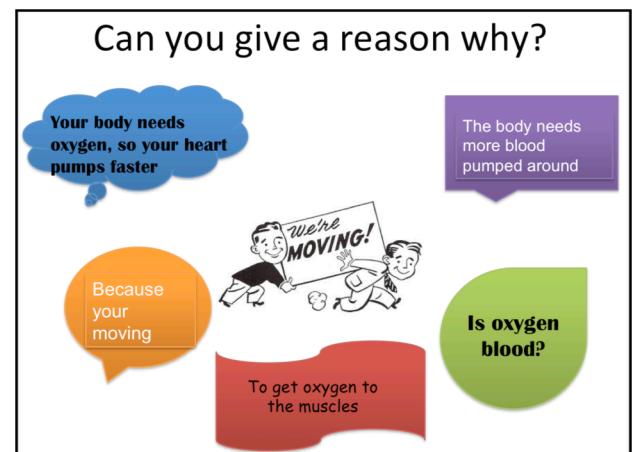


Figure 12: Science case teacher's PowerPoint Slide, an example of student answers to be used to give feedback to class (A4)

For example, video data gathered in the lesson A4 shows how the teacher was using feedback in the form of effective questioning to help a student with a misconception in relation to the energy content in sugar. Firstly the teacher provided the student with ample wait



Figure 13: Students engaged during group work with Educreations (A4)



time for the student to construct their answer. When the student cannot answer she probes the student for understanding using further questioning, when the student is still unsure she makes use of a random recall application on her iPad to call on a student from the class to help with the answer. This indicates how the teacher made use of numerous effective questioning techniques sequentially in her feedback practices to help alleviate a misconception that a student was having. During this lesson students were seen to be very engaged with technology and were familiar with using it in class. The majority of groups were focused on completing their work co-operatively. The teacher discussed how the application (*Educreations*) aided co-operative learning and feedback practices during teacher interviews (discussed in section four).

As the project is rooted in design based research it is important to examine and modify activities to make them more relevant and useful to the teachers and students who are using them. In light of this both researchers and YSA reviewed the A4 activity and a *reteach* lesson was planned. The teacher planned the following changes for the lesson:

- A whole class discussion on group work and the importance of roles when working in a group. This is important in relation to low achieving students being active in these types of activities and not being overshadowed by other students.
- Distribute the groups differently, with a fair distribution of active and non-active students.
- Planning worksheet to keep the students on task and focused before and during the activity.
- More integration of technology within the lesson.

Again at the beginning of the lesson the teacher used information gathered from the *Educreations* application to build structured feedback for the group. This was once again very effective as it helped students to move forward with their learning. As Figure 14 demonstrates, when listening back to the students work the teacher noticed that students were disputing about group roles and participation. The teacher used this information to clarify to students the need to work co-operatively in class in order to meet the learning objectives. She also reiterated the importance of not only concentrating on the individual group role, but also participating fully in group work. In addition, she provided students with the objectives of the lesson so the students could be informed about where their learning was going. Here the teacher was employing the formative assessment strategy of clarifying, sharing and understanding learning intentions for the students.

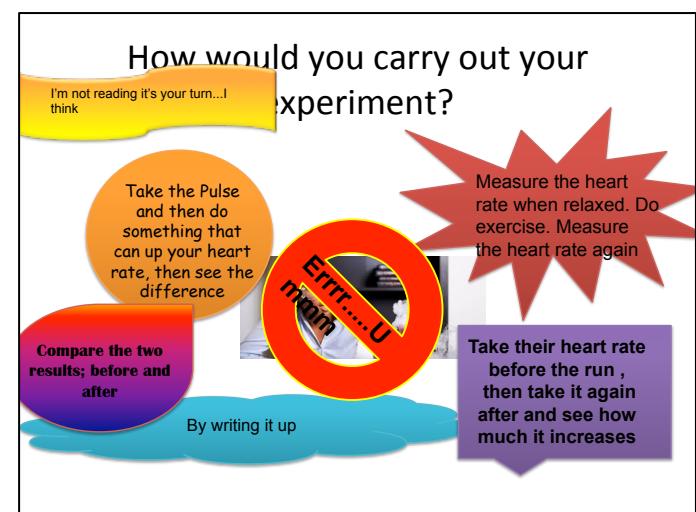


Figure 14: Science case teacher's PowerPoint Slide (reteach lesson), an example of student answers to be used to give feedback to class (A4)



