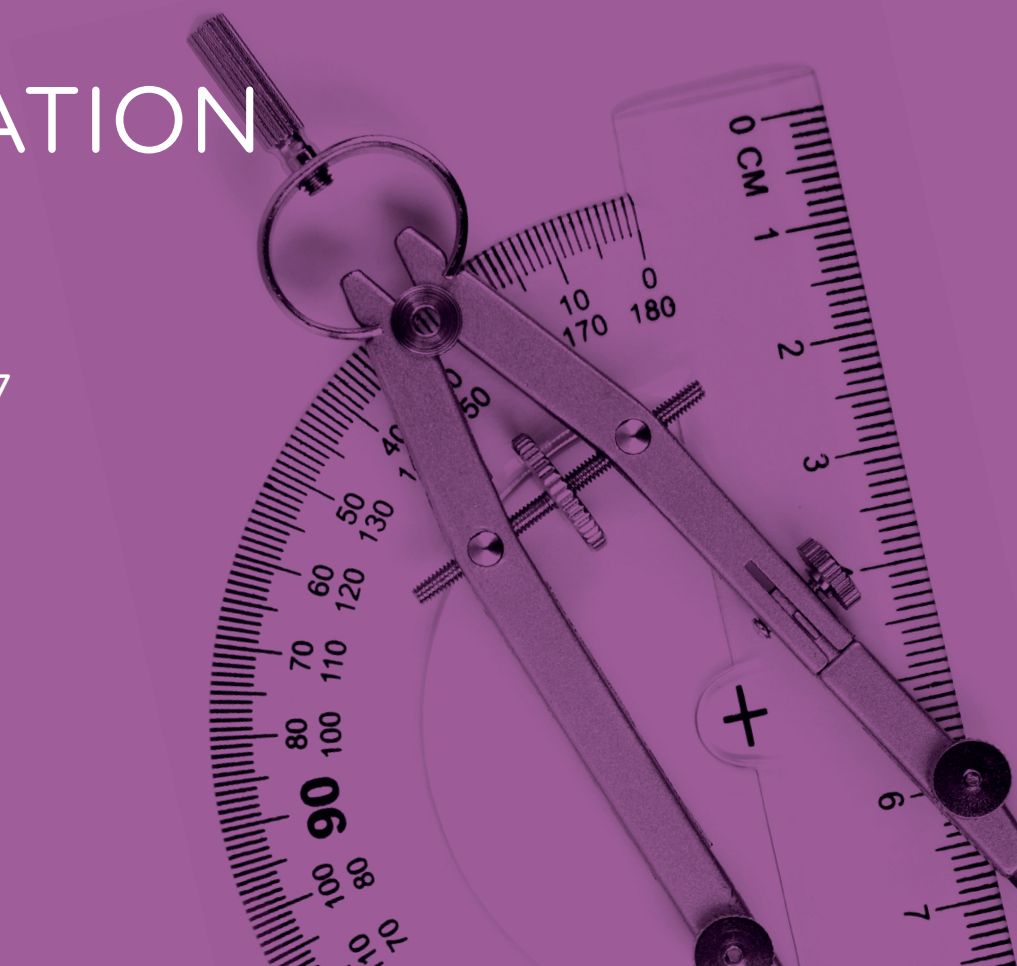
LEVEL 3

WJEC Level 3 Certificate in

STATISTICAL PROBLEM SOLVING USING SOFTWARE

SPECIFICATION

Teaching from 2015
For award from 2017



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1 INTRODUCTION

1.1 Qualification Title and Code

This specification covers the following qualification:

