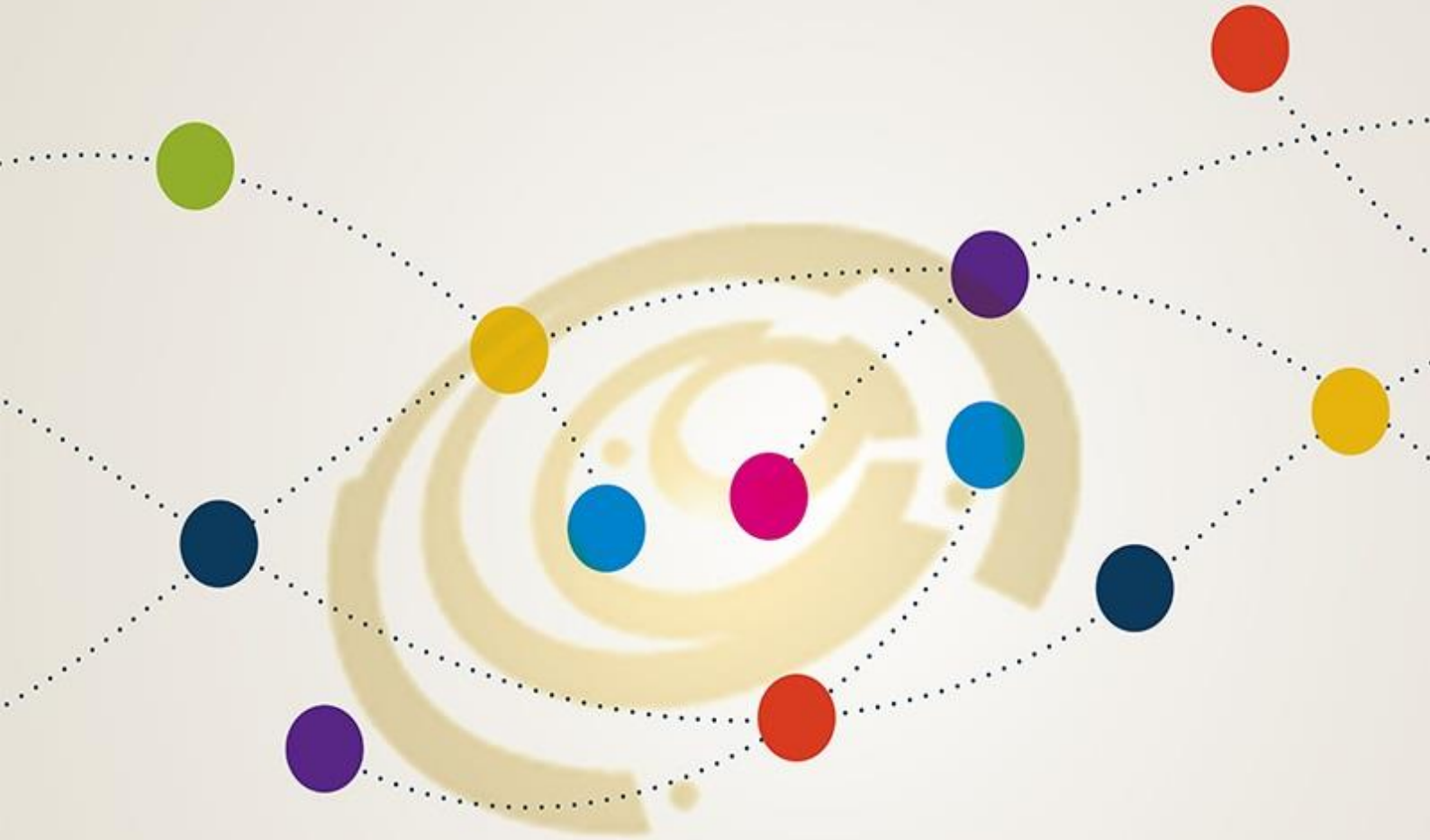


Junior Cycle Mathematics

Guidelines for the Classroom-Based Assessments and Assessment Task

First Edition

NCCA

September 2018

Contents

Introduction

This document, *Junior Cycle Mathematics: Guidelines for the Classroom-Based Assessments and Assessment Task* provides:

- general information on Classroom-Based Assessments
- detail of the nature and scope of the two Classroom-Based Assessments described in the curriculum specification for mathematics
- the Features of Quality used to decide the level of achievement in each Classroom-Based Assessment
- guidelines for schools, teachers and students on completing the Classroom-Based Assessments in mathematics
- details of the Assessment Task in mathematics and how the school supports its completion.

These guidelines should be used in conjunction with the curriculum specification for *Junior Cycle Mathematics* and the *Assessment Toolkit* for junior cycle, which includes further details of the subject learning and assessment review process and other aspects of junior cycle assessment set out in these guidelines.

All documentation can be accessed at http://www.curriculumonline.ie/Junior-cycle/Junior-Cycle-Subjects/Mathematics. An outline of assessment in junior cycle can be found in the *Framework for Junior Cycle 2015* which can be accessed at http://www.education.ie/en/Publications/Policy-Reports/Framework-for-Junior-Cycle-2015.pdf.

Classroom-Based Assessments: General Information

Classroom-Based Assessments (CBAs) are best described as the occasions when the teacher assesses the students using the specific tasks set out in the curriculum specification. They are completed within the time allocated for mathematics, which is a minimum of 240 hours. The Classroom-Based Assessments and the Features of Quality, which support teacher judgement, are set out in these guidelines.

Although the assessment is similar to the ongoing assessment that occurs every day in class, in the case of Classroom-Based Assessments, the teacher's judgement is recorded for Subject Learning and Assessment Review, and is used in the school's reporting to parents and students. Students prepare for the Classroom-Based Assessments over specified periods of time in second and third year. The results of other projects, homework, or tests undertaken by the students in the course of their normal classwork do not add up to the award of a descriptor for the Classroom-Based Assessment.

Deciding the level of achievement for the Classroom-Based Assessments

There are four level descriptors of achievement in each Classroom-Based Assessment: *Exceptional, Above expectations, In line with expectations*, and *Yet to meet expectations.* All work submitted is judged to fit one of these four descriptors.

Teachers use the Features of Quality, set out in these guidelines (p19 and 31), to decide the level of achievement in each Classroom-Based Assessment. The Features of Quality are the criteria used to assess the student work as best fitting one of the following Descriptors:

- **Exceptional** describes a piece of work that reflects the Features of Quality for the Classroom-Based Assessment to a very high standard. While not necessarily perfect, the strengths of the work far outstrip its flaws, which are minor. Suggestions for improvement are easily addressable by the student.
- **Above expectations** describes a piece of work that reflects the Features of Quality for the Classroom-Based Assessment very well. The student shows a clear understanding of how to complete each area of the task. Feedback from the teacher might point to the necessity to address some aspect of the work in need of further attention or polishing, but on the whole the work is of a high standard.

- **In line with expectations** describes a piece of work that reflects most of the Features of Quality for the Classroom-Based Assessment well. It shows a good understanding of the task in hand and is free from significant error. Feedback might point to areas needing further attention or correction, but the work is generally competent and accurate.

- **Yet to meet expectations** describes a piece of work that falls someway short of the demands of the Classroom-Based Assessment and its associated Features of Quality. Perhaps the student has made a good attempt, but the task has not been grasped clearly or is marred by significant lapses. Feedback will draw attention to fundamental shortcomings that need to be addressed.

