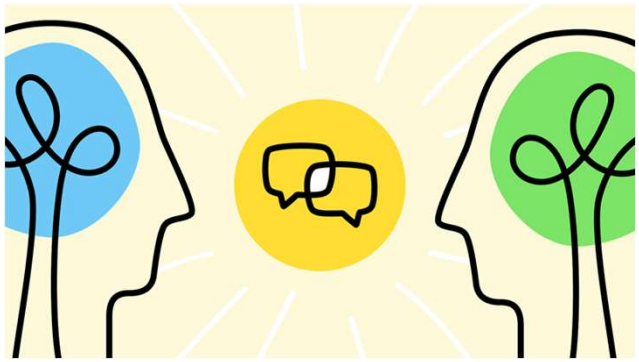
Consensus Marking 15 March 2025

by Mr. Ho Tik Shun

SBA Task



padlet

What are the challenges you have encountered when implementing B2 in school?

How do you think of using this sample task for your SBA in school?

Can the tasks address the concerns you have raised on B2?


承傳
凝聚
Andrew's Data - Excel
Systolic BP (mmHg)
Diastolic BP (mmHg)
Heart Rate (per min)
136.00
92.00
77.00


it's Show Time

Sharing by Ms. Jennifer Leung in SBA Conference (12 Oct 2024)

Challenges/obstacles

Class Data

Students' Work

Full Report VS Guided Questions

Scenario – Cold Pressor Test

Topic: Coordination & Response

Authentic Scenario

Sudden temperature stress can trigger physiological responses in the human body by activating the autonomic nervous system.

The **Cold Pressor Test** is used clinically as a stress test to evaluate cardiac autonomic function. The procedures in the test assess an individual's *responses in the cardiovascular system* and *pain tolerance level* in response to exposure to cold stress on a hand. The test involves immersing a person's hand in ice-cold water for a specified duration (e.g., 5 minutes) while monitoring the individual's pain tolerance level and cardiovascular responses.

In this investigation, you will investigate your own *cardiovascular responses* and *pain tolerance level* to cold stress on your hand in the cold pressor test. You will also examine factors that may influence an individual's pain tolerance in response to cold stress on the hand using class data.

Cold Pressor Test Procedure

1. Measure and record your height and weight with a scale.
2. Use an electric arm sphygmomanometer to measure your initial blood pressure and heart rate.
3. Immerse your hand up to the wrist into the tray of ice water (*Figure 1*). Start the stopwatch immediately after immersion.
4. Measure your blood pressure and heart rate at 1-minute intervals using the electric arm sphygmomanometer (*Figure 2*).
5. Withdraw your hand from the water after 5 minutes or when you feel physiological discomfort, whichever occurs first. Record the duration of immersion immediately after the withdrawal of hand. (Try to tolerate the cold water for **at least 1 minute**.)
6. Measure your blood pressure and heart rate 2 minutes after the withdrawal of your hand, at 1-minute intervals using the electric arm sphygmomanometer.
7. Rate your perceived level of pain on a scale from 0 to 5 (0 = no pain, 1-2 = mild pain, 3-4 = moderate pain 5 = severe pain).

Figure 1. Immersing a hand in ice-cold water covering the palm and wrist

Figure 2. Measuring the blood pressure and heart rate using an electric arm sphygmomanometer

Data Recording

(a) Record your personal information in the space provided below.

- Age: _____
- Sex: ☐ Male ☐ Female
- Height (cm): _____
- Weight (kg): _____

(b) Record the data collected from the cold pressor test:

[B1] ☐ U ☐ B

(1) Perceived level of pain (0-5): _____

(0 = no pain, 1-2 = mild pain, 3-4 = moderate pain, 5 = severe pain).

(2) Duration of immersion of the hand (min: sec): _____

Cardiovascular responses	**Time after immersing the hand in ice-cold water (min)**						**Time after withdrawing hand (min)**	
	0	1	2	3	4	5	1	2
Systolic blood pressure (mmHg)								
Diastolic blood pressure (mmHg)								
Heart rate (beats per min)								

Collecting a relatively large data set

Title: Changes in systolic blood pressure, diastolic blood pressure and heart rate during the cold pressor test

Scientific competencies
(NGSS Lead States, 2013) (OECD, 2020)

Evaluating & designing scientific enquiry

Interpreting data & evidence scientifically

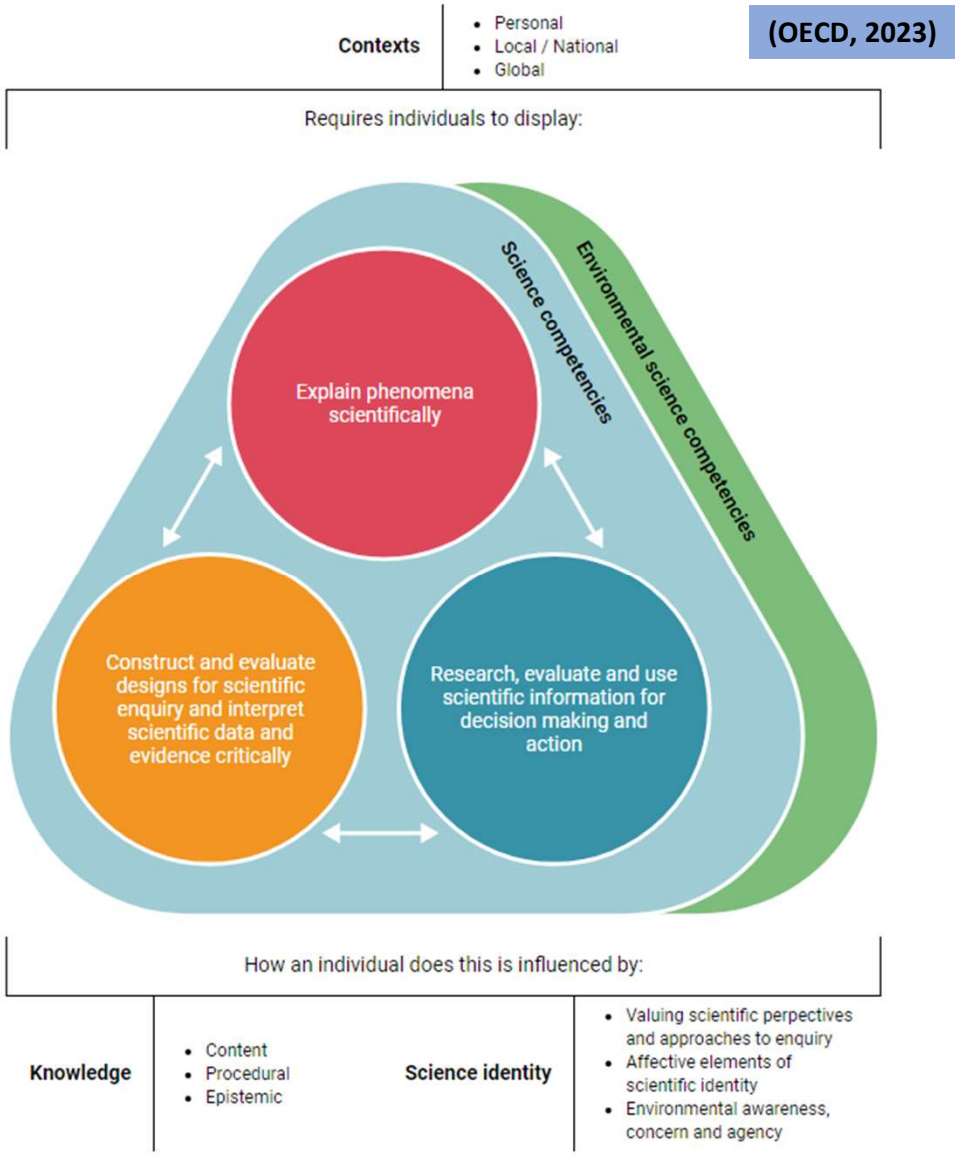
(OECD, 2023)

Construct and evaluate designs for scientific enquiry and *interpret scientific data and evidence critically*

↕

Procedural understanding
(Gott & Duggan, 1995)

(OECD, 2023)



B2 Assessment Guidelines

- Data Recording, Analysis & Interpretation
- Constructing & Evaluating Explanations
- Errors, Limitations & Improvement
- Future Work & Conclusion
- Others

