SASTA OLIPHANT SCIENCE AWARDS

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Scientific Inquiry

Year 9-10

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Does the amount of fertiliser in a water body impact the amount of dissolved oxygen in the water body?

Telisa Minami

Introduction

Eutrophication is the process of when a water body is overly enriched with excess nutrients (mostly from chemical fertilisers), activating an exponential increase in the growth rate of the plant life (namely algae) in the water body (National Oceanic and Atmospheric Administration 2022). This rapid and excessive growth of plant life then results in the significant depletion of the total oxygen dissolved in the water body. With insufficient oxygen dissolved in the water for other organisms, the water body eventually becomes a 'dead zone' incapable of supporting life and its prior marine ecosystem (BYJU'S n.d.). Eutrophication is mainly caused by industrial agricultural practices and improper and or unregulated sewage systems and treatments, and is considered to be a severe environmental problem due to the extreme water and biodiversity degradation it causes (Education.com n.d.). This experiment demonstrated how the amount of fertiliser in a water body impacts the amount of dissolved oxygen in it, and attempted to chemically replicate eutrophication and its extreme effects on the quality of water bodies.

Aim

To investigate the impact fertilisers may have on the amount of dissolved oxygen present in a waterbody and subsequently the health of the plants present in the waterbody.

Hypothesis

If the amount of fertiliser increases in a waterbody, the amount of dissolved oxygen in the waterbody decreases.

Independent variable

The amount of fertiliser (tsp): 0.00, 0.25, 0.50, 1.00

Dependent variable

The amount of dissolved oxygen in the respective waterbodies (mg/L)

Controlled variables

Variable	*Method of control*	*Reason - why it should be controlled*
Amount of pond water in each jar	All four jars/trials will contain 280ml of pond water.	The amount of pond water in each jar must be controlled to ensure the basic accuracy of the dissolved oxygen levels in each trial- if different amounts of pond water were in each jar, the accurate effects of differing amounts of fertiliser would be uncertain.
Amount of possible sunlight received per day	All four jars testing different amounts of fertilisers are placed at the same location by the window bench during the	Though the actual amount of sunlight the different trials receive per day cannot be controlled, the amount of possible sunlight can. To ensure they are receiving the same

	entire practical.	amount of sunlight during all the different times of the experiment will reduce the uncertainties in the results.
General temperature of all trials' environment	All jars are placed indoors in the same room during the entire practical.	Though the temperature of the room cannot yet be controlled, the room temperature all trials experience can. The same room temperature being available for all different trials during the practical will help decrease the uncertainties in the results.
Type of jar all trials are placed in	300ml glass jars are used for all trials receiving different solutions.	Using the same 300ml glass jars for all three different variables ensures that all trials are growing in the same environments, and further increases the accuracy of the results.
Amount of time oxygen sensor is placed in each jar when measuring the amount of dissolved oxygen in a waterbody	The dissolved oxygen sensor will be put into every trial/jar for 10 minutes.	The dissolved oxygen sensor requires time to accurately read the dissolved oxygen in any waterbody. Thus, the amount of time the sensor is placed in each trial throughout the experiment is crucial to ensure the accuracy of the results.

Uncontrolled variables

Uncontrolled variable	*Reason it could not be controlled*
Temperature of the room trials develop in	The temperature or heat of the room in which the experiment is conducted in at this stage cannot be controlled to be consistent due to external factors (i.e. heater, large windows allowing in great sunlight, heat travelling from open door), under this experiment's circumstances.
The climate all the trials would experience during the experiment	The different climates throughout the experiment would inevitably be an uncontrolled variable that could likely have an effect on the development of the trials (e.g. a rainy day with minimal sunlight would affect the possible growth of a plant and thus its oxygen levels). Climate is something that cannot yet be controlled specifically and be very irregular depending on the season and other contributing factors.

Materials

- 1 x dissolved oxygen sensor
    - 1 x optical sensor probe
    - 1 x dissolved oxygen metre
- 4 x 300ml jars
- 1200mL living pond water
- 2 tsp liquid fertiliser
- 1 x tsp
- 1 x 1/4 tsp
- 1 x 1/2 tbsp

Method

Preparing the experiment

1. Label the four jars with masking tape: controlled, ¼ tsp (fertiliser), ½ tsp (fertiliser), and 1 tsp (fertiliser).
2. Fill each jar with 280ml of living pond water, ensuring that each jar has approximately the same amount of living organisms (i.e. plants present in the waterbody).
3. Add the following amounts of liquid fertiliser into each of their corresponding jars - none to the 'controlled' jar, ¼ tsp to the '¼ tsp' jar, ½ tsp to the '½ tsp jar, and 1 tsp to the '1 tsp' jar.
4. Lightly screw on the jar lids for every jar.
5. Set the four jars in a sunny location indoors (e.g. on a bench top next to the window), ensuring that that location remains consistent throughout the entire practical.

Conducting the experiment (i.e. measuring the dissolved oxygen)

1. Set up the dissolved oxygen sensor, connecting the optical sensor probe to the dissolved oxygen metre.
2. Place the readied oxygen sensor into the control group jar for 10 minutes; record observations and results in the data table.
3. After results are recorded for the jar, lightly rinse the optical sensor probe.
4. Repeat steps 2-3 from the least amount of fertiliser jar to the most until all jars have been measured.
5. Repeat steps 1-4 immediately after preparing the experiment and everyday after the initial measurement until 14 days have passed since the beginning of the experiment.

Risk assessment

Risk	*Hazard statement*	*Precautionary statement*	*Treatment*
Glass jar breaking and causing cuts and potential injury.	Glass jars may break and cause severe cuts and external injury if mishandled.	Handle glass jars with extreme care and gentleness; ensure that hands are secure when holding it. Inspect and discard any chipped or cracked jars, no matter how small the damage. Sweep up broken glass with a brush and dustpan; do not use fingers.	If indeed injured by a cracked glass jar, treat scratch wounds and cuts with medical ointment. If bruised, place an ice-pack on the wound. If any internal injuries are discovered, seek medical assistance.
Irritation or possibly worse eye injuries caused by contact made with liquid fertiliser	Liquid fertiliser may cause extreme irritation or possibly worse eye injuries if accidentally made contact with the eye.	Handle fertilisers with caution and care, preventing spillage or leakage. Avoid contacting hands with one's face while using it. Rinse hands straight after using fertiliser; use gloves if necessary.	If indeed made contact with the eye, gently rinse the eye with tap water for 5-10 minutes. If pain does not cease, seek medical assistance.

