

**Internal Assessment Resource**

**Digital Technologies | Hangarau Matihiko Level 1**

This resource supports assessment against Achievement Standard 91885[[1]](#footnote-1)

**Standard title:** Demonstrate understanding of searching and sorting algorithms

**Credits:** 3

**Resource title:** Digital detectives

**Resource reference:** Digital Technologies | Hangarau Matihiko 1.9A Version 1

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| This resource:   * Clarifies the requirements of the achievement standard * Supports good assessment practice * Should be subjected to the school’s usual assessment quality assurance process * Should be modified to make the context relevant to students in their school/kura environment and ensure that submitted evidence is authentic |

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| Date version published by Ministry of Education | December 2017 Version 1  To support internal assessment from 2018 |
| Authenticity of evidence | Teachers/Kaiako must manage authenticity for any assessment from a public source, because students may have access to the assessment schedule or student/ākonga exemplar material.  Using this assessment resource without modification may mean that students’ work is not authentic. The teacher/kaiako may need to change figures, measurements or data sources or set a different context or topic to be investigated or a different text to read or perform. |

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**Teacher/Kaiako guidelines**

The following guidelines are supplied to enable teachers/kaiako to carry out valid and consistent assessment using this internal assessment resource.

Teachers/kaiako need to be very familiar with the outcome being assessed by the achievement standard. The achievement criteria and the explanatory notes contain information, definitions, and requirements that are crucial when interpreting the standard and assessing students/ākonga against it.

**Context/Te Horopaki**

This activity requires students to develop a portfolio of evidence outlining their comprehensive understanding of searching and sorting algorithms including photographic or video evidence of them carrying out at least one searching algorithm and one sorting algorithm.

1. Students will be asked to provide evidence of an investigation into practical uses of searching and sorting in the real world. In this investigation, they should outline their understanding of the purpose of searching and sorting and the reasons why they are important. They should also discuss the relationship between searching and sorting and any implications that the behaviour of these algorithms may have for the user.
2. Students will carry out a demonstration of a search algorithm selected from either linear (sequential) or binary search. The teacher can choose from a variety of methods for this including cards, cups, phonebooks or other unplugged resources like those detailed in the “cs-unplugged” resource or using online resources like those provided in the [“computer science field guide](http://csfieldguide.org.nz/en/chapters/algorithms.html#searching)”.
3. Similarly, students will carry out a demonstration of a sorting algorithm selected from; selection sort, insertion sort, bubble sort, quick sort or merge sort. As before, students will need to show evidence that they have carried out this algorithm using their chosen method and they have provided sufficient evidence in their portfolio.
4. Students should then determine how the cost of a chosen algorithm changes as the size of the data set increases. They should also have the opportunity to investigate and discuss the best, worst and average case scenarios for two searching or sorting algorithms and how different data sets may affect the results. Cost can be thought of as ‘how many operations’ and that ‘how many comparisons’ is a reasonable way to measure ‘how many operations’.
5. Students should be given the opportunity to determine costs and best, average and worst-case behaviour from their own data, rather than presenting formulas copied from external sources. Students should be careful to be clear about the details of the algorithm that they are discussing.

***Further teacher guidance***

* The intention of this standard is that students should demonstrate their own understanding, and the expectation is that the understanding will be at the depth appropriate to a Level 1 student.
* Students are only expected to use maths appropriate to NCEA Level 1 (for example, logarithms are not covered in Level 1 maths).
* Some of the sorting algorithms are naturally expressed recursively. Students are not expected to be able to code up these algorithms themselves. They can, however, give clear, informal, descriptions of the algorithms. Students need to be clear about the details of the algorithm that they are using, as this may affect efficiency.
* There are downloadable programs on, e.g. the CS Field Guide that students can use for large datasets.
* Ensure that students do not plagiarise material, particularly from Wikipedia and the CS Field Guide.
* “Determine”, at this level, does not require the derivation of a formula for time complexity (at any level).
* Students should make use of the data that they have generated themselves to determine the behaviour of the algorithm.