When using the Features of Quality to assess the level of student achievement in a Classroom-Based Assessment, teachers use 'on-balance' judgement. The teacher should read the Features of Quality (starting with *Yet to meet expectations*) until they reach a descriptor that best describes the work being assessed. While it should be noted that none of the descriptors imply faultless achievement, evidence of work for the award of Exceptional should closely match the criteria for that level within the Features of Quality. Where it is not clearly evident which quality descriptor should apply, teachers must come to a judgment based on the evidence from the student's work, to select the descriptor that best matches the student's work overall. This 'best fit' approach allows teachers to select the descriptor that 'on balance' describes the work being assessed.

Teachers should not assume that the results of a group of students being assessed will follow any particular distribution pattern, as the students' work is being judged only against the Features of Quality rather than other students' performances.

Teacher judgements about the quality of student work, with the aim of arriving at a shared understanding of standards and expectations, are supported by annotated examples of student work published on curriculum online https://www.curriculumonline.ie/Junior-cycle/Junior-Cycle-Subjects/Mathematics; by the features of quality in these guidelines; and by collaboration and discussion with colleagues during Subject Learning and Assessment Review meetings.

The autonomy of the school in preparing students for the Classroom-Based Assessments

These guidelines set out a range of options for the Classroom-Based Assessments so that they can suit the particular needs and circumstances of students and the school. Students and teachers have a choice of topics and formats for both the Mathematical and Statistical investigations. A variety of possibilities are presented as to how the mathematical investigation can be conducted, the nature of the investigation itself and the role the teacher plays in facilitating the students' Mathematical investigation. Similarly, when completing the second Classroom-Based Assessment, students are encouraged to use a variety of support materials and to present their work in a variety of formats. Within the parameters set by these guidelines, the range of themes and topics for the assessments can be determined independently by the school, teachers and students.

How the school supports the completion of the assessments.

The school supports the completion of the assessments by:

- ensuring that the NCCA *Guidelines for the Classroom-Based Assessments and Assessment Task* are provided to teachers
- supporting teachers in recording the level Descriptors awarded to each student
- retaining records and pieces of work, as appropriate, for the purposes of Subject Learning and Assessment Review
- applying the guidelines for Subject Learning and Assessment Review
- supporting teachers and students in the completion of the Assessment Task
- following arrangements for transfer of the completed Assessment Tasks to the State Examinations Commission for marking
- applying inclusive assessment practices and ensuring accessibility of assessment for all students
- reporting the outcomes of Classroom-Based Assessments to students and their parents/guardians as part of the school's on-going reporting procedures and through the Junior Cycle Profile of Achievement (JCPA).

To facilitate providing feedback to students during their engagement with assessment, the process of completing the Classroom-Based Assessment should be viewed as part of teaching and learning, and not solely for assessment purposes. It is envisaged that teachers will guide, support and supervise throughout the process.

Support may include

- clarifying the requirements of the task
- using annotated examples of student work to clarify the meaning and interpretation of the Features of Quality to students
- providing instructions at strategic intervals to facilitate the timely completion of the assessments

providing supports for students with special educational needs (SEN)

Note that only work which is the student's own can be accepted for assessment in the JCPA.

Inclusive assessment practice

Schools facilitate inclusive assessment practices whether as part of ongoing assessment or Classroom-Based Assessments. Where a school judges that a student has a specific physical or learning difficulty, reasonable supports may be put in place to remove, as far as possible, the impact of the disability on the student's performance in Classroom-Based Assessments. These supports e.g. the support provided by a special needs assistant or the support of assistive technologies, should be in line with the arrangements the school has put in place to support the student's learning throughout the school year.

Classroom-Based Assessments in Mathematics

There are two Classroom-Based Assessments in Mathematics. They are assessed at a Common Level. They relate to specified learning outcomes and link to important aspects of the development of students' mathematics knowledge, understanding, skills, and values. Both Classroom-Based Assessments relate to

> *priorities for learning and teaching in mathematics, with a particular emphasis on problem solving and communicating.*
>
> *(Specification for Junior Cycle Mathematics, p22)*

They are scheduled to be undertaken by students in a defined time period within class contact time to a national timetable (as advised by the NCCA) in the school calendar. Following the second of these assessments students will complete an Assessment Task which is marked by the State Examinations Commission as part of the state-certified examination in Mathematics. The Classroom-Based Assessments for mathematics and indicative timings are outlined in Table 1 below.

Table 1: Classroom-Based Assessments: Mathematics

Classroom-Based Assessments	Format	Student preparation	Completed
Mathematical investigation	A report may be presented in a wide range of formats	A student will, over a three-week period[1], follow the Problem-solving cycle to investigate a mathematical problem. **Problem-solving cycle:** define a problem; decompose it into manageable parts and/or simplify it using appropriate assumptions; translate the problem to mathematics if necessary; engage with the problem and solve it if possible; interpret any findings in the context of the original problem.	Towards the end of Year Two
Statistical Investigation	A report may be presented in a wide range of formats	A student will, over a three-week period follow the Statistical enquiry cycle. **Statistical enquiry cycle:** formulate a question; plan and collect unbiased, representative data; organise and manage the data; explore and analyse the data using appropriate displays and numerical summaries and answer the original question giving reasons based on the analysis section.	Year Three

[1] The date range during which it is advised the three-week period for the Mathematical investigation should be allocated, will be published separately in a Key Dates document each year.

Assessment Task

The Assessment Task is a written task completed by students during class time. It is not marked by the class teacher but is sent to the State Examinations Commission for marking as part of the state-certified examination in Mathematics. The Assessment Task is specified by the NCCA and is related to the learning outcomes on which the second Classroom-Based Assessment is based. In the case of mathematics, this is the Statistical Investigation. The details of the Assessment Task are outlined in Table 2 below.

Table 2: The Assessment Task: Mathematics

Format	Student preparation	Completed
Students complete a specified written task which is sent to the SEC for marking.	The Assessment Task will link to the Statistical Investigation.	Following completion of the second Classroom-Based Assessment in Year Three.

Classroom-Based Assessment 1:

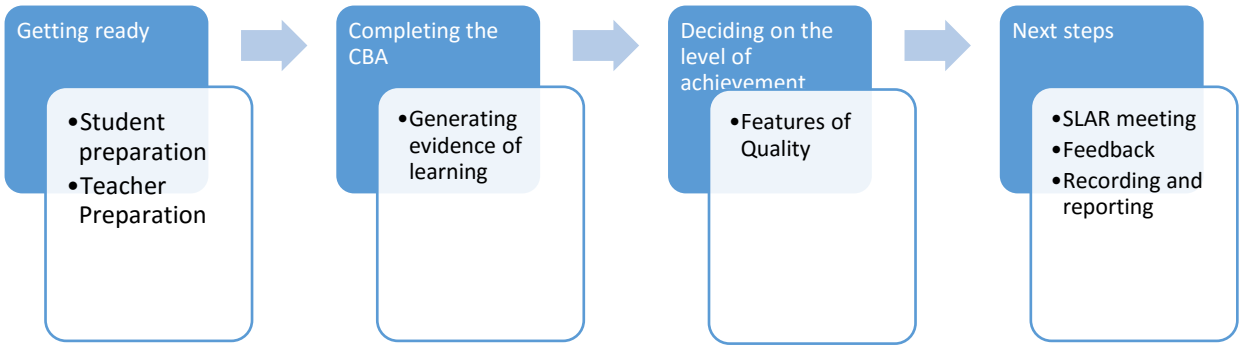
Mathematical Investigation

The Mathematical Investigation (MI) gives students an opportunity to research a question they have about some phenomena of interest from the world around them or that they have come across in the course of their mathematical studies or their studies in other subjects. The development of inquiry, collaborative, practical, recording and reporting skills will be central here, such as posing questions and mathematising situations, working with others, designing experiments, conducting experiments, sourcing, generating and recording data, processing and analysing the data to make valid conclusions, and communicating the method used, data recorded, findings, and reflections on the investigation.