Results

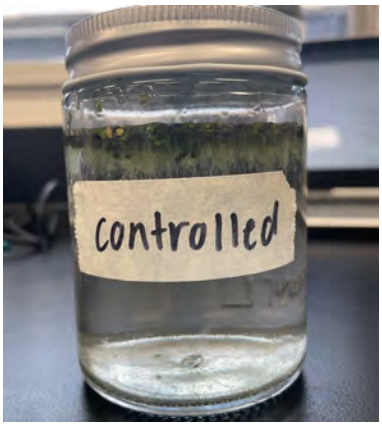
Raw data:

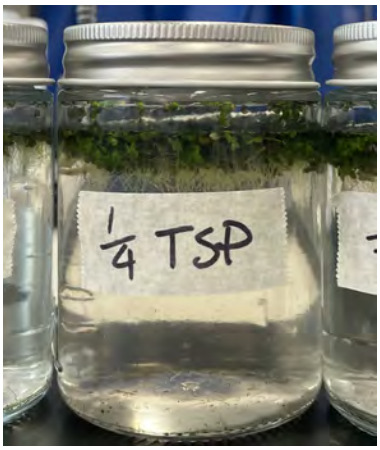
Table 1: Raw data demonstrating the effect of different amounts of fertiliser has on the dissolved oxygen of water bodies

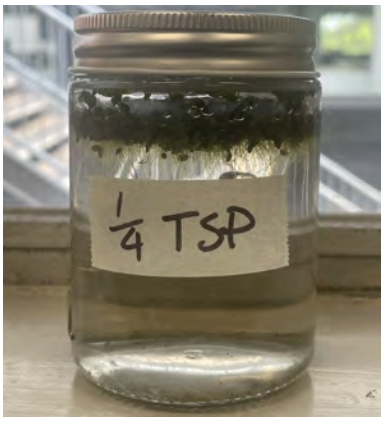
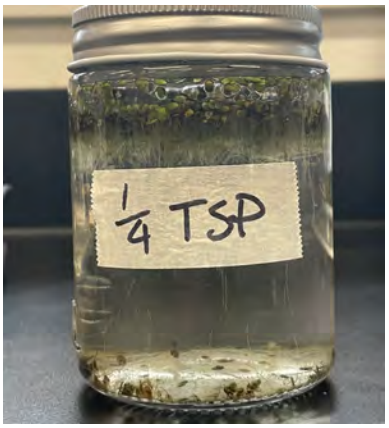
	Dissolved oxygen levels of each group throughout the experiment (mg/L)					
Amount of fertiliser (tsp)	Day 1 (20/10)	Day 2 (21/10)	Day 3 (25/10)	Day 4 (27/10)	Day 5 (28/10)	Day 6 (01/11)

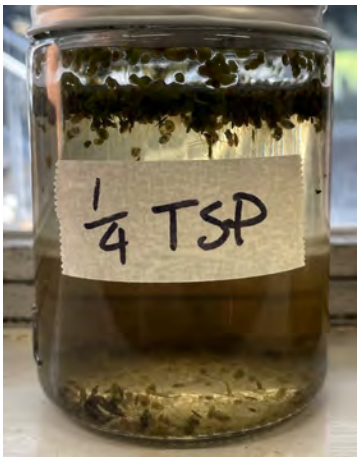
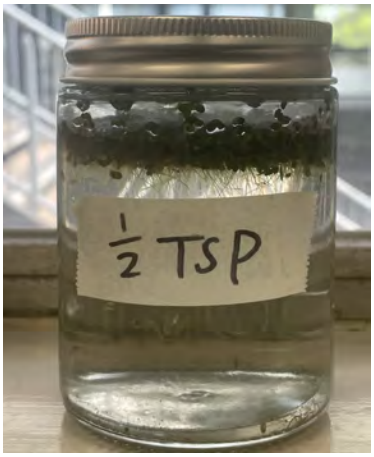
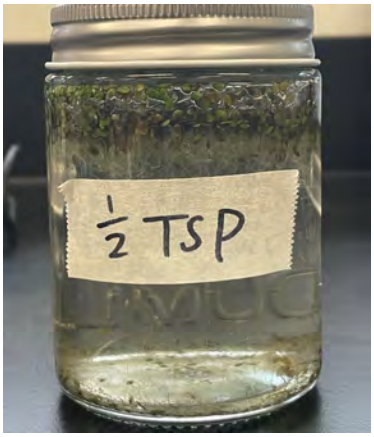
0.00 (control)	6.7	7.2	8.0	8.2	8.5	8.8
0.25	6.5	4.8	4.3	3.2	3.2	4.5
0.50	6.8	6.0	3.9	2.2	2.3	1.9
1.00	6.1	5.9	0.6	3.5	2.0	0.9

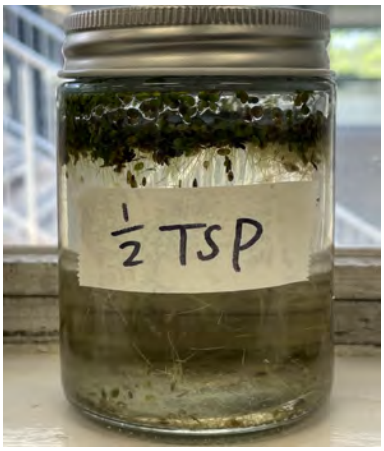
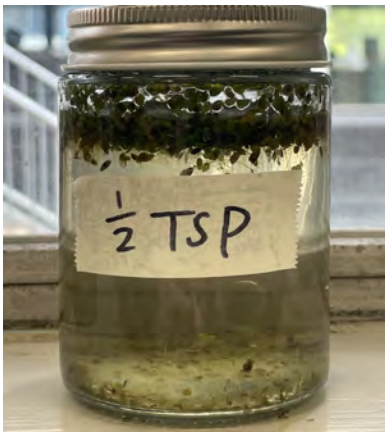
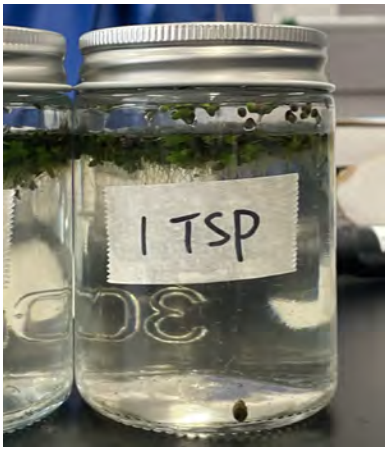
Table 2: Qualitative data of growth

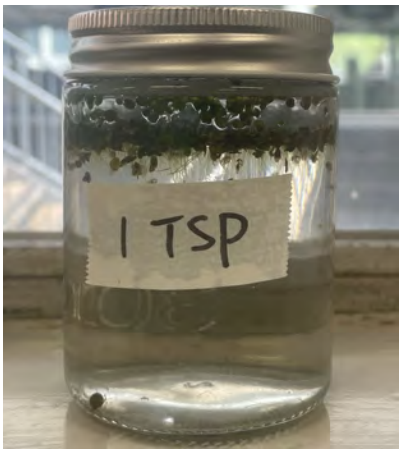
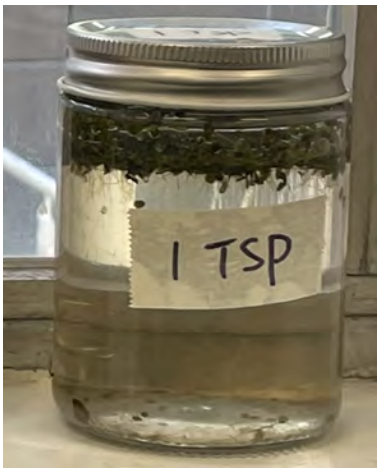
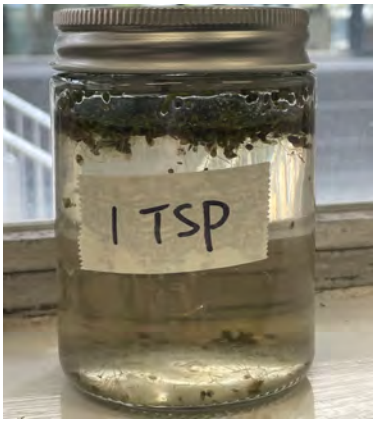
Amount of fertiliser (tsp)	Observations	Photographs
0.00 (control)	**Day 1 (20/10/22) - right after set up:** - Least amount of live pond water (green bits) - Was unable to ensure that all groups had precisely equal amounts of the live plants in the pond water	
	Day 2 (21/10 - 9:22am): - Clear condensation is visible (most likely from the water heating up) - Increased dissolved oxygen level may be due to oxidation and photosynthesis of the plants in the live pond water - No additional plant growth detected	
	Day 3 (25/10 - 1:45pm): - Less condensation is visible as the jar was set ajar - No additional plant growth detected - Instead, looks like there is less plants present (possibly due to the dissolved oxygen sensor picking up some plants as it transfers across the groups)	

