National Certificate of Educational Achievement
TAUMATA MĀTAURANGA Ā-MOTU KUA TAEA

Exemplar for Internal Achievement Standard

Science Level 1

This exemplar supports assessment against:

Achievement Standard 91921

Demonstrate understanding of the use of a range of scientific investigative approaches in a context

An annotated exemplar is a sample of student evidence, with a commentary, to explain key aspects of the standard. It assists teachers to make assessment judgements at the grade.

New Zealand Qualifications Authority

To support internal assessment

Grade: Achieved
For Achieved, the student needs to demonstrate understanding of the use of a range of scientific investigative approaches in a context. This involves carrying out three different investigative approaches that answer a question (or sub-questions) within the chosen context and describing the purpose of using each investigative approach, supported by evidence. The student has carried out three investigative approaches and described the purpose of using each approach to answer the specific sub-question. The student described their first approach as involving spending time in the forest carefully looking around, taking notes, and sketching what they could see so they could build a detailed picture of the biotic and abiotic features present at Talbot Forest. They also described how a second approach – using identification tools and close examination – helped them work out which plant species were present and allowed them to record this information clearly. The student then outlined how a simplified classroom setup enabled them to compare how seeds germinate under different conditions, giving them a way to investigate what might happen in the forest without needing to control a large outdoor environment. For Merit, the student could give an evidence-based reason explaining why each approach was (or was not) appropriate for answering the specific question. For example, for the first approach, they could explain that site recording was appropriate for identifying biotic and abiotic factors because it provided first-hand measurements that directly helped to answer the question (such as 14°C vs 19°C, or changes in light from 15 lux to 973 lux).

Achieved

NZQA Intended for teacher use only

Investigation 1

THE OVERARCHING QUESTION: How do biotic and abiotic factors in Talbot Forest allow the different plants to germinate and grow?

Pātai/ My Question: What are the abiotic and biotic factors that affect plants in Talbot forest?

Name and describe the type of investigation and what I did

- Exploring and Observing

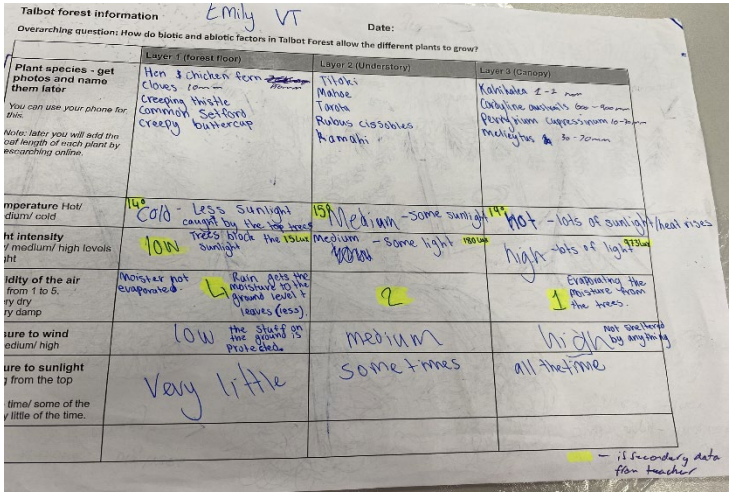
We travelled to Talbot Forest and while we were there we searched for biotic and abiotic factors that affect the plants in Talbot Forest.
I had a sheet of paper and I drew a map of a section of the forest and then labelled the plants and other things I could recognise on my drawing.
I then wrote down what temperature, light intensity, humidity of the air, exposure to wind and the exposure to sunlight on all three of the different layers in the forest (forest floor, understory, canopy).

This investigation let us find out what the forest looks like and it showed us all of the layers in the forest such as the forest floor, the understory and the canopy layer. It also showed us what the temperature, light intensity, humidity of the air, exposure to wind and the exposure to sunlight on all three of the different layers in the forest. I found out what some of the plants are in the forest from briefly looking and taking a guess.

Type of data I collected

I used annotated diagrams and drawings to find our data. I drew all of the layers in the forest on a map and what abiotic factors and biotic I could see in them. The abiotic factors that I found in my drawing were stones, rocks and a sign with information about the forest. The biotic factors that I found were small and large trees, vines, grass, ferns, small shrubs, bushes and moss in some areas.

