Earth Science (2000)

Sample assessment instrument and student responses

Extended laboratory-based and/or field based investigation: Interaction between Earth systems

This sample is intended to inform the design of assessment instruments in the senior phase of learning. It highlights the qualities of student work and the match to the syllabus standards.

Criterion assessed

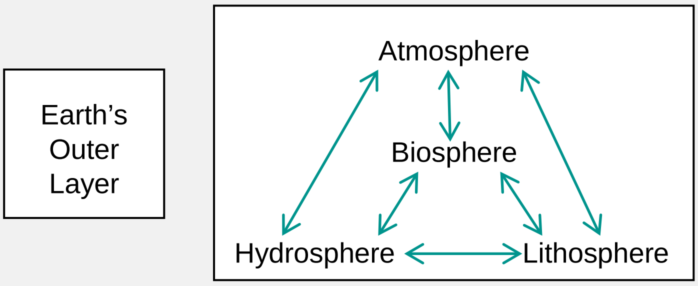
- Knowledge, conceptual understanding and application
- Working scientifically
- Using information scientifically

Assessment instrument

The work presented in this sample is in response to an assessment task.

Task

Identify one local example of the interaction between two or more components of Earth's outer layer. Conduct an investigation to demonstrate an understanding of the local example.



1. Decide on your topic of inquiry and propose possible research questions.

2. Research a range of theoretical resources for information about your topic. Prepare a succinct, but clear overview of the relevant concepts that explain the interaction you are investigating.

3. Plan a scientific investigation — either an experiment or detailed field observations.

   - Implement your investigation, making sure to collect and organise data logically and systematically.
   - Assess and critically evaluate the validity and adequacy of your data.
   - Interpret information and relationships within the data.
   - Draw and evaluate a well-supported conclusion.

4. Prepare a scientific report, 1000 words in length.

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Instrument-specific criteria and standards

Student responses have been matched to instrument-specific criteria and standards; those which best describe the student work in this sample are shown below. For more information about the syllabus dimensions and standards descriptors, see http://www.qsa.qld.edu.au/1954.html#assessment.

	Standard A	Standard C
Knowledge, conceptual understanding and application	The student consistently: • recognises and explains relationships amongst straightforward and complex concepts, comparing and contrasting them where appropriate	The student consistently: • recognises and explains most of the obvious relationships amongst straightforward concepts
Working scientifically	Either individually or as a member of a group, the student consistently: • recognises and identifies investigation question for a problem including those that are complex • plans a scientific investigation of a problem including elements of complexity • implements an investigation using scientific techniques and following procedures safely and correctly • records and organises relevant information logically and systematically • assesses and critically evaluates the validity and adequacy of qualitative and quantitative data	Either individually or as a member of a group, the student consistently: • recognises and identifies investigation question for a straightforward problem • plans a scientific investigation of a straightforward problem • implements an investigation using scientific techniques and following procedures safely but with some errors • records relevant information • assesses some aspects of the validity and adequacy of qualitative and quantitative data
Using information scientifically	The student work has the following characteristics: • provides logical and detailed interpretations of information, and of relationships within the information • offers convincing and valid conclusions, and logical and well-supported evaluations of conclusions • presents information cogently and clearly as a report, demonstrating control of the conventions of language and using accurate referencing	The student work has the following characteristics: • provides simple explanations of information • offers justifiable conclusions, and partial evaluations of conclusions • presents information clearly for the most part, as a report, using given genres, using some basic conventions of language and using some referencing

Student response — Standard A

The annotations show the match to the instrument-specific standards.