The Mathematical Investigation comprises of four areas of activity: *defining the problem statement, finding a strategy and translating it to mathematics (if necessary), engaging with the problem and solving it if possible, and interpreting the solution in the context of the original problem*. Students may collaborate with peers at various stages during the process and then compile a report of their findings individually.

Under normal circumstances each student/group should work on a different investigation.

Figure 1: Process for conducting CBA 1



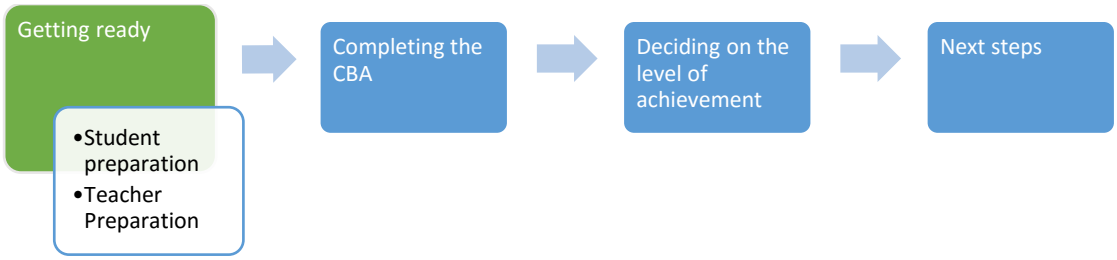
The Mathematical Investigation promotes student engagement through:

- Choice about the topic on which to focus
- Choice about communication formats
- The possibilities for student collaboration.

The learning outcomes assessed will, to an extent, depend on the topic chosen and the medium in which the work is presented. Some that may be particularly interesting are:

Unifying Strand	
Building blocks	U.1 recall and demonstrate understanding of the fundamental concepts and procedures that underpin each strand U.2 apply the procedures associated with each strand accurately, effectively, and appropriately
Representation	U.4 represent a mathematical situation in a variety of different ways, including: numerically, algebraically, graphically, physically, in words; and to interpret, analyse, and compare such representations
Connections	U.5 make connections within and between strands U.6 make connections between mathematics and the real world
Problem Solving	U.7 make sense of a given problem, and if necessary mathematise a situation U.8 apply their knowledge and skills to solve a problem, including decomposing it into manageable parts and/or simplifying it using appropriate assumptions U.9 interpret their solution to a problem in terms of the original question U.10 evaluate different possible solutions to a problem, including evaluating the reasonableness of the solutions, and exploring possible improvements and/or limitations of the solutions (if any)
Generalisation and Proof	U.11 generate general mathematical statements or conjectures based on specific instances U.12 generate and evaluate mathematical arguments and proofs
Communication	U.13 communicate mathematics effectively: justify their reasoning, interpret their results, explain their conclusions, and use the language and notation of mathematics to express mathematical ideas precisely

Getting ready



Student preparation

Students should have developed sufficient knowledge, skills and understanding over the course of first and second year to undertake a Mathematical Investigation. As part of ongoing teaching, learning and assessment of the learning outcomes for Junior Cycle Mathematics, students should have opportunities to develop problem solving skills as they realise various learning outcomes across strands, as appropriate, including asking questions about the world around them, decomposing problems into manageable parts, simplifying problems using appropriate assumptions, mathematising situations where necessary and interpreting the solution to problems in context. As students' progress through junior cycle, they should be encouraged to identify questions within mathematics and from other subjects or the world around them that they want to know more about. While the Classroom-Based Assessment is summative, it is envisaged that throughout junior cycle, formative assessment by teachers, the students themselves and their peers is used to allow students, teachers and parents to aid their development and track their progress. From an early stage, through their engagement with rich task based learning experiences, students should be familiar with the problem-solving cycle. This is best achieved when students use success criteria for ongoing assessments throughout first, second and third year. At an appropriate moment in their learning, students should be familiarised with the Features of Quality which will be used to judge the quality of their Mathematical Investigation.

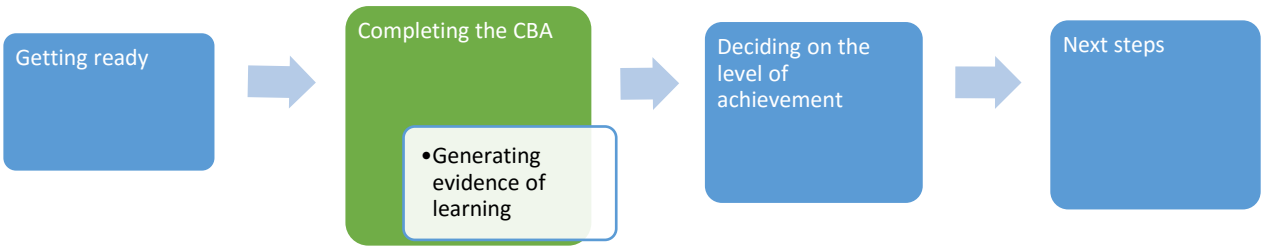
Teacher preparation

It is important to set the times and dates for implementation as early as possible. The key date to establish at the outset is the timing of the *Subject Learning and Assessment Review* meeting from the range of dates provided by the NCCA. In setting this date the school will be guided by its own local circumstances bearing in mind that the Mathematical investigation assessment must be completed by the end of Year Two. Once the school has decided on this date the teachers and students can plan for the completion of the Mathematical Investigation. The timing of the process may vary from school to school provided it is completed within the specified time period.

In order to become familiar with the assessment of the Mathematical Investigation, it will be helpful to:

- Review the Junior Cycle Mathematics specification and the Assessment Toolkit
- Discuss the assessment of the Mathematical Investigation with your colleagues and plan any teaching and revision that may be required.
- Download and view annotated examples of MIs (which will be made available on www.curriculumonline.ie in Spring 2019).

Completing the Mathematical Investigation



Over the course of three weeks, students will engage in activities that belong to 4 distinct stages of the problem-solving process. These activities contribute to the generation of their evidence of learning and achievement in the Mathematical Investigation

A. Defining the problem statement

B. Finding a strategy or translating the problem to mathematics

C. Engaging with the mathematics to solve the problem

D. Interpreting and reporting

It is not intended to present the stages as a rigid and linear process. For some problems it may not be possible to simply move through them consecutively to produce an answer. It may be the case that students move backwards and forwards between the stages and the activities may be revisited at different times as students complete the investigation.

A. Defining the Problem Statement

For this part of the investigation students may work individually or in small groups. Each student must contribute to the work of the group.

Students can decide to choose a problem from within mathematics or seek to answer a question or shed some light on a phenomenon from another subject or the world around them.

Once a student has decided the problem they would like to investigate, they will need to *define the problem.* This process of understanding and exploring the problem requires not only knowing what they want to find but also the key pieces of information that need to be put together to obtain a solution to the problem.

Problems that involve a phenomenon from the world around them or *a real-world problem,* are often open-ended, that means there is an opportunity for creative problem-solving and interpretation. Students will need to build a mathematical representation of the phenomenon in order to gain a better understanding of it or to predict future behaviour. Real world problems may be broad and

complex and during this stage of the problem-solving process students refine their idea; the goal being a concise problem statement that indicates exactly what the output of their mathematical representation will be. To do this they will need to do some research and brainstorming to decide what are the main factors influencing the phenomenon and what factors can be quantified. They may also find it necessary to make certain assumptions that help to simplify the problem and sharpen the focus.