	Day 4 (27/10 - 2:40pm): due to time constraint, only left sensor in each jar for 5 minutes instead of 10 - No plant growth detected - Again, less condensation visible	
	Day 5 (28/10 - 12:18pm): due to time constraint, only left sensor in each jar for 5 minutes instead of 10 - No plant growth detected - Instead, looks like there is less plants present (possibly due to the dissolved oxygen sensor picking up some plants as it transfers across the groups)	
	Day 6 (01/11 - 9:40am): - No plant growth detected - Water is very clear - the exact same clarity as day 1	
0.25	**Day 1 (20/10/22) - before fertisliser is added; right after set up:** - Contains visibly the most live plants - Inconsistency in live plant amount is due to the reason already stated in	

	Day 2 (21/10 - 9:33am): - Clear condensation is visible (same reason as control) - No additional plant growth detected - The fertiliser immediately taking effect on the oxygen levels	
	Day 3 (25/10 - 1:57pm): - Less condensation is visible as the jar was set ajar - No additional plant growth detected - However, some plants have sunk to the bottom of the jar (more than any other jar) + some plants have stuck to the sides of the jar	
	Day 4 (27/10 - 2:46pm): due to time constraint, only left sensor in each jar for 5 minutes instead of 10 - Tinted yellow **(REASON)** - Roots have grown longer and thicker (though greenery does not seem to have increased) - More have sunk to the bottom	
	Day 5 (28/10 - 12:23pm): due to time constraint, only left sensor in each jar for 5 minutes instead of 10 - Tinted yellow/brown **(REASON)** - Not much has changed since day 4, colour just seems more apparent	

	Day 6 (01/11 - 9:51am): - Have turned even murkier, the brown tint has grown even stronger - A clump of plants have sunk to the bottom of the jar, along with the roots	
0.50	**Day 1 (20/10/22)- before fertisliser is added; right after set up:** - Contains visibly a little less live plants than ¼ tsp group - Inconsistency in live plant amount is due to the reason already stated in	
	Day 2 (21/10 - 9:45am): - Though dissolved oxygen did decrease from day 1, it decreased less than ¼ teaspoon group, which contains **less** fertiliser **(POSSIBLE REASON)** - Clear condensation is visible (same reason as control) - No additional plant growth detected	
	Day 3 (25/10 - 2:07pm): - Less condensation is visible as the jar was set ajar - Similar to ¼ tsp jar - No additional plant growth detected - However, some plants have sunk to the bottom of the jar (less than ¼ tsp jar) + some plants have stuck to the sides of the jar	

	Day 4 (27/10 - 2:51pm): due to time constraint, only left sensor in each jar for 5 minutes instead of 10 - Tinted yellow/green **(REASON)** - Similar to ½ tsp jar, roots have grown longer and slightly thicker than control - Many random roots floating in the jar, some foliage has sunk to the bottom	
	Day 5 (28/10 - 12:29pm): due to time constraint, only left sensor in each jar for 5 minutes instead of 10 - Tinted green/yellow **(REASON)** - Not much has changed since day 4, colour just seems more apparent	
	Day 6 (01/11 - 10:01am): - Similar to ¼ tsp, have turned even murkier, the brown tint has grown even stronger - A great clump of plants have sunk to the bottom of the jar, along with the roots - Making the bottom murky as well	
1.00	**Day 1 (20/10/22) - before fertisliser is added; right after set up:** - Contains visibly a little more plants than control group - Inconsistency in live plant amount is due to the reason already stated in	

	Day 2 (21/10 - 9:57am): - Though dissolved oxygen did decrease from day 1, it decreased at a difference less than both ½ and ¼ teaspoon groups which both contain **less** fertiliser **(POSSIBLE REASON)** - Clear condensation is visible (same reason as control) - No additional plant growth detected	
	Day 3 (25/10 - 2:18pm): - Again less condensation is visible as the jar was set ajar - Similar to ¼ tsp jar - No additional plant growth detected - However, some plants have sunk to the bottom of the jar (similar to the other jars) + some plants have stuck to the sides of the jar	
	Day 4 (27/10 - 2:56pm): due to time constraint, only left sensor in each jar for 5 minutes instead of 10 - Lightly tinted yellow/green **(REASON)** - Similar to ½ tsp jar, roots have grown longer and slightly thicker than control - Many random roots floating in the jar, some foliage has sunk to the bottom	
	Day 5 (28/10 - 12:35pm): due to time constraint, only left sensor in each jar for 5 minutes instead of 10 - Not as tinted as ½, ¼ jars - but is evidently murkier than control group - Not much has changed since day 4, murkiness just seems more apparent	

	Day 6 (01/11 - 10:12am): - Similar to ¼ and ½ tsp, have turned <u>much</u> murkier, the brown tint has grown even stronger - A great clump of plants have sunk to the bottom of the jar, along with the roots - Making the bottom murky as well	