***Project based learning and collaboration***

Students are encouraged to work with a partner to help them record their demonstration of their chosen algorithms in photos or videos. This can help students easily communicate their understanding of the algorithm and how it works. Students should annotate the photographs to help explain their processes. If online tools are used, annotated screenshots should be used for their report.

Give clear guidance as to how much evidence a student needs to provide.

**Conditions/Ngā Tikanga**

Where a group approach is used, the teacher/kaiako needs to ensure that each student creates their own report outlining their understanding of searching and sorting algorithms in their own words.

The 3 credits for the achievement standard indicates that approximately 30 hours needs to be allocated for teaching, learning (in and out of the classroom) and assessment in a programme of study. You may want to give students guidance on appropriate style and format for their portfolio. This achievement standard does not assess writing format or style.

While a written report gives an opportunity to assess individual student understanding, recordings of classroom observation can contribute to a student demonstrating their understanding of searching and sorting algorithms as required by the standard. Electronic documents can have short embedded videos for the same purpose if the teacher deems this appropriate. Annotated photographs are also useful in explanations. Quality not quantity is important.

Conditions of Assessment related to this achievement standard can be found at <http://ncea.tki.org.nz/Resources-for-Internally-Assessed-Achievement-Standards>

**Resource requirements/Ngā Rauemi**

Students will need access to the web, digital devices and information from a variety of sources, such as: extracts, and/or notes from textbooks, the computer science field guide or “cs-unplugged”. Useful resources include:

<http://csfieldguide.org.nz/en/chapters/algorithms.html> CS education research group. (2017). Computer Science Field Guide. Retrieved 21 May, 2017, from <http://csfieldguide.org.nz/en/index.html>

<http://csunplugged.org> CS education research group. (2017). Computer Science Unplugged. Retrieved 21 May, 2017, from http://csunplugged.org/

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**Student/Ākonga instructions**

**Introduction/Kupu Arataki**

This assessment activity requires you to carry out research into how searching and sorting algorithms work, and how they are used in the real world.

You are going to be assessed on how comprehensively you demonstrate your understanding of searching and sorting algorithms.

You may work with others while investigating the topic; however, you must each submit your own evidence in your own words.

Teacher note: Insert due dates and timeframes

**Task/Hei Mahi**

Follow the instructions below to provide evidence of your understanding of searching and sorting algorithms. Before you begin, decide how you will provide evidence of your understanding for your teacher and how much evidence (e.g. a presentation, videos, images with annotation, or a report). You may wish to a use a combination of evidence types in an online portfolio.

* Investigate ways in which searching and sorting algorithms are applied in the real world. Describe, in your own words, at least one example of searching and one example of sorting in a real-world context. Discuss the implications of having efficient algorithms for searching and sorting in these real-world contexts.
* Explain the relationship between searching and sorting. For example, explain the impact of having sorted or non-sorted data on the choice of searching algorithm.
* Carry out one searching and one sorting algorithm of your choice. You may demonstrate these for your teacher or provide video or photographic evidence of carrying out the algorithm. You may use physical objects such as cards or cups.
* Investigate two different searching algorithms or two different sorting algorithms. Determine the best, average and worst-case costs of each algorithm that you have selected. Investigate the effects of cost of the two different algorithms with different data sets (e.g. different size, sorted vs unsorted, inverse order). To help you understand cost, think of it as ‘how many operations’ and that ‘how many comparisons’ is a reasonable way to measure ‘how many operations’.

You may want to work with a partner in order to capture photographic or video evidence of your demonstration. Use the resources your teacher will have chosen for you.

You will each need to provide evidence of your own demonstration and should annotate thepictures, screenshots, sketches, or videos describing the steps you took.

**Evidence:**

In your evidence, describe what you understand about the cost of the various algorithms that you have demonstrated.

Compare how this changes as the size of the sample increases and how this may change for different algorithms. You may choose to graph the data gained from various tests on different data sizes that you have carried out and then explain what the graph shows.