B. Finding a strategy or translating the problem to mathematics

Once students have a problem statement clearly defined they are ready to embark on planning a solution strategy. Now they draw on prior learning making connections within mathematics, with mathematics and other subjects or with mathematics and the world around them. During this phase of strategising they interpret what is needed to solve the problem so that they can determine how to find the answer. Sometimes this involves the interpretation or analysis of an essentially nonmathematical scenario. In this case students' strategies may involve simplifying the problem by making an initial set of assumptions which leaves them ready to *translate the problem to mathematics* by defining the details of their mathematical representation. To do this they must study the scenario to determine what the important factors or variables are, interpret these mathematically, and develop a representation. They then use the representation they devise to analyse the problem situation mathematically, draw conclusions, and assess them for reasonableness of the solution.

C. Engaging with the mathematics to solve the problem

Once students have decided on a strategy or an initial mathematical representation of the phenomenon they can use a mathematical technique to get a solution to the problem.

Note: Multiple approaches can be taken to build a solution and the approach can often depend on their mathematical competence at this stage in their learning. Students should therefore be encouraged to work on their own for this stage of the problem-solving process.

Teachers should encourage students to look into their personal toolkit for a mathematical technique to use. They should remind students that sometimes if they start with an incorrect approach, a better approach will naturally emerge. The following questions can be used by teachers to support students through this stage of the process

- Have you seen this type of problem before?
- If so, how did you solve it? If not, how is this problem different?

- Do you have a single unknown, or is this a problem with lots of variables that may depend on each other?
- Is the representation linear or non-linear?
- Are there any digital tools you could use to help?
- Would a graph or other visual representation help provide insight?
- Is your mathematical representation too complicated? How about you look again at your assumptions and try to simplify it
- Can you hold some values constant and allow others to vary to see what is going on?

D. Interpreting and reporting

Students may work individually or in groups to reflect on their work. They should be encouraged to critically discuss and record various aspects of their investigation, such as the design of the experiment and possible improvements, the limitations of their data, any possible theoretical or practical implications of their findings, and further related investigations that they might conduct and why.

Students must work individually to compile the report of their investigation, using the information/data they have recorded in their research throughout the investigation.

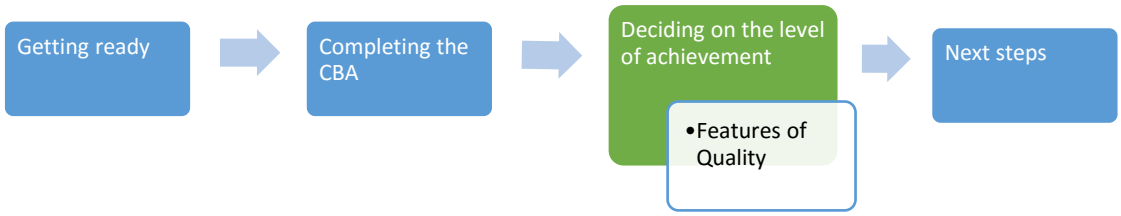
Evidence of learning

The following evidence is required:

- A report
- Student research records.

Students will report their research and findings in a format of their choice. The report can be completed at the end of the investigation. If a typed or hand-written report is the format of their choice, the total length of the report would typically be in the 400-600 words range (excluding tables, graphs, reference list and research records), but this should not be regarded as a rigid requirement. MIs may be effectively presented in other formats, but care must be taken that all the work can be judged on the final product alone. For example, a poster presentation may allow students to show that they can select and present highlights of their investigation, but it may be prudent to include a short, written report to communicate any work related to the solution that is not represented on the poster. When planning the content of their report, students should be familiar with the Features of Quality used to judge the level of achievement of their work.

Deciding on the level of achievement



Features of Quality

Key Features of Quality[2] in support of student and teacher judgement for the Mathematical Investigation are described here. The Features of Quality are the criteria used to assess the student work as best fitting one of the four Descriptors. Before using the Features of Quality below it may be helpful to review the information on:

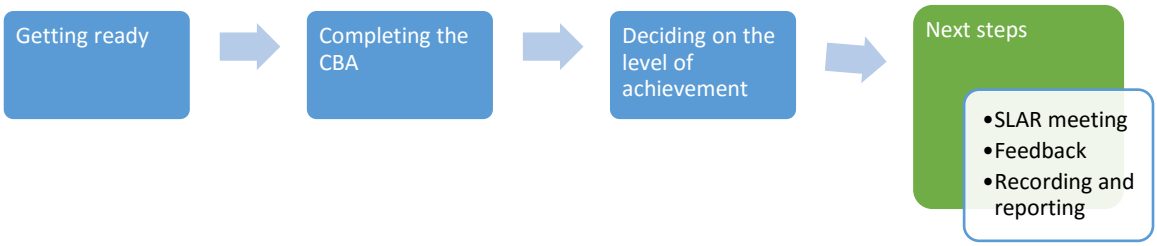
- Making 'on-balance' judgements (page 7)
- Inclusive assessment (page 9).

[2] These Features of Quality are Draft and will be revised following their use with authentic pieces of student work. The revised FOQs will be published in the second edition of this document in Spring 2019

Features of Quality for the Mathematical Investigation	
Exceptional	
Defining the Problem Statement	▪ Poses a concise problem statement and clarifies and simplifies the problem by making justified assumptions, where appropriate
Finding a strategy or translating the problem to mathematics	▪ Develops an efficient justified strategy and evaluates progress towards a solution, conjectures relationship between variables where appropriate
Engaging with the mathematics to solve the problem	▪ Mathematical procedures are followed with a high level of precision, and a justified answer is achieved; solution/observations are generalised and extended to other situations where appropriate
Interpreting and reporting	▪ Deductive arguments used and precise mathematical language and symbolic notation used to consolidate mathematical thinking and justify decisions and solutions; strengths and/ or weaknesses in the mathematical representation/ solution strategy are identified
Above expectations	
	▪ Poses a problem statement and clarifies/simplifies the problem by making assumptions, where appropriate
	▪ Justifies the use of a suitable strategy to engage with the problem and identifies any relevant variables
	▪ Suitable mathematical procedures are followed, and accurate mathematical language, symbolic notation and visual representations are used; attempts are made to generalise patterns in the solution/observation
	▪ Checks reasonableness of solution and revisits assumptions/ strategy to iterate the process, if necessary, uses formal mathematical language to communicate ideas and identifies what worked well and what could be improved

In line with expectations
▪ With limited guidance poses a problem statement, breaks the problem down into manageable steps and simplifies the problem by making assumptions, if appropriate
▪ Chooses an appropriate strategy to engage with the problem
▪ Records observations/data systematically and follows suitable mathematical procedures with minor errors; graphs and/or diagrams/ words are used to provide insights into the problem and/or solution
▪ Assesses the reasonableness of the solution and makes a concrete connection to the original question, uses everyday familiar language to communicate ideas
Yet to meet expectations
▪ Uses a given problem statement and with guidance breaks the problem down into steps
▪ Uses a given strategy
▪ Records observations/data and follows some basic mathematical procedures
▪ Comments on any solution

Next steps



Subject Learning and Assessment Review meeting

Shared understandings of standards within junior cycle will arise through professional discussion in Subject Learning and Assessment Review (SLAR) meetings where staff bring their own examples of student work and compare their judgements with other colleagues and with annotated examples of student work provided by the NCCA. Over time, this process will help develop a greater understanding of standards and ensure consistency of judgement about student performance.

Samples of Mathematical Investigations by students will be gathered for discussion at Subject Learning and Assessment Review meetings. In preparation for the Subject Learning and Assessment Review meeting, each teacher will identify one example of students' work for each descriptor, where feasible, and will have these available for discussion at the meeting.