Within this lesson there were some changes to the teachers questioning skills. She began the lesson using questioning directed individually at particular students and many of her questions were of a lower order. Questions such as “where do we get our energy from” and “what is carried in the blood” were directed at individual students causing other students to become disengaged with the activity and get distracted by the camera at the back of the room. This could have been detrimental to low achieving students as their lack of engagement was not moving them forward in their learning, however as the lesson progressed the teacher adapted more questions of a higher order and it was evident that she wanted students to explain their reasoning to their activity conclusions. The teacher challenged the students by asking them why their results were as they are and what would they do differently if they were to repeat the process.

3. Further Information

Questions to drive student learning (directing them to the learning outcomes):

- How does exercise affect heart rate?
- How does rest affect heart rate?
- Is your pulse the same as your heart rate? What is an adult’s average pulse rate at rest?

Questions to probe understanding:

- Why does your heart beat faster when you exercise?
- Is exercise the only thing that affects heart rate?
-

Questions to get students thinking about their own learning (metacognition):

- What did you learn about heart rate?

Initial questions leading to the questions students will work on during the activity:

- What does your heart do?
- Why does your heart beat?
- What does blood bring to all the parts of your body? Why do all parts of our body need oxygen?
- Why do all parts of our bodies need food?
- Does your heart rate stay the same all the time?
- Does exercise affect your heart rate?



Worksheet 1: Heart Rate Investigation

1. Do you think exercise changes your heart rate?
2. Can you give a reason why?
3. If you were designing an experiment to test this, what equipment would you need?
4. How would you carry out your experiment?
5. How would you make your experiment fair?
6. What conclusions would you expect from carrying out this experiment?



Worksheet 2: Heart Rate Investigation

1. Did everyone in the group participate in the experiment?
2. What can you conclude from doing this experiment?
3. Were your results as you expected?
4. If you were to do this experiment again what would you do differently?
5. What was your favourite part of this FaSMEd activity?





4. References

Technology	Device	Description, how teachers and students used the technology	Functionality of technology	Formative Assessment
Educreations www.educreations.com	iPad (app)	Screen casting application, visual and audio recording of student work	- Sending and displaying - Processing and analysing	- Activating students as resources for each other - Providing feedback that moves learning forward
Explain Everything (Alternate to Educreations) www.explaineverything.com	Any tablet device (available as an iPad, android, chromebook and windows app)	Screen casting application, visual and audio recording of student work	- Sending and displaying - Processing and analysing	- Activating students as resources for each other - Providing feedback that moves learning forward
Schoology www.schoology.com	Any device with a modern web browser – smart phones, tablets, PC's, laptops etc. (available as an iPad app)	Online learning environment that allows teachers to create and manage academic courses for their students. It provides teachers with a method of managing lessons, engaging students, sharing content, and connecting with other educators.	-Interactive Environment	- Activating students as resources for each other - Providing feedback that moves learning forward -Activating students as owners of their own learning
Logger software used in conjunction with hand held sensor technology www.vernier.com	Any device that is Bluetooth compatible or has a USB port	For example temperature probes. Used to gather data in real time to facilitate in depth analysis of graphs created via the logger software (LoggerPro).	- Sending and displaying - Processing and analysing	-Activating students as owners of their own learning - Activating students as resources for each other - Engineering effective classroom discussions that elicit evidence of student understanding

Bell, B., & Cowie, B. (2001). The characteristics of formative assessment in science education. *Science Education*, 85(5), 536-533.

Black, P., & Wiliam, D. (1998). Assessment and classroom learning. *Assessment in education*, 5(1), 7-74.