**Phil Feain** - Hello and good afternoon to everyone attending this Algorithmics SAT Training Webinar for 2023. My name is Phil Feain and I'm the Curriculum Manager for Digital Technologies. This afternoon's webinar will be presented by Ivan Carlisle, State Reviewer for Algorithmics. Co-presenting with Ivan will be Greg Breese, former State Reviewer for Algorithmics and one of the key stakeholders of the study since before it started, before 2015.

At this stage of the webinar would like to do the Acknowledgement of Country. The VCAA respectfully acknowledges the Traditional Owners of Country throughout Victoria and pays respect to the ongoing living cultures of First Peoples.

In terms of asking questions, please ensure that you ask your questions using the Q&A function. It's located at the bottom right of your screen. We ask that you please ask the questions to all panellists so the panellists can see the questions coming in from the audience. And this also helps us with moderating the questions we receive. We'll endeavour to answer as many of your questions as we can during the webinar. And all questions received will assist us in preparing further advice for the study. As questions come in they'll wait and we'll get to different sections of the presentation and we'll go through any questions. That way we can flow through the presentation and end on time.

The purpose of this session today is to provide an overview of the SAT for Unit 3 Outcome 3 and Unit 4 Outcomes 1 and 2. To unpack the SAT criteria in the 2023 Administrative information for School-based Assessment. And to provide a brief overview of authentication, assessment and marking. In terms of resources we have several resources available on our study page. So we've got the Administrative information for School-based Assessment and that's the SAT criteria. Have the blank Authentication record form. You can download those for each of your students. We also have a group of on-demand videos which link off the study page. So Background to the SAT, Criteria 1-4, Criteria 5-7, Criteria 8-10, Authentication and Administration of the SAT. And we also have support material there, which is the old Advice for teachers. So at this stage of the presentation I'll hand over to Ivan and Greg, they'll look after you for the rest of this presentation and I'll appear in the background during our question time. Thanks very much Greg. Thanks very much Ivan.

**Ivan Carlisle** - Thanks Phil and welcome attendees. I guess the first thing, and the most important thing to take away from this presentation is it is a new version of the study design this year. It's very important that you're referring to the current resources and there's much documentation that Phil's just mentioned on the VCAA website that is there to assist you in administering the new study design and the assessments there in including this SAT. Phil, do you want to flip through to the next slide? Thank you.

So, specifically with respect to the SAT, the key document that you want to refer to, apart from the study design of course, is this document titled here. So the Administrative information for the SAT, which of course can be found on the VCAA's resources page. We're going to go through the criteria that's captured in this document today and some of the other elements of the document and really spell out hopefully the intent of the SAT and things to take into consideration in administering it. Next slide, Phil. Thank you.

So just some information about the SAT. So the student's level of achievement in Unit 3 Outcome 3, Unit 4 Outcomes 1 and 2 are assessed through this particular assessment and it contributes 20% to a student's study score and it's the most significant piece of assessment in the study apart from the exam. Next slide. Thanks Phil.

This is an extract from the study design and this gives, I guess the overview of the SAT, the initial specification of the SAT. We've got the outcomes on the left and the particulars of the tasks on the right, which we will spell out as we go through the criteria. It's worth appreciating, just as you get initial perspective of the SAT, is that it does span across Units 3 and 4. Unit 3 Outcome 3 is an outcome that's sort of the culmination of all the work that students have, all the knowledge and skills that students have developed over the course of Unit 3 and it's about applying those knowledge and skills to a real-world problem context. And the SAT is really targeted about giving students an authentic opportunity to apply that algorithmic problem-solving process.

Unit 4 Outcomes 1 and 2, they draw upon those more advanced skills around analysis of the efficiency of algorithms and getting into more advanced algorithm design elements. And we'll talk quite a bit today around how to approach the development of an appropriate SAT so that all of these elements can be assessed in a meaningful way, but also a way that's realistic to what we can expect of students. Before we move on, Greg, is there anything you wanted to add on this slide?

**Gregory Breese** - I think you've given a great summary there Ivan and I think we'll, I guess build on our understanding of the three components as we go through the more detailed breakdown when we do the criteria.

**Ivan Carlisle** - Sure. Thanks Phil. Next slide. Okay, so some things to consider about the SAT, sort of at a high level before we get into it. The SAT is not to be run like a SAC. Students should have several classes a week to work on this and can work on it outside of school time. Teachers are to regularly observe student progress and provide feedback in the Authentication record form and in the documentation for the SAT, as you'll see, there's quite a bit of sort of structure and indication of how to go through that authentication process. Teachers need to be aware of the VASS dates for the submission of the SAT scores for Units 3 and Unit 4.

So this SAT, being that it spans across both Unit 3 and Unit 4, the elements of the SAT that pertain to Unit 3 that needs to be assessed and those assessment outcomes need to be entered into VASS as part of the student's Unit 3 work. And then the elements that correspond to the Unit 4 part of the SAT obviously are put into VASS for the Unit 4. Teachers should only use the current year's Administrative information.

So I mentioned at the start, that if there's nothing else that you take away from today's session, it's that we are in a new version of the study design this year. This SAT and other assessment tasks are quite different to those from the previous study and it's really important to be across all the information that's been provided with these new considerations. Next slide. Thanks Phil.

It's worth taking a moment to think about the intent. So I mentioned before that it is an opportunity for students to apply that algorithmic-problem solving process to a real-world/applied problem context. So they're doing that initially drawing from those Unit 3 knowledge and skills. And then for Unit 4 they're explicitly considering the efficiency of their solutions. And so as we talk about approaches to the design of this SAT, we really want to think, how are students benefiting from this type of assessment. It is very distinct from assessments like exams and so on. It really gives students an opportunity for understanding all those knowledge and skills in a more authentic sort of context. And we want to capitalise on that as much as possible. Is there anything else Greg that you wanted to mention at this juncture?