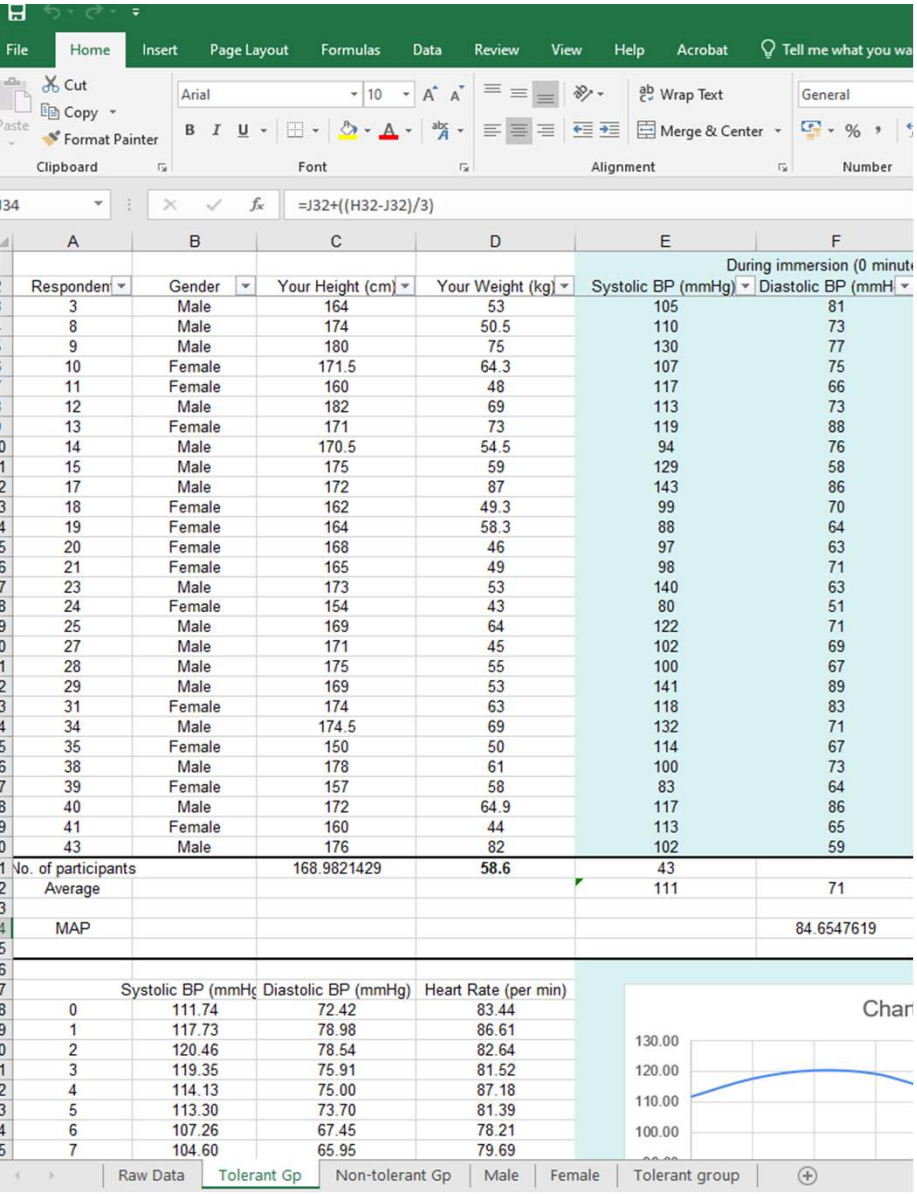
Mark range	Quality of work	Performance
9-10	Excellent	The report shows most of the good performances and a few excellent performances.
6-8	Good	The report shows most of basic performances and some good performances.
3-5	Fair	The report shows some basic performances and a few good performances.
1-2	Poor	The report shows a few basic performances.

	Basic Performances	Good Performances	Excellent Performances
Data Recording, Analysis & Interpretation	B1. Record qualitative data using clear descriptions/quantitative data (corrected to appropriate decimal places/ significant figures) properly.	G1. Construct and use appropriate representations (e.g., tables, graphs and/or diagrams) to organise and display data.	
	B2. Carry out basic calculations (e.g., percentages, frequencies, rates, means, ratios) to simplify or summarise data.	G2. Compare data sets based on (semi-)quantitative and/or qualitative data.	E1. Apply concepts of basic statistics (e.g., range, variance, standard deviation, error bar) to compare and explain data sets.
	B3. Identify anomalous data, if any, in the data set.	G3. Explain why the data are considered anomalous.	E2. Suggest possible explanations for anomalous data (e.g., human related errors) or ways to confirm if the data are anomalous.
			E3. Interpret the results in the control(s) to evaluate the success of the experiment/the influence of the experimental manipulation.
Constructing & Evaluating Explanations	B4. Describe and interpret the relationships/trends and patterns in the data sets, if any, in relation to the investigative problem.	G4. Explain the relationships/trends and patterns in the data sets in relation to the investigative problem using scientific ideas and principles.	
		G5. Describe and interpret the relationships/trends and patterns in more complex data sets (e.g., with multiple variables), if any, in relation to the investigative problem.	E4. Explain the relationships/trends and patterns in more complex data sets (e.g., with multiple variables) in relation to the investigative problem using scientific ideas and principles.
		G6. Evaluate if the testing hypothesis, if any, is supported, refuted, or remains undetermined according to the data.	E5. Discuss alternative hypothesis, if any.
	B5. Make claim(s) based on data/evidence in relation to investigative problem.	G7. Construct (an) evidence-based claim(s) that include(s) qualitative and/or quantitative data to explain the investigative problem.	E6. Construct (an) evidence-based explanation(s)/Evaluate alternative explanations in relation to the investigative problem.
Errors, Limitations & Improvement		G8. Identify significant measurement errors (e.g., uncertainties/errors inherent in the measurement system).	E7. Explain the impact of measurement error on the validity and reliability of data/conclusion.
		G9. Suggest valid improvements to reduce (the impact of) measurement error (e.g., using better tools, repeating measurements).	E8. Explain why the improvements can reduce (the impact of) measurement error.
		G10. Explain the limitations of experimental design (e.g., sample selection, sample size, range and intervals) in generating data to answer the investigative problem.	E9. Suggest and explain valid improvements/further data collection to address the limitations of the experimental design in relation to the investigative problem.
Future work & Conclusion		G11. Make informed decisions based on the data/findings of the investigation.	
		G12. Suggest new investigations to be conducted that are relevant to the findings of the investigation.	E10. Discuss the generalisability of the conclusion.
	B6. Make a conclusion in relation to the investigative problem.		
			E11. Discuss how to modify or extend an investigation to answer a new investigative question.
Others		G13. Explain how a specific step can impact on the validity and reliability of the data.	E12. Evaluate the overall validity and reliability of the data/evidence or methods that can influence the validity and reliability of the data/evidence.
			E13. Assess the appropriateness and adequacy of the experimental design (e.g., selection of the range and interval of the independent variable(s), measurement of the dependent variable(s), confounding variables, biases in the data) based on the data.

Unattained | Basic | Good | Excellent

Student's Performance Summary

Question	Performance item	Performance level
(b)	[B1]	☐ U ☐ B
(d)(1)	[G1]	☐ U ☐ B ☐ G
(d)(2)	[G5]	☐ U ☐ B ☐ G
(d)(3)	[E4]	☐ U ☐ B ☐ G ☐ E
(e)(1)	[G8]	☐ U ☐ B ☐ G
(e)(2)	[E7]	☐ U ☐ B ☐ G ☐ E
(f)	[B6]	☐ U ☐ B
(g)(1)	[G2]	☐ U ☐ B ☐ G
(g)(2)(i)	[G7]	☐ U ☐ B ☐ G
(g)(2)(ii)	[G7]	☐ U ☐ B ☐ G
	[B2]	☐ U ☐ B
(g)(3)	[E8]	☐ U ☐ B ☐ G ☐ E
(g)(4)	[E12]	☐ U ☐ B ☐ G ☐ E
Total		**___ U ___ B ___ G ___ E**
Mark		**___ / 10**



Responden	Gender	Your Height (cm)	Your Weight (kg)	Systolic BP (mmHg)	During immersion (0 minut Diastolic BP (mmH
3	Male	164	53	105	81
8	Male	174	50.5	110	73
9	Male	180	75	130	77
10	Female	171.5	64.3	107	75
11	Female	160	48	117	66
12	Male	182	69	113	73
13	Female	171	73	119	88
14	Male	170.5	54.5	94	76
15	Male	175	59	129	58
17	Male	172	87	143	86
18	Female	162	49.3	99	70
19	Female	164	58.3	88	64
20	Female	168	46	97	63
21	Female	165	49	98	71
23	Male	173	53	140	63
24	Female	154	43	80	51
25	Male	169	64	122	71
27	Male	171	45	102	69
28	Male	175	55	100	67
29	Male	169	53	141	89
31	Female	174	63	118	83
34	Male	174.5	69	132	71
35	Female	150	50	114	67
38	Male	178	61	100	73
39	Female	157	58	83	64
40	Male	172	64.9	117	86
41	Female	160	44	113	65
43	Male	176	82	102	59
No. of participants		168.9821429	58.6	43	
Average				111	71
MAP					84.6547619

	Systolic BP (mmHg	Diastolic BP (mmHg)	Heart Rate (per min)
0	111.74	72.42	83.44
1	117.73	78.98	86.61
2	120.46	78.54	82.64
3	119.35	75.91	81.52
4	114.13	75.00	87.18
5	113.30	73.70	81.39
6	107.26	67.45	78.21
7	104.60	65.95	79.69