I labelled my drawing and wrote down the abiotic factors that I could see and feel in the different layers of the forest such as the temperature, light intensity, humidity of the air, exposure to wind and exposure to sunlight. I wrote this down on the other side of the paper that my map was on so that I could further investigate it.



Conclusion/ What did you find out

I found out how abiotic factors such as the temperature, light intensity, humidity of the air, exposure to wind and exposure to sunlight in the different layers of the forest allow the different plants to germinate and grow in Talbot Forest.

The forest floor was cold (14 degrees Celsius), it had low light intensity as the larger trees blocked the sunlight (15 lux), the humidity was at a 4 on a scale from 1-5 (1 being very dry and 5 being very damp), the exposure to wind was low as it is protected by the larger trees, the exposure to sunlight was very little as the trees above blocked it out.

The understory was medium heat (15 degrees Celcius), it had a medium light intensity (180 lux), the humidity was at a 2, the exposure to wind was medium as it was slighty protected by larger trees but not as much as the forest floor was, the exposure to sunlight is sometimes as it is slightly blocked out by the larger trees but not too much.

The canopy layer was hot (19 degrees Celsius) as it had lots of sunlight and the heat also rises to the top, it had high light intensity (973 lux) as the sunlight got all parts of it, the humidity was at a 1 as most of the moisture from the trees is evaporated, the exposure to the wind was high because there is nothing to shelter the trees up there, the exposure to sunlight was all the time as it is not blocked at all.

Give evidence to explain WHY this investigation type was useful (or not) to answer this question. Quote your data.
This investigation type was useful because exploring and observing allowed us to stand back and make detailed notes and a detailed drawing about many of the biotic and abiotic factors that we could see at Talbot Forest like the temperature, light intensity, humidity of the air, exposure to wind and exposure to sunlight.
A disadvantage of using exploring and observing is that it only gives you a quick look at an area so your drawing/notes may not be fully accurate so you may find that you need to go back and have another look at that area again to make sure you have all the information that you need.

This investigation let us find out what the forest looks like and it showed us all of the layers in the forest such as the forest floor, the understory and the canopy layer. It also showed us what the temperature, light intensity, humidity of the air, exposure to wind and the exposure to sunlight on all three of the different layers in the forest. I found out what some of the plants are in the forest from briefly looking and taking a guess.

Investigation 2

Pātai/ My Question: What plants live in the forest and what size leaves do they have?

Type of investigation and what I did
The purpose of this investigation was to show us what plants are living in Talbot Forest and help us know what they look like and how to identify them.

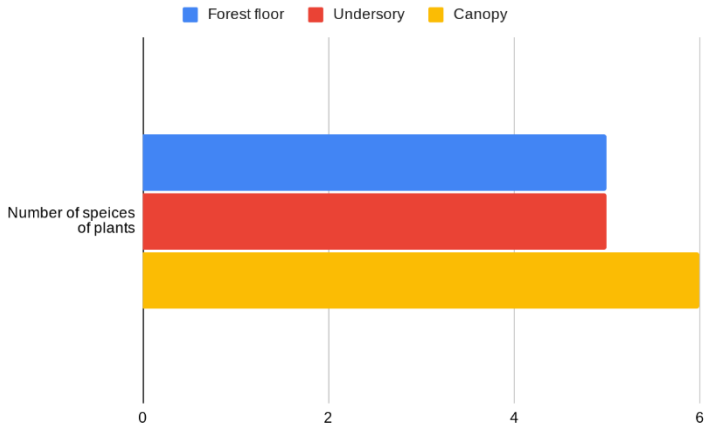
- Classifying and Identifying

We downloaded an app called “Aotearoa Species Classifier” on one person in our groups phone so that we could accurately classify what plants we found.
We then scanned the different plants that we found in the different layers of the forest.
We then wrote down what the names of the plants we found on the same sheet of paper that we wrote down the temperature, light intensity etc.

This investigation allowed us to find out what plants are living in Talbot Forest. We found out that there are multiple different plant species living in the forest and in the different layers. In total we found 16 different species across all of the layers. We found 5 in the forest floor, 5 in the understory and 6 in the canopy.
The species we found in the forest floor are Fern hen & chicken, white clover, creeping thistle, common seal heal and creeping buttercup.
The species we found in the understory are titoki, mahoe, tarata, kamahi and five finger.
The species we found in the canopy are kahikatea, kauri, pukatea, totara, pahautea and matai.