**Gregory Breese** - Look, as we go into the, I guess, in the designing of the SAT, for those who are familiar with the previous iteration, the study design, you'll be familiar with the previous analysis of a naïve algorithm that the students did at the beginning of Unit 4. And then they consequentially developed an improved design. And I guess part of the thinking in the construction of this new assessment is that the students themselves are to some extent creating in Unit 3 a perhaps naïve solution to the problem that they are studying and then analysing that and developing improved solution.

So there are definite connections between this new task and elements of what you may have been previously familiar with. But the, I guess, scope of that initial design, where students may have actually had this quite large project in Unit 3 that is not there anymore. Instead the students are probably tackling a real-world problem that may have a maybe more narrow scope to it, but that they will be, I guess, going through this full iterative improvement algorithm design cycle across the year.

**Ivan Carlisle** - Thanks Greg. Next slide Phil. So with respect to Principles for problem selection, so we've mentioned a few things here. Problem selection is I think a really important part of writing a good SAT and there's a lot to be said about careful problem selection and how to sort of scrutinise whether it's an appropriate problem to give students that will allow students to demonstrate all the various things that we want to see on the SAT.

So a couple of ideas: Teachers are to provide students with a real-world/applied problem context. The problem should be stated in terms that are sufficiently general to allow for individual students to approach it in different ways. The problem context should lend to the data modelling and algorithm design approaches studied in Unit 3, but also have the potential to benefit from the advanced algorithm design methods studied in Unit 4. And I think this last dot point is one that we need to be particularly mindful of, this SAT does span Unit 3 and Unit 4.

And so in the past when teachers were identifying good problem ideas for the various assessments that they wrote, often they probably had a narrower consideration of the knowledge and skills that that problem needed to be appropriate for. And so this is something I think new this year that requires a little bit of extra consideration from teachers. Now, in terms of problem selection in coming up with different ideas, it might be helpful to find initial sort of kernels of ideas by looking across competitions and those sorts of things. But of course such ideas would need to be carefully developed.

They might be just initially kernels, but having problems that are very typical problems in the broader sort of computer science discipline that are easy to sort of Google different approaches and solutions. That's something that a teacher would need to be wary of because obviously students are spending a lot of time on these problems and we want them to apply that algorithmic problem-solving process authentically themselves. And so the problem should be somewhat unique or interesting in our particular context. Greg, did you want to add to that?

**Gregory Breese** - I guess I'll just add there are within Unit 4 quite a range of different approaches that the students will study. They'll study divide and conquer, they'll study dynamic programming, they'll study heuristic approaches to problems. And it's worth, I guess, considering that it is important that some of these approaches are applicable, they don't need to all be applicable, but certainly you need some of them to be applicable. And it will often be the case that the heuristic methods that the students study are often very broadly applicable to a wide range of problems when, I guess, the complexities of the problem warrant the associated compromises.

The other thing I'd say is it is worth you, when you're picking problems earlier in the year, actually tackling it in a variety of ways yourself and just seeing, well what are the different types of solutions that this directions students might go in. And if you find that there the problem seems to be lending itself to only really one way of solving it, then that's an indication that maybe the problem needs some additional complexity, perhaps, so that there are diverse ways that students might tackle the problem. If your problem has really only one sort of natural way of solving it, then you may run into some authentication challenges.

**Ivan Carlisle** - Thanks Greg. Phil next slide please. So over the next couple of slides, we're just providing a couple of example problem contexts. These are just kernels of ideas for problems really for us as reference points in discussion just to raise some sorts of things that you ought to be considering as you're selecting and developing the problem scenarios that you would present to your class for your SAT.

So I'll just quickly read through this one. A take-away delivery service company that operates exclusively in the Melbourne CBD employs a number of delivery riders. Riders are rostered-on in proportion to the level of demand for deliveries. Riders have capacity to carry upwards of three orders at a time. Riders are paid at a rate per kilometre travelled. The company requires a programme for assigning riders to deliveries that maximise the company's profit.

So if I was taking this as a kernel of an idea to initially develop, what might look attractive to me initially is I could see how many of the graph algorithms that we study in Unit 3 could be applicable. By virtue of the fact that the problem talks about the Melbourne CBD, I've got a concrete data set that I can use for modelling, which would lean to the graph abstract data type and so on. But what I would be really cautious about is thinking, okay, if I was developing a solution here, could I then take it through to that unit for level of knowledge and skills in a way that there are pathways forward in terms of maybe some of those advanced algorithm design approaches, but also in a way that is at a level of challenge that's appropriate to the students so that they've got an opportunity to demonstrate things that are not overly onerous.

For instance, the time complexity analysis that we expect of students. If the algorithms are going well beyond the complexity of what we would usually intend in the course, is that going to be appropriate for students? Are there essentially a naïve solution that the student can establish initially and then a pathway for improvement that your cohort of students will get traction on. So with respect to this problem, it's not important for us to sort of work that out in a precise way here, but they're the sorts of things I'd be thinking about with respect to this bit of stimulus. Anything you wanted to add for this one Greg?

**Gregory Breese** - No, I think we can talk about the second example now.

**Ivan Carlisle** - Sure. Thanks Phil.

**Gregory Breese** - So this example I think has been taken from one of the previous exams. So we've got Bernie is developing a mobile robot for a national park. The robot will travel through the park using existing paths and deposit animal food at feeding stations. Those feeding stations will be changed every season to match the movement of animals during the year. Bernie is currently designing the algorithm that the robot will use to select the most efficient path it should take to visit all of the feeding stations by minimising the distance it travels. And so what might this problem... What's appealing about this problem is that students are going to probably be able to recognise that they can model this using graph data structures, which is something they'll study quite a lot in Unit 3. And that for a small version of the problem, it's likely that they can probably apply some graph traversal or graph search type techniques in order to find a basic sort of result.