Further details on managing the Subject Learning and Assessment Review process can be accessed in the Appendix at at https://www.ncca.ie/en/junior-cycle/assessment-and-reporting/slar-meetings

Recording and Reporting CBA results

Following the Subject Learning and Assessment Review each individual teacher re-considers the judgement they made of their student's work based on the outcomes of the meeting and where necessary makes the appropriate adjustments to the level of achievement awarded to the work. A record of final descriptors awarded is kept by the class teacher and is shared with the SLAR facilitator, to be used in reporting progress and achievement to parents and students as part of the school's ongoing reporting procedures and through the Junior Cycle Profile of Achievement (JCPA).

Where it arises that a student does not submit any work for the Classroom-Based Assessment, a descriptor cannot be awarded, as there is no work to discuss against the Features of Quality. In such cases, 'Not reported' should be selected when inputting results for the JCPA. Further information in relation to reporting Classroom-Based Assessment descriptors for the JCPA is available from the DES at the following link https://www.education.ie/en/Schools-Colleges/Services/Returns/Post-Primary-Online-Database-P-POD-Project/

Using Feedback

Providing effective feedback is a crucial step in using the Mathematical Investigation to support learning in mathematics. Students will be informed of the Descriptor they have been awarded once the SLAR meeting has taken place and its outcomes have been processed. However, effective feedback goes beyond the naming of the Descriptor awarded. Feedback on the strengths of the student's work, and on areas for improvement can be used to support their future learning. Further information on the use of feedback can be found at https://www.ncca.ie/en/junior-cycle/assessment-and-reporting/focus-on-learning

Querying a result

Queries in relation to the Descriptors awarded for the Classroom-Based Assessments, where they arise, will be dealt with by the school.

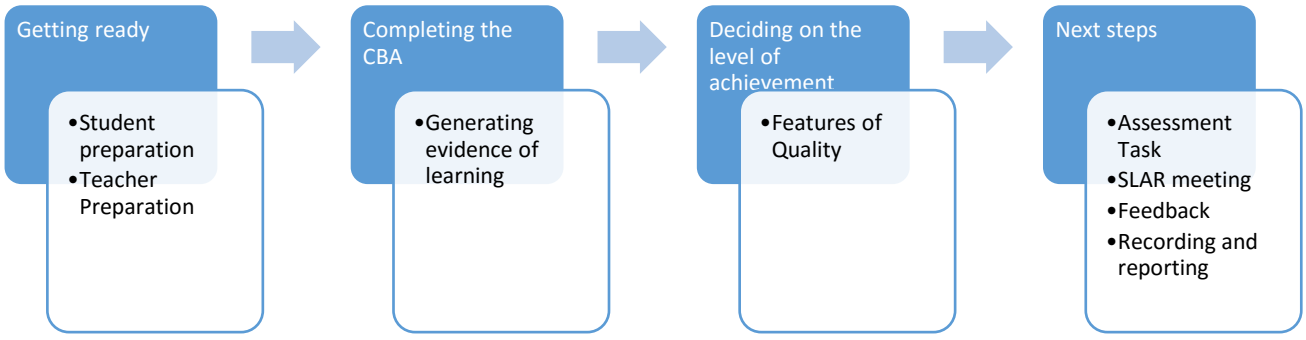
Classroom-Based Assessment 2: Statistical Investigation

The Statistical Investigation (SI) gives students an opportunity to carry out an investigation that involves varying data. This data may be related to work they have encountered in other subjects or to a question they have about some quantitative phenomena of interest from the world around them. As with CBA 1 the development of inquiry, collaborative, practical, recording and reporting skills will be central. The SI provides an opportunity to display evidence of the development of skills such as posing questions, working with others, designing studies (experiments, surveys or observational studies), conducting studies, generating and recording primary data, processing and analysing the data, dealing with variability in data, making valid conclusions, interpreting conclusions in context and communicating findings to others.

This time students follow the statistical enquiry cycle and the SI comprises four areas of activity associated with each stage of the cycle: *designing the investigation*, *identifying the variables of interest and choosing reliable, valid measurement methods for gathering data on each variable, gathering, organising and managing the data, analysing and interpreting the data in the context of the original question*. It is encouraged, but not required, that students collaborate with classmates, except where it is indicated that students must work on their own. Students compile a report of their findings individually.

Under normal circumstances each student/group should work on a different investigation.

Figure 2: Process for conducting the SI



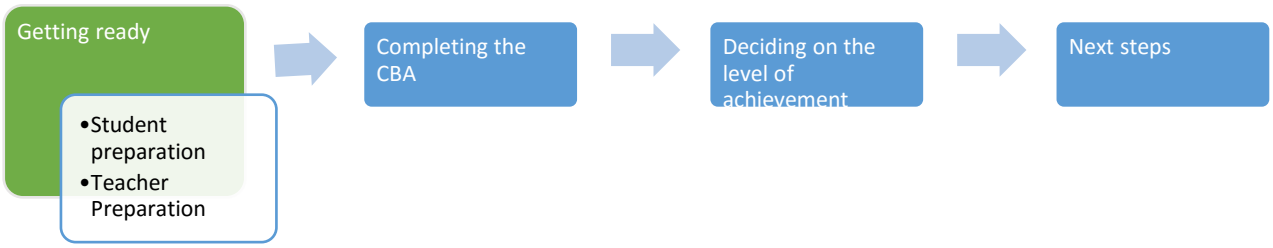
Statistical Investigations promote student engagement through:

- Choice about the question on which to focus
- Choice about the analysis method
- Choice about reporting/communication formats

The learning outcomes assessed will, to an extent, depend on the topic chosen and the medium in which the work is presented. Some that may be particularly interesting are:

Statistics and Probability Strand	
SP3	Carry out a statistical investigation which includes the ability to a. generate a statistical question b. plan and implement a method to generate and/or source unbiased, representative data d. select, draw and interpret appropriate graphical displays of data e. select, calculate and interpret appropriate summary statistics to describe aspects of data. h. discuss the assumptions and limitations of conclusions drawn from sample data or graphical/numerical summaries of data
Unifying Strand	
Problem Solving	U.7 make sense of a given problem, and if necessary mathematise a situation U.8 apply their knowledge and skills to solve a problem, including decomposing it into manageable parts and/or simplifying it using appropriate assumptions U.9 interpret their solution to a problem in terms of the original question U.10 evaluate different possible solutions to a problem, including evaluating the reasonableness of the solutions, and exploring possible improvements and/or limitations of the solutions (if any)
Communication	U.13 communicate mathematics effectively: justify their reasoning, interpret their results, explain their conclusions, and use the language and notation of mathematics to express mathematical ideas precisely

Getting ready



Student preparation

Students should have developed sufficient knowledge, skills and understanding over the course of their studies to-date to undertake an SI in the middle of third year. As part of ongoing teaching, learning and assessment of the learning outcomes for Junior Cycle Mathematics, students should have opportunities to develop statistical enquiry skills, including skills to report on and evaluate information as they realise various learning outcomes. While the Classroom-Based Assessment is summative, it is envisaged that, throughout junior cycle, formative assessment is used to allow students, teachers and parents to aid students' development and track their progress.

From an early stage, students should be familiar with and learn/understand how to conduct statistical investigations. This is best achieved when students use success criteria for ongoing assessments throughout first, second and third year. At an appropriate moment in their learning, students should be familiarised with the Features of Quality which will be used to judge the quality of their Statistical Investigation.

