

2022 VCE Environmental Science external assessment report

General comments

In 2022 most students were able to complete the Environmental Science examination in the allotted time. This was the first year of the new study design and the examination incorporated some of the key knowledge and key science skills that have been added to the subject. Students should expect to answer questions that cover the entire variety of topics outlined in the study design, while recognising that not all points can be covered in each external examination each year.

While handwriting is not considered in awarding marks, it is an area that needs to improve to support the assessment process. There was also some concern about how prepared some students were to answer some basic mathematical calculation questions. There are some types of Environmental Science questions that require basic mathematical skills that students should try to be better prepared for based on examples from previous examinations.

It was evident in the way some students responded to questions that they had 'pre-prepared' answers (often based on questions from past examinations). Students should revise and prepare for the examination each year and part of this should include completing past examinations. However, students must read each individual question carefully and avoid providing an answer that might have suited a past question without covering the specific requirements of the new question.

Feedback from teachers suggested that there was an expectation that the first short-answer question would be a Simpson's Index of Diversity (SID) calculation using data set out in a table, as has been the case for a number of years. Students should be aware that while examinations may have some consistency over time, no specific area or type of question can be 'guaranteed' to be included on every examination each year. The aim of presenting the SID data in a different format was to test the understanding of what the calculation indicates when presented in a different way.

Some areas for improvement include the understanding and correct use of specific science terms (for example, validity, accuracy and precision), as well as the sustainability principle terms. Students' responses to questions about climate change and the greenhouse effect varied greatly. Higher-scoring responses showed a correct discussion of relevant concepts for example, global warming potential and the interactions between solar energy that is absorbed by Earth's surface, re-emitted and reflected by atmospheric gases involved in the greenhouse effect). Responses that did not score well still connected the so-called 'hole' in the ozone layer with global warming (which demonstrates an incorrect scientific understanding) or used very simple ideas such as the 'gases acting like a blanket and keeping Earth warm'. The standard of responses overall this year saw fewer students producing clear, concise and fully complete answers based on the expected VCE Environmental Science knowledge, especially for the higher-mark questions such as Questions 3c. and 7c.

Specific information

This report provides an indication of what answers may have included. Unless otherwise stated, these are not intended to be exemplary or complete responses.

The statistics in this report may be subject to rounding resulting in a total more or less than 100 per cent.

Section A – Multiple-choice questions

The table below indicates the percentage of students who chose each option. Grey shading indicates the correct answer.

Question	Correct answer	% A	% B	% C	% D	% E	% No answer	Comments
1	D	8	8	18	66	0	0	Based on the information provided that the local people consume fish species as a food resource from the wetland, the correct answer is option D 'provisioning services'.
2	A	83	2	4	12	0	0	
3	B	3	55	36	6	0	0	The definition of a 'biodiversity hotspot' includes two ideas: that the area has large numbers of endemic species and that many of these species are heavily threatened by habitat loss and other human activities, which are covered in option B. Many students incorrectly chose option C possibly because they thought of rapid evolution creating new species as a 'hotspot'.
4	C	5	1	92	2	0	0	
5	A	67	35	6	3	0	0	Many students correctly selected option A. A consequence of low genetic diversity would be inbreeding because of a limited variety of alleles for genes within that species and so there are not many differences between individuals. This can mean that there are fewer opportunities to adapt to environmental changes or a greater chance of genetic diseases being shown in an inbred population.
6	D	5	7	10	79	0	0	
7	B	31	52	12	4	0	0	Students needed to be clear about the difference between a dependent and independent variable in a scientific investigation. A dependent variable refers to something that depends on other factors, in this case the number of different species (option B) in the two areas of the urban lake. Many students incorrectly selected option A as the dependent variable; however, the level of human impact is the independent variable (i.e., the cause of the difference in species richness).
8	D	5	6	10	78	0	0	
9	C	50	1	44	5	0	0	Fifty per cent of students incorrectly chose option A as the answer. Although ecological, economic and sociocultural dimensions are factors involved in sustainable development, option C is the correct answer. Biocentrism, ecocentrism and anthropocentrism are listed as three of the four value systems that influence decision-making processes in the study design.
10	D	1	15	1	83	0	0	