I guess something to be cautious with a problem like this, this to students who may be quite familiar with the Unit 4 content, it will be fairly evident to them that this is the travelling salesman problem and that they may be able to just sort of apply everything that they've learned about that directly. Even for some students will be familiar with that even earlier on in the year. And so if that's the case then you're perhaps limiting your ability to see how they adapt their solutions to the particularities of this context. All right.

And so you would need to think about how you could provide some more specific details about the problem so that they couldn't just give a really very generic TSP solution. Ivan, do you have anything to add?

**Ivan Carlisle** - I'll just mention, yeah, two things with respect to this. So whilst we've taken this particular question example from a past exam, obviously you wouldn't do that in developing your SATs. And the other thing here is, as I said with the previous slide, these are just kernels of an idea in terms of what you would present to your students. They need to be more fleshed out context than this. Some detail, constraints, information, concrete information for them to build data models on, all of those sorts of things that they can get their hooks into properly. Next slide. Thanks Phil. Do you want to begin with this one Greg, or?

**Gregory Breese** - Yeah. Yes. Yep. So this is a problem that I have used in previous SAT training sessions. So in this example, we have a tour guide company taking guided tours within a theme park. The park contains an artificial island, they're surrounded by moat and there's tourist attractions on both, both on the island and also on the park around the outside of the moat. The tourists' attractions have some varying appeal score with some being more attractive to the visitors than others.

There's a number of bridges that cross the moat to allow travel in either way. And we're going to divide the moat up into sections such that each section contains either a bridge or an attraction on one or both sides. And each traction you're given some sort of measure of its value to the tourists. We start at a bridge and the tour group will do a tour around the moat, either on the inside or the outside and stop at any attractions that they visit. As they do so, we've added this condition that they can only have up to two bridge crossings on their whole tour.

And so they'll sort of, they'll travel around and they'll travel around the inside for a bit and the outside for a bit, but they can't sort of go back and forward, back and forward taking only the most valuable attractions. And so I guess this is a problem that immediately sort of... you might recognise probably a dynamic programming approach where you're looking at the working around and what is the best cost that you can do at a particular position around in the tour being on the, either the inside or the outside of the moat, having made some number of crossings so far, it's well suited to that.

But this is certainly also a problem where they could apply a brute force search, some sort of graph traversal, a divide and conquer type approach. And there's a wide range, I guess, of algorithmic type strategies that students could apply here. I guess some cautions I would have reading through a problem like this is, am I giving students enough flexibility in how they model the information about the problem? So there's quite a lot of quite almost directive information around how the information will be presented to the students.

And so is there enough flexibility that students might actually have different data structures that their algorithms are working on? Because a feature of, I guess, really well suited problems will be that there are different ways that students may choose to model the information in the problem. Do you have anything to add to that Ivan?

**Ivan Carlisle** - No, I think that was well said. So Phil, next slide please.

Okay, so now we're going to launch into the criteria. We're first going to look at the criteria that relate to the Unit 3 part of the SAT, so Criteria 1-4. Next slide please Phil. This is just an overview that's in the documentation right at the start, which the idea is to, in a very succinct manner, just step you through the elements to consider for Unit 3 and how the outcomes, the observations and submissions and the criterion map together. It's useful just to give you a bit of orientation, I guess, on the task, but obviously when you're really getting into the detail of things, it's much more important to be looking at the other parts of the document and especially the criteria.

So essentially what we're wanting students to do in the Unit 3 part of the SAT is a teacher will provide the students with a real-world/applied problem context. The students are then to specify the problem in precise terms, so the algorithmic problem that they're focusing on solving. Identifying it's salient features and modelling it with abstract data types. Students are then to design an algorithmic solution to the problem. In the process of that, they'll consider various approaches, but they only need to design one solution. They'll communicate that solution formally as pseudocode and then they need to justify their solution just to the level that we expect in Unit 3, which as we talk about the criteria we'll make a bit more clear. Next slide. Thanks Phil.

So Criteria 1, so as I said a moment ago, they have been provided with a problem context by their teacher. And what we are looking at here is both the skills in specifying a problem and modelling its key features. So we've got three indicators that are being examined by this criterion so that a student specifies an algorithmic problem, the student explains the salient features of the real-world/applied problem and the student models the problem using ADTs.

So in terms of the sorts of things that you'd want to consider, I guess at this early part of the SAT is that students are engaging with the problem context that you've given them in a way that's appropriate to the knowledge and skills that are being studied in Unit 3. And I think it's very important that in checking students' work, you're sort of giving them a sense that they've understood what's expected of them in the SAT at this point and that they're not going off in a direction that is not congruent with the intent of the SAT. And so an early check-in with each student I think is really worthwhile here.

We want students obviously to be applying the algorithmic problem-solving process to an authentic problem sort of context. And they're still, I guess getting a sense of their algorithmic problem-solving process and for them to deviate far from what's intended from the SAT at this point is not helpful to them. In terms of assessing students against this criterion. When multiple indicators like this are encountered in a single criterion, the teacher should take a holistic approach to determining essentially the level of performance demonstrated by the student. Greg, did you want to weigh in on this criterion?

**Gregory Breese** - I think it'd be worth us going and unpacking some of those performance descriptors. I will just point out that the indicator, the first indicator specifies an algorithmic problem. Kind of also going back to some of the things we were talking about earlier. The problem the students are given doesn't necessarily need to be completely specified, or a well specified problem. It may be that there are some ambiguities that in fact the students need to navigate and make some decisions around very early on in their design process around for them what is going to be important about how they are going to approach this problem.