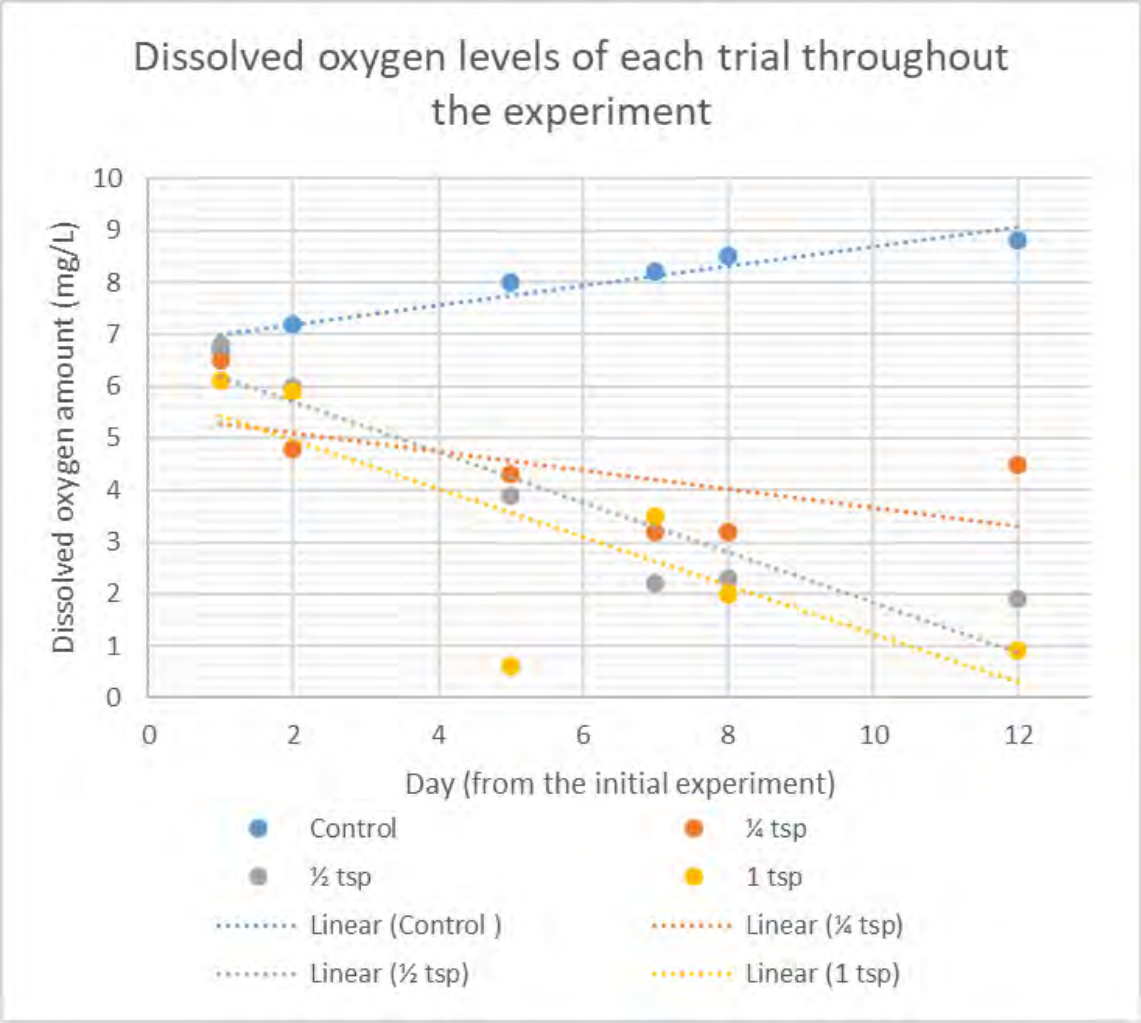


Figure 1: Dissolved oxygen levels of each trial throughout the experiment

Processed data:

Table 3: Total difference in amount of dissolved oxygen in water bodies with different amount of fertilisers after 14 days

Fertiliser amount (tsp)	Difference in dissolved oxygen amount (mg/L)

0.00	+2.1
0.25	-2.0
0.50	-4.9
1.00	-5.2

Sample calculation:
Final dissolved oxygen amount - initial dissolved oxygen amount
= Difference in dissolved oxygen amount

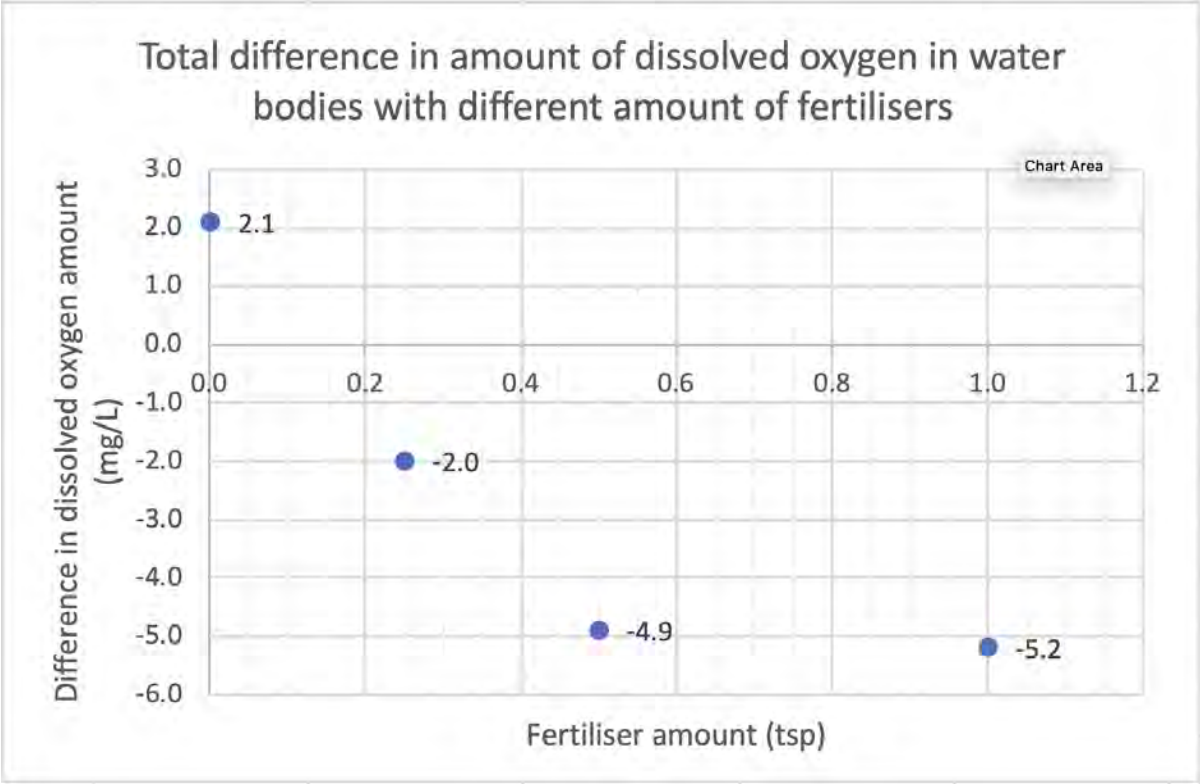


Figure 2: Total difference in amount of dissolved oxygen in water bodies with different amount of fertilisers

Discussion

The results strongly supported the hypothesis - that if the amount of fertiliser increases in a waterbody, the amount of dissolved oxygen in the waterbody decreases - as specifically highlighted by Figure 1, Figure 2, and Table 3. As clearly demonstrated in Table 3, as the amount of fertiliser increases (i.e. 0 tsp, ¼ tsp, ½ tsp, 1 tsp), the difference in the dissolved oxygen amount from the initial day of the experiment to the final significantly decreases almost proportionally to the amount of fertiliser (i.e. +2.1mg/L, -2.0mg/L, -4.9mg/L, -5.2mg/L respectively). This is further corroborated in Figure 1, which visually shows that despite some fluctuations, any fertiliser amount over zero has an overall negative linear trendline, especially in the notably higher amounts of fertiliser (i.e. ½ tsp, 1 tsp)'s steeper linear trends which are almost parallel to each other. This is again supported by Figure 2, which visibly shows the clear decrease in dissolved oxygen as the fertiliser increases - where the first three points almost lie in a precise negative linear trendline, displaying a negative linear relationship with the final point (i.e. 1 tsp dissolved oxygen amount) being an outlier.