Question	Correct answer	% A	% B	% C	% D	% E	% No answer	Comments
11	C	2	42	52	3	0	0	Students had some difficulty in correctly identifying the type of population data as being quantitative (option C). A significant number of students incorrectly identified the data as being qualitative (option B). Students should be able to identify counting the population numbers of marsupials as quantitative data.
12	C	5	5	87	2	0	0	
13	C	1	24	73	3	0	0	
14	D	10	9	15	65	0	0	Monitoring sea surface temperatures can provide climate change modellers with useful data. The methods used by scientists include using temperature sensors on ships and buoys (option D). The incorrect responses selected by students ranged through the other three options, indicating a lack of understanding of this method.
15	D	5	0	2	93	0	0	
16	C	3	1	87	9	0	0	
17	D	3	1	4	92	0	0	
18	C	14	22	60	4	0	1	There were a range of incorrect options chosen for this question, with only 60 per cent of students choosing option C – carbon dioxide. Students should have an understanding of the sources of gases involved in the natural greenhouse effect and the carbon cycle.
19	D	6	19	22	53	0	0	A method of carbon sequestration is capturing greenhouse gas emissions (mainly carbon dioxide) from fossil fuel power stations and injecting these gases deep into the ground in suitable geological structures (option D). The key to sequestration methods is to capture the carbon dioxide before it enters the atmosphere rather than filtering the atmosphere and storing these gases in the ocean. Old growth forests (option B) are already acting as carbon sinks.
20	D	21	4	29	46	0	0	Both Question 14 and this question required an understanding of scientific methods used to collect data on climate change – a key part of the Environmental Science study. Students should be able to recognise the correct methods of providing evidence of past atmospheric conditions in paleobotany, ice-core sampling and the use of temperature monitoring (to compare current and long-term data with information extrapolated from the past). The answer is option C because climate modelling is not a method of collecting data, rather it uses collected data to develop theories about climate in the past and make predictions of future climate change.
21	B	4	59	5	32	0	0	There was some misunderstanding of the processes involved in the interaction of solar energy, in this case visible light, and the

Question	Correct answer	% A	% B	% C	% D	% E	% No answer	Comments
								surface of Earth. Students who understood the pathways and interactions correctly identified option B. As part of the natural greenhouse effect, visible light is absorbed by the surface of Earth and re-emitted as infrared radiation. Some visible light is reflected but not as infrared radiation, making option D incorrect.
22	C	7	4	85	4	0	0	
23	B	2	90	3	5	0	0	
24	C	4	8	76	11	0	0	
25	D	22	5	10	63	0	0	Understanding the energy conversions from coal in a power station to electricity in the grid meant that option D was the correct answer. Coal is a form of chemical energy burnt in the furnace to produce thermal energy (heat), and then through the boiler it heats water to produce steam, which drives the turbine and the generator (both mechanical forms of energy) to create electricity.
26	C	15	15	44	25	0	1	Some students found it difficult to calculate mathematical answers. The correct option of approximately 40 per cent is reached by multiplying 70 per cent by 0.8 (80 divided by 100) and again by 0.8 (80 divided by 100) and then 0.9 (90 divided by 100), since energy is lost at each stage.
27	D	8	43	4	45	0	0	The source of energy in a fully electric car comes from whatever energy source was used to create the electricity stored in the battery, that is an energy source such as wind or coal (option D). Many students incorrectly chose option B; the battery itself does not provide the original source of the energy.
28	B	20	71	8	1	0	0	Some students were not clear about the difference between the first law of thermodynamics (energy cannot be created nor destroyed) and the second law, which refers to the idea that no energy conversion can be 100 per cent efficient and that some of the original energy will be lost as waste heat (option B). This is clear in the example given with petrol and diesel engines losing up to 60 per cent of the energy in petrol as heat.
29	A	79	4	1	15	0	0	
30	A	73	4	16	7	0	0	

Section B

Question 1a.

Mark	0	1	2	Average
%	10	39	52	1.4

Most students were able to correctly state the trend from the graph and wrote that species richness decreased with the increasing elevation or height in metres. As a simple 'state the trend' question, figures from the graph were not required to explain this. Responses that did not score well missed the link between the two pieces of data.

Question 1b.