**Ivan Carlisle** - So if we start getting into these performance descriptors, I'll read from the last column that has the most fleshed out of those. So provides clear and precise specification of the algorithmic problem, suitably formulated from the real-world/applied problem context. So we have used the language here of the algorithmic problem and we want students to really distil from that problem context, that core sort of problem that lends to the algorithmic problem-solving approach and they're engaging with the context in a formal way.

And next, jumping into the second indicator, so identifies a comprehensive range of features of the real-world/applied problem and by considering their relevant characteristics, selects a suitable set of salient features to model. So the information that's given in the problem and how they've specified and focused it in for the algorithmic problem, there will be a number of features that students will be considering and weighing up and going through that process of abstraction to identify those features that are most salient.

And we want to have students communicate their thinking process around that. If you think about some of these criteria that we'll be talking about today, we're really interested in... with respect to a lot of these performance descriptors around the process of students... in many instances we're interested in the process that students are going through in working through to what ultimately their design is.

And so a student talking about the rejection of a feature of the problem and putting emphasis on another feature that is of particular importance to the algorithmic problem that they're honing in on, that sort of thinking we want students to make visible and that's what we are looking at when we're applying this particular indicator. Did you want to add anything yet Greg, or I'll keep going with the others. Okay.

So with the next one, it says, Models selected features of the problem using coherent and fit-for-purpose combinations of suitable ADTs. And I'll keep going, describes how features of the problem map to the data model, describes signature specifications for key operations of the data model. So a thoughtful problem context may lend itself to different approaches to be modelled by the ADTs examined in the course. And students might consider and have thoughtful judgements that they've made around their selection of what's an appropriate arrangement of ADTs to apply in modelling features of the problem. They should be explicitly mapping the model that they construct to the features of the problem.

This is something that, in assessments throughout the history of this course has been a very important point that we want students to be clearly connecting between the real-world problem context to that abstracted and modelled representation. Now, this last part of this indicator describes signatures for key operations of the data model. If you think about it, this is the formal communication of the particulars of abstract data type in the context of a model. And we've seen this as sort of a higher level of performance when students are formally describing these signatures. So you'll note that that appears in the High and the Very high, but not further down in the levels of performance for this particular indicator. Greg, anything to add?

**Gregory Breese** - What I might I guess build on there is just give a bit of an outline of the progression, some of the factors that each of these indicators build on as we progress from left to right, rather than sort of go through and read through each paragraph. But in terms of specifying an algorithmic problem, higher level responses will include, I guess, a more formal translation of the problem from a very context driven real-world problem into an algorithmic and abstracted algorithmic problem that they've sort of defined formally. And as they do so there's, I guess, increasing clarity and precision in how they've actually stated what is the actual problem they are tackling.

And then in terms of explaining the salient features of the problem, as we progress from left to right, we will see the students, I guess, use more discretion in terms of their choice of what variables in the problem are actually important for them to create a good solution. Their ability to consider a range of the features of the problem and to have shown, I guess judgement in their selection of what factors actually will be important to carry forward from the maybe more context heavy description into how they're going to actually capture data in terms of solving the algorithmic problem.

In terms of the modelling of the problem using abstract data types, we sort of will see as the students achieve higher levels of performance they are selecting data structures that are perhaps more appropriate to the data that they're working with, that they have really clearly identified how the data and the problem is being translated into the ADTs. And then at the highest levels they're also describing some signatures of some key operations that relate to the problem as it's being solved.

And so an example of that when we say key operations of the data model, a starting point there is, well, they've defined their algorithmic problem. Well, what are the inputs of their algorithmic problem and what are its outputs as a problem as a whole would be a really key example of what you might consider a key operation of their actual problem that they're solving. Did you have anything to add to that Ivan?

**Ivan Carlisle** - No, I'm happy to... Phil, if we could move to the next slide?

So this is just a point of advice and I've sort of mentioned it earlier I guess, but we want the SAT to be meaningful for students. They are new to applying that algorithmic problem-solving methodology and looking at how students are engaging with the SAT at the very earliest stages and making sure that they've understood the nature of the task and going in the right direction is I think important at the start for students to get as much out of this SAT as possible. Anything else you wanted to add Greg?

**Gregory Breese** - No, I think we're ready now that I'd be... If there's any questions as we go through the criteria here, just use the Q & A feature and we'll sort of just check in on that as we get to the end of each criteria. I think we can keep going to Criteria 2.

**Phil Feain** - Yeah, guys, there's no questions at this point. We're halfway through the session.

**Ivan Carlisle** - Great, thank you. So next slide. Thanks Phil. Okay, so our second criterion is skills in the design of an algorithm to solve a real-world/applied problem. We have two indicators here. So it considers suitable algorithmic approaches to the problem and describes the design of an algorithmic solution to the real-world/applied problem. So this first indicator, students should be taking time to investigate a number of algorithm design approaches in engaging with the problem and comparing and contrasting to make a judgement as to what approach that they want to take through to actually design. So it is not an expectation that students are fully designing multiple algorithm designs here. It's really that consideration process that they're going through. And this process is obviously helpful for them to really understand the ins and outs of the problem.

At the Very high level, the performance descriptor says Thoroughly compares the suitability of several algorithm design approaches to then determine the most appropriate approach. Again, we want students to really make their thinking visible. We really want them to comment on the suitability of approaches in contrast to others and that they end up appreciating this in relation to that algorithmic problem that they've specified. Did you want to add to that before I talk about second indicator, Greg?

**Gregory Breese** - I think the only thing I'd add is in terms of what to determine the most appropriate, so what sorts of features might be considered in what is appropriate and certainly in Unit 3, students are often going to be more likely to be considering things like, will the algorithm produce a good solution? Will it produce a correct solution? And a consideration maybe of the feasibility of the algorithm certainly is not necessarily going to be evident when the students are doing this first part of the SAT.