The increase in dissolved oxygen for the control group (i.e. 0 tsp fertiliser) throughout the entire experiment as shown by all the results, particularly by the positive linear trendline showcased in Figure 1, is most likely due to the continuous use of oxygen for respirationo of the thriving plants in the water body. As the jars are placed in a sunny location, the plants in the control group jar which did not come in contact with any fertilisers can continue to photosynthesise and as a byproduct, release more dissolved oxygen into the water body (University of Florida 2020). Thus, not only did the control group not decrease its dissolved oxygen amount, but increased it due to the continuous oxidation of the plants who were not affected by the chemical fertiliser - additionally emphasising that water bodies have the best health when it has made no contact with chemical fertilisers.

As shown in the observations and photographs taken of the trials in Table 2, the trials with fertilisers grow progressively darker and murkier (yellow/brown/green) as the days progress. This is likely due to the significant amount of excess nutrients added to the trials that leads to the extremely accelerated growth of plant life - as seen in the thicker roots of the plants - which can result in a significantly shortened plant life span. The decay of the dead plants then quickly makes the water body murky (University of Minnesota Extension 2021). The dead plants of the water bodies can be easily identified in Table 2, where more plants appear to have sunk to the bottom of all the fertiliser trials as the experiment progresses. Subsequently, this increases the likelihood of the significant depletion of oxygen through the decomposition of the dead plant matter (consumed by bacteria) and nightly respiration - where plant life uses up oxygen during night (Burford 2019).

Chemical fertilisers consist of essential plant nutrients to supply plants with faster or better growth, the main ones being: nitrogen, phosphorus, and potassium (Science Learning Hub 2013). Nitrogen is a vital macronutrient for the functioning of plants and a key component of amino acids; phosphorus is a constituent of plant cells and is essential for the growing tip of the plant whilst potassium is an abundant inorganic cation which ensures optimal plant growth (NSW Government n.d.). While beneficial for agricultural industries, chemical fertilisers pose a serious problem for all global marine ecosystems- especially with improper and or unregulated sewage systems. Thus, the results strongly supported the hypothesis - that if the amount of fertiliser increases in a waterbody, the amount of dissolved oxygen in the waterbody decreases.

Errors and improvements

Type of error	*What was the error?*	*How does it affect the results?*	*How can this be improved?*
Systematic	• A limitation in time for check up points • The trials could not be checked on daily as they could only be checked and observed during lesson time and that excluded the weekends	• It affects the extra qualitative data that could have been collected and used to support the results • It would also increase the precision of the experiment as a whole	• If this experiment is not done at school, the fertiliser trials should be checked on and observed daily or even more frequently
Systematic	• A limitation in time for the whole experiment • The experimentas originally meant to span 14 days or more; however, due	• It affects the additional raw data that could have been collected and used to support the results • It would also increase the overall reliability and	• If this experiment is not done at school, the experiment should span 14 days or more • If this experiment is

	to restricted lesson dedicated to experimentation, this could not be done (experiment spanned 12 days instead)	accuracy of the results and experiments	to be redone at school, prepare the experiment as early as possible
Random	• The amount of plant life and other organisms in each trial could not be guaranteed to be precisely equal	• Greatly decreases the precision and accuracy of the results and overall experiment • Increases the uncertainties	• Possibly weigh the visible plant life and organisms and distribute the equal masses to each trial

Conclusion

The aim of this experiment has been met - fertilisers have a significant influence on the amount of dissolved oxygen present in a waterbody and subsequently the health of the plants in the water body. The results strongly supported the hypothesis - that if the amount of fertiliser increases in a waterbody, the amount of dissolved oxygen in the waterbody decreases - as specifically highlighted by Figure 1, Figure 2, and Table 3. Despite the multiple benefits that come from using chemical fertilisers for agriculture, they have a significantly negative effect on water bodies and contribute immensely to the degradation of global marine ecosystems as demonstrated in this experiment.

References

Education.com n.d., *Bloomin' Algae!*, Education.com, viewed 28 October 2022, <https://www.education.com/science-fair/article/eutrophication/>.

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University of Florida 2020, *Photosynthesis*, University of Florida, viewed 3 November 2022, <https://plants.ifas.ufl.edu/manage/overview-of-florida-waters/>.

University of Minnesota 2021, *Ask Extension: Do fertilisers help or hurt plants?*, University of Minnesota, viewed 3 November 2022, <https://extension.umn.edu/yard-and-garden-news/ask-extension-do-fertilizers-help-or-hurt-plants#:~:text=Too%20much%20 fertilizer%20>

OSA RISK ASSESSMENT FORM

for all entries in (✓) ☐ Models & Inventions and ☑ Scientific Inquiry

This must be included with your report, log book or entry. One form per entry.

STUDENT(S) NAME: Telisa Minami ID: 0206-080

SCHOOL: Glenunga International Highschool

Activity: Give a brief outline of what you are planning to do.

The effect of the amount of fertiliser in water bodies on the amount of dissolved oxygen in said waterbodies will be investigated via observing four jars containing different amounts of liquid fertiliser (0tsp, 1/4tsp, 1/2tsp, 1tsp)'s dissolved oxygen levels throughout fourteen days. All jars will contain 280mL of pond water as the waterbody and a dissolved oxygen sensor will be crucial to the experiment.

Are there possible risks? Consider the following:

- Chemical risks: Are you using chemicals? If so, check with your teacher that any chemicals to be used are on the approved list for schools. Check the safety requirements for their use, such as eye protection and eyewash facilities, availability of running water, use of gloves, a well-ventilated area or fume cupboard.
- Thermal risks: Are you heating things? Could you be burnt?
- Biological risks: Are you working with micro-organisms such as mould and bacteria?
- Sharps risks: Are you cutting things, and is there a risk of injury from sharp objects?
- Electrical risks: Are you using mains (240 volt) electricity? How will you make sure that this is safe? Could you use a battery instead?
- Radiation risks: Does your entry use potentially harmful radiation such as UV or lasers?
- Other hazards.

Also, if you are using other people as subjects in an investigation you must get them to sign a note consenting to be part of your experiment.

Risks	How I will control/manage the risk
Glass jar breaking and causing cuts and potential injury.	Handle glass jars with extreme care and gentleness; ensure that hands are secure when holding it. Inspect and discard any chipped or cracked jars, no matter how small the damage. Sweep up broken glass with a brush and dustpan; do not use fingers.
Irritation or possibly worse eye injuries caused by contact made with liquid fertiliser.	Handle fertilisers with caution and care, preventing spillage or leakage. Avoid contacting hands with one's face while using it. Rinse hands straight after using fertiliser; use gloves if necessary.

(Attach another sheet if needed.)

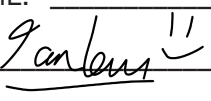
Risk Assessment indicates that this activity can be safely carried out

RISK ASSESSMENT COMPLETED BY (student name(s)): Telisa Minami

SIGNATURE(S): 

☐ By ticking this box, I/we state that my/our project adheres to the listed criteria for this Category.

TEACHER'S NAME: Ian Lau

SIGNATURE:  DATE: 29/06/23

Log book

Telisa Minami

Contains:

- Mindmap deconstructing Inquiry question
- Signed Risk Assessment
- All raw data collection, notes, and dates

1. Initial ideas about the science behind the topic

↳ eutrophication: when excess nutrients (commonly fertilisers containing phosphate, nitrates etc) are added to a water body, algae/plant life grows tremendously & sucks up all the oxygen in the water, depleting dissolved oxygen & killing other living things.