Mark	0	1	2	3	Average
%	24	32	37	7	1.3

Few responses received full marks for this question. Students found it difficult to make the link between what the Simpsons Index of Diversity (SID) indicates and species richness. Some correctly noted that SID requires species richness (i.e., the total number of different species) and also includes the number of individuals in each species (or relative abundance). Therefore, in terms of the calculation of SID, the trend is similar because the relative abundance must also have been similar across the three sites (or did not vary significantly).

Question 1c.

Mark	0	1	2	Average
%	11	34	55	1.5

One suitable fieldwork sampling technique for collecting biodiversity data needed to be identified and briefly outlined. Many students outlined the basic steps in using quadrats or transects in the field. Other successful responses clearly described the mark–recapture method of quantifying species numbers in an area.

Question 1d.

Mark	0	1	Average
%	19	81	0.8

Most students were able to explain that because the sparrow is endemic to the alpine region of Taiwan it is only found in this specific region or area and nowhere else.

Question 1e.

Mark	0	1	2	3	Average
%	37	29	24	10	1.1

This question was poorly answered overall. Students were not always able to apply the term ‘validity’ correctly in their answer or link the idea of the range of the sparrow and how this could have impacted the results of the study. The sparrow moves through different elevations within this range over the year due to seasonal factors and this may have impacted on the sampling results. If the counting was done at a certain time of year the sparrow may not have been recorded at that elevation because of where it was feeding at the time. Therefore, students needed to discuss the idea of validity – did the study actually measure what it was intended to measure (i.e., the abundance and richness of the alpine species at the different elevations).

Question 2a.

Mark	0	1	2	Average
%	5	45	50	1.5

Most students correctly outlined the link between climate change (i.e., global warming increasing average temperatures) leading to more frequent drier habitat conditions with more fuel and an increase in the intensity and frequency of fires.

Question 2b.

Mark	0	1	2	3	Average
%	9	20	31	40	2.0

Two ways the increased intensity and frequency of fires might threaten the Graveside Gorge wattle were provided by most students, with some relevant context. These included the increase in intensity burning more wattle plants or destroying seeds or killing ant colonies. If the fire frequency increased, then there was insufficient time for the seedlings to germinate and grow or for the ants to re-populate.

Question 2c.

Mark	0	1	2	Average
%	62	29	8	0.5

Few students were able to correctly explain how the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) would offer protection to a plant such as the Graveside Gorge wattle. The key element missing from most responses was that the EPBC Act, as the Australian Government’s key piece of environmental legislation, provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places. Therefore, the EPBC Act gives the legal power to stakeholders and requires action by them to implement management strategies to protect the wattle. Many students incorrectly wrote that the EPBC Act would outline specific strategies to conserve the wattle and its habitat.

Question 2d.

Mark	0	1	2	Average
%	17	57	27	1.1

Higher-scoring responses outlined the role of the National Seed Bank in terms of collecting and storing native seeds, particularly those of rare and threatened flora. To support future populations, stored seeds of the Graveside Gorge wattle would be germinated and propagated, and then the seedlings could be replanted at suitable locations to increase the population size and genetic diversity. Responses that did not score well confused a seed bank with a gene bank.

Question 2e.

Mark	0	1	2	Average
%	25	31	44	1.2

The concept of using a wildlife corridor as a strategy to increase the population of Graveside Gorge wattle was reasonably well explained by most students. Higher-scoring responses explained that by linking separated populations there could be an exchange of genetic material between previously isolated populations, or that the ants could more widely disperse the seeds within the region.

Question 2f.

Mark	0	1	Average
%	21	79	0.8

Most students correctly stated the new conservation category as 'endangered', based on the ranking system used to classify conservation status.

Question 3a.

Mark	0	1	2	3	Average
%	9	34	43	14	1.6

This question required a clear comment on the user pays principle and how this principle would lead the council to choose site A over site B for the location of a water park. Therefore, the principle would direct that most of the costs involved in setting up the water park would be passed on to those who use the new service/resource (i.e., waterpark users) rather than the broader local community, and should aim to increase the sustainability of any resource use. To reduce initial costs for the council, site A would involve less expenditure because they own the land and would not have extra costs in building a bridge. The costs of developing the water park would then be paid for by those using the water park and camping ground in the future.

Question 3b.