**Ivan Carlisle** - And the second indicator, the Very high performance descriptor says Clearly explains an algorithm that solves the specified problem and involves combinations or modifications of algorithms or algorithm design patterns. So here we want them to describe in detail the algorithm that they have sort of settled upon and that they have tailored to this problem context and that the algorithm is essentially non-trivial that takes into consideration the subtleties of the problem context and the... with all those sorts of considerations around combinations and/or modifications so that it's not just a direct pickup of a course algorithm and hopefully the problem context that's been provided allows for a more thoughtful development of an algorithm here that's a little bit more interesting.

**Gregory Breese** - Yeah, there's a real, I guess, room in this criteria for students to be rewarded for developing more complex solutions.

**Ivan Carlisle** - Okay, Phil, we might jump to the next slide. So just a couple of things to mention with respect to Criterion 2. While students are expected to consider multiple solutions, they are only expected to design one solution in the Unit 3 component of the SAT. Students may, for example, consider a greedy approach to a problem, but reject it on the basis that a greedy approach will not yield an optimal solution for a particular problem context, and instead opt for a brute force. That just gives a bit of an example of sorts of considerations that students maybe making, the sort of looking at the feasibility or efficiency of the algorithm is not the focus at this part of the SAT. That's something that students will be looking at explicitly in the Unit 4 part of the SAT. So this is an opportunity for any questions with respect to Criterion 2 and if there's no questions, let's move to Criterion 3.

**Phil Feain** - Yep, no questions at this stage.

**Ivan Carlisle** - Thank you. So Criterion 3: Skills in the communication of an algorithmic solution to the real-world/applied problem. Now, a formal communication of an algorithm is in pseudocode. The indicator here is communicates the algorithmic solution in pseudocode. And the performance descriptors here are really engaging with how students are able to basically communicate formally their algorithms and to draw up on those elements and structures and so on in their pseudocode, including things like iteration, conditionals, recursion and so on in a appropriate way and levels of sophistication where they can formally communicate their algorithms to this authentic real-world problem.

And you can see as the performance descriptors move from Very low to Very high, we're seeing that they're able to draw upon more sophisticated elements of algorithm construction. So at the highest levels we're seeing them make use of a more modular approach and functional abstractions and so on. Whereas the Very low, there's limited elements of the algorithm are expressed in pseudocode. So they've already got a partial communication of something rather than fully really realising out the proper expression of the algorithm.

But they're also having issues in terms of things like initialising variables and having the logic correct and so on. And so this is a real opportunity for students not to just describe their design but to communicate it very precisely and for teachers to forge an understanding that the students have that more sophisticated appreciation for the logic and structure and the working nature of the student's understanding of their design. Greg, did you want to add to that?

**Gregory Breese** - No.

**Ivan Carlisle** - So we'll jump to the next page. So formal communication of algorithmic solution in pseudocode is what is required here. Whilst some students may find it beneficial to experiment with their designs in a programming environment, implementing their solutions in code is not required of the SAT. So here the emphasis is very much on pseudocode. It may be that some students benefit from a bit of experimentation in a programming environment, but that's not the emphasis of the SAT. I don't think there's any questions for Criterion 3, so we might jump to Criterion 4.

**Phil Feain** - Yeah, no questions at all at this point.

**Ivan Carlisle** -Thank you. So Criterion 4 is the final criterion for the Unit 3 component of the SAT. The criterion is skills in the justification of an algorithmic solution to the real-world/applied problem. The indicator justifies a solution to the real-world/applied problem. Here, it really is the culmination of the Unit 3 part. They are only expected to justify the selection of the solution by clearly demonstrating the suitability coherence and fit for purpose nature of their solution, but appreciating that it's still essentially a naïve solution. They haven't been expected to consider efficiency and that's not what we want them to do here. We want them to consider, does the solution give a correct solution to the problem? Does it meet the requirements of the problem? All of those sorts of elements of what are being considered here. Whereas Unit 4, when we move into formal analysis and more advanced approaches, the feasibility is considered more formally. Greg, did you want to mention anything on this criterion?

**Gregory Breese** - Only it might be worth, I guess, mentioning that the student's responses that address the elements of this criteria may be separate or integrated with some of their considerations of the approaches that we spoke about back earlier in Criteria 2.

**Ivan Carlisle** - Absolutely. So it really is a criterion that forms a culmination of the Unit 3 component. And so yeah, there's going to be reflections on earlier parts of the process that they've gone through. Next slide. Thanks, Phil.

Students are not expected to consider the efficiency. So I mentioned that previously, but it's worth emphasising as we start readying ourselves for the Unit 4 elements. I don't think there's any questions at this time, so we'll jump to the next part.

**Phil Feain** - Yeah, no questions. If you do have any questions, feel free to ask by the way.

**Ivan Carlisle** - Thank you. So now at this point, Unit 3's complete the marks of all the assessment around Unit 3 have been done. Marks will be entered into VASS and so on. Now, we're moving onto the Unit 4 part. So this is Unit 4 Outcomes 1 and 2 that we're considering and it applies to Criteria 5-10. Next slide. Thanks, Phil.

As an overview of essentially what students are working through in this stage. So students determine the time complexity of their initial solution. So that's the solution that they designed in Unit 3. If a student wasn't able to develop a solution in Unit 3, it would be appropriate for a teacher to provide something like a brute force solution so they've got something to do the time complexity analysis of. Students explain the consequences of the time complexity of their initial solution.

So being a naïve solution, it's likely that this might show that their solution is not going to be feasible to the context. Students design an improved data model and algorithm combination. Students are assessed on the quality of their improved solution. Students determine the time complexity of their improved solution and then they compare the suitability of their solutions. And so you can see that Unit 4 Outcomes 1 and Unit 4 Outcome 2 are somewhat interwoven in this process where we're looking at time complexities and then improving our solutions and then further reviewing the time complexity and comparing. Next slide. Thanks, Phil.