Comments	
Presents information cogently and clearly as a report, demonstrating control of the conventions of language and using accurate referencing	**Effect of Land Topography on Wind Attributes**
Recognises and identifies investigation question for a complex problem.	**Aim:** The aim of this research was to find the effects of the topography on the wind's attributes. The attributes investigated included wind direction, consistency and speed. It was hypothesised that topography would have an effect on the wind's attributes. It was predicted the further the wind travelled along the land, the less consistent and slower it would be and that the wind would curve to the leeward side of the headland.
Recognises and explains relationships amongst straightforward and complex concepts, comparing and contrasting them where appropriate.	**Relevant Topics:** ***Wind and Fluid Dynamics:*** The earth's systems have a tendency to move towards a state of equilibrium. In the atmosphere this is achieved by wind. An area of high atmospheric pressure has more air particles per cubic metre than an area of low atmospheric pressure. Air moves from areas of high pressure to areas of low pressure, creating a state of equilibrium by balancing the air pressure. This movement of air causes wind. Wind speed is directly proportional to the difference in pressure zones. The greater the difference in pressure, the stronger the wind (Williams 2004). Wind always takes the path of least resistance. When a land form is in the path, wind will travel in the most efficient way. It will travel around or over land forms, depending on the topography and wind direction. This movement also relates to air pressures, but at a more localised level. The topography creates localised higher and lower pressure areas, and protected areas where the wind will have no impact. When there is an object in the way it displaces some of the space the wind would have taken up. Consequently the wind has to compress to fit around the object in the easiest way possible. This also relates to the atmosphere moving towards a state of equilibrium (Laughlin 1997). Objects in the path of the wind affect its flow and speed, specifically the topography the wind is flowing over. Generally, the rougher the surface or the more vegetation, the greater the impact on the immediate wind speed (Laughlin 1997).

Plans a scientific investigation of a problem including elements of complexity.

Research Methodology:

Equipment:

1. Wind Meter
2. Wind Vane
3. Compass
4. Pen
5. Paper with table for data collection

Method:

1. An open location without obstruction was selected. Collection sites were evenly spaced at the location.

The location

2. Wind direction was determined using a wind vane. The degree from north the wind was travelling was recorded. The variability of wind direction was taken into account and recorded.
3. Average wind speed was measured at the same site using a wind meter. Observations for 20 seconds were taken, the average speed recorded and a note was taken of the wind speed consistency.
4. Repeated steps 3 and 4 at every site. To reduce the influence on the data collection of changes in wind speed and direction, movement between sites was undertaken in less than 30 minutes. .
5. After data had been collected at every site, conditions were checked at the first site to ensure they had not changed significantly. If the change had been significant, the data would be incorrect and should not be used to come to a conclusion about the relationship between topography and the attributes of the wind.
6. Data was collected in different conditions, to explore different scenarios.

Critically evaluates the validity and adequacy of qualitative and quantitative data.

Results:

Problems encountered:

The main problem encountered was the collection of data within a limited time frame whilst obtaining accurate readings. The data was collected in the smallest amount of time possible, because wind speed and direction change rapidly. Some data was excluded because after location one was checked a second time, the direction and speed of the wind had dramatically changed, making it invalid. The other problem encountered, was choosing locations that were clear of obstacles in every wind direction. Sometimes a location had to be altered, for example, a boat on a trailer was directly in the way on one occasion, and the data collection point was moved approximately 5m. Without moving, the data for location would have been invalid.

- All data below is the average reading within 20 seconds.
- Wind consistency: consistent (Con) <2 change, regular (Reg) 2-4 change, inconsistent (Incon) > 4 change
- Direction consistency: consistent <5^{o}, regular 5^{o}-20^{o}, inconsistent >20^{o}
- The wind direction recorded was the true direction (how many degrees clockwise from north).

Records and organises relevant information logically and systematically.

Data 1:

Site	Wind speed (km/h)	Speed consistency	Wind directions (^{o})	Direction consistency
1	8.5	Reg	70	Incon
2	6.0	Incon	80	Incon
3	6.5	Incon	90	Incon
4	7.5	Reg	40	Reg
5	10	Con	40	Reg
6	8.0	Reg	70	Reg
7	8.5	Reg	70	Reg
8	9.0	Incon	85	Incon
9	4.0	Incon	30	Incon
10	5.0	Incon	45	Incon
11	5.5	Incon	20	Incon
12	11	Reg	55	Con

Table 1: Wind speed, direction and consistency for Data 1.

Provides logical and detailed interpretations of information, and of relationships within the information.

Wind direction	Interpretation
	The wind was coming from the North East (NE). The wind was curving around to the west side of the point. The wind hitting the east side of the point curved towards the headland, then up and over it to continue in a north easterly direction.

Table 2: Wind movement for Data 1.