+ fertilizer runoff of water pollution

2. Factors that may influence the investigation, possible Independent variables

↳ different amounts of algae in different pond water may influence the results

Possible IV:

↳ ~~difference~~ in mass of algae before & after adding fertiliser (g)

↳ difference in amount of depleted oxygen (ppm)

3. What factors may need to be controlled?

Controlled variables

↳ amount of pond water in each jar

↳ consistent position the jars are placed in throughout 14 days

4. What factors may not be able to be controlled?

Uncontrolled variables

↳ amount of sunlight

↳ temperature of environment

↳ climate of environment

Fertilisers

Does the amount of ~~phosphate~~ in a waterbody impact the amount of dissolved oxygen (oxygen quantity) in the waterbody? algae growth?

(amount of oxygen available to living aquatic organisms)

5. What are the possible options for methodology?

- letting the algae develop over a period of time & then obtain qualitative + quantitative data (7 - 14 days +)

6. How will qualitative and quantitative data be collected?

Qualitative data

↳ observations of algae growth throughout the 14 days

Quantitative data

↳ quantity of dissolved oxygen

7. What is the initial Hypothesis?

If the amount of fertiliser increases, the amount of dissolved oxygen in the water body decreases / algae growth increases.

8. What safety and ethics need to be considered?

↳ consuming fertiliser?

↳ breaking jars - scratches, cuts

Independent variable and justification

- Amount of fertiliser in the waterbody (g)

↳ the phosphate + chemical properties in the fertilizer is what affects the DV: amount of dissolved oxygen/ algae growth

Materials and justification

- Dissolved oxygen sensor
  ↳ measures the dependent variable
- 4 jars → 1 control, 3 of varying fertilisers
  ↳ to hold the pond water/waterbody
- Pondwater
  ↳ what the whole experiment is in
- Fertilisers
  ↳ the independent variable
- ~~Measuring materials~~

Dependent variable and justification

- The amount of dissolved oxygen (mg/L / ppm)

↳ chose this over algae growth because it is more directly related to eutrophication - the issue I want to explore

OSA RISK ASSESSMENT FORM

for all entries in (✓) ☐ Models & Inventions and ☑ Scientific Inquiry

This must be included with your report, log book or entry. One form per entry.

STUDENT(S) NAME: Telisa Minami ID: 0206-080

SCHOOL: Glenunga International Highschool

Activity: Give a brief outline of what you are planning to do.

The effect of the amount of fertiliser in water bodies on the amount of dissolved oxygen in said waterbodies will be investigated via observing four jars containing different amounts of liquid fertiliser (0tsp, 1/4tsp, 1/2tsp, 1tsp)'s dissolved oxygen levels throughout fourteen days. All jars will contain 280mL of pond water as the waterbody and a dissolved oxygen sensor will be crucial to the experiment.

Are there possible risks? Consider the following:

- Chemical risks: Are you using chemicals? If so, check with your teacher that any chemicals to be used are on the approved list for schools. Check the safety requirements for their use, such as eye protection and eyewash facilities, availability of running water, use of gloves, a well-ventilated area or fume cupboard.
- Thermal risks: Are you heating things? Could you be burnt?
- Biological risks: Are you working with micro-organisms such as mould and bacteria?
- Sharps risks: Are you cutting things, and is there a risk of injury from sharp objects?
- Electrical risks: Are you using mains (240 volt) electricity? How will you make sure that this is safe? Could you use a battery instead?
- Radiation risks: Does your entry use potentially harmful radiation such as UV or lasers?
- Other hazards.

Also, if you are using other people as subjects in an investigation you must get them to sign a note consenting to be part of your experiment.

Risks	How I will control/manage the risk
Glass jar breaking and causing cuts and potential injury.	Handle glass jars with extreme care and gentleness; ensure that hands are secure when holding it. Inspect and discard any chipped or cracked jars, no matter how small the damage. Sweep up broken glass with a brush and dustpan; do not use fingers.
Irritation or possibly worse eye injuries caused by contact made with liquid fertiliser.	Handle fertilisers with caution and care, preventing spillage or leakage. Avoid contacting hands with one's face while using it. Rinse hands straight after using fertiliser; use gloves if necessary.

(Attach another sheet if needed.)

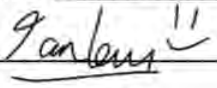
Risk Assessment indicates that this activity can be safely carried out

RISK ASSESSMENT COMPLETED BY (student name(s)): Telisa Minami

SIGNATURE(S): 

☐ By ticking this box, I/we state that my/our project adheres to the listed criteria for this Category.

TEACHER'S NAME: Ian Lau

SIGNATURE:  DATE: 29/06/23

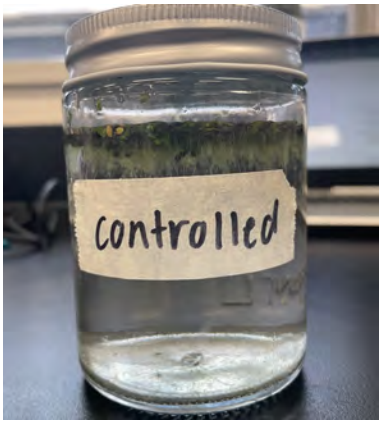
Raw data:

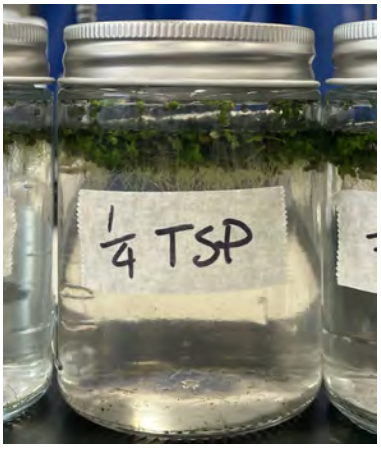
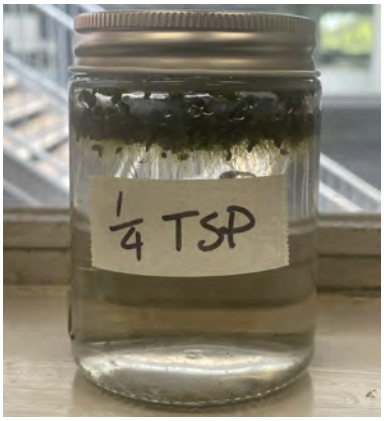
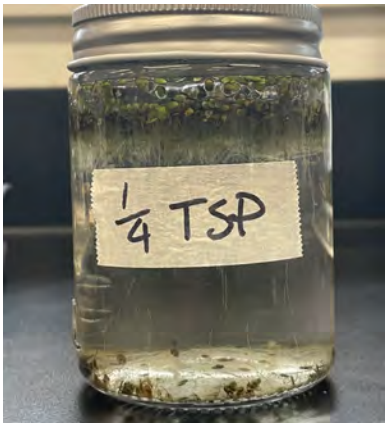
Table 1: Raw data demonstrating the effect of different amounts of fertiliser has on the dissolved oxygen of water bodies