So Criterion 5, skills in the determining of time complexity of algorithms. So here, those formal analysis knowledge and skills that students will have explored in their course are being applied to initially their solution from Unit 3. And at the very high level we can see analyses the time complexity of a sophisticated algorithm that involves functional abstraction and or recursion by identifying the time complexities of a broad range of pseudocode elements and logically combining these to produce a tight upper bound of the algorithm's time complexity.

I won't get into detail, but it's important to realise that some of the expectations around time complexity of analysis have changed in this version of the study design. And so care should be taken that the expectations from students here should align with the current study design. This criterion is one of note in the sense that it gets applied with respect to the student's work in terms of the analysis of their initial algorithm design, but also with respect to the analysis of their improved design.

And when teachers are formulating a judgement as to the performance demonstrated by the student, they should be looking at what students were able to do on balance between those two instances of formal analysis. We do want to see the working from students in terms of, it might be application of the Master Theorem or, depending on the nature of the algorithm, different ways of working out and you are looking at those sorts of points of evidence to form an appreciation as to the level of performance demonstrated by the student. Greg, anything you wanted to add here?

**Gregory Breese** - I think you've covered that pretty well.

**Ivan Carlisle** - Okay, thank you. Phil, next slide please. So I've mentioned this but just to reinforce, this criteria is applied to both the analysis of time complexity of the initial solution and the improved solution. So initially they apply it to that initial solution, then they go further into the project of developing an improved solution and they, we say subsequently analyse. Next slide. Thanks, Phil. You can jump to the next one straight away.

So Criteria 6 says understanding of the consequences of an algorithm's time complexity on its real-world application. So if you imagine that they've analysed the initial solution and determined the time complexity, that might show to a student that essentially they've developed a naïve solution that is not going to be sufficiently efficient for the demands of the problem context. And so what we want from students here is that they are able to show that they understand the implications of the solution being inefficient.

So the very high descriptor says, clearly and precisely explains the consequences of an algorithm's time complexity on its real-world application, including through a thorough discussion of practical input sizes and its suitability to the problem's requirements. And so students forming a meaningful insight at this point in the project really allows them to see the benefits of then coming up with an improved solution. And the nature of many of the problems that we consider these sorts of efficiency considerations are really meaningful and so we want students to authentically engage with this. Anything to add here, Greg?

**Gregory Breese** - No, I think we've covered that pretty well and this Criteria 5 and 6 really looking at Unit 4 in Outcome 1, you've got the time complex analysis and then well, what are the consequences of that for your use of an algorithm? And we see that those two as real core aspects of this outcome, I guess present in each of these criteria.

**Ivan Carlisle** - Next slide. Thanks, Phil. So given the selection of an appropriate problem context, the initial solutions designed by students will likely have issues of efficiency, they should be appreciating when tackling this part of the SAT. And so a thought for problem selection by the teacher, it should lead hopefully to a situation here where students have recognised that their initial approach has been limited and they need to take it further. I don't think there's any questions at this point, so we'll jump to Criterion 7.

So Criterion 7 is skills in the comparison of the time complexities of algorithmic solutions to a real-world problem. And so here our indicators compares whether the solutions will render the problem tractable and the real-world implications of this and compares the relative efficiencies of the solutions with regard to the constraints of the real-world/applied problem context.

Now, this criterion here, if you think back several slides when we first introduced the Unit 4 part of this SAT is really a criterion assessing students' conclusion of their project in a sense with respect to the comparative efficiency of their designs. And so the reason it's at Criterion 7 is because it relates to Unit 4 Outcome 1, but in terms of where it would feature likely in a student's work is this sort of final write up which will have elements that are assessed by Criterion 10 and 7. And so think about this as their concluding reflection on the efficiency of their solutions in comparison. And when we get to Criterion 10, I'll talk a little bit about the emphasis of Criterion 10 in that respect, but here students should really be showing that they've understood in a sophisticated way at the very high level the benefits of the process that they've gone through.

So I'll just read the performance descriptors at the very high level, a comprehensive comparison of whether the solutions would render the problem tractable and the thorough discussion of the relevant implications of this to their potential application to the problem and a precise and comprehensive comparison of the relative efficiency of the solutions with regard to their time complexities and the constraints of the real-world problem. So yeah, they should be able to compare the sort of the technical aspects of efficiency with respect to their formal analysis of their two designs, but they should also be relating that back to its implications to the problem context. Greg, anything you'd like to add here?

**Gregory Breese** - I guess only that this criteria gives you, I guess an opportunity for students to show, I guess some judgement around the level, just how meaningful is the degree of any improvement and a real opportunity for students to... They're really looking for more than just, one is faster than the other. It's got to be... Have some consideration as to whether or not the improvement would make a meaningful impact on the practical application of the algorithm or not.

**Ivan Carlisle** - Absolutely. Next slide. Thanks, Phil. So as I've mentioned, the evidence provided by students in relation to this criteria will likely feature in their concluding comparison interwoven with their evidence against Criterion 10. I think we'll jump straight to Criterion 8. Skills in the design of an improved data model and algorithm combination. So this criterion sits at Criterion 8 because it corresponds to Unit 4 outcome 2, and this is the first criterion that corresponds to Outcome 2. So describes the design of an improved algorithmic solution to the real-world/applied problem.

At the very high performance level it's designs an improved data model and algorithm combination utilising advanced algorithm design approaches and/or innovative combinations or modifications of algorithms. Succinctly and precisely describes the solution communicating the algorithm in pseudocode. So a couple of things to mention here, that notion of communicating in pseudocode for this particular design is only sitting at the high and very high level, whereas at Unit 3 we assess their communication in pseudocode as a distinct criterion. Here it's just with respect to their design, some degree of formal specification. Here, what they're doing is designing an improved solution. There's not the same degree of consideration of different approaches.