Data 2:

Site	Wind speed (km/h)	Speed consistency	Wind directions (°)	Direction consistency
1	5	Incon	320	Incon
2	2	Incon	20	Incon
3	4	Incon	340	Incon
4	9	Reg	310	Reg
5	15	Con	280	Reg
6	20	Reg	280	Reg
7	22	Incon	300	Reg
8	21	Incon	270	Incon
9	12	Incon	260	Incon
10	22	Reg	240	Reg
11	21	Reg	240	Reg

Table 3: Wind speed, direction and consistency for Data 2.

Provides logical and detailed interpretations of information, and of relationships within the information.

Wind direction	Interpretation
	In this case the wind was stronger. The wind was generally coming from the West (W). As seen left this wind hit the headland on the west side. It curved around to the east of the point where it was mostly protected.

Table 4: Wind movement for Data 2.

Provides logical and detailed interpretations of information, and of relationships within the information.

Data 3:

Site	Wind speed (km/h)	Speed consistency	Wind directions (°)	Direction consistency
1	7.0	Reg	25	Reg
2	8.0	Incon	25	Incon
3	7.5	Incon	25	Incon
4	9.0	Reg	30	Incon
5	13	Con	35	Con
6	7.5	Reg	35	Reg
7	8.0	Reg	45	Reg
8	9.5	Incon	30	Incon
9	0.5	Incon	Flux	Incon
10	8.5	Incon	30	Incon
11	9.5	Incon	30	Incon
12	13	Con	35	Con

Table 5: Wind speed, direction and consistency for Data 3.

Wind direction	Interpretation
	In the third instance, the wind was coming from North North East (NNE), directly on the headland. The headland acted like a wedge and the wind split to both sides of the point. The wind was consistent over the headland, as there were no greatly protected spots.

Table 6: Wind movement for Data 3.

Provides logical and detailed interpretations of information, and of relationships within the information.

Data 4:

Site	Wind speed (km/h)	Speed consistency	Wind directions (°)	Direction consistency
1	11	reg	25	Reg
2	11	Incon	25	Incon
3	10	Incon	25	Incon
4	10	Reg	30	Reg
5	14.5	Con	35	Con
6	12.5	Incon	35	Incon
7	12.5	Reg	45	Incon
8	6.0	Incon	30	Incon
9	2.0	Incon	Flux	Incon
10	8.5	Reg	30	Reg
11	7.0	Reg	30	Reg
12	15	Con	35	Con

Table 7: Wind speed, direction and consistency for Data 4.

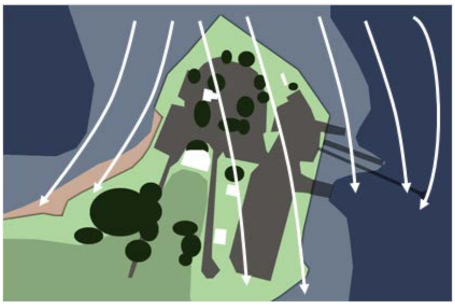
Wind direction	Interpretation
	The fourth data collection was in a Northerly (N). The wind was split more noticeably by the headland again. It curved to both sides of the point.

Table 8: Wind movement for Data 4.

Provides logical and detailed interpretations of information, and of relationships within the information.

Data 5:

Site	Wind speed (km/h)	Speed consistency	Wind directions (°)	Direction consistency
1	7.5	Incon	110	Reg
2	8	Incon	110	Reg
3	7.5	Incon	150	Incon
4	8.5	Incon	110	Reg
5	11.5	Con	110	Con
6	7.5	Reg	120	Reg
7	8	Reg	130	Reg
8	8	Reg	120	Reg
9	<1	Incon	Flux	Flux
10	<1	Incon	Flux	Flux
11	<1	Incon	Flux	Flux
12	3.5	Incon	90	Very incon

Table 9: Wind speed, direction and consistency for Data 5.

Wind direction	Interpretation
	The fifth data collection, the wind came from the South East (SE). The wind passed straight by the point and slightly curved around to the west side, leaving it very protected, with hardly any wind. On the east side of the point the wind curved to the north quite abruptly to be able to pass by the tip of the point rather than going over the land form. At the south end of the recordings, the wind did the opposite. It curved towards the point and then went over; this was the most direct, easiest route for it to travel to the other side.