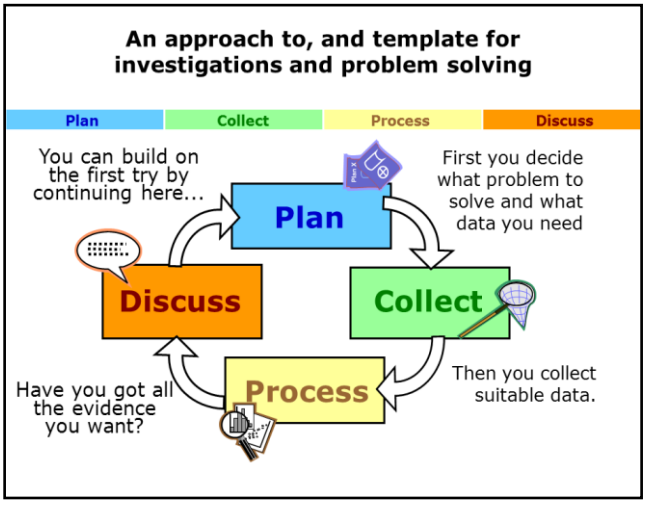
601/4546/8	WJEC Level 3 Vocational Certificate in Statistical Problem Solving using Software

1.2 Statement of purpose

The WJEC Level 3 Vocational Certificate in Statistical Problem using Software is an Applied General qualification.

In 2013, a report by the Royal Statistical Society and Institute and Faculty of Actuaries observed that data on an unprecedented scale impacts on every aspect of everyday life. In academic disciplines where statistics was once a marginal, they claim it is now central and a core consideration.

The objective of this qualification is to assist the understanding of the problem-solving cycle of planning, collecting, processing and discussing in meaningful contexts and to use statistical software to process real data sets. It has been specifically designed to be taught in schools and colleges to equip learners aged 16-19 with a broad range of skills empowering them to successfully negotiate statistical problems in Higher Education or the world of work.



The Problem Solving Approach - resource from the Royal Statistical Society Centre for Statistical Education, Plymouth University

Learners who follow this qualification will study one unit. Assessment is via a controlled assessment and an external examination which will give them opportunity to:

- use the problem solving cycle to solve problems
- use statistical software to process real data sets
- interpret and analyse statistical output
- develop the skills of project-based research, development and presentation

This qualification was originally developed in collaboration with colleagues from Mathematics in Education and Industry (MEI) and the Royal Statistical Society Centre for Education (RSSCSE) based at Plymouth University.

This new programme answers many of the issues raised in three pivotal reports –

- The Advisory Committee on Mathematics Education (ACME) report 'Mathematical Needs: Mathematics in the workplace and in higher education' in June 2011,
- The Royal Statistical Society and The Actuarial Profession's report 'The Future of Statistics in our Schools and Colleges' published in January 2012
- The Royal Statistical Society and Institute and Faculty of Actuaries' report 'A world full of data. Statistics opportunities across A-level subjects' published in October 2013

Progression

This WJEC Level 3 Vocational Certificate in Statistical Problem Solving Using Software has been designed to support learners as they progress from Key Stage 4 and GCSE learning on to other higher level qualifications. This qualification can be studied alongside other academic or vocational qualifications supporting progression from any study at level 2.

There are no previous learning requirements for this specification. Any requirements set for entry to a course based on this specification are at the school/college's discretion.

This specification builds on subject content which is typically taught at Key Stage 4, in particular GCSEs in Mathematics and/or Statistics. Learners will be taken beyond the descriptive use of statistics at GCSE, so that they will be able to use statistics to aid decision-making across numerous disciplines including humanities, psychology, sociology, sciences and business at level 3. It will also prepare those learners that wish to progress to Higher Education to study for qualifications which have embedded quantitative/statistical elements.

The qualification also supports adult learners with an interest in the subject, or those currently working within a role where statistical analysis is required.

Employability

The qualification furnishes learners with good statistical skills as well as hands-on experience using real data sets related to a subject they may be studying or a job which they are interested in.

Examples of occupations that offer opportunities for suitability qualified individuals include: Actuary, Forensic statistician, Environmental statistician, Government statistician, Medical statistician, Pharmaceutical statistician, Market research statistician, Sports statistician, School teacher, University lecturer and Statistical consultant.

2 QUALIFICATION STRUCTURE

WJEC Level 3 Certificate in Statistical Problem Solving using Software

The qualification structure comprises two components and is summarised in the table below.

Unit Title	Mandatory/ Optional	Assessment (Internal/ External)	GLH
Statistical Problem Solving using Software	Mandatory	Internal	180
	Mandatory	External	

Learners must complete both the internally assessed and externally assessed components to achieve the WJEC Level 3 Certificate in Statistical Problem Solving using Software.
The internal assessment is synoptic for the **whole** qualification.