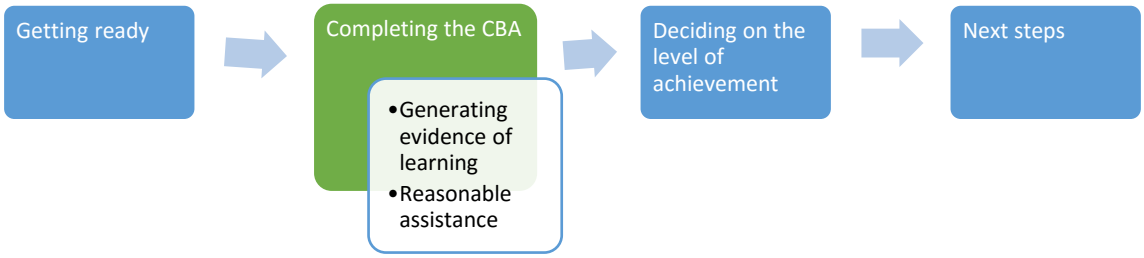
Teacher preparation

The key date to establish at the outset is the timing of the *Subject Learning and Assessment Review* meeting for the SI. In setting this date the school will be guided by its own local circumstances bearing in mind that the SI assessment must be completed during a defined period in Term One of Year Three. Once the school has decided on this date the teachers and students can plan for the completion of the SI. The timing of the process may vary from school to school but within national timelines.

In order to become familiar with the assessment of the SI, it will be helpful to:

- Review Junior Cycle Mathematics specification and the Assessment Toolkit.
- Discuss the assessment of the SI with your colleagues and plan any teaching and revision that may be required.
- Download and view annotated examples of SIs (which will be made available on www.curriculumonline.ie in Autumn 2019)

Completing the Statistical Investigation



Over the course of three weeks, students will be engaged in four activities that contribute to the generation of their evidence of learning and achievement in the Statistical Investigation:

A. Designing the investigation which involves formulating a statistical question and planning to collect unbiased, representative data which controls for potential confounding variables using one of the three approaches; surveys, designed experiments or observational studies.

B. Identifying the variables of interest and choosing reliable, valid measurement methods for gathering data on each variable.

C. Organising and managing the data gathered which involves summarising the data graphically and/or numerically.

D. Analysing and interpreting the summaries in the context of the original question highlighting any limitations of the study.

A. Designing the investigation

For this part of the investigation students may work individually or in small groups. Each student must contribute to the work of the group.

Once students have decided on a topic of interest to them they begin to formulate the statistics question. Statistical questions specify populations and measurements of interest and anticipate answers based on data that vary. Students should clearly identify which collection method is appropriate for their investigation.

By third year students' sophistication in data collection and analysis should extend to the need for representative sampling and adequate sample size. Statistical questions should be designed in an unbiased manner so as not to narrow potential responses. Students should display an awareness of the importance of avoiding bias, by making efforts to ensure sampling is representative and

confounding variables i.e. unmeasured variables that may influence the results of the study, are controlled.

Ideally students should also be familiar with appropriate use of technology to sort and display data.

B. Identifying the variables of interest

Once students have decided on a question, they then need to decide on appropriate variables, for example, age, gender or hours spent on homework, to answer the question. The choice of attribute leads to choices of measures for that attribute, for example if measuring exercise students could use both time in minutes and exercise intensity using a 1-10 scale.

C. Organising and managing the data

Note: Multiple approaches can be taken to displaying and describing data, the approach can often depend on students' mathematical competence at this stage in their learning. Students should therefore be encouraged to work on their own for this stage of the statistical problem-solving process.

Once data is gathered students should endeavour to find patterns or relationships in their data sets by summarising their data both numerically and graphically. They may use a variety of graphical displays such as stem and leaf plots, histograms, bar charts, etc. They should also summarise the data collected numerically using measures of centrality and spread such as mean, median or mode and range.

D. Analysing and interpreting the summaries in the context of the original question

Finally, students should analyse the data by comparing distributions visually using multiple graph types. They should use informal inference to look for differences between distributions, for example, the median of one group is higher than that of the other. Students should choose the most appropriate data display to report their findings and draw conclusions from the data related to their investigative question. They should recognise that all findings from the analysis of samples must be interpreted with uncertainty and be cautious when generalising the results to the population.

Students must work individually to compile the report of their investigation, using the information/data they have recorded in their research throughout the investigation.

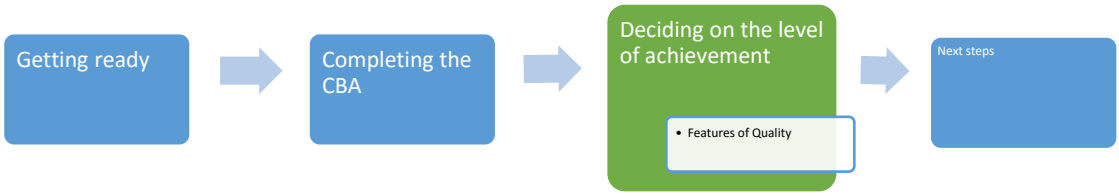
Evidence of learning

The following evidence is required:

- A report
- Student research records.

Students will report their research and findings in a format of their choice. The report can be completed at the end of the investigation or at the end of each main area of activity as outlined above. If a typed or hand-written report is the format of their choice, the total length of a written report would typically be in the 650-800 words range (excluding reference list and research notes), but this should not be regarded as a rigid requirement. SIs may be effectively presented in other formats (e.g. posters, podcasts, or multimedia), but care must be taken that all the research can be judged on the final product alone. For example, a poster presentation may allow students to show that they can select and present highlights of their research, but it may be prudent to include a written report of approximately 400 words to convey the deeper research underpinning it. Depending on the chosen format, some reports may involve fewer words, but nonetheless they will present all the research and findings using other media. When planning the content of their report, students should be familiar with the Features of Quality used to judge the level of achievement which will be awarded to their work.

Deciding on the level of achievement



Features of Quality

Key Features of Quality[3] in support of student and teacher judgement for the Statistical Investigation are described here. The Features of Quality are the criteria used to assess the student work as best fitting one of the four Descriptors. Before using the Features of Quality below it may be helpful to review the information on:

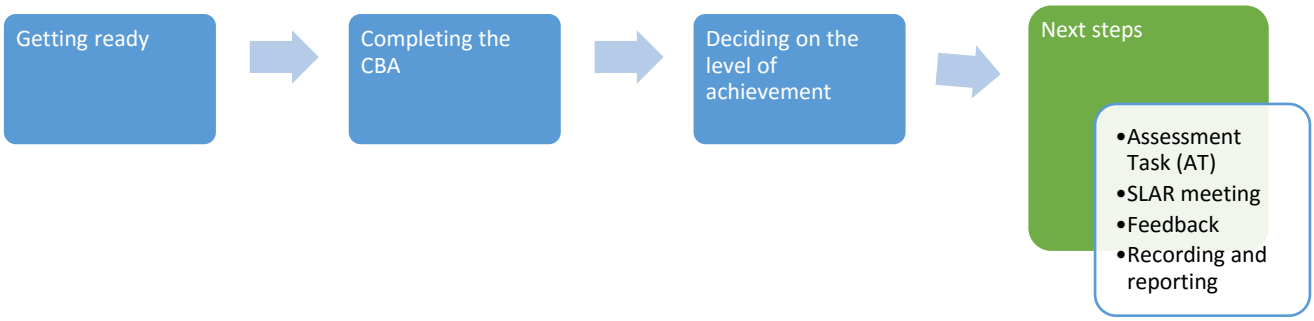
- Making 'on-balance' judgements (page 7)
- Inclusive Assessment (page 9).

[3] These Features of Quality are Draft and will be revised following their use with authentic pieces of student work. The revised FOQs will be published in the second edition of this document in Spring 2020.