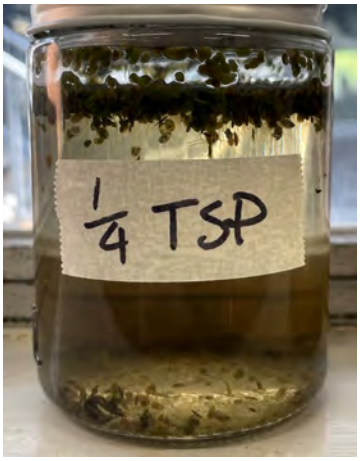
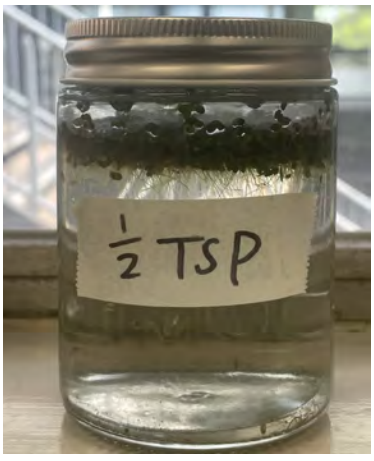
	Dissolved oxygen levels of each group throughout the experiment (mg/L)					
Amount of fertiliser (tsp)	Day 1 (20/10)	Day 2 (21/10)	Day 3 (25/10)	Day 4 (27/10)	Day 5 (28/10)	Day 6 (01/11)
0.00 (control)	6.7	7.2	8.0	8.2	8.5	8.8
0.25	6.5	4.8	4.3	3.2	3.2	4.5
0.50	6.8	6.0	3.9	2.2	2.3	1.9
1.00	6.1	5.9	0.6	3.5	2.0	0.9

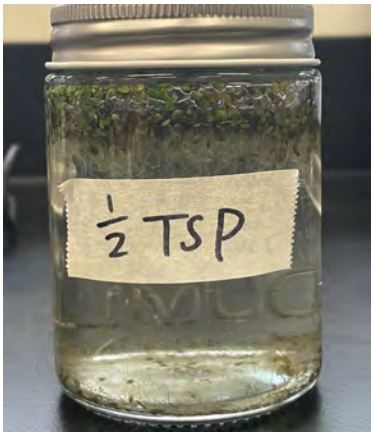
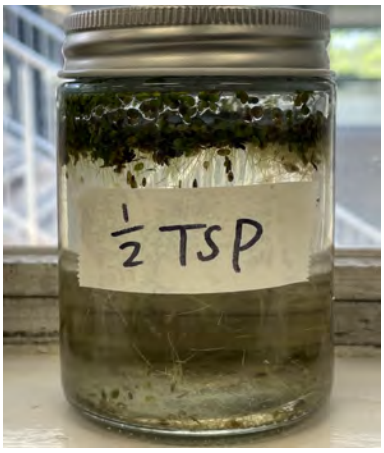
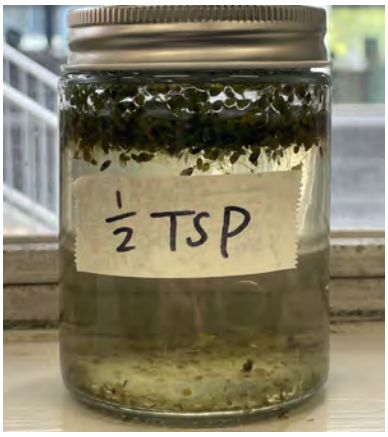
Table 2: Qualitative data of growth

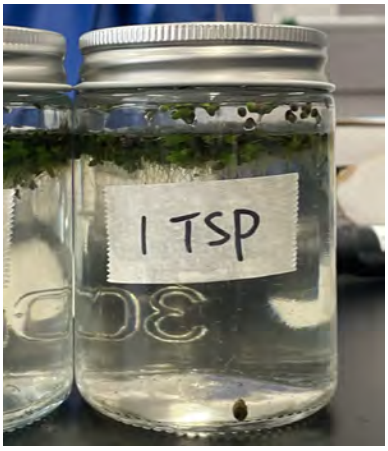
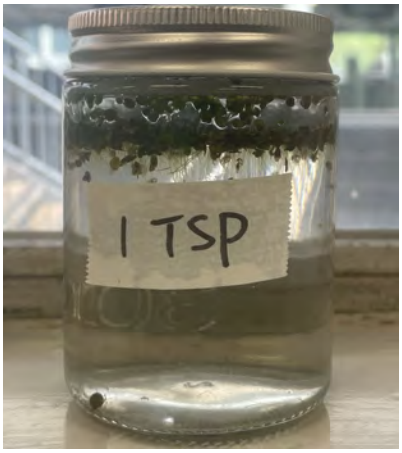
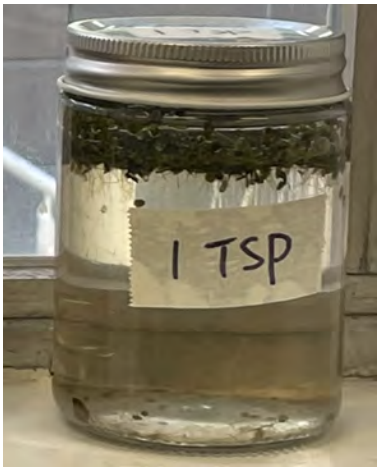
Amount of fertiliser (tsp)	Observations	Photographs
0.00 (control)	**Day 1 (20/10/22) - right after set up:** - Least amount of live pond water (green bits) - Was unable to ensure that all groups had precisely equal amounts of the live plants in the pond water	
	Day 2 (21/10 - 9:22am): - Clear condensation is visible (most likely from the water heating up) - Increased dissolved oxygen level may be due to oxidation and photosynthesis of the plants in the live pond water - No additional plant growth detected	

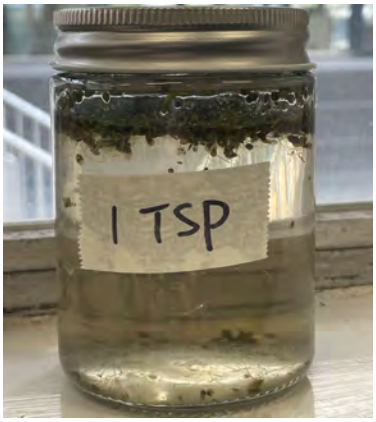
	Day 3 (25/10 - 1:45pm): - Less condensation is visible as the jar was set ajar - No additional plant growth detected - Instead, looks like there is less plants present (possibly due to the dissolved oxygen sensor picking up some plants as it transfers across the groups)	
	Day 4 (27/10 - 2:40pm): due to time constraint, only left sensor in each jar for 5 minutes instead of 10 - No plant growth detected - Again, less condensation visible	
	Day 5 (28/10 - 12:18pm): due to time constraint, only left sensor in each jar for 5 minutes instead of 10 - No plant growth detected - Instead, looks like there is less plants present (possibly due to the dissolved oxygen sensor picking up some plants as it transfers across the groups)	
	Day 6 (01/11 - 9:40am): - No plant growth detected - Water is very clear - the exact same clarity as day 1	