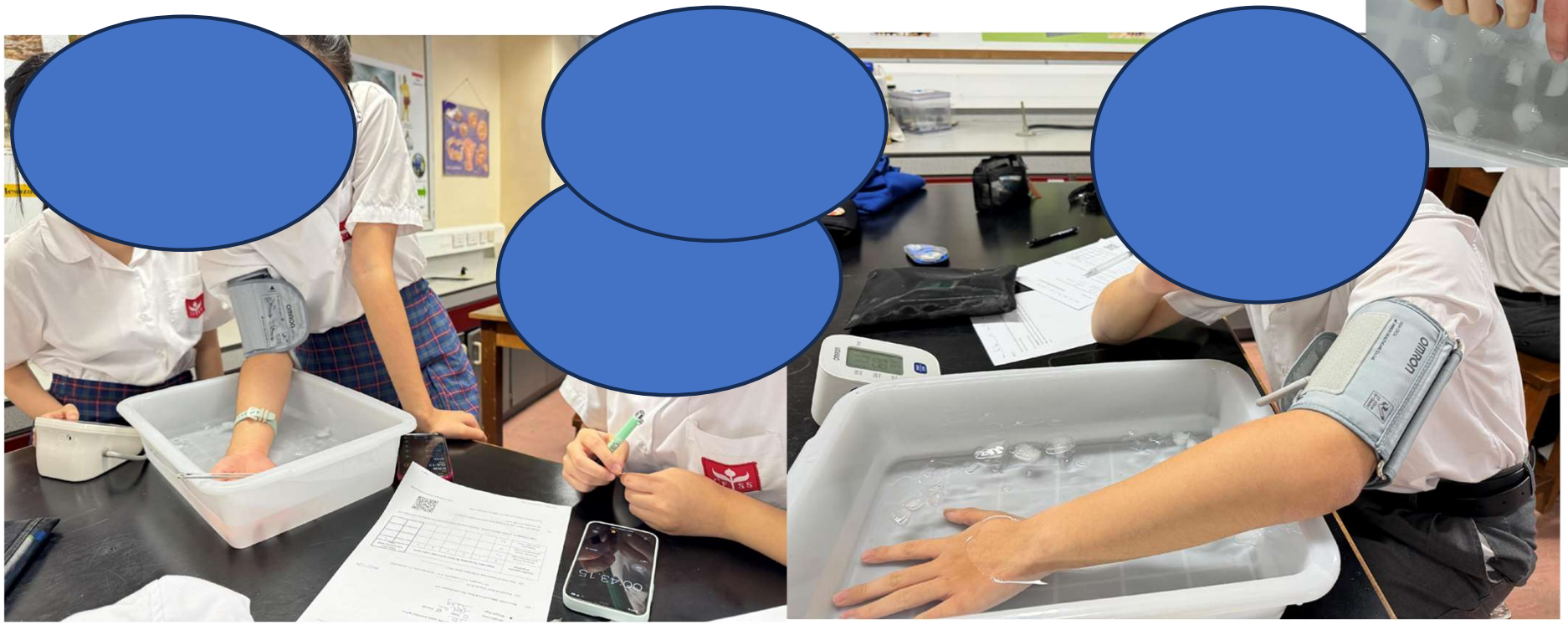
Cold Pressor Test

- Sufficient number of guiding questions (within 40-50 mins) with sufficient G/E questions
- More complex data set
  - Multivariate design
  - Pooling class data

Encourage meaningful use of data for
- finding unknown patterns
- explanation building

Student scripts obtained from...

- An EMI co-educational school
- Two S.5 classes with similar learning ability (55 students)
- Taught by the same Biology Teacher for 3 years



Discussion on the samples…

Questions

- What are your ***general impressions*** of the samples?
- Did you encounter ***any difficulties*** in scoring the samples?

Data Recording

(a) Record your personal information in the space provided below.

- Age: _____
- Sex: ☐ Male ☐ Female
- Height (cm): _____
- Weight (kg): _____

(b) Record the data collected from the cold pressor test:

[B1] ☐ U ☐ B

(1) Perceived level of pain (0-5): _____

(0 = no pain, 1-2 = mild pain, 3-4 = moderate pain, 5 = severe pain).

(2) Duration of immersion of the hand (min: sec): _____

Cardiovascular responses	**Time after immersing the hand in ice-cold water (min)**						**Time after withdrawing hand (min)**	
	0	1	2	3	4	5	1	2
Systolic blood pressure (mmHg)								
Diastolic blood pressure (mmHg)								
Heart rate (beats per min)								

Collecting a relatively large data set

Title: Changes in systolic blood pressure, diastolic blood pressure and heart rate during the cold pressor test

Data Analysis & Interpretation

(d) Scientists construct graphs to observe trends and patterns in the data.

Scan this QR code to learn about different types of graphical representations.

(1) Construct **a suitable graph** to show the changes in your cardiovascular responses (i.e., systolic blood pressure, diastolic blood pressure and heart rate) during the cold pressor test (i.e. just before your hand immersion in the ice-cold water to 2 minutes after withdrawing your hand)

[G1] ☐ U ☐ B ☐ G

G1. Construct and use appropriate representations (e.g., tables, graphs and/or diagrams) to organise and display data.

Concepts for marking

- ***Appropriate labelling of axes*** with ***correct units***
  - Heart rate (beats per minute)
  - Blood pressure (mmHg)
  - Time (min)
  - Indicating the time when the hand was withdrawn
- ***Appropriate title***
  - Cardiovascular Responses during Cold Pressor Test
- ***Appropriate scales***

(Note: hand-drawn graphs not on graph paper → unattained)

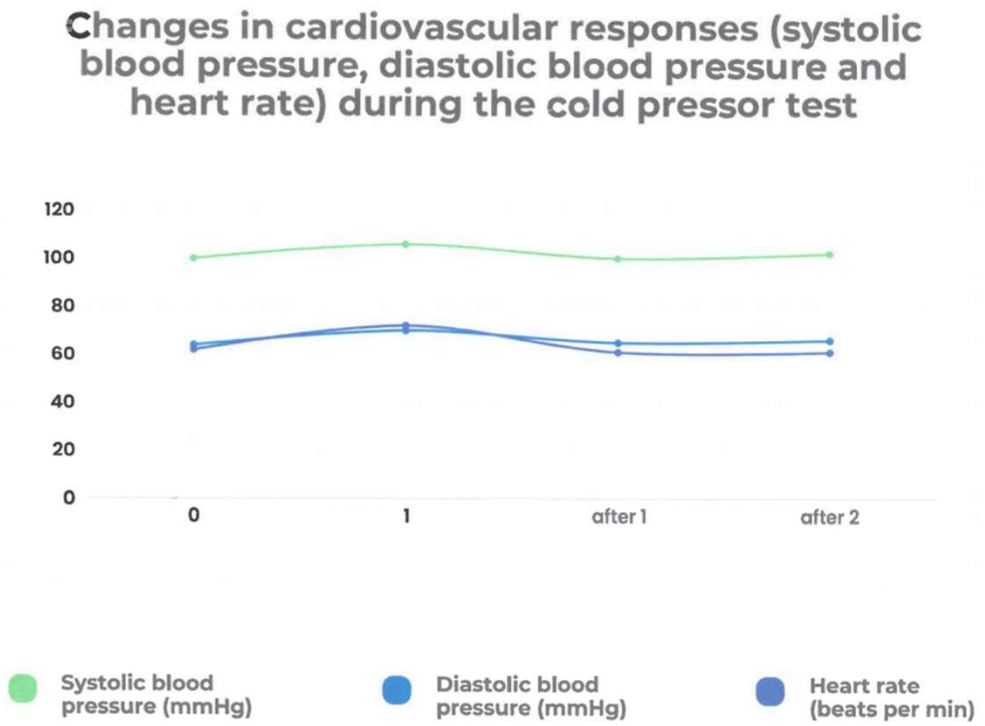
Achieve all of the three requirements→ Good