3 ASSESSMENT

Learners who follow this qualification will study one unit.
Assessment is a combination of internal and external assessment components.
The relative weighting of the internal and external components is shown in the table below.

Assessment (Internal/External)	**%**
Internal	60
External	40

3.1 External assessment

Details of the external assessment component are as follows:

- 1 hour time-tabled examination;
- Total of 35 marks;
- The learning outcomes and assessment criteria listed in the table below will be assessed in the written examination;
- Each assessment criteria listed in the table below will be assessed in each series;

	Assessment Criteria	Marks	%
LO1	**AC1.1** Formulate a statistical investigation	**14 - 17**	**40 - 50**
	AC1.3 Plan how to collect data		
	AC1.4 Plan how to process the data		
	AC1.5 Justify the design of the statistical investigation		
LO2	**AC2.2** Evaluate the suitability of data collected	**2 - 5**	**5 - 15**
LO3	**AC3.3** Interpret the results of statistical output	**7 - 10**	**20 - 30**
LO4	**AC4.1** Draw conclusions from statistical output	**4 - 7**	**10 - 20**
	AC4.2 Evaluate the effectiveness of the problem solving method used		

- Each paper will assess learners' ability to interpret and analyse statistical output. The focus of the external assessment is interpretation, rather than calculation.
- The use of calculators will be allowed during the external assessment (see Appendix 3 for further details) but the use of statistical software is not required or permitted;
- Available in June of each year;
- Learners are allowed one re-sit opportunity. The highest grade will contribute towards the overall grade for the qualification;
- WJEC will produce a mark scheme, which will be used as the basis for marking the examination papers;
- The Principal Examiner will produce a report each series providing feedback. It will provide helpful observations and commentary on the work produced for the series and can assist teachers in preparing their learners for the next series of examinations;
- Graded Level 3 Pass, Level 3 Merit and Level 3 Distinction.

Grade descriptors are used by WJEC to set grade boundaries for external assessment. Grade descriptors give a general indication of the standards of achievement likely to have been shown by learners awarded particular grades. The grade awarded will depend in practice upon the extent to which the learner has met these descriptors. Shortcomings in some aspects of the examination may be balanced by better performances in others.

An Award meeting involving experienced examiners and teachers will be required to set the following grade boundaries for the external assessment.

The following grade boundaries will be set at the Award meeting:

- Distinction/Merit
- Merit/Pass
- Pass/Ungraded.

The grade descriptors can be found in Appendix 2.

The descriptors must be interpreted in relation to the content specified in the specification; they are not designed to define that content. Once grade boundaries have been set by WJEC, learner marks are then converted to UMS marks. Further details on UMS marks can be found in Section 4.

3.2 Internal assessment

For the internal assessment component, WJEC Level 3 Vocational Certificate in Statistical Problem Solving using Software has adopted the principles of controlled assessment as set out in the Joint Council for Qualifications document 'GCSE, GCE, ELC, Functional skills, Principal Learning in the Diploma and Project Qualifications – instructions for conducting controlled assessment'. This document can be accessed through the JCQ website (www.jcq.org.uk). Each centre must ensure that controlled assessment is conducted in accordance with these controls.

The following principles apply to the controlled assessment:

- The unit is assessed through summative controlled assessment
- The controls for the assessment is provided in a model assignment;
- Performance bands are provided to enable centres to mark the controlled assessment;
- Evidence must clearly show how the learner has met the standard for the higher grades;
- Appropriate statistical software **must** be used to process data during the controlled assessment.

There are three stages of assessment that will be controlled:

- Task setting
- Task taking
- Task marking

Task setting

For internal assessment, WJEC has produced a model assignment for the unit. Centres are, however, allowed to modify the assignment within specified parameters. This will allow centres to tailor the assessment to local needs. The model assignment has been written to ensure the following controls are in place:

- The unit is assessed through one assignment;
- The assignment must have a brief that sets out an applied purpose. An applied purpose is a reason for completing the tasks that would benefit society, a community, organisation or company. Further details are in the Statement of Purpose in Section 1.2;
- The assignment can specify a number of tasks but tasks must be coherent, i.e. show how the assessment requirements all contribute to the achievement of the applied purpose of the assignment;
- The assignment must provide each learner with the opportunity to address all assessment criteria and all performance band requirements;
- The assignment must indicate the acceptable forms of evidence. These must conform to those forms set out in the model assignment;
- Where a centre has adapted the model assignment, there must be evidence of quality assuring its fitness for purpose. Sample documentation for this activity is available from WJEC.