Table 10: Wind movement for Data 5.

Discussion of Results:

Wind Direction:

The results have shown that the topography affects the attributes of the wind. The most obvious effect is upon the wind direction.

The wind direction was greatly affected by the shape of the land. The wind always curved around into the leeward side of the headland, because it had slightly lower pressure than other areas. The wind also curved towards the point where it was easiest for it to go over the headland or curve around the end.

Wind Speed:

The topography affected the wind speed. On the jetty or the sand spit, the wind was consistent and stronger, indicating that the land had the effect of slowing the wind down and making it slightly inconsistent. This effect may also have been magnified by the artificial concrete walls on and around the headland, disrupting the wind and creating turbulence, slowing down the wind making it slightly more inconsistent.

Consistency:

The wind direction and speed consistency was mainly based on the objects that disrupt the path or create turbulence, including trees, cars and small buildings. Turbulence slows the wind down and disrupts the wind direction. From the data, the inconsistent sites had obstructions affecting the wind. This in turn made the wind inconsistent in both speed and direction. The position of data collection points on the leeward of the point, protected from the wind, also made readings inconsistent.

Possible Improvements:

Assesses and critically evaluates the validity and adequacy of qualitative and quantitative data.

The best way to improve the accuracy of these findings would be to collect the data at different locations for a longer time (different seasons and weather conditions) and on more occasions. Additional improvements would be using digital equipment to reduce human error and locating small electronic weather units on the headland to collect data simultaneously and reduce the variability of gusts and weather changes.

Conclusion:

Offers convincing and valid conclusions, and logical and well-supported evaluations of conclusions.

The topography of the land had a significant effect on the attributes of the wind. The wind changed direction to take the easiest route. It always curved around the leeward of the headland because of slightly lower pressure. The air compressed to get around the area the land had displaced, and then spread out when there was more room, to establish equilibrium.

The wind speed was affected in the same way. It was weaker on the leeward side of the point because the shape of the land created turbulence, protecting it from the strong wind making the wind inconsistent. The topography also greatly affected the speed of the wind. More objects in the wind's path created turbulence, slowing the wind down and making it less consistent.

Using accurate referencing.

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Student response — Standard C

The annotations show the match to the instrument-specific standards.

Comments

Presents information clearly for the most part, as a report, using given genres, using some basic conventions of language and using some referencing.

Recognises and identifies investigation question for a straightforward problem.

Recognises and explains most of the obvious relationships amongst straightforward concepts.

Water Speeds in Unprotected Area's

Aim

By doing this experiment I hope to be able to explain and show results that agree with my hypothesis of that the water speeds will get slower when the water has to flow through mangrove areas. I aim to show that this is true and by the results, showing the differences in these water speeds.

Concept Overview

When doing this experiment, there are certain factors in this estuary/bay environment that needed to be either controlled or monitored when doing the experiment.

The external factors were:

- Height and movement of tide
- Wind speed
- Water depth

What are Mangroves?

Mangroves are what we call the collection of salt tolerant plants that are found along coastal areas and up rivers in the tropics and subtropics (www.wettropics.gov.au/pa/pa_mangroves.html, anonymous, 2010). There are many different types of mangroves that inhabit our estuaries and coastal environments.

There are a few different types of mangrove roots that need to be looked at when conducting this experiment so you can see if they make differences to the water speeds.

The most common roots in the area are pencil roots and prop roots. Where this experiment was conducted, the environment consisted of only pencil roots.

Mangroves and their roots can be a big impact on the water speeds in the mangrove environment. The mangroves create a force that repels the flow of the water and this will therefore partially slow the water down. The more mangroves, the more force that is impacted on the water flow. Water likes to flow straight but as there are more and more objects in the way, this will therefore slow the water speed. So in this case the denser the mangroves that the water needs to flow through, the slower the water will flow.

Methodology

For the methodology to work and to get reliable results I need the external factors (wind, water depth etc.) to be similar if not the same for both of the measurements that I will be taking.