Achieve some of the three requirements → Basic

Hardly achieve any of the three requirements unattained

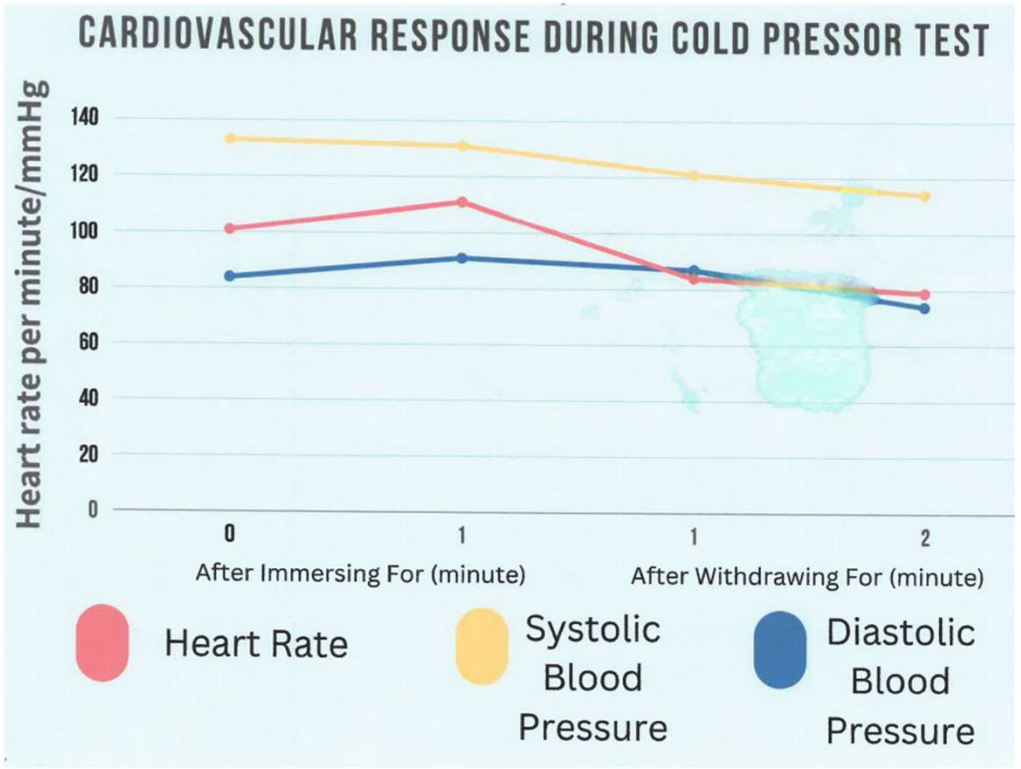
Students' Performance

Student A



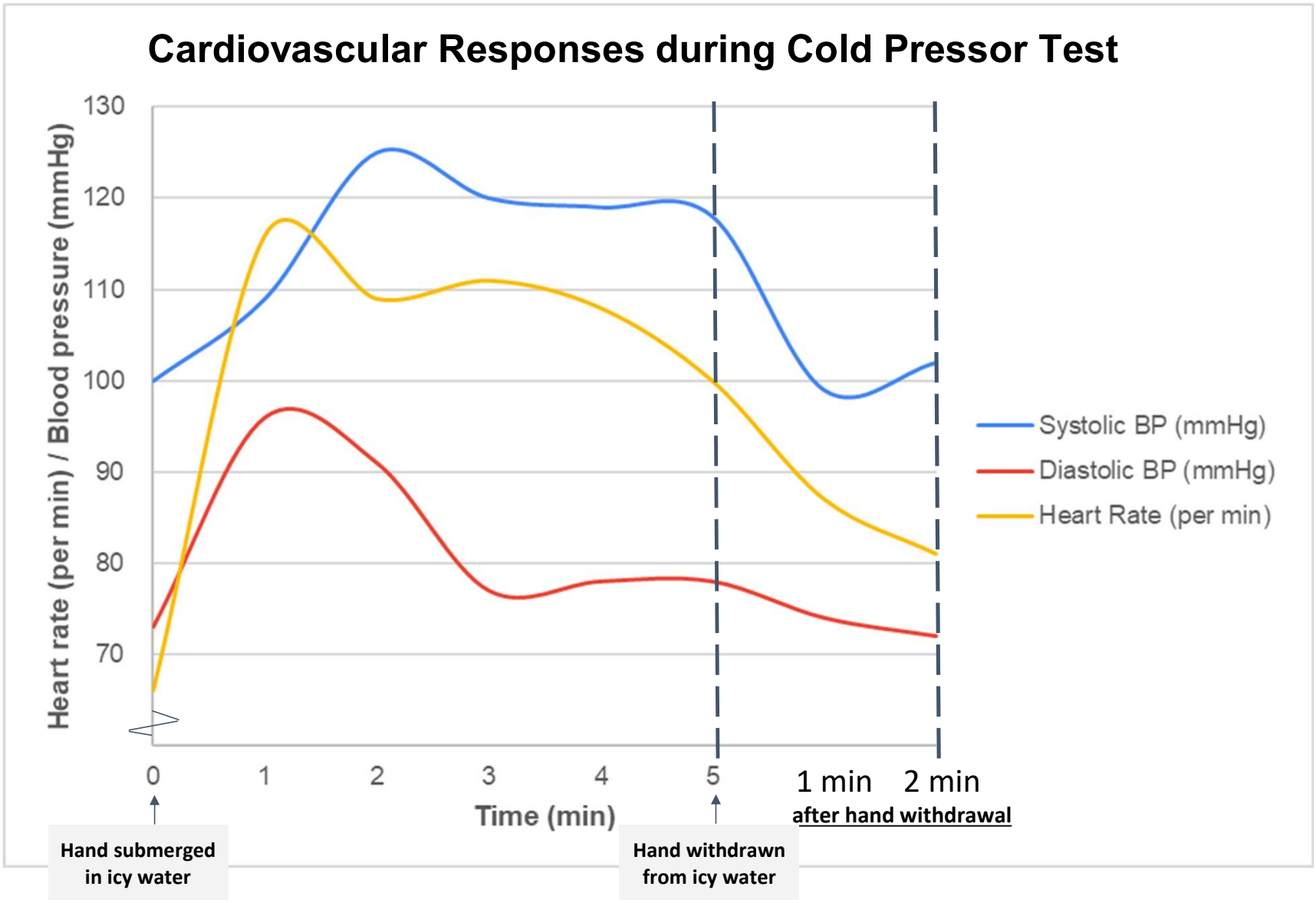
Basic

Student B



The time when the hand was withdrawn is not indicated

Basic


Cardiovascular Responses during Cold Pressor Test
Heart rate (per min) / Blood pressure (mmHg)
130
120
110
100
90
80
70
0
1
2
3
4
5
1 min
2 min
Time (min)
after hand withdrawal
Systolic BP (mmHg)
Diastolic BP (mmHg)
Heart Rate (per min)
Hand submerged in icy water
Hand withdrawn from icy water

Good

Data Analysis & Interpretation

(d) Scientists construct graphs to observe trends and patterns in the data.

Scan this QR code to learn about different types of graphical representations.

(1) Construct **a suitable graph** to show the changes in your cardiovascular responses (i.e., systolic blood pressure, diastolic blood pressure and heart rate) during the cold pressor test (i.e. just before your hand immersion in the ice-cold water to 2 minutes after withdrawing your hand)

[G1] ☐ U ☐ B ☐ G

(2) Describe the changes in your cardiovascular responses during the cold pressor test.

[G5] ☐ U ☐ B ☐ G

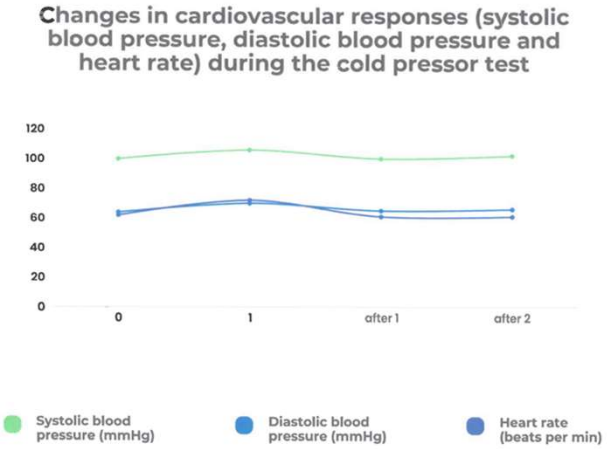
G5. Describe and interpret the relationships/trends and patterns in more complex data sets (e.g., with multiple variables), if any, in relation to the investigative problem.

Concepts for marking

- *Describe* ***the general trends*** (for the changes in heart rate and blood pressure) , not merely stating the data
- Identify time ***periods*** showing the changes/trends

  (i.e., 0 to 1 min/time of withdrawal, and after withdrawal)

Student A

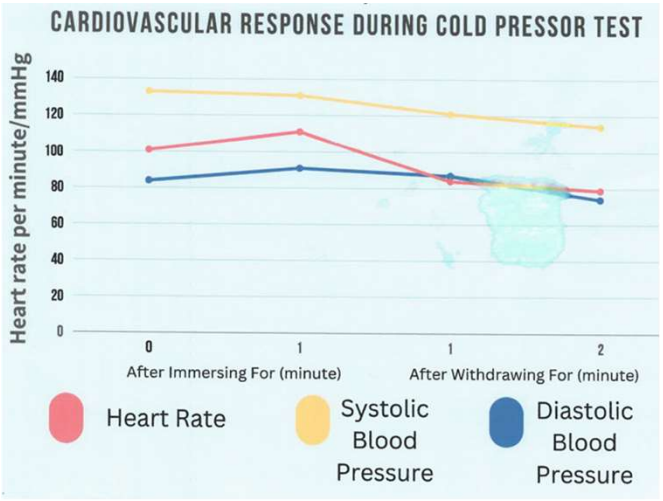


Basic

Merely stating the data without describing the general trend

At the start of the test, by the time of 0 min, the systolic blood pressure was 100 mmHg originally, it increased and reached 106 mmHg after immersing the hands to cold water for 1 minute. It increased 6 mmHg in 1 minute. While the diastolic blood pressure was 64 mmHg at the beginning of the test, it increased to 70 mmHg after 1 minute. Last but not least, the initial heart rate was 62 beats per min. It increased to 72 beats per min after 1 min, having 10 beats difference.