Mark	0	1	2	Average
%	14	64	22	1.1

An understanding of the sustainability principle of conservation of biodiversity and ecological integrity was required to answer this question. Responses that did not score well used the simplified idea that the principle requires the protection of the ecosystem (i.e., that biology and ecology must be conserved), rather than the complete concept of maintaining the diversity and quality of ecosystems and enhancing their capacity to adapt to change and provide for the needs of future generations. Therefore, the concerns the camping ground stakeholders might have with using site A would focus on the potential impact of the water park on the riverbank vegetation and water quality of the river. The principle would direct that negative ecosystem impacts are minimised, and that the environmental quality should be preserved for future generations.

Question 3c.

Mark	0	1	2	3	4	5	6	Average
%	14	19	30	24	10	2	0.5	2.1

This complex question required the use of a number of environmental science concepts and a cohesive argument using information from the scenario. It was poorly answered by a large number of students and few students received full marks. The question required some analysis of the scenario, the correct application of the precautionary principle and an explanation of how a risk analysis tool would be used as part of the environmental management process.

High-scoring responses indicated that a risk analysis would initially identify the potential risks of the water park, as well as the level and likelihood of each risk. The precautionary principle, defined as 'where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation', would suggest that further environmental investigations of both sites was required and clear identification of possible negative impacts should be considered before progressing with development. Specific discussion of potential risks and their management, such as taking water from river, treating it with ozone/salt or the ecosystem disturbance from building a bridge and other infrastructure should have been discussed. Responses that did not score well were not well constructed, did not use specific information from the scenario in context and simply applied the precautionary principle as 'being cautious and trying not to damage the environment'.

Question 4a.

Mark	0	1	2	Average
%	63	8	29	0.7

Many students had difficulty in correctly reading the data from the graph and used the figure that was on the line rather than the section of the graph between the two lines, which actually shows the amount of methane emissions from each of the different sources. For example, methane emissions from natural gas sources in 2005 were 6300 minus 4700 metric tonnes (t), which equals 1600 t, rather than the 6300 t figure from the line. Based on the correct calculation the percentage change was around 14.5 per cent and to gain full marks working needed to be shown. Incorrect answers used the 2000 figure rather than the figure for 2005.

Question 4b.

Mark	0	1	2	Average
%	58	38	4	0.5

The majority of students had difficulty answering this question correctly. There was confusion about what the term 'natural gas' refers to – a naturally occurring fossil fuel that is a mixture of gaseous hydrocarbons consisting primarily of methane. The main reason for an increase in methane emissions from natural gas sources is the increasing global population and the demand for this fuel for heating and cooking purposes. The extraction of natural gas fuel results in leaks of methane into the atmosphere.

Incorrect answers outlined the combustion of natural gas contributing methane to the atmosphere (the combustion contributes carbon dioxide rather than methane) or discussed the methane produced by increasing numbers of cattle globally (which is not the source of the fossil fuel, natural gas).

Question 4c.

Mark	0	1	2	Average
%	57	29	13	0.6

An important concept from the study design is an understanding of the interactions between the different forms of solar energy that are absorbed, re-emitted and reflected by atmospheric gases, and therefore the role of these gases in the greenhouse effect. Methane absorbs infrared radiation that has been re-emitted from Earth's surface. This heats up the methane gas molecules, and the reradiated heat causes the atmosphere to warm as part of the natural greenhouse effect. Using 'light' rather than 'reradiated infrared radiation' or the simple concept of 'trapping heat with a blanket' were not detailed enough responses at this level.

Question 4d.

Mark	0	1	2	Average
%	59	31	10	0.5

The concept of warming potential was not well understood in general, and responses that did not score well just restated what was in the question stem. Methane has a shorter atmospheric life but individual molecules of methane absorb a lot more infrared radiation when compared to a carbon dioxide molecule, therefore each molecule of methane (over its lifespan) contributes more to global warming by absorbing more heat energy. The process whereby molecules trap energy keeps heat near Earth's surface rather than allowing it to escape back into space. In addition to its stronger heat-trapping power, methane also reacts with other molecules in the atmosphere to form ozone, another greenhouse gas.

Question 4e.

Mark	0	1	2	Average
%	34	48	18	0.9

The question required two different ways to reduce methane emissions from landfill sources. Responses that did not score well did not focus on landfill. High-scoring responses outlined ideas including improving

composting methods (by making decomposition more aerobic), better recycling methods in general to reduce paper or biomass waste going to landfill, and capping over a landfill area and trapping methane, which can be used as an energy source or sequestered underground.