They're really looking at their initial solution, recognising that it is likely deficient in terms of its efficiency, identifying a way to improve it, which will likely follow from the Outcome 2 knowledge and skills, so the different algorithm design patterns and algorithms that are explored in Unit 4 Outcome 2 to, yeah, make some level of improvement. And there is a process element to this particular criterion. We want to see the thinking from students as they're formulating that design in contrast to Criterion 9, which we'll talk about in a moment. Greg, anything you'd like to add here?

**Gregory Breese** - I guess as you mentioned, Ivan, we're really just looking for one new design here and the students, I guess, they're expected to already be quite familiar with the problem by now and that is a factor in them being able... that we're really just looking for them to take that... They've already familiarised themself with the problem quite a bit already. Okay, so now go and design a better algorithm.

**Ivan Carlisle** - We'll jump to the next slide. Thanks, Phil. So the criterion focuses on assessing the application of the knowledge and skills involved in the process of designing an improved solution. And we'll jump straight to Criterion 9 now, Phil. So Criterion 9 is skills in advanced algorithmic problem-solving. Here what we are looking at is the quality of the improved solution. And this is quite a contrast from Criterion 8 where you know the student is going through that process of design. This is... they've communicated that new design and what you're doing here is looking at it in terms of, what is its quality, is it a real improvement, have they really locked onto a good solution here with respect to the problem.

So very high level of performance here is the improved solution exhibits considerable advantages over the initial solution with regard to its efficiency, coherence, and fitness for purpose. And obviously measured against the quality of the initial solution, it might be that a student actually provided a pretty good initial solution too. So you're thinking about the improvements made here with respect to those Unit 4 knowledge and skills and insights. And yeah, we felt that it's an important criterion to have to just really focus on that quality of the improved solution as opposed to separately the process of designing it. Anything to add here, Greg?

**Gregory Breese** - No, I think we've covered that pretty well.

**Ivan Carlisle** - Okay, Phil, to the next slide. The criterion focuses on assessing the quality of the improved solution that has been designed by the student. And no questions at this point, so we'll go straight to Criterion 10.

So Criterion 10 really wraps up the Unit 4 Outcome 2 part of the Unit 4 SAT component and focuses on skills in the comparison of algorithmic solutions in terms of their coherence and fitness for purpose. As I mentioned earlier when we talked about Criterion 7, the student work that is demonstrating their performance with respect to Criterion 10 is likely to be interwoven with what they demonstrate with respect to Criterion 7. But the emphasis is different here, we're looking at the algorithmic solutions in terms of their coherence and fitness for purpose.

Whereas Criterion 7, we're really looking around efficiency. So the very high performance descriptor here says comprehensively compares the algorithmic solutions based on their design features. Coherence and fitness as solutions to the real-world problem, including the thorough identification of their similarities and differences. And the students should be thinking about, does it solve the problem? Is it suitable against the practical problem context that's been considered. All of those things are what students are drawing out in this comparison. Greg, anything you'd like to add here?

**Gregory Breese** - No, I think we've covered that pretty well.

**Ivan Carlisle** - Very good. Okay, next slide. Thanks, Phil. So the evidence provided by students in relation to this criteria will likely feature in their concluding comparison, interwoven with Criterion 7. So re-emphasizing those points each time because we have written the criteria in such a way that they're very much associated with the Unit 4 Outcome 1 and Outcome 2 in those blocks. But obviously as they apply to how students journey through the Unit 4 part of the SAT, there's elements from Unit 1 and Unit 2 that happen at different stages. And so it's important just to draw attention to that. Next slide. Thanks, Phil. And the next one.

Okay, so now we're going to talk about authentication. Now SATs are an opportunity for students to engage with knowledge and skills from VCE courses in a way that is authentic and interesting for students. And that means they spend a lot of time on these tasks, that they are working on them in class and outside of class. They're not doing these tasks under test conditions and so on. And so teachers need to take the time to observe the development of a student's work throughout the SAT. And that careful observance of how students are thinking through the task and developing their work means that even if an issue arises in terms of them not making a final submission, teachers have evidence that they can draw upon for awarding performance where it's appropriate. Next slide. Thanks, Phil.

We'll sort of get into a little bit of information around the details of authentication. But it's just, I think really important to note that SATs are a different animal with respect to other sorts of assessments and they are really worthwhile for students and teachers need to be very considered in how we administer them so that they can be a really worthwhile opportunity for students, but that we can also authenticate. So this is required as part of the SAT process, must be completed by the teacher and the student at each observation and submission point. Should not be completed right at the end. Can be requested from the VCAA. And so as part of the SAT documentation, there's a record that must be completed for both Unit 3 and Unit 4.

And as students are working on these things from lesson to lesson, getting around to your students and checking in on them and completing this record is really quite important. And we've got quite a few... So we've got quite a few steps around this that are probably in number similar to the number of criteria. I just noticed a question around Criteria 7 and 9 switching and so on. What I mentioned earlier about that is the order of the criteria following in many respects the Unit 4 Outcome 1 and Unit 4 Outcome 2 in terms of how they sit in sequence. So they're grouped in that way and that's the rationale for the ordering. But in the document itself, that table at the start gives a sense of how the students journey through the task. Okay, we'll jump to the next slide. Thanks, Phil.

So here is that authentication template that needs to be completed with the teachers in conjunctions to students. And it explicitly says, what observations need to be undertaken and there's descriptors there. And the table at the start of this document give a very clear sense of when that should apply or be applied by teachers in the process of the assessment. So I won't read through the detail of this, but you can see they link pretty closely to the criterion and it should be something that's carefully carried out by the teacher and it is something that the VCAA can ask to see. Anything you wanted to add at this point, Greg?