Student B



Good

General trends + time periods

beats/min

decreasing by 32 compare to initial

The cardiovascular responses show a general decreasing trend. Initially, the heart rate was at 101 per min, where it firstly shortly rises to 111 per minute after immersing for 1 minute, however continuing to decrease till 87 after immersion and 79 per minute at last after decreasing for 2 minute. A similar trend can be seen for Diastolic blood pressure, measured initially at 84 mmHg, where it increases to 91 mmHg at immersing after 1 minute, however decreases after then, and reaches 74 mmHg after withdrawing for 2 minute, decreasing by 10 mmHg comparing to initial. And for Systolic blood pressure, it shows a gradual decreasing trend throughout the test, from 133 mmHg initial, dropping by 19 mmHg to 114 mmHg after withdrawing the hand after 2 minutes.

(3) It is known that the sympathetic nerves become more active in response to cold stress on the hand. Based on your biological knowledge, explain the changes in ***heart rate*** that occur during the first minute of the cold pressor test.

[E4] ☐ U ☐ B ☐ G ☐ E

E4. Explain the relationships/trends and patterns in more complex data sets (e.g., with multiple variables) in relation to the investigative problem using scientific ideas and principles.

Concepts for assessment

Achieve three requirements → Excellent

Achieve two requirements → Good

Achieve one requirement → Basic

Hardly achieve any requirement → unattained

- ***State the response***

  The **heart rate increased** during the first minute of the cold pressor test.

- ***Describe the regulation process***

  The sympathetic nerve becomes more active and **releases more noradrenaline**

- ***Identify the effector (i.e., SA node)***

  The noradrenaline **stimulates the activity of the SA node**, increasing the heart rate

(3) It is known that the sympathetic nerves become more active in response to cold stress on the hand. Based on your biological knowledge, explain the changes in ***heart rate*** that occur during the first minute of the cold pressor test.

Student A

[E4] ☐ U ☐ B ☐ G ☐ E

When the hands immerse in cold water, the sympathetic nerves become more active, leading to the release of adrenaline and noradrenaline. These stress hormones stimulate the heart to beat faster, increasing heart rate. In the first minute of the test, the increased heart beat help maintain body temperature and increase metabolic rate.

Not accurate

Reference

- The ***heart rate increased*** during the first minute of the cold pressor test.
- The ***sympathetic nerve becomes more active*** and ***releases more noradrenaline.***
- The noradrenaline ***stimulates the activity of the SA node*** and the cardiac muscle, increasing the heart rate.

Basic

(3) It is known that the sympathetic nerves become more active in response to cold stress on the hand. Based on your biological knowledge, explain the changes in ***heart rate*** that occur during the first minute of the cold pressor test.

Student B

[E4] ☐ U ☐ B ☐ G ☐ E

For the first minute period of the cold pressor test, heart rate increases ✓. This is due to the sudden drop in temperature on the surface of the hand, such actively activating sympathetic nerves, which contributes to maintain homeostasis. Sympathetic nerve is able to trigger the release of hormones, such as norepinephrine, which stimulates and sends more active signals to the SA node ✓, where then leads to the increase in heart rate, as SA node is responsible to contol the beating pace of the heart. With the increase in heart rate, it increases blood supply to the body, where the blood contains oxygen, which is used to generate more heat ~~is~~ converted by energy by metabolic activities, such as respiration.

Not accurate

Reference

- The ***heart rate increased*** during the first minute of the cold pressor test.
- The ***sympathetic nerve becomes more active*** and ***releases more noradrenaline.***
- The noradrenaline ***stimulates the activity of the SA node*** and the cardiac muscle, increasing the heart rate.

Good

(e) (1) State *one* significant measurement error that occurred when measuring your cardiovascular responses.

[G8] ☐ U ☐ B ☐ G

G8. Identify significant measurement errors (e.g., uncertainties/errors in the measurement system, including random and systematic errors).

Concepts for marking

- Any reasonable measurement errors (Good performance)
  - Related to the limitations of the instrument (takes 30 s to measure each reading)
  - Emotional status of the participant

- Human errors as a result of mistakes in operation should have been addressed in Area A but significant ones may still be awarded basic performance

(e) (1) State *one* significant measurement error that occurred when measuring your cardiovascular responses.

[G8] ☐ U ☐ B ☐ G

Student A

Inaccurate placement of the heart rate monitor. Improper placement of the monitor will result in erroneous heart rate measurements, affecting the accuracy of the cardiovascular response data collected during the cold pressor test.

The error mentioned is not a measurement error but mistakes in the operation during the experiment.

Basic

(e) (1) State *one* significant measurement error that occurred when measuring your cardiovascular responses.

[G8] ☐ U ☐ B ☐ G

Student B

The effect of the fluctuating of emotions and movement based on it. Individual's emotions can be easily affected, actions such as laughing or feeling worried while carrying out the test may lead to mood swings and changes, such affecting the accuracy of readings measured due to the fluctuating and unstable emotions.

Errors due to changes in blood pressure caused by the emotional status of the participant are mentioned

Good

to the body to rapidly response to the cold stress.

(e) (1) State *one* significant measurement error that occurred when measuring your cardiovascular responses.

[G8] ☐ U ☐ B ☐ G

The cardiovascular responses are not measured accurately at 1-minute interval since the third minute of immersing my hand into the ice water. When measuring the blood pressure and heart rate, the sphygmomanometer showed 'error' and no valid reading is obtained. The sphygmomanometer is then immediately restarted and readings were taken, and causing the data reading from the 3rd minute to have a delay for around 30 seconds. This may be due to the moving or the position of hand slightly changed to nearby the level same as the heart.

(2) Explain how this measurement errors can affect the validity of this investigation.

Limitation of the measurement tools is mentioned **Good**

(2) Explain how this measurement errors can affect the validity of this investigation.

[E7] ☐ U ☐ B ☐ G ☐ E

E7. Explain the impact of measurement error(s) on the validity and reliability of data/conclusion.

Concepts for marking

- State and explain the effect of the identified measurement error on the ***measured heart rate*** and ***blood pressure***.

- Explain why the measured values are invalid (i.e., not only affected by the cold treatment but ***also by other factors not related to the one under investigation***.)

(2) Explain how this measurement errors can affect the validity of this investigation.

[E7] ☐ U ☐ B ☐ G ☐ E

Student A

Inaccurate placement of the heart rate monitor can lead to erroneous heart rate readings during the cold pressor test affecting the validity of investigation. If the sensor is not correctly positioned or shifts during the test, the recorded heart rate data may not reflect the individual's true cardiovascular response to the cold pressor stimulus.

Unattained

(2) Explain how this measurement errors can affect the validity of this investigation.

[E7] ☐ U ☐ B ☐ G ☐ E

Student B

As mentioned, emotions of one may change in many ways in a short period of time, when feeling worried due to the freezing painful feeling from one's hand, or even being affected by the external environment, this can lead to the fluctuating of emotions, unable to keep ourselves with a stable and calm mind, such our heart beat may increase ✓ re to change in intense or unstable emotions, leading to incorrect readings of cardiovascular responses.

or trigger further vasoconstriction

- ✓ The measurement error affecting the measured blood pressure should also be explained.

Good

(2) Explain how this measurement errors can affect the validity of this investigation.

[E7] ☐ U ☐ B ☐ G ☐ E

When participants feel stressed, anxiety, the neuroendocrine regulatory mechanisms that modulate cardiovascular function will be affected and hormones (cortisol and adrenaline) are released, (and heart rate ✓) cause the blood vessels constrict. This constriction increases the blood pressure. (and heart rate?) Also, the anxiety level may change during the test. Since the blood pressure change with the anxiety level change ✓, therefore, the blood pressure increases may obscure ✓ the physiological effects of the cold-water stress stimulus.

- State and explain the effect of the identified measurement error on the measured heart rate and blood pressure.
- Explain why the measured values are invalid (i.e., not only affected by the cold treatment but also by the unstable emotion of the participant.)

Excellent

(f) What can you conclude from this part of the investigation? [B6] ☐ U ☐ B

B6. Make a conclusion in relation to the investigative problem.

Concepts for marking

- State the change of heart rate and blood pressure when the hand was immersed in ice-cold water

(f) What can you conclude from this part of the investigation? [B6] ☐ U ☐ B

Student A

Data collection methods can ensure the reliability and validity of the results. It can minimize confounding factors and accurately capture cardiovascular responses to stress.

Unattained

Student B

From the investigation; it can be observed that when our body is stimulated by sudden cold signals, corresponding cardiovascular response and activities can be observed, such as the increase of heart rate, serving the purpose to maintain a homeostasis internal environment.