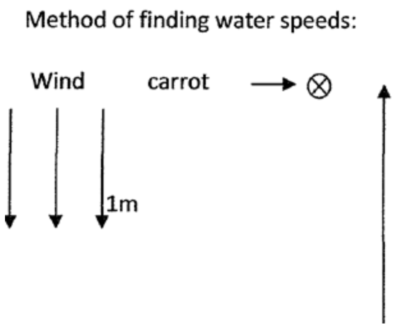
Variables that need to be the same:

- Wind speed
- Water depth
- Tide height

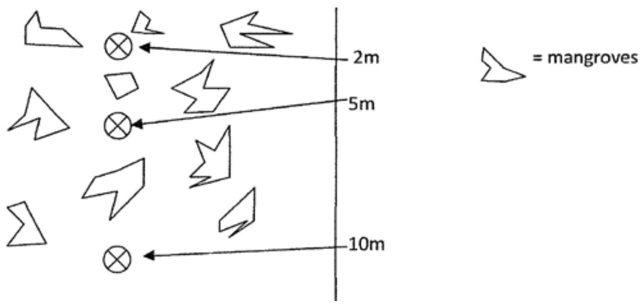
Equipment

Plans a scientific investigation of a straightforward problem.

- Small cube of carrot
- Piece of cotton (to attach to carrot)
- Stopwatch
- Clipboard with paper
- Tape measure



By dropping the carrot and letting it get pushed by the water to get to the 1m mark and timing it will give a clear reading of the water speed. I will do this at least five times in each location. Also I will try to doing the same experiment but in certain depths and change how deep I put it in the mangroves, e.g. Test 2, 5, 10 or more of protected mangroves.



Procedure:

Plans a scientific investigation of a straightforward problem.

1. Two locations were identified — one with which was open and lead straight into a bay — the second with a deep mangrove environment.
2. Once the right locations were found, by using the tape measure to measure out a metre in both the locations and marked these with sticks.
3. After this was done, drop the cube of carrot into the water and time how long it takes to drift the whole metre. Do this 5 times for each location.

Records and organises relevant information.

Results

Unprotected Environment Water Speeds (0m)	
Attempt	**Time (s)**
1	22.68
2	24.17
3	23.64
4	21.97
5	22.13

Protected Environment Water Speeds (5m)	
Attempt	**Time (s)**
1	31.70
2	33.21
3	35.72
4	30.09
5	34.13

Protected Environment Water Speeds (2m)	
Attempt	**Time (s)**
1	27.01
2	26.07
3	27.96
4	27.55
5	28.32

	Unprotected Waters Average = 22.9 s/m Speed = 0.157 km/h **Protected Waters (5m)** Average = 33 s/m Speed = 0.109 km/h **Protected Waters (2m)** Average = 27.4 s/m Speed = 0.131 km/h
Provides simple explanations of information.	The path of the carrot through the mangroves was straight as it was deep enough for the cube of carrot to sit higher in the water column then the mangrove roots. Other than this observation there is nothing else to note. I would of also have liked to get some results for at the 10m mangrove mark but as the tide was too low to make it impossible and I had to unfortunately forget this small part of what I was hoping to do. One thing that was noticeable while doing the assignment was that the piece of carrot only moved when the chop from the wind would pass over the top of it. The wave would pick it up and move it slowly as it passed. The piece of carrot would only drift very slowly between the wind chop.
	Discussion of Results By looking at the above results it is shown that the further protected you become in the mangroves the slower the water speeds are. By working out the water speeds in kilometres we can make detailed decisions about how much faster or slower the water speeds are in the protected and unprotected environments. By these results on the above page it is shown that the water has slowed down considerably as you get further into the mangroves. This would be from the mangroves sheltering the water speed and slowing it down. Doing different locations for this type of experiment could further enhance my results and give more numbers to look at. By doing this experiment with different wind speeds, water depths and the density of the mangroves it could explain more to the water speeds relating in these foreshore environments.
Offers justifiable conclusions, and partial evaluations of conclusions.	***Conclusion*** The data that has been collected and the results that were found have indicated that the water speeds in these estuary environments slow down as the mangroves get denser. The results show this and the differing water speeds have been calculated to agree with this.
	Bibliography www.wettropics.gov.au/pa/pa_mangroves.html, anonymous, 2010

Acknowledgments

The QSA acknowledges the contribution of Redlands College in the preparation of this document.