Features of Quality for the Statistical Investigation	
Exceptional	
Designing the investigation	▪ Poses a question that anticipates variability and seeks generalization, study design will produce as far as practical reliable and valid results by taking into account variability and confounding variables
Identifying the variables of interest	▪ Describes relationship between the variables and describes considerations related to reliability and fairness
Organising and managing the data	▪ Use distributions to analyse the data and justifies measures of centre used to describe the data
Analysing and interpreting data summaries	▪ Interprets the data in relation to the original question; conclusion displays understanding of the limitations of generalising to the population and considers the need to reformulate the original question in light of the findings
Above expectations	
	▪ Poses a question that anticipates variability and seeks generalisation; data collection plan shows awareness of how variability affects the validity and reliability of the findings
	▪ Chosen measuring strategy will provide valid and reliable data
	▪ Uses appropriate data displays and describes the data in terms of measures of centre and spread
	▪ Reports the findings and the conclusion refers to the original question and attempts to look beyond the data

In line with expectations
▪ Poses a question that anticipates variability and plans to collect/source the type of data appropriate for the question posed
▪ Identifies variables and develops a measuring strategy for measuring the dependent and independent variable
▪ Displays data in a way that allows patterns to be identified, identifies patterns and describes the data in terms of those patterns
▪ Makes a concrete connection to the original question of the investigation but does not look beyond the data
Yet to meet expectations
▪ Uses given statistics question and collection method
▪ Gathers and displays data
▪ Makes statements about the data displayed
▪ No concrete connection back to the original question

Next steps



The Assessment Task

Students undertake a written Assessment Task to be submitted to the State Examinations Commission for marking as part of the state-certified examination for Mathematics. The Assessment Task will be allocated 10% of the marks used to determine the grade awarded by the SEC.

The Assessment Task is directly related to the nature and focus of the second Classroom-Based Assessment the Statistical Investigation, which is *to pose a question, gather and analyse data and interpret it in the context of the original question*. The knowledge and skills developed by students during this Classroom-Based Assessment emerge from their growing awareness of *statistical inquiry*.

The Assessment Task will comprise of **some or all** of the following:

- Engagement with a short stimulus in written, audio, audio-visual or multi-modal format in preparation for the written task
- A written task that tests the students in:
    - their ability to engage critically in a balanced review of a statistical investigation: evaluation of the design, the selection of variables, validity of the measurement methods, the organisation of data, the analysis and interpretation of summaries of the data and the limitations of the investigation
    - their ability to apply their learning from the statistical investigation to unseen contexts and data
    - their capacity to reflect on the skills they have developed

The Assessment Task is offered at a Common Level and the questions posed will take into account the broad cohort of students taking the assessment. Including the experience of the stimulus material, the Assessment Task takes approximately a double class period or two single class periods (i.e. a minimum of 80 minutes) to complete. The student response is written into a pro-forma booklet and the school

forwards the completed student booklets for the Assessment Task in accordance with arrangements set out by the SEC.

The Assessment Task for Mathematics will be undertaken following the completion of the Classroom-Based Assessment. Schools will have some flexibility in choosing the 2 class periods for completion, with a window of one week being identified during which the Assessment Task must be undertaken by students.

Where a student is absent for the completion of all or part of the Assessment Task, schools should make local arrangements in the school to allow the student to complete the task as close as possible to the timeframe scheduled for completion.

The mark awarded for the Assessment Task will be aggregated by the SEC with the mark awarded for the examination to determine the overall grade awarded by the SEC.

Subject Learning and Assessment Review meeting

Shared understanding of standards within junior cycle will arise through professional discussion in Subject Learning and Assessment Review meetings where staff bring their own examples of student work and compare their judgements with other colleagues and with annotated examples of student work provided by the NCCA. Over time, this process will help develop a greater understanding of standards and ensure consistency of judgement about student performance.

Samples of Statistical Investigations by students will be gathered for discussion at the Subject Learning and Assessment Review meetings. In preparation for the Subject Learning and Assessment Review meeting, each teacher will identify one example of students' work for each descriptor, where feasible, and will have these available for discussion at the meeting.

Further details on managing the Subject Learning and Assessment Review process can be accessed in the appendix and at https://www.ncca.ie/en/junior-cycle/assessment-and-reporting/slar-meetings

Recording and Reporting CBA results

Following the Subject Learning and Assessment Review each individual teacher re-considers the judgement they made of their student's work based on the outcomes of the meeting and where necessary makes the appropriate adjustments to the level of achievement awarded to the work. A record of final descriptor awarded is kept by the class teacher and is shared with the SLAR facilitator, to be used in reporting progress and achievement to parents and students as part of the school's ongoing reporting procedures and through the Junior Cycle Profile of Achievement (JCPA).

Where it arises that a student does not submit any work for the Classroom-Based Assessment, a descriptor cannot be awarded, as there is no work to discuss against the Features of Quality. In such cases, 'Not reported' should be selected when inputting results for the JCPA. Further information in relation to reporting Classroom-Based Assessment descriptors for the JCPA is available from the DES at the following link https://www.education.ie/en/Schools-Colleges/Services/Returns/Post-Primary-Online-Database-P-POD-Project/

Using Feedback

Providing effective feedback is a crucial step in using the SI to support learning in mathematics. Students will be informed of the Descriptor they have been awarded once the SLAR meeting has taken place and its outcomes have been processed. However, effective feedback goes beyond the naming of the Descriptor awarded. Feedback on the strengths of the student's work, and on areas for improvement can be used to support their future learning. Further information on the use of feedback can be found at https://www.ncca.ie/en/junior-cycle/assessment-and-reporting/focus-on-learning

Querying a result

Queries in relation to the Descriptors awarded for the Classroom-Based Assessments, where they arise, will be dealt with by the school.

Appendix 1

Mapping the Unifying strand to the Problem-solving cycle.

Stage in the Problem Solving Cycle	Learning outcomes Students should be able to ……
Define the problem statement	U.5 make connections within and between strands U.6 make connections between mathematics and the real world U.7 make sense of a given problem and if necessary mathematise a situation U.8 apply their knowledge and skills to solve a problem, including decomposing it into manageable parts and/or simplifying it using appropriate assumptions U.12 generate and evaluate mathematical arguments and proofs
Finding a strategy or translating the problem to mathematics	U.7 make sense of a given problem and if necessary mathematise a situation U.8 apply their knowledge and skills to solve a problem, including decomposing it into manageable parts and/or simplifying it using appropriate assumptions U.4 represent a mathematical situation in a variety of different ways, including: numerically, algebraically, graphically, physically, in words; and to interpret, analyse, and compare such representations U.13communicate mathematics effectively: justify their reasoning, interpret their results, explain their conclusions, and use the language and notation of mathematics to express mathematical ideas precisely
Engaging with the mathematics to solve the problem	U.1 recall and demonstrate understanding of the fundamental concepts and procedures that underpin each strand U.2 apply the procedures associated with each strand accurately, effectively, and appropriately U.4represent a mathematical situation in a variety of different ways, including: numerically, algebraically, graphically, physically, in words; and to interpret, analyse, and compare such representations U.11 generate general mathematical statements or conjectures based on specific instances

Interpreting and reporting	U.9 interpret their solution to a problem in terms of the original question U.12 generate and evaluate mathematical arguments and proofs U.13communicate mathematics effectively: justify their reasoning, interpret their results, explain their conclusions, and use the language and notation of mathematics to express mathematical ideas precisely

Appendix 2

Evaluating the suitability of a topic for investigation for the Classroom -Based Assessments

Sample Topic CBA 1: Planning a trip for visiting relations	
Is this topic course-related, an issue of personal interest, or one with local relevance?	This topic could incorporate mathematics from each of the strands and is possibly an issue of personal interest.
Can you define a precise problem statement related to this topic?	Yes there are many problem statements that could emerge from this topic.
Can you define a statistical question that can be answered by collecting data and where there will be variability in that data?	Yes there are aspects of this topic that lend themselves to the development of a statistical question and subsequent investigation.
Do students have autonomy over the solution strategy they can use to solve the problem?	Yes it allows students to use tools and prior knowledge, including concepts from many strands and other subjects, to make decisions and justify those decisions. Students may use multiple methods to come to a conclusion and multiple representations to demonstrate and justify their thinking.
Conclusion This is a suitable topic to choose as a basis for a CBA	