Type of data I collected

We used a graph to display our data.
The graph is showing that we found 5 different plant species in both the forest floor and understory, and that we found 6 different plant species in the canopy.



Forest Floor: Asplenium bulbiferum (Fern hen & chicken), Trifolium repens (white clover), Cirsium arvense (creeping thistle), Prunella vulgaris (common seal heal), Ranunculus repens (creeping buttercup).

Understory: Alectryon excelsus (titoki), Melicytus ramiflorus (mahoe), Pittosporum eugenioides (tarata), Weinmannia racemosa (kamahi), Pseudopanax arboreus (five finger).

Canopy: Dacrycarpus dacrydioides (kahikatea) , Agathis (kauri), Laurelia novae-zelandiae (pukatea), Podocarpus totara (totara), Libocedrus bidwillii (pahautea), Prumnopitys taxifolia (matai).

Conclusion/ What did you find out

From the data that I collected, I found out that the forest floor and the understory both have the same amount of different plant species (5) and that the canopy has a slightly larger amount (6). That means in total we found 16 different species across all three of the layers. I also found out what plant species are living in each layer.
The species of plants that we found on the forest floor were: Asplenium bulbiferum (Fern hen & chicken), Trifolium repens (white clover), Cirsium arvense (creeping thistle), Prunella vulgaris (common seal heal), Ranunculus repens (creeping buttercup).
The species of plants that we found in the understory were: Alectryon excelsus (titoki), Melicytus ramiflorus (mahoe), Pittosporum eugenioides (tarata), Weinmannia racemosa (kamahi), Pseudopanax arboreus (five finger).
The species of plants that we found in the canopy were: Dacrycarpus dacrydioides (kahikatea) , Agathis (kauri), Laurelia novae-zelandiae (pukatea), Podocarpus totara (totara), Libocedrus bidwillii (pahautea), Prumnopitys taxifolia (matai).

Give evidence to explain WHY this investigation type was useful (or not) to answer this question. Quote your data.

This investigation type was useful because classifying and identifying allowed us to find out what plant species are living at Talbot Forest and made it really simple for us to make detailed notes about it.
A disadvantage of classifying and identifying is that it is quite limited and doesn't give any information about the relationship between the plants and the layers that they are living in.
This investigation allowed us to find out what plants are living in Talbot Forest. We found out that there are multiple different plant species living in the forest and in the different layers. In total we found 16 different species across all of the layers. We found 5 in the forest floor, 5 in the understory and 6 in the canopy.
The species we found in the forest floor are Fern hen & chicken, white clover, creeping thistle, common seal heal and creeping buttercup.
The species we found in the understory are titoki, mahoe, tarata, kamahi and five finger.
The species we found in the canopy are kahikatea, kauri, pukatea, totara, pahautea and matai.

Investigation 3

Pātai/ My Question: Do the layers in the forest allow the seeds of the native plants to germinate better than no layers?

Type of investigation and what I did

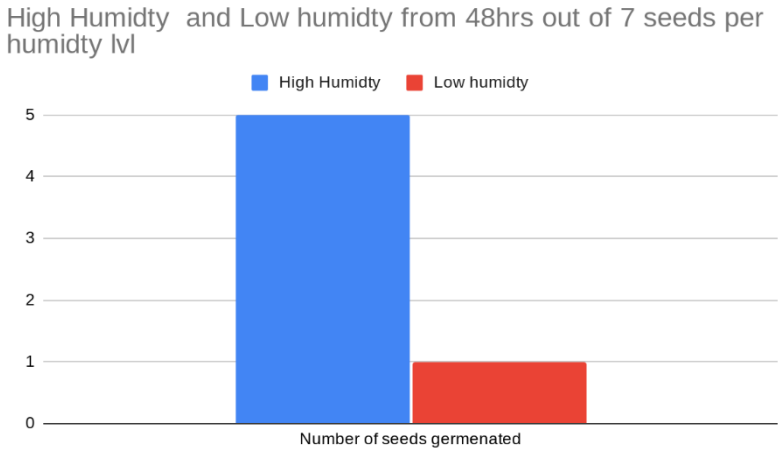
- Modelling

- We had 2 yellow lids and a tile
- We put a cotton ball in each lid and spread it out so the cotton ball covered the whole lid
- We added the same amount of water to each of the cotton balls (using a pipette) so it was slightly wet
- We then placed 7 mung beans in each of the lids on top of the cotton ball and made sure that they were all evenly spread out
- Then we placed both of the lids on the tile
- We placed a cut-in-half bottle on top of one of the lids secured it with blue tack and left the other lid uncovered
- We left the seeds for 48 hours (2 days) to germinate and then came back and recorded what happened

The purpose of this investigation is to help us see if seeds germinate differently if they are covered which means they will have higher humidity or if they are uncovered which means they will have low humidity.
This investigation let us find out that seeds that are covered and have a higher humidity are more likely to germinate and will germinate faster than seeds that aren't covered and have a low humidity which will take much longer.

Type of data I collected

The graph shows that in total we had 5/7 seeds start to germinate in the lid that was covered (high humidity) and that only 1/7 seeds started to germinate in the lid that was not covered.



Conclusion/ What did you find out

During this investigation, I found out that seeds covered by the forest's layers are more likely to germinate. This is because the layers that protect them create humidity in the air which helps the seeds to germinate better. I also found that the seeds that were not covered by anything were dehydrated and the cotton ball had no moisture left in it but the seeds and cotton balls that were covered were still very hydrated and moist.
In total, 5/7 seeds had germinated in the lid that was covered.
In total, 1/7 seeds had germinated in the lid that wasn't covered.

Give evidence to explain WHY this investigation type was useful (or not) to answer this question. Quote your data.

This investigation type was useful because modelling allowed us to see how seeds would germiate in the forest without having to leave the classroom as the forest is a large area and would be harder to control the environment.
A disadvantage of using modelling is that doing the modelling experiment in the classroom will not be the exact same of what is actually happening in the forest.
This investigation let us find out that seeds that are covered and have a higher humidity are more likely to germinate and will germinate faster than seeds that aren't covered and have a low humidity which will take much longer.

Short overall conclusion

How your investigations all contribute to the overarching question

All of my investigations contribute to the overarching question because they all show a small amount of what is happening in the forest and how it is affecting the seeds to germinate and grow into plants. Exploring and observing contributed because it gave me a good overview of what the forest looked like and helped me to find out things such as temperature, light intensity, humidity of the air, exposure to wind and exposure to sunlight which helped me because seeds need a few of those things to germinate and it also helps show how it can affect plants to survive in that habitat. Identifying and classifying contributed because it showed me how many plant species are living in each layer and helped me be able to go into further inspection about what adaptations they have and need to survive. Modelling contributed because it helped show me what it looks like when a plant is germinating and what will help it to germinate. For example, it germinated better when it was covered by the plastic bottle which represents the trees covering the seeds in the forest floor. All of the investigations contribute in their own way to make this investiagtion easier for me to do and figure out how seeds germinate and how plants grow in Talbot Forest.

Grade: Merit
For Merit, the student needs to explain the use of a range of scientific investigative approaches in a context. This involves explaining why the approach was or was not appropriate to answer the relevant question(s). This explanation needs to be supported with evidence. The student has explained that beginning with an approach focused on comparing data across different locations was appropriate because it allowed them to identify possible relationships between surrounding land use and the nutrient levels found in the river. They supported this with evidence from the nitrogen and phosphorus measurements collected at various sites. When investigating whether ions were present in the water, the student used evidence from direct observations taken from multimeter readings, showing how the electrical conductivity of the water samples provided reliable evidence for answering that question. The student also showed that grouping the samples based on the ions they contained, and identifying the specific substances present at different levels, was a suitable way to determine the types and concentrations of ions in the river. For Excellence, the student could analyse how each approach contributed to the overall understanding of Manawatū River water quality, showing how the data collected from each approach connect, corroborate, or conflict and what this means for understanding the context.

Merit

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What is the water quality of the Manawatu River? To answer this question our class did three different investigations using several types of investigation.

The first investigation was pattern seeking, the aim of this investigation was to find trends in nitrogen and phosphorous levels along the Manawatu River. Pattern seeking was an appropriate type of investigation as we were looking for trends and patterns that show if the use of the areas surrounding the river affect the levels of nitrogen and phosphorous within the river. Pattern seeking helped find those trends as we were comparing sample location and levels of nitrogen. To find these patterns we looked at graphs and maps showing the levels of nitrogen and phosphorous and the locations of different water samples. We looked at if there were patterns in levels of nitrogen and phosphorous in each sample, if and how the use of the area surrounding the river affected this. We used this type of investigation as it was the most effective at finding an answer to our question compared to fair testing as we didn't do any test, classify and identify as we weren't grouping things, or any of the other types of investigation. At the end of this investigation, I concluded that there are trends in the levels of nitrogen and phosphorus. One of the trends I found was that throughout the samples from the river there were similar levels of nitrogen and phosphorus almost constantly. Another trend is that river water samples taken near farmland usually had higher levels of nitrogen and phosphorous as these are prominent chemicals in fertilizer which tends to runoff into our rivers. An example of this was sample 1 1, which had the second highest levels of phosphorous and high levels of nitrogen with 0.76mg/l of nitrogen and 0.065mg/l of phosphorous which was taken near farmlands. This investigation answers the overarching question, what is the water quality of the Manawatu River? Because through this investigation I found out that the quality of the river changes throughout the course of the river, at some parts there's more nitrogen and phosphorous then others due to how the area around it is being used, at these parts the quality of the river is worse than other places.

The second investigation was exploring and observing, the aim of this investigation was to find out if there are ions in the Manawatu River. Exploring and observing was an appropriate type of investigation as we were exploring how the different water samples from along the river conducted electricity. We observed the multimeter reading. This investigation type allowed us to get clear results and helped us to fulfill the aim of our investigation. We used the investigation type of exploring and observing as it allowed us to come to a better conclusion then if we were to use another type of investigation, for example we wouldn't use fair testing because we didn't need to change anything with each test. If we wouldn't use modeling as we weren't predicting anything. Looking at all the different types of investigation, observing and exploring seemed the most appropriate choice. Using exploring and observing I was able to conclude that there are ions in the Manawatu River. I know this as I observed that the multimeter readings ranged between 04.-06. Milliamps for all the samples. This means the water samples could conduct electricity, as there must be ions present in the water for it to conduct electricity. This investigation helped me to answer the overarching question as too many ions in a river is bad and could lower the quality of the river. Too many ions within the river could be due to pollution and could be a sign of dangerous chemicals such as phosphates, nitrates, and other metals in our rivers.

The third and last investigation we did was classifying and identifying, the aim of this investigation was to find out what specific ions were present in the Manawatu River. Classifying and identifying was an appropriate type of investigation to answer this question as we looked at which samples contained different ions, put them in groups and identified what samples contained these ions, what ones had low levels, medium levels, and high levels. We used classifying and identifying instead of one of the other types of investigation as this one allowed us to get better and more useful results than if we used a different type of investigation. For example, we wouldn't have used pattern seeking as we weren't looking for patterns or trends and we wouldn't use modeling as we weren't using models. Classifying

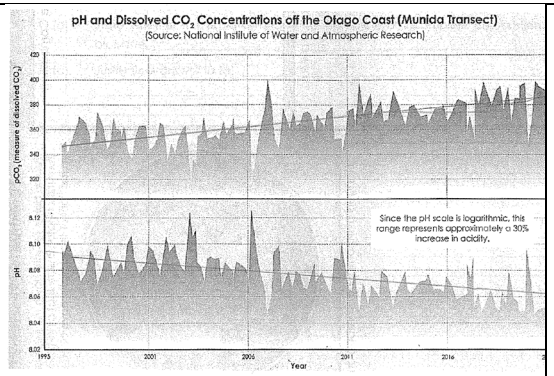
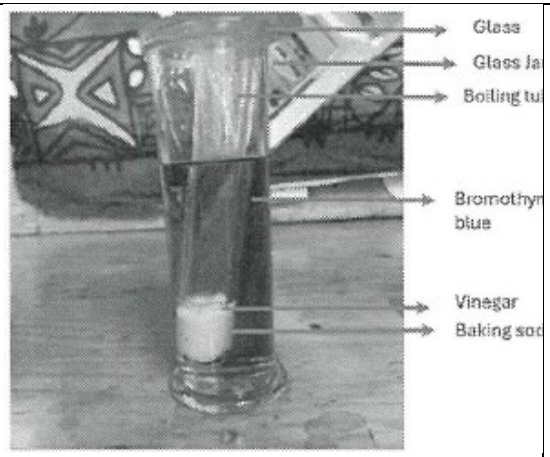
and identifying was the most reasonable and effective type of investigation to answer this question. Using classifying and identifying, I concluded that the Manawatu River contains chloride, phosphate, and nitrate and what levels of these ions are present in each sample. All the samples had low levels of nitrate and most samples also contained low levels of phosphate. However, two of these samples, 2 and 5, had higher levels that sat between medium and low. This investigation helped answer the overarching question as it helped me find out which ions are present in the river and what level of them are present.