Question 5a.

Mark	0	1	2	Average
%	14	48	38	1.3

The predictions from the climate modelling indicated reduction in snow cover, higher snowlines, less rainfall and higher temperatures. Based on these predictions two risks to the alpine ecosystem were required and high-scoring responses stated two ideas such as lack of water availability for plant and animal species resulting in a change to ecosystem communities, a shrinking alpine habitat putting pressure on species that require snowfall, or reduced water flow in alpine streams placing pressure on aquatic species. Responses that did not score well included the negative impacts of the predicted climate changes on humans rather than ecological systems.

Question 5b.

Mark	0	1	2	Average
%	22	54	24	1.0

Not all students understood the term ‘mitigation’ and many could not explain the link between providing incentives to purchase electric cars and slowing the rate of climate change. High-scoring responses clearly explained that petrol cars produce more greenhouse gas emissions over their lifetime and that the lower carbon dioxide emissions from electric cars reduce the enhanced greenhouse effect by absorbing less infrared radiation in the atmosphere.

Question 5c.

Mark	0	1	2	Average
%	23	32	45	1.2

Many students were able to correctly name a relevant stakeholder (such as ski resort owners, tourism groups, local Native Title councils or local environmental groups) and provide a climate change mitigation strategy this group could use. Responses that scored highly focused on strategies to improve the efficiency of energy use or replacing fossil fuel with non-fossil fuel energy sources by switching to solar or wind power.

Question 5d.

Mark	0	1	2	Average
%	44	41	15	0.7

Most students correctly identified that the viewpoint of Kai (i.e., that these strategies will contribute to reducing climate change globally) was scientifically correct, and that Finley’s idea that these strategies would reduce climate change in the local area was incorrect. Students had greater difficulty in explaining why this was correct and did not clearly explain how greenhouse gas emissions move through the atmosphere on a

global scale. If changes were made in the local area the changed atmospheric gas composition does not just sit over that location to impact climate change only at a local scale.

Question 5e.

Mark	0	1	2	3	Average
%	31	25	31	14	1.3

Suitable methods for sourcing water in a sustainable manner so that snow-making can continue without contributing to water scarcity should have focused on using effluent water, and then treating and recycling this water. Any methods that removed water from other local water sources (such as building a dam) increased water scarcity and were incorrect responses.

Question 6a.

Mark	0	1	2	Average
%	33	44	22	0.9

Coal seam gas was an addition to the new study design and most students had an understanding of this energy source. The combustion of coal seam gas, as with other fossil fuels, releases carbon dioxide into the atmosphere. The consequence of using this source is a further imbalance to the carbon cycle. Long-term stored carbon within coal seam gas resources is being released faster than it can be stored in carbon sinks.

Question 6b.

Mark	0	1	2	3	Average
%	29	21	32	19	1.5

Not all students had a clear understanding of the extraction process for coal seam gas and incomplete answers just stated 'drilling for gas'. Fracking refers to the high-pressure injection of water/sand and fracturing of rock to release the fossil fuel. Toxic chemicals and methane can be released into the environment and may contaminate water supplies. This destruction of habitat around a fracking site or the removal of this finite resource may negatively impact on the ability of future generations to use these resources, and therefore impacts on intergenerational equity.

Question 6c.

Mark	0	1	2	3	Average
%	31	30	29	11	1.2

Responses that correctly described using either energy source were accepted, if they made it clear how both peak and base power loads could be maintained. Most students suggested it was best to use coal seam gas because it could be stored and used as needed in a gas-fired electrical generation plant. This generator could supply the base load and be increased to generate peak loads as required. Other students argued that it would be possible to use wind energy, even though it is an intermittent source, if the area had sufficient windy days and a suitable battery storage system. High-scoring responses made clear the difference between base and peak load.

Question 6d.

Mark	0	1	2	Average
%	14	46	40	1.3

A variety of answers that described the key environmental reason for opting to use wind energy rather than coal seam gas were accepted. Common responses included that using wind would reduce greenhouse gas emissions and therefore reduce the contribution to the enhanced greenhouse effect, or that using wind power would reduce land degradation and habitat destruction from the coal seam gas fracking process, thereby maintaining the ecological integrity of the region.