Unattained

Reference

- Did not mention the blood pressure increased when the hand was immersed in ice-cold water

(g) To make sense of the class data provided in the *Google Spreadsheet*, you have conducted additional online research to gather more information.

All you need to know about the Cold Pressor Test!

Individuals can be grouped into two groups, the *tolerant group* and the *non-tolerant group* based on the results in the cold pressor test. Tolerant group can tolerate hand immersion in ice-cold water for more than 1.5 minutes while non-tolerant group cannot tolerate hand immersion in ice-cold water for more than 1.5 minutes and would withdraw their hands.

1. The two groups would perceive different levels of pain during the cold pressor test.

2. The two groups show different changes in *Mean Arterial Pressure* (MAP). The changes can be seen at 1 minute during the cold pressor test.

   *MAP is a measure of the average pressure exerted on the arterial walls throughout the cardiac cycle and can be calculated using the following formula:

$$MAP = DBP + \frac{SBP - DBP}{3}$$

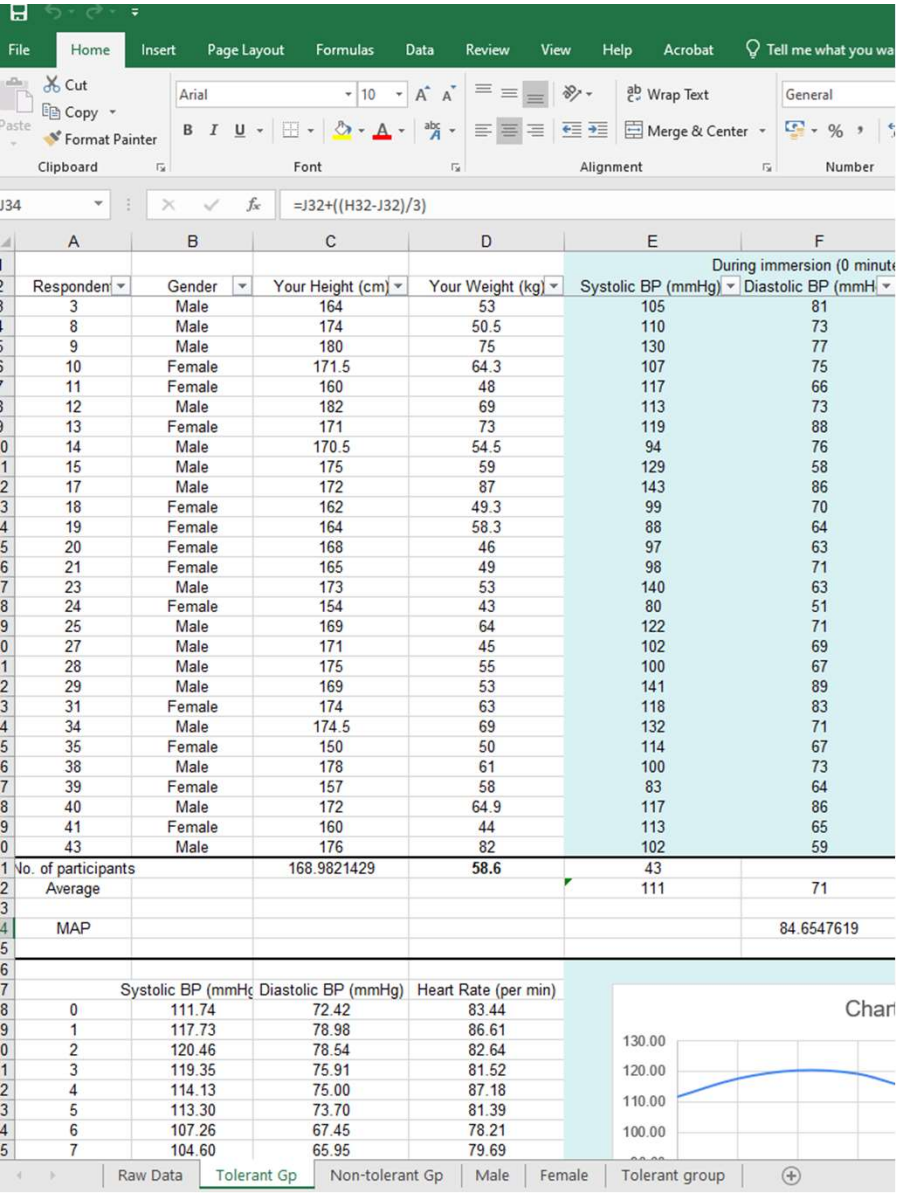
   SBP = Systolic blood pressure; DBP = Diastolic blood pressure

3. Female with a height of less than 150 cm show more variations in the change in *cardiac output* during the immersion period than males with a height of 150 cm or above.

G2. Compare data sets based on (semi-)quantitative and/or qualitative data.

(1) If the class is divided into two groups based on the above criterion (i.e., the **tolerant group** and the **non-tolerant group**), compare the average weight of individuals in these two groups.

[G2] ☐ U ☐ B ☐ G



Responden	Gender	Your Height (cm)	Your Weight (kg)	Systolic BP (mmHg)	Diastolic BP (mmH
				During immersion (0 minut	
3	Male	164	53	105	81
8	Male	174	50.5	110	73
9	Male	180	75	130	77
10	Female	171.5	64.3	107	75
11	Female	160	48	117	66
12	Male	182	69	113	73
13	Female	171	73	119	88
14	Male	170.5	54.5	94	76
15	Male	175	59	129	58
17	Male	172	87	143	86
18	Female	162	49.3	99	70
19	Female	164	58.3	88	64
20	Female	168	46	97	63
21	Female	165	49	98	71
23	Male	173	53	140	63
24	Female	154	43	80	51
25	Male	169	64	122	71
27	Male	171	45	102	69
28	Male	175	55	100	67
29	Male	169	53	141	89
31	Female	174	63	118	83
34	Male	174.5	69	132	71
35	Female	150	50	114	67
38	Male	178	61	100	73
39	Female	157	58	83	64
40	Male	172	64.9	117	86
41	Female	160	44	113	65
43	Male	176	82	102	59
No. of participants		168.9821429	**58.6**	43	
Average				111	71
MAP					84.6547619

	Systolic BP (mmHg	Diastolic BP (mmHg)	Heart Rate (per min)
0	111.74	72.42	83.44
1	117.73	78.98	86.61
2	120.46	78.54	82.64
3	119.35	75.91	81.52
4	114.13	75.00	87.18
5	113.30	73.70	81.39
6	107.26	67.45	78.21
7	104.60	65.95	79.69

- **Tolerant group** can tolerate hand immersion in ice-cold water for more than 1.5 minutes
- **Non-tolerant group** cannot tolerate hand immersion in ice-cold water for more than 1.5 minutes and would withdraw their hands.

Sorting data into two groups…

Mean Weight

- Tolerant Group: **58.6 kg**
- Non-tolerant Group: **49.3 kg**

Concepts for marking

Approach:

- Correctly put the data into two groups and calculate the average weight of each group
- Compare the average weight of the two groups

(1) If the class is divided into two groups based on the above criterion (i.e., the **tolerant group** and the **non-tolerant group**), compare the average weight of individuals in these two groups.

[G2] ☐ U ☐ B ☐ G

Student A

There are 13 students belong to the non-tolerant group while 28 students belong the tolerant group. The average weight of individuals in tolerant group is 58.6 kg ✓ while the average weight of individuals in non-tolerant group is 49.3 kg ✓ having a 9.3 kg differences. The data can show that students having heavier weight can withstand cold more than students having a lighter weight. ✓

Good

Mean Weight

- ☐ Tolerant Group: 58.6 kg
- ☐ Non-tolerant Group: 49.3 kg

(1) If the class is divided into two groups based on the above criterion (i.e., the **tolerant group** and the **non-tolerant group**), compare the average weight of individuals in these two groups.

[G2] ☐ U ☐ B ☐ G

Student B

For the non-tolerant group, their average weight is 49.28k ✓ while for the tolerant group, their average weight is 58.6k ✓ Where there are 15 student belonging in the non-tolerant group, and 28 being in the tolerant group. The average weight of the tolerant group is heavier than that of non-tolerant group by 9.32kg. This indicate that having a relatively heavier weight allows participate to withstand and immerse their hand in ✓ ice-water for a longer period of time

Good

Mean Weight

- ☐ Tolerant Group: 58.6 kg
- ☐ Non-tolerant Group: 49.3 kg

(g) To make sense of the class data provided in the *Google Spreadsheet*, you have conducted additional online research to gather more information.

All you need to know about the Cold Pressor Test!

Individuals can be grouped into two groups, the *tolerant group* and the *non-tolerant group* based on the results in the cold pressor test. Tolerant group can tolerate hand immersion in ice-cold water for more than 1.5 minutes while non-tolerant group cannot tolerate hand immersion in ice-cold water for more than 1.5 minutes and would withdraw their hands.