**Gregory Breese** - I guess just to reemphasize the importance of doing this regularly. With these tasks, students will be doing work on the task, at times not under your direct supervision. And so having this audit trail of the student's work along the way is important for you forming your belief that the work that they submit at the end is their own work.

**Ivan Carlisle** - Next slide. Thanks, Phil. And so this is the same template but for the Unit 4 elements of the work and the observations here. Again, if you... there's a table at the start of the document that sort of clearly shows how the observations and the criterion and the stages of the project relate to each other. And for teachers who are just trying to get oriented on, I guess how students journey through this SAT, that table's meant to really give clarity there. So implore teachers to take a bit of time just to get perspective on that task, but the idea of how we've structured things is really so that students can apply authentically as possible that algorithmic problem-solving process and with respect to authentication here, so that as students are completing elements of that assessment, teachers can see how a student's thinking is developing and ensuring that what students are doing is their own work essentially. Next slide. Thanks, Phil.

So this is an opportunity for any questions on authentication. I think the only question that's come up so far is with respect to the ordering of the criterion, which I've tried to answer, but I would say that table very early in the document is probably the best thing I can refer a teacher to in that respect. Next slide. Thanks, Phil.

**Phil Feain** - Yeah, just before we go on, Ivan, I know this year there's been content in the media about AI and stuff like that and student work and et cetera. But the reason why we have very robust authentication procedures like we do for the SAT and also the SACs is so if teachers follow that, they're ensuring authentication of student work that should be enabling them to determine whether student work is their own. And that's why we also ask for students and teachers to both sign off on that work as they progress. Gives evidence, clear audit path, as Greg was saying for the student. But also too, sometimes students lose work before its due, yet the teacher has cited that work. It means that that student shouldn't be penalised either. So it gives advantage for both processes. Thank you. I'll move on.

**Ivan Carlisle** - Absolutely. Thank you.

**Gregory Breese** - One thing I might just mention on that authentication that maybe we didn't cover yet was just as students may be doing work on the SAT outside of class time, it is very important that they're given substantial time in class time to work on the SAT and that's also very important for your authentication because it gives you that time where you can actually observe what they're doing and it would certainly not be appropriate for the majority of the work to be being done outside of class time at all.

**Ivan Carlisle** - Absolutely. Next slide. Thanks, Phil. Getting into assessment. So as we mentioned earlier, the SAT as a Unit 3 part and a Unit 4 part and the assessment data associated with Unit 3 part needs to be inputted into VASS at the appropriate time for the Unit 3 marks. So this table here has the... is where you can capture the marks across the assessment as a whole, but those first several rows are going to form the Unit 3 component. Anything that anybody wants to add here? Okay. Next slide. Thanks, Phil.

Give yourself enough time for marking, consider a staged approach. So milestones, obviously that authentication process allows you to see how students' work is developing and obviously the breakup of Unit 3 and Unit 4 breaks it up a little bit as well. Consider VASS dates when organising your timeline. So Unit 3 Outcome 3. So Criteria 1-4, that's due Monday, 17th of July. And for Unit 4, the assessment data for that is due Wednesday, 1st of November. Onto the next slide. Thanks, Phil.

**Gregory Breese** - I just ... say a few things just on the marking. Can we go back to maybe actually the previous slide, Phil? So the criteria divided into bands 1-2, 3-4, 5-6, 7-8, 9-10. And these describe a progression that you will see in the student's work. And so it's worth us, I think talking about how you might go approaching scoring students either the low or high end of those bands. And so if you have students who are... You've assessed their work as being in the Very high band that you would look at, you then have room to be making some, perhaps some assessments of the student's work against both the criteria but also comparatively against one another in determining whether they may be awarded a 9 or a 10.

And so it would be appropriate for you to be awarding the better work a 10 and then the other work a 9. Both students may have scored a Very high, but this provides you with a way of differentiating the student's scores within that band.

**Ivan Carlisle** - Yep. And obviously similar at the low end and so on.

**Gregory Breese** - Looks similar across all the bands. And this provides you with a way of differentiating the student's work.

**Ivan Carlisle** - Jump two slides thanks Phil. So it doesn't look like there's question's against assessment. Jump to the next slide. So understanding of the SAT for Unit 3, Outcome 3 and Unit 4 Outcomes 1 and 2, and the SAT criteria and the 2023 Administrative information for School-based Assessment. Authentication assessment and marking is what we've been trying to do in this session today. Obviously, it's just one session in time and there's a lot of information to digest and there's things that as you are writing the SAT that you've got to think through quite carefully.

There's a lot of documentation on the VCAA pages that are there to assist with this process. And yeah, we really implore you to make use of those resources. And it is the first year with the new study design and this SAT. And so yeah, it's a year to really take the time to understand the intent and make it as worthwhile and rigorous and appropriate process for students as possible. Anything anybody'd like to add? No. Okay. Next slide. Thanks, Phil. I think this is you, Phil.

**Phil Feain** - Yeah, I was going to say, I think this is me. Do we have any final questions? It's a good time to ask before we wrap it up. Okay, well, I'll talk for a minute or so and then, then we'll wrap up. If we think of any questions in that time, it'd be worthwhile asking. But what I'd like to do is thank you for attending this session. If you have any details regarding Algorithmics or any questions, you can contact me here at these contact details on this slide. That's my phone number there and email address there.

I'd like to thank Ivan and Greg for a really good session tonight. These two were the key people involved in the writing of this study design and also the advantage of having it tonight is to give you the intent of the tasks and the criteria and explaining what you need to do. And that's a really important thing to get that sense of understanding behind the words and each criteria. So thank you, Greg. Thank you, Ivan. Much appreciated tonight. Have a great night, everyone. And all the best for 2023.

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