0.25	**Day 1 (20/10/22) - before fertisliser is added; right after set up:** - Contains visibly the most live plants - Inconsistency in live plant amount is due to the reason already stated in	
	Day 2 (21/10 - 9:33am): - Clear condensation is visible (same reason as control) - No additional plant growth detected - The fertiliser immediately taking effect on the oxygen levels	
	Day 3 (25/10 - 1:57pm): - Less condensation is visible as the jar was set ajar - No additional plant growth detected - However, some plants have sunk to the bottom of the jar (more than any other jar) + some plants have stuck to the sides of the jar	
	Day 4 (27/10 - 2:46pm): due to time constraint, only left sensor in each jar for 5 minutes instead of 10 - Tinted yellow **(REASON)** - Roots have grown longer and thicker (though greenery does not seem to have increased) - More have sunk to the bottom	

	Day 5 (28/10 - 12:23pm): due to time constraint, only left sensor in each jar for 5 minutes instead of 10 - Tinted yellow/brown **(REASON)** - Not much has changed since day 4, colour just seems more apparent	
	Day 6 (01/11 - 9:51am): - Have turned even murkier, the brown tint has grown even stronger - A clump of plants have sunk to the bottom of the jar, along with the roots	
0.50	**Day 1 (20/10/22)- before fertisliser is added; right after set up:** - Contains visibly a little less live plants than ¼ tsp group - Inconsistency in live plant amount is due to the reason already stated in	
	Day 2 (21/10 - 9:45am): - Though dissolved oxygen did decrease from day 1, it decreased less than ¼ teaspoon group, which contains **less** fertiliser **(POSSIBLE REASON)** - Clear condensation is visible (same reason as control) - No additional plant growth detected	

	Day 3 (25/10 - 2:07pm): - Less condensation is visible as the jar was set ajar - Similar to ¼ tsp jar - No additional plant growth detected - However, some plants have sunk to the bottom of the jar (less than ¼ tsp jar) + some plants have stuck to the sides of the jar	
	Day 4 (27/10 - 2:51pm): due to time constraint, only left sensor in each jar for 5 minutes instead of 10 - Tinted yellow/green **(REASON)** - Similar to ½ tsp jar, roots have grown longer and slightly thicker than control - Many random roots floating in the jar, some foliage has sunk to the bottom	
	Day 5 (28/10 - 12:29pm): due to time constraint, only left sensor in each jar for 5 minutes instead of 10 - Tinted green/yellow **(REASON)** - Not much has changed since day 4, colour just seems more apparent	
	Day 6 (01/11 - 10:01am): - Similar to ¼ tsp, have turned even murkier, the brown tint has grown even stronger - A great clump of plants have sunk to the bottom of the jar, along with the roots - Making the bottom murky as well	

1.00	**Day 1 (20/10/22) - before fertisliser is added; right after set up:** - Contains visibly a little more plants than control group - Inconsistency in live plant amount is due to the reason already stated in	
	Day 2 (21/10 - 9:57am): - Though dissolved oxygen did decrease from day 1, it decreased at a difference less than both ½ and ¼ teaspoon groups which both contain **less** fertiliser **(POSSIBLE REASON)** - Clear condensation is visible (same reason as control) - No additional plant growth detected	
	Day 3 (25/10 - 2:18pm): - Again less condensation is visible as the jar was set ajar - Similar to ¼ tsp jar - No additional plant growth detected - However, some plants have sunk to the bottom of the jar (similar to the other jars) + some plants have stuck to the sides of the jar	
	Day 4 (27/10 - 2:56pm): due to time constraint, only left sensor in each jar for 5 minutes instead of 10 - Lightly tinted yellow/green **(REASON)** - Similar to ½ tsp jar, roots have grown longer and slightly thicker than control - Many random roots floating in the jar, some foliage has sunk to the bottom	

	Day 5 (28/10 - 12:35pm): due to time constraint, only left sensor in each jar for 5 minutes instead of 10 - Not as tinted as ½, ¼ jars - but is evidently murkier than control group - Not much has changed since day 4, murkiness just seems more apparent	
	Day 6 (01/11 - 10:12am): - Similar to ¼ and ½ tsp, have turned <u>much</u> murkier, the brown tint has grown even stronger - A great clump of plants have sunk to the bottom of the jar, along with the roots - Making the bottom murky as well	

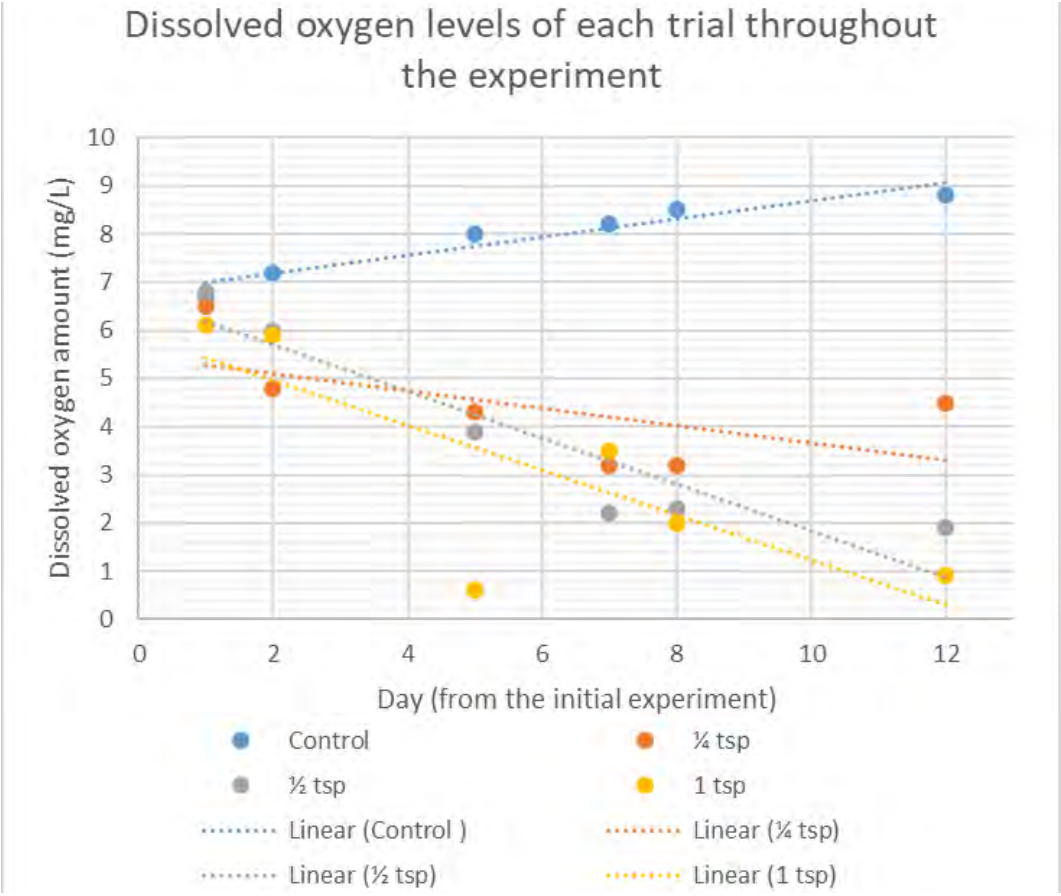


Figure 1: Dissolved oxygen levels of each trial throughout the experiment (04/11)