1. The two groups would perceive different levels of pain during the cold pressor test.

2. The two groups show different changes in *Mean Arterial Pressure* (MAP). The changes can be seen at 1 minute during the cold pressor test.

   *MAP is a measure of the average pressure exerted on the arterial walls throughout the cardiac cycle and can be calculated using the following formula:

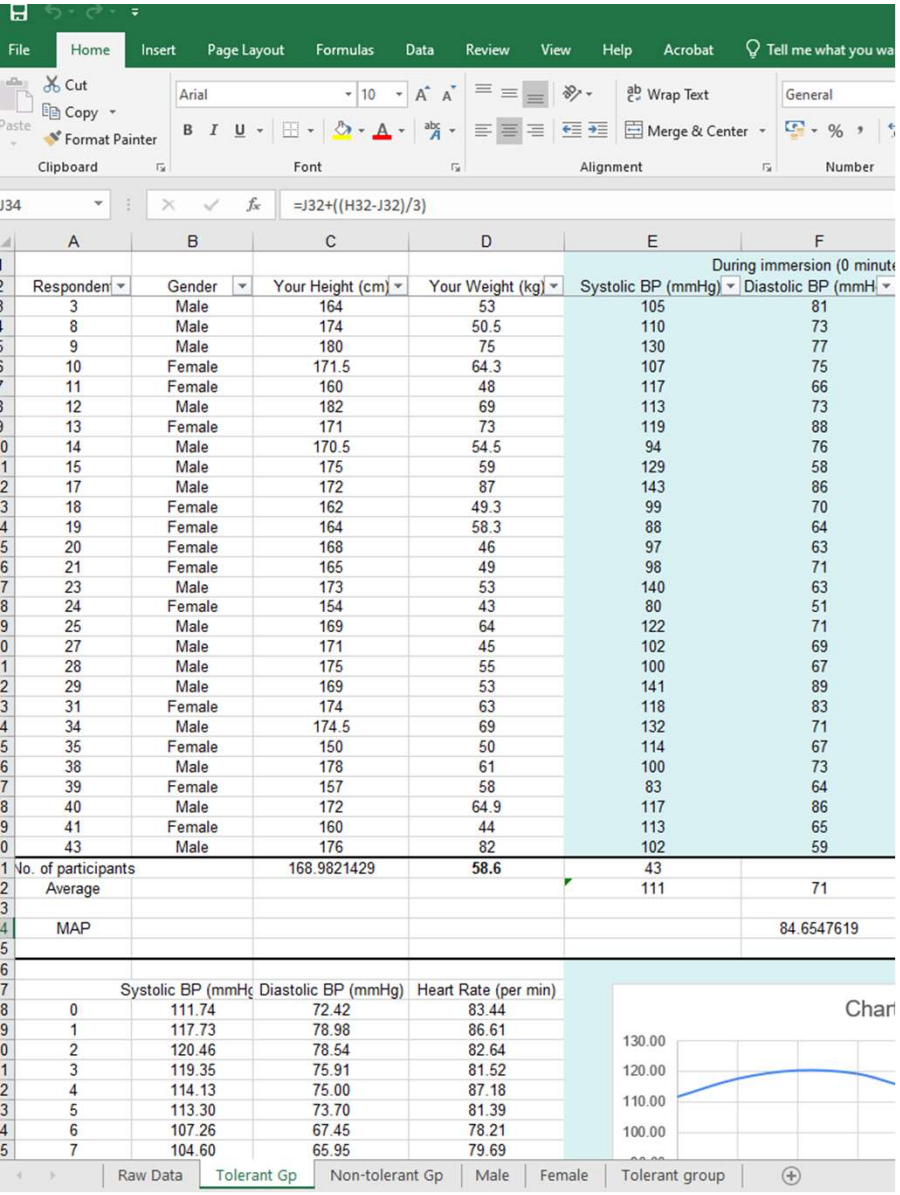
$$MAP = DBP + \frac{SBP - DBP}{3}$$

   SBP = Systolic blood pressure; DBP = Diastolic blood pressure

3. Female with a height of less than 150 cm show more variations in the change in *cardiac output* during the immersion period than males with a height of 150 cm or above.

G7. Construct (an) evidence-based claim(s) in relation to the investigative problem using relevant data.

(2) Explain whether the class data **supports** or **does not support** each of the statements about the differences in the two groups as mentioned in the above online research.



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- **Tolerant group** can tolerate hand immersion in ice-cold water for more than 1.5 minutes
- **Non-tolerant group** cannot tolerate hand immersion in ice-cold water for more than 1.5 minutes and would withdraw their hands.

Sorting data into two groups…

Mean Pain Level (out of 5)

- Tolerant Group: **3.25**
- Non-tolerant Group: **3.73**

Approach:

- Students will use the data of the perceived level of pain for the two groups
- They will compare the means of this parameters for the two groups to assess the validity of the statement.

(2) Explain whether the class data **supports** or **does not support** each of the statements about the differences in the two groups as mentioned in the above online research.

Student A

Good

Mean Pain Level (out of 5)
- ☐ Tolerant Group: 3.25
- ☐ Non-tolerant Group: 3.73

Statement	Put a "✓" into the appropriate boxes	Explanation based on evidence from the class data (*Note*: Include quantitative data whenever appropriate)
1	☑ Support ☐ Do NOT support ✓	The average pain level of the tolerant group is 3.25 ✓ while the average pain level of the non-tolerant group is 3.7 ✓ The pain perceived by tolerant group is less than the non-tolerant group. [G7] ☐ U ☐ B ☐ G

Student B

Good

Statement	Put a "✓" into the appropriate boxes	Explanation based on evidence from the class data (*Note*: Include quantitative data whenever appropriate)
1	☑ Support ☐ Do NOT support ✓	The average level of pain recorded from the non-tolerant group is 3.6154 (to 4dp), while it is 3.25 ✓ the tolerant group, this shows that the tolerant group has perceived less pain comparing to that of non-tolerant group [G7] ☐ U ☐ B ☐ G

(g) To make sense of the class data provided in the *Google Spreadsheet*, you have conducted additional online research to gather more information.

B2. Carry out basic calculations (e.g., percentages, frequencies, rates, means, ratios) to simplify or summarise data.

G7. Construct (an) evidence-based claim(s) in relation to the investigative problem using relevant data.

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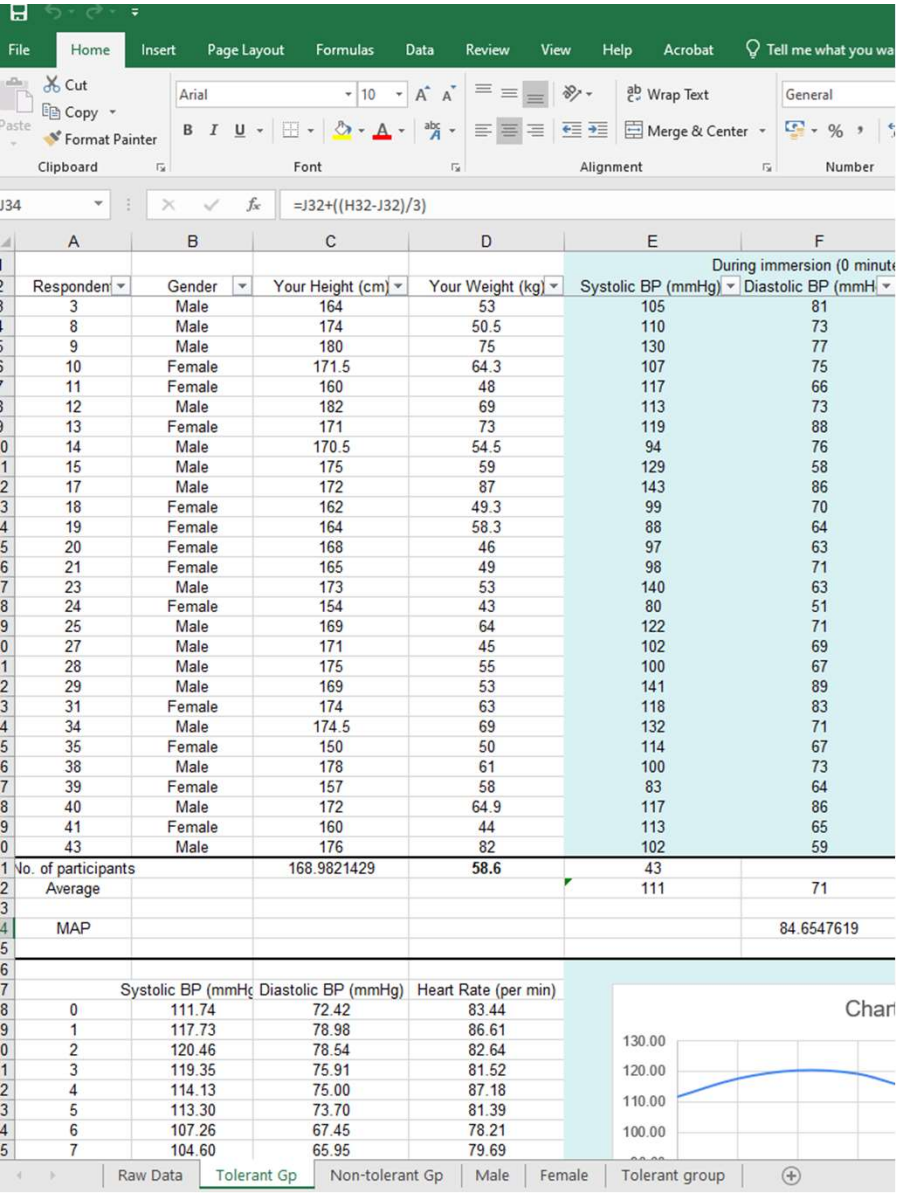