Appendix 3

Supporting formative assessment during an application

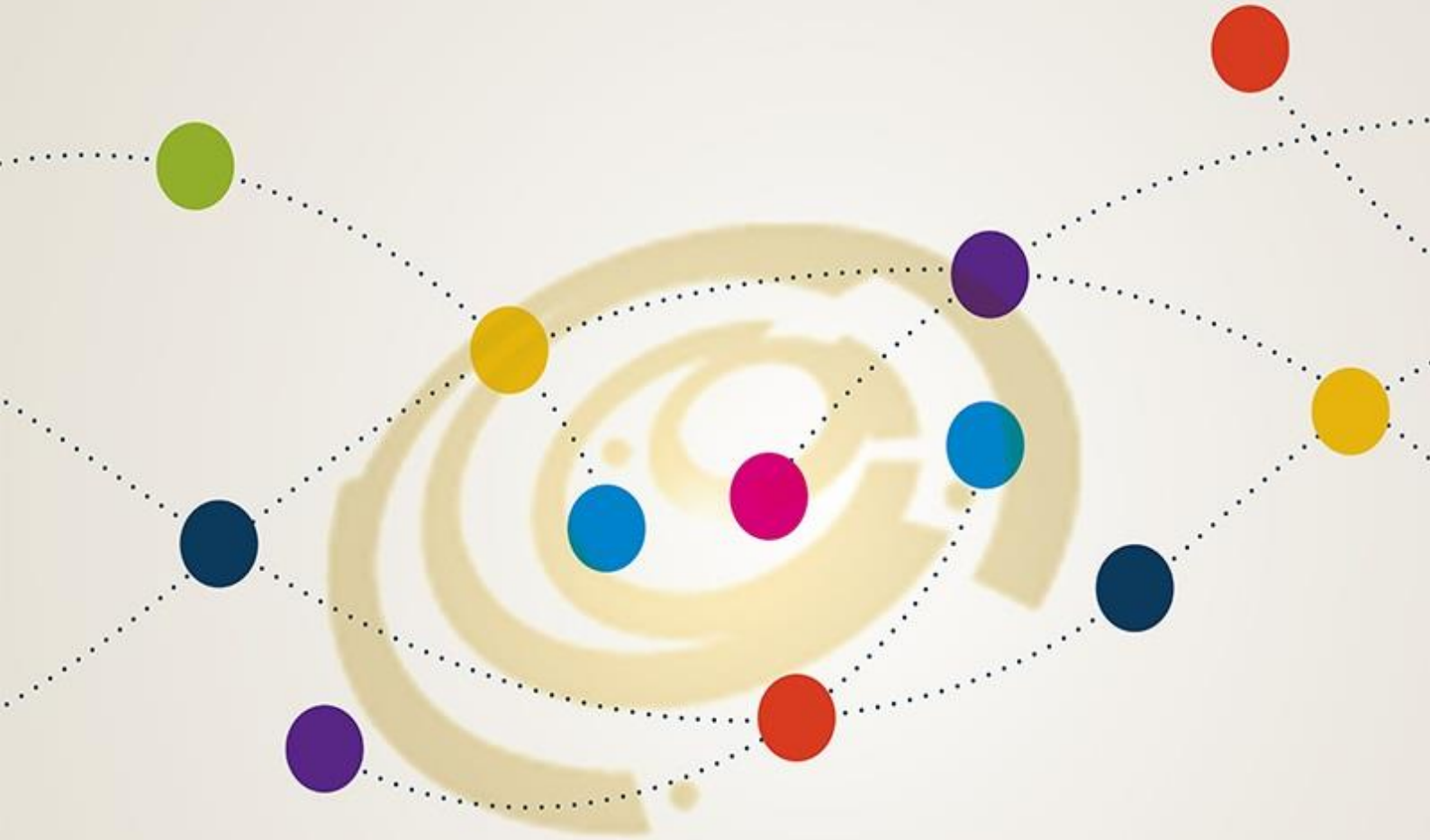
Mathematical investigation CBA- 1

Area of Activity	Questions to focus on during formative feedback	Vocabulary to build
Defining the problem	What is the big problem that you are trying to investigate/solve? Does it have more than one possible answer?	Open-ended problem Constraints
Defining the problem	What is the specific problem your mathematical representation is going to investigate/solve? What elements are you going to focus on during your investigation?	Specific, focus
Translating to Mathematics (if necessary)	What ideas did you think about that you decided not to try?	Eliminate, prioritise
Translating to Mathematics (if necessary)	What have you assumed in order to investigate/solve the problem? Why did you make these choices?	Assumptions
Translating to Mathematics (if necessary)	What quantities are important? Which ones change and which ones stay the same?	Variables
Engaging with the problem and solving it if possible	Where did you find the numbers that you used?	Research
Engaging with the problem and solving it if possible	What pictures, diagrams or graphs might help people understand your information, mathematical representation and results?	Diagrams, graphs tables
Engaging with the problem and solving it if possible	What mathematical ideas did you use to describe the situation and solve your problem?	Mathematical ideas
Interpreting the solution	How do you know that your calculations are correct? Did you remember to use units €, cm etc ?	Calculation, unit
Interpreting the solution	When does your mathematical representation work? When do you need to be careful because it might not?	Limitations
Interpreting the solution	How do you know that you have a good useful mathematical representation? Why does your representation make sense?	Testing, validation
Interpreting the solution	Could you do anything to make your mathematical representation better or more accurate?	Improvement, iteration
Communicating /Reporting results	Explain your representation in words and mathematical notation	Mathematical notation
Communicating /Reporting results	How did each of your teammates help?	Collaboration
Communicating /Reporting results	What are the most important things for your audience to understand about your mathematical representation and/or solution?	Audience

Appendix 4

Supporting formative assessment during the Statistical investigation CBA- 2

Area of Activity	Questions to focus on during formative feedback	Vocabulary to build
Formulating a statistics question	Does the question anticipate an answer that varies? Might different people answer the question differently? Does your question look to generalise to beyond your sample?	Variability Statistics question
Formulating a statistics question	Does the question specify the population you will be gathering the data from? Does the question specify the measurements you will be making?	Populations Measurements
Gathering unbiased representative data	Is the sample big enough to capture variability? Have you controlled for confounding variables?	Sampling Sample size
Gathering unbiased representative data	How do you know that the sample is representative of the full population? How do you know that the data you will gather is not biased?	Sampling techniques
Identifying the variables	What quantities are important? Which ones change and which ones stay the same?	Variables
Identifying the variables	How will you gather data on each variable? Will the methods you'll use give valid data? Will the data be reliable?	Measurement Valid, reliable
Organising and managing data	What pictures, diagrams or graphs might help people understand your information? Do the pictures diagrams or graphs adequately show the variability in the data?	Diagrams, graphs tables
Organising and managing data	Can you describe your data using numbers? Have you identified which summary measure is most appropriate (mean/mode/median) Have you quantified the variability in the data	Data Summaries
Interpreting the data	When does your conclusion hold up? When do you need to be careful about what you can conclude?	Limitations
Interpreting the solution	Could you do anything to make your statistical investigation better or more accurate?	Improvement, iteration
Communicating /Reporting results	How did each of your teammates help?	Collaboration
Communicating /Reporting results	What are the most important things for your audience to understand about your statistical investigation?	Audience



NCCA