Task taking

There are five areas of task taking that are controlled: time, resources, supervision, collaboration and resubmission.

Time

Each model assignment will specify the total amount of time available for summative assessment. Centres have the discretion for how that time is allocated to each task.

Resources

The assessor can determine which resources should be provided to all learners to ensure fair and valid assessment takes place. Where specific resource controls must be in place, these will be stated in the model assignment. Learners must have access to appropriate statistical software whilst completing the controlled assessment.

Supervision

Learners must normally be supervised by an assessor whilst completing controlled assignment tasks. Model assignments will specify if supervision is not required. Centres must have in place systems to ensure learners cannot access evidence they have been developing outside of supervised activities.

Authentication

Supervision is in place to ensure the authenticity of evidence produced for summative assessment. Assessors should not provide input or guidance to learners during the controlled assessment time. This includes providing formative feedback on the evidence being produced. Assessors can provide guidance on the requirements of the task and remind learners of the performance bands and how they can be interpreted. Assessors must intervene where there is a Health and Safety hazard observed.

Learners can review and redraft evidence independently within the time controls for the assessment.

Learners must sign a declaration to confirm that all evidence submitted for moderation is their own work and that any sources used have been acknowledged.

Assessors must sign a declaration to confirm that evidence submitted for moderation was completed under the controlled conditions set out in the model assignments.

Collaboration

The model assignment will indicate whether:

- Group work must take place;
- Group work is forbidden;
- Centres can elect to complete tasks through group work.

Where group work takes place, the following principles must be applied:

- Tasks should allow each member of the group to have full access to all performance bands for all assessment criteria;
- Learners **must** provide an individual response as part of any task outcome;
- Evidence of individual response may include written evidence (e.g. notes, evaluations, mind maps, etc.) and/or audio-visual evidence (e.g. recordings, photographs, drawings, designs, etc.);
- Evidence must be clearly attributable to each individual member of the group;
- Individual contributions must be clearly identified and stated on the accompanying authentication sheet which must be signed by both the teacher and the candidate;

- Assessment of the individual must be based on the individual contribution to the evidence produced;
- Learners achievement must not be affected by the poor performance of other group members;
- Learners achievement must not benefit from the performance of other group members.

Re-submission

Learners may re-enter internally assessed units. The learner must submit a new assessment, completed within the same levels of control. They cannot improve previously submitted work.

Learners have one resit opportunity for each assessed component.

Where an individual learner who has previously submitted group work for assessment wishes to resit an internally assessed unit, one of the following options **must** be taken:

- the candidate must create a new piece of work within the same group;
- the candidate must create a new piece of work within a new group;
- the candidate must create a new piece of work with non-assessed candidates;
- the candidate must create an individual piece of work.

The same levels of control for group work, as outlined above, will apply to candidates who choose to re-sit.

Task marking

All marking of evidence must be made against the assessment criteria and performance band statements given in each unit specification. Evidence marked must comply with the controlled requirements set out in the model assignment.

Written evidence must be annotated to show how it relates to the assessment criteria and performance band requirements.

Performance evidence, for example of giving a presentation, must be made on observation records. Observation records will include a description of learner performance as well as a summative statement on the quality of that performance. Where performance is observed by someone other than an assessor, the 'witness' must complete a witness statement. Assessors will need to authenticate the statement either through scrutiny of supporting evidence and/or questioning of the learner and/or witness. If the statement is authenticated, it can be allowed to contribute to the evidence for assessment. Evidence of authentication will also need to be included.

Marking should only be undertaken by a designated assessor. An assessor should have appropriate expertise in the subject and level for a specified unit. The assessor is responsible for ensuring that:

- Assessment is conducted under specified controlled conditions;
- They are clear about the requirements of the learning outcomes, assessment criteria and performance band statements prior to commencing controlled assessment;