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7	104.60	65.95	79.69

Sorting data into two groups…

MAP

Tolerant Group:

- 0 min **84.65 mmHg**
- 1 min **92.51 mmHg**

Non-tolerant Group:

- 0 min **87.15 mmHg**
- 1 min **88.09 mmHg**

$$MAP = DBP + \frac{SBP - DBP}{3}$$

SBP = Systolic blood pressure; DBP = Diastolic blood pressure

Approach:

- Students will choose the blood pressure data at the 1st minute and 0 minute and calculate the changes in mean arterial pressure (MAP) for both groups.
- They will compare the values between the two groups to evaluate the validity of the statement.

Concepts for marking

- **Calculate the value correctly** (**B2** - Carry out ***basic calculations*** (e.g. percentages, frequencies, rates, means, ratios) to simplify or summarise data)

- **Select the appropriate claim**
- **Identify the appropriate data set to justify the claims**

  (**G7** - ***Construct (an) evidence-based claim(s)*** that include(s) qualitative and/or quantitative data to explain the investigative problem)

(2) Explain whether the class data **supports** or **does not support** each of the statements about the differences in the two groups as mentioned in the above online research.

Student A

2	☑ Support ☐ Do NOT support	The MAP of tolerant group is 84.6 at the beginning, while it increased to 93.9. While the MAP of non-tolerant group is 86.2, it increased to 88.1 after 1 min. [G7] ☐ U ☐ B ☐ G [B2] ☐ U ☐ B

Basic **Unattained**

MAP

Tolerant Group:
- ☐ 0 min 84.65 mmHg
- ☐ 1 min 92.51 mmHg

Non-tolerant Group:
- ☐ 0 min 87.15 mmHg
- ☐ 1 min 88.09 mmHg

Student B

2	☑ Support ☐ Do NOT support	The MAP for non-tolerant group at 0 minute is 87.1556, ✓ and 88.0952 a ✓ minute after immersing, showing a difference of 0.9396 in MAP. While for the tolerant group, the MAP at 0 minute is 84.6546, while the MAP at 1 minute after immersing raises obviously to 90.5114, increased by 5.8571. Such two groups show a different change in level of MAP, where tolerant group's MAP increased larger by 4.9175. [G7] ☐ U ☐ B ☐ G [B2] ☐ U ☐ B

Good **Unattained**

(3) The method used in this investigation to measure an individual's ***perceived level of pain*** is subject to measurement error. Describe and explain ***one*** improvement to reduce the impact of this error.

[E8] ☐ U ☐ B ☐ G ☐ E

E8. Explain why the improvements can reduce (the impact of) measurement error(s).

Concepts for marking

- ***Describe one improvement***

  Changes in the rating scale and descriptors for different pain levels

- ***Explain why the improvement can reduce subjectivity among different individuals***

  (e.g., Providing clear reference points in terms of the rating scale to ensure that students have a standardised framework to assess and quantify the pain levels in comparable ways between different individuals)

(3) The method used in this investigation to measure an individual's ***perceived level of pain*** is subject to measurement error. Describe and explain ***one*** improvement to reduce the impact of this error.

[E8] ☐ U ☐ B ☐ G ☐ E

More details for pain level can be described to give a clear standard for students. Except providing numbers for each pain level, details and expressions may be added. For example, 0 represents no any pain feelings, while 10 represents the most painful level with the feeling of being punctured or sting by a bee.

simulation.

Student A

Good

(3) The method used in this investigation to measure an individual's ***perceived level of pain*** is subject to measurement error. Describe and explain ***one*** improvement to reduce the impact of this error.

[E8] ☐ U ☐ B ☐ G ☐ E

Student B

Excellent

More intervals of pain level with detailed descriptions can be added in order to provide a clear standard for students to follow, as for the current measurement, only short range numbers were provided with no explanations. With the adding of smaller intervals (0-10) and with detailed explanation (eg. pain like being punched, pain like breaking an arm, etc.) students can express their level of pain more precisely and clear.

Reference

- Use more than one type of measure to reflect the pain level (e.g., skin colour of the hand)
- Provide clear reference points in terms of the rating scale to ensure that students have a standardised framework to assess and quantify the pain levels accurately.

(This is less preferred: Expand the range from 0-5 to 0-10 on the scale; giving more scales can allow finer differentiation but still the methodology can be considered as not accurate)

(4) Explain why your conclusions about whether the factors investigated (i.e., sex, height) can influence the level of pain tolerance are of limited generalizability, even if they are based on class data.

E12. Discuss the generalisability of the results/conclusion.

Concepts for marking

- ***Reason related to sample size/selection***

  too small to adequately represent the larger population
- ***Reason related to sample characteristics/diversity***

  lacking diversity in terms of sex, height, or other relevant factors
- ***Limitation in the study design in making causal claims***

  (e.g., the data only allow investigation of relationships between the factors but not their causal relationships)

(4) Explain why your conclusions about whether the factors investigated (i.e., sex, height) can influence the level of pain tolerance are of limited generalizability, even if they are based on class data.

[E12] ☐ U ☐ B ☐ G ☐ E

[E12] ☐ U ☐ B ☐ G ☐ E

Factors such as sex and height ✓ and weight may affect the data. However class data cannot represent all people. The level of pain tolerance can be affected by living environment, countries and other factor. Therefore, the level of pain tolerance are limited.

Student A

Only mentioned reason related to sample characteristics/diversity

Basic

(4) Explain why your conclusions about whether the factors investigated (i.e., sex, height) can influence the level of pain tolerance are of limited generalizability, even if they are based on class data.

[E12] ☐ U ☐ B ☐ G ☐ E

Student B

[E12] J ☐ U ☐ B ☐ G ☐ E

Although class data represents a rather large ✓ sized data, however if compared to the population, it is not large enough to represent the entire population. Factors such as sex and height ✓, even weight may be able to be compared or considered in class data, however factors such as races, countries, living environments, etc, these factors that often require a large population to compare cannot be investigated. Such leads to the limited generalizability

Reference

- Sample size is too small and may not adequately represent the larger population.
- The class data may lack diversity in terms of sex, height, or other relevant factors.
- Limitation in the study design in making causal claims is missing

Good

Question	Performance item	Performance Level	
		Student A	Student B
(b)	[B1]	☐ U ☑ B	☐ U ☑ B
(d)(1)	[G1]	☐ U ☑ B ☐ G	☐ U ☑ B ☐ G
(d)(2)	[G5]	☐ U ☑ B ☐ G	☐ U ☐ B ☑ G
(d)(3)	[E4]	☐ U ☑ B ☐ G ☐ E	☐ U ☐ B ☑ G ☐ E
(e)(1)	[G8]	☐ U ☑ B ☐ G	☐ U ☐ B ☑ G
(e)(2)	[E7]	☑ U ☐ B ☐ G ☐ E	☐ U ☐ B ☑ G ☐ E
(f)	[B6]	☑ U ☐ B	☑ U ☐ B
(g)(1)	[G2]	☐ U ☐ B ☑ G	☐ U ☐ B ☑ G
(g)(2)(i)	[G7]	☐ U ☐ B ☑ G	☐ U ☐ B ☑ G
(g)(2)(ii)	[G7]	☐ U ☑ B ☐ G	☐ U ☐ B ☑ G
	[B2]	☑ U ☐ B	☑ U ☐ B
(g)(3)	[E8]	☐ U ☐ B ☑ G ☐ E	☐ U ☐ B ☐ G ☑ E
(g)(4)	[E12]	☐ U ☑ B ☐ G ☐ E	☐ U ☐ B ☑ G ☐ E
		3 U 7 B 3 G 0 E	**2 U 2 B 8 G 1 E**
		Most Basic **Some Good**	**Most Good** **Few Excellent**
		7 /10	**8 /10**

Mark range	Quality of work	Performance
9-10	Excellent	The report shows most of the good performances and a few excellent performances.
6-8	Good	The report shows most of basic performances and some good performances.
3-5	Fair	The report shows some basic performances and a few good performances.
1-2	Poor	The report shows a few basic performances.

Student A

3 U 7 B 3 G 0 E

Most Basic
Some Good

7 /10

Student B

2 U 2 B 8 G 1 E

Most Good
Few Excellent

8 /10


THANK
YOU