Question 7a.

Mark	0	1	2	3	Average
%	36	23	24	17	1.2

The focus of this question was to identify the environmental concerns regarding the extraction of resources to create large-scale battery systems. Mining for lithium, zinc and other metals required to produce battery systems can cause major environmental disturbances to ecosystems through the clearing of land or potential chemical spills during the extraction process. Extraction through the machinery used in mining also releases greenhouse gases contributing to global warming. The focus had to be on the impacts of extraction and not on other issues, such as economic concerns around the cost of the battery system.

Question 7b.

Mark	0	1	2	Average
%	38	34	27	0.9

This question was not well answered by students. It is important to have the energy source (i.e., a hydro-powered generator or battery) closer to the users, due to a reduction in energy lost in transmission, thereby increasing the energy efficiency and using fewer energy resources. Responses that did not score well proposed, for example, that it would be easier to check on the storage system if it were close to the community.

Question 7c.

Mark	0	1	2	3	4	Average
%	22	31	30	14	3	1.5

Students found this more complex question difficult to fully answer. High-scoring responses explained that data on biodiversity and the ecology of a region should initially be collected to provide a baseline on the current ecosystems. Issues such as overall ecological health and risks to key species and communities should be assessed. This data would then be incorporated into a management plan for the pumped hydro energy storage (PHES) and would guide how the PHES is constructed and operates. Ongoing assessment and monitoring, once the PHES is in operation, would be required to check for any negative environmental

impacts or changes over time related to the baseline data on biodiversity. If there were any concerns, identified actions could be put in place to manage these negative impacts and maintain original biodiversity.

Question 7d.

Mark	0	1	2	Average
%	31	51	19	0.9

This question seemed to confuse many students. The basic reason for choosing a large-scale battery storage system rather than pumped hydro is access to water and a suitable site. Pumped hydro might not be an option due to an insufficient water source or lack of a suitable dam site. In general, a battery system can be constructed and used at any location. One mark was awarded to students who stated that energy from a battery system was available for immediate use.

Question 8a.

Mark	0	1	2	3	Average
%	30	5	12	53	1.9

Many students were able to accurately plot the data points from the table for moisture content (%), then from the manual method on the graph, join these points with a smooth line and add the line to the key. Some incorrect responses involved drawing a line of best fit around the points on the graph.

Question 8b.

Mark	0	1	2	3	Average
%	23	4	11	63	2.1

Most students correctly identified that the creek was located at about 30 metres from the starting point and described two pieces of evidence: that moisture levels reached above 90 per cent at this point and the tree canopy height was 0 metres. These two pieces of evidence led to the suggestions that the soil was extremely wet (near a water source) and that trees were unlikely to grow in a creek.

Question 8c.

Mark	0	1	Average
%	44	56	0.6

Most students clearly stated the correlation between soil moisture and canopy height as suggested by the data. The correct answer was that as soil moisture increases (gets closer to 100%), the canopy height becomes lower.

Question 8d.

Mark	0	1	2	Average
%	40	44	16	0.8

Analysis of the data highlighted differences in the soil moisture content measured in the field and in the laboratory. High-scoring responses suggested two reasons for the difference. These reasons included poor experimental technique in the laboratory, some moisture loss through evaporation from when the sample was taken in the field and when tested in the laboratory, and that the digital meter was calibrated incorrectly and tested consistently higher. It was incorrect to state that because data was collected digitally it will be more accurate than a manual method.

Question 8e.

Mark	0	1	Average
%	28	72	0.7

Most students correctly identified the data point that was not included on the graph as an 'outlier'.

Question 8f.

Mark	0	1	2	3	4	Average
%	32	18	23	14	12	1.6

This question was not well answered, with many students confusing the meanings of the terms 'precision' and 'accuracy', as well as not applying these terms to the arguments presented. The argument that the drone should remeasure the tree height at the site multiple times per day and that this would help with data precision but not necessarily accuracy was correct. This is because by remeasuring tree height multiple times students would be able to collect more results, which allows for precision to be established (more than one measurement is required). Precision refers to how closely a set of measurement values agree with each other rather than accuracy (the tree height value is considered to be accurate if it is judged to be close to the 'true' value) but because the students don't actually know what the true value is, taking multiple measurements won't necessarily make the data more accurate.