These three investigations help to answer the overarching question of, what is the water quality of the Manawatu River? As I learnt about different things that could affect the quality of the water such as what ions are in the river and what levels of those ions are present throughout the river. Using several types of investigation allowed me to look at how different things affect water quality and how. After these investigations I have concluded that the quality of the Manawatu River depends on what area of the river you test. The river is filled with ions such as Phosphate, Nitrate, and chloride. Too much of these ions can cause problems with the quality of the river such as causing algae to over grow or to harm or kill invertebrate and fish. Water quality of the Manawatu River isn't great and needs to be improved.

Grade: Excellence
For Excellence, the student needs to analyse the use of a range of scientific investigative approaches in a context. This involves focusing on analysing how the range of approaches contribute to an integrated understanding of the context. The student has analysed how using data-trends, direct observations, and predictive simulations contributed evidence towards understanding ocean acidification. The student has shown how the information gained from each of these individual investigative approaches helped them understand one aspect of ocean acidification (the "*little questions*"), and how combining all three provided a more comprehensive, connected understanding of the wider context (the "*overarching question*").

OVERARCHING QUESTION: Why should we be concerned about ocean acidification?			
	INVESTIGATION 1	**INVESTIGATION 2**	**INVESTIGATION 3**
LITTLE QUESTION	Are the oceans around NZ becoming more acidic?	What is causing our oceans to become more acidic?	What does ocean acidification mean for the future of our kai moana?
TYPE OF INVESTIGATION	Pattern Seeking	Observing & Exploring	Modelling
EVIDENCE GATHERED (CONCLUSION)	From 1995 to 2021, pCO2 levels were increasing from 35-390. During this same time period, pH levels were lowering and becoming more acidic going from 8.18.05. This shows us that pCO2 levels rise while pH levels drop.	When vinegar (acid) was added to baking soda (alkali), it released carbon dioxide. When this carbon dioxide settled in the solution (water), it created carbonic acid. This gives us the formula: Carbon dioxide + water → carbonic acid (CO2 + H2O → H2CO3)	Oysters build their shells using aragonite (a form of calcium carbonate) which dissolves quickly as the oceans become more acidic. Scientists predicted what NZ's aragonite saturation state would be in the future. Oyster larvae struggle to grow when aragonite levels drop under 2. Using this, we found out that after 2075 oyster larvae will struggle to grow in NZ waters.
WHY WAS THIS INVESTIGATION TYPE USED TO ANSWER THE QUESTION?	Pattern seeking is an investigation used by scientists to identify patterns and relationships between different variables over time. It can be used to gather information for other investigation methods such as exploring & observing and to see the relationship between variables that are hard to control. Since the ocean is a variable that is almost impossible to control as there is so much variation, we used this approach by analysing data collected by the natural Institute of Water and Atmospheric Research that had been put into a graph. This way we were able to draw trend lines indicating what happened to both the pCO2 levels and acidification levels over time. After analysing these graphs, I found out that as the amount of carbon dioxide entering our water was increasing, our oceans pH levels were decreasing and becoming more acidic.	Scientists use exploring and observing to gain a general understanding of a topic and to discover new information. Tools are usually used to aid this investigation to extend the scientists senses so they can gather more data. We used this approach to observe what happened to water after being mixed with CO2 to see how the oceans are becoming more acidic. To do this, we used the set up below:	Scientists use modelling to represent and test ideas so they can predict possible future outcomes, it can be especially helpful to test things that are too expensive in real life. We used this approach by analysing a model created by the NOOA which predicts future aragonite levels in sea water. It was based on historic data and projected carbon dioxide emissions so they could predict the aragonite saturation state in the future due to carbon dioxide which causes ocean acidification. The model showed aragonite levels in the ocean from 1861-2000 so we were able to observe the saturation state in future years and recorded it in a table.