Consider and discuss your understanding of best case, worst case and average case scenarios as you investigate the cost of performing an algorithm on different data sets (e.g. different size, sorted vs unsorted, inverse order).

Your evidence can be shown using annotated photographs, annotated sketches, videos or a written description.

**Assessment schedule/Mahere Aromatawai: Digital Technologies | Hangarau Matihiko** **91885 – Digital detectives**

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| **Evidence/Judgements for Achievement/Paetae** | **Evidence/Judgements for Achievement with Merit/Kaiaka** | **Evidence/Judgements for Achievement with Excellence/Kairangi** |
| The student demonstrates understanding of searching and sorting algorithms which involves:   * describing applications of searching and sorting   **For example (partial evidence):**  *Searching and sorting are used in a library to help us find the books that we want. The books are stored on the shelves in a sorted order which makes searching for the book you want a lot easier….the books are organised in a way that makes it easier for us to find them….*  *All of the names in a phone book are sorted so they appear in alphabetical order...this makes it much easier for us to find the name that we need….*   * carrying out a searching algorithm accurately   There is evidence of an accurate understanding of the steps required to undertake one of the searching algorithms like a linear or binary search. This evidence can be supported by teacher attestation if the written annotated or video evidence within the report is incomplete or unclear.   * carrying out a sorting algorithm accurately   There is evidence of an accurate understanding of the steps required to perform a sorting algorithm, for example the selection sort or quick sort. This evidence can be supported by teacher attestation if the written, annotated or video evidence is incomplete or unclear.   * describing how the cost for a chosen searching or sorting algorithm changes as the size of the problem increases   **For example (partial evidence):**  *“When we were given the bigger list of words to look through it would have taken us twice as long to check each word to find the one we needed because there were twice as many words…....*  *using binary search if the list was twice as long you would only need to do one more search….*  *but what if the list was twice as long?….. you would have to…….*  *...but with a pile of 20 cards we would have to go through the algorithm…….”*  *The examples above are indicative samples only* | The student demonstrates in-depth understanding of searching and sorting algorithms which involves:   * explaining the relationship between searching and sorting   **For example (partial evidence):**  *“When we were given an unsorted list we could not easily find the word we were looking for because…….*  *….the data has to be sorted before the algorithm works…..*  *...if they were not sorted before we tried to find something…..this is because*  *...you can only use binary search on data that has been sorted because…”*   * determining the best, average and worst-case costs of two related searching or sorting algorithms and explaining the implications   **For example (partial evidence):**  *“When we used the linear search the worst case would be that we might have to look through all the data in order to…..this is not the case with the binary search because….*  *the best case would be that we find the ball under the cup on the first try…...but on average……..this means that…..*  *if you weigh the heaviest container first……*  *….the best case would be that…..this means...*  *...“the average” case would be that I would need 6 tries…..but if you use binary search…..*  *if the boxes were already in order….this would be the best case….but on average…..”*  *The examples above are indicative samples only* | The student demonstrates comprehensive understanding of searching and sorting algorithms which involves:   * discussing real world usage and implications of searching and sorting algorithms   **For example (partial evidence):**  *...with 3.5 billion searches a day on average...imagine how long it would take…..*  *...Amazon’s 5 million digital documents...if the data wasn’t sorted….*  *...quicksort is used most commonly even on large data sets like……..*  *...medical and scientific advances, such as searching for DNA sequences, have been made possible by….*   * investigating the cost of searching and sorting algorithms with different data sets.   **For example (partial evidence):**  *….in our experiment it took 6 more iterations with unsorted data because…*  *...when the data was reversed...the algorithm still took……*  *...when there were 10 times as many words the linear search would take….. while the binary search would only take...*  *...we see a more linear increase in the cost...when compared to...the difference is much more notable as the size of the sample increases….*    *The examples above are indicative samples only* |

Final grades will be decided using professional judgement based on a holistic examination of the evidence provided against the criteria in the Achievement Standard.

1. This achievement standard is derived from both *The New Zealand Curriculum* and *Te* *Marautanga o Aotearoa.* [↑](#footnote-ref-1)