Year	Aragonite saturation state
2000	3.1
2025	2.5
2075	1.9
2100	1.7

		 We put baking soda in a boiling tube that was inside a jar of water mixed with bromothymol blue solution. We then added vinegar and covered the top with glass to observe what happened. We saw the vinegar and baking soda fizz and bubble up which showed them releasing carbon dioxide A while later, we found out that the bromothymol blue solution had turned yellow meaning that once the carbon dioxide had mixed with it, it turned acidic (yellow). This left us with the final solution of carbonic acid and gave us the formula: Carbon dioxide + water → carbonic acid	Using this information, we found out that in 2075 NZ oyster larvae will struggle to brow because of ocean acidification. And, if things keep going at this rate, after 2100 oyster larva might start dying instantaneously.
WAS THIS INVESTIGATION TYPE APPROPTIATE (OR NOT)?	It was appropriate to use pattern seeking to answer our little question of “Are the oceans around NZ becoming more acidic?” This approach allowed us to analyse real date with variables we would be unable to control ourselves as the ocean is too wide a variable for us to manage. The NIWAR scientists had gathered lots of data from the years 1995-2021 so we could observe the trends in graphs to tell	It was not appropriate to use exploring and observing to answer our little question of “What is causing our ocean to become more acidic? While this investigation did show us what effect carbon dioxide had on water, it was very inaccurate. Since we used tap water rather than ocean water, we were unable to see how the carbon dioxide might have affected our ocean differently. By not using sea water, the time it took for the	It was appropriate to use modelling to answer our little question of “What does ocean acidification mean for the future of our kai moana? By using modelling, we were able to get an idea of how our oceans would be affected by acidification by observing the aragonite levels in New Zealand. We wouldn’t be able to predict these future levels with a different approach as modelling helped us to predict a possible future outcome which

	us more about ocean acidification. The graph showing pCO2 levels overtime doesn't help answer our little question as much, however, it does contribute to our broader question of "Should we be concerned about ocean acidification?" as it shows the effects of our carbon usage in the water and how our actions are leading to ocean acidification. It also helped to generate questions such as "How does ocean acidity change over time?" or "What happens to the oceans pH levels when pCO2 levels increase?"	carbon to affect the water and the effect that it had was inaccurate. Alongside this, carbon dioxide is not trapped with ocean in real life so having a glass lid trapping the CO2 was unrealistic. A better approach would have been modelling so we were able to accurately scale down the experiment and see what would happen when the factor of carbon dioxide was introduced to ocean water. This way the experiment would give us more accurate information and clearly answer our question by showing that it was carbon dioxide making our oceans more acidic. It could also generate questions like 'what happens when carbon dioxide and ocean water interact?"	cannot be done with something like fair testing. We learned through this investigation that after 2075 oyster larva will begin to die in NZ due to insufficient aragonite levels which could greatly affect NZ's kai moana therefore helping to answer our question about the effects of ocean acidification to the future NZ ecosystem. This helped us generate questions like 'what could happen in the future if ocean acidification levels continue to rise?' and we are able to explore the effects of this future through a model when the scale is too big for us to control.

Analyse how using three different types of investigative approaches together enabled you to answer your overarching question or not?

Why should we be concerned about ocean acidification? To answer this question, we were required to split it into three smaller question to answer the two main aspects of the question. We used two investigative approaches to analyse the effects of acidification on NZ currently and then 1 investigation to observe future effects which are reason for concern. Using all these, I was able to answer our main question.

The first little question that was generated by our overarching question was "Are the oceans around NZ becoming more acidic?" It was important to start our investigation here and we used pattern seeking to analyse the effect of ocean acidity to answer this question. We needed lots of data to answer this question but, instead of exploring and observing, we used pattern seeking for this question. Since we already had data provided by Natural Institute of Water and Atmospheric Research, we didn't need to collect it ourself in order to answer the question as we provided scientific evidence to use instead of what is actually happening in the world. We would not have been able to collect this data ourself as the ocean is too unpredictable and we cannot control it. By using pattern seeking with the information provided through the exploring and observing done by the scientists, we were able to establish trends on the rising levels of ocean acidification. We discovered that as pCO2 levels were rising, the oceans pH was lowering meaning it was getting more acidic with carbon dioxide. This gave us the knowledge we needed to answer our big question as we can see a reason for concern in the fact that it is on the rise. We needed the other investigations to truly answer the why part of the question. Pattern seeking helped us generate our next little question of "What is the effect of carbon dioxide on water?" so we could look deeper into the reason our oceans were becoming more acidic now that we know that acidification levels are rising.

What is causing our ocean to become more acidic? We chose to use exploring and observing to answer this question, as we were focused on gathering new information that can be used to give us a general understan9ng about the cause of ocean acidification. Modelling might have been a better method to use instead of this because we could accurately see the cause with sea water compared to tap water, however we did not have access to sea water so exploring and observing still worked well to answer the question. When carrying out this investigation we used tools such as dye so we could clearly see what happened to the water when it was mixed with carbon dioxide. By using tap water compared to sea water we were limiting the information we gathered so modelling would have been much more helpful to gather the information we needed. With the information we did receive of observing the acidification of water when mixed with carbon dioxide, we generated our next question looking into what future carbon dioxide levels might do to ocean acidification, which gave us the question of "What does ocean acidification mean for the future of our kai moana?" It helped answer our big question by giving us information on the cause of ocean acidification so we know what we are doing to cause the concern for ocean acidification.

What does ocean acidification mean for the future of our kai moana? This is the question we generated from our exploring and observing. This required us to use information from the NOOA website. This website used data from pattern seeking to establish trends that helped determine what acidity levels might be in the future. They did this by using historical data and projected carbon dioxide emissions and used aragonite as the substance they measured as it used by many sea creatures, particularly oysters, to build their shells. Using a computer program to simulate and see these trends was appropriate when looking into the future so we can see trends because the data is so complex. This information collected from pattern seeking was essential to create a model of what the aragonite levels might be for NZ in the future. With this approach we were able to see how oyster larvae would be effected in NZ in the future as it would become hard for them to grow after 2075. This is because of the predicted aragonite levels we observed at this time for NZ which was the right information to answer our little question as we can see what will, happen to some of NZ marine life in the future. This helped answer our overarching question as we were able to see why we should be concerned about ocean acidification. Learning that marine life would struggle to grow in the future is a huge reason for concern if ocean acidity keeps on rising like the model suggested.

By breaking our overarching question of Why should we be concerned about ocean acidification? Into three parts, we were able to see scientific reasoning as to why we should be concerned about ocean acidification. These three investigations all involved collecting data to help do things like establish trends and generate questions. They all used each other to help answer each little questions, as scientists used exploring and observing to get the data we used for pattern seeking, and the model we used was based on pattern seeking data and evidence to predict the future. Some differences between these approaches was that in exploring and observing we collected the data ourself and just recorded the results of what we saw. With pattern seeking, we were just presented the information and had to find the relationships and trends ourself. Meanwhile modelling did the pattern seeking for us while we used it to record the different levels over years in a table. Some advantages of pattern seeking is that it shows us accurate data that allows us to see trends we need to answer questions especially when the variables are difficult to control in an investigation. A disadvantage is that it doesn't give us an accurate full picture as some graphs only show short period of times and trends may be different in the long run. An advantage of exploring and observing is that it is good to give us a general understanding and give us the big picture that pattern seeking leaves out. A. disadvantage is that it is not 100% accurate as in our case where we didn't have access to sea water so observed tap water instead. Finally, an advantage of modelling is that we were able to predict outcomes which is impossible with other investigations. This way we can see how things change overtime as certain factors (like carbon dioxide) increase. A disadvantage is that there is no way to ensure that this will actually happen in the future as factors in the environment might change overtime as new technology is in traduced. Overall, these three different approaches and little questions helped us answer our big question by first discovering how it was an issue by seeing acidification levels rise. Then we got to the root of the issue which is carbon dioxide, something present in everyday life causing reason for concern. And finally, the why we should care part demonstrated through modelling as we see the possible effects that acidification will have on NZ by analysing its sea life. This shows us why ocean acidification is big reason for concern as it is on the rise due to a product that is all over our atmosphere (carbon dioxide) and its proved to have a large impact on sea creatures and life meaning we should be concerned to act on it and stop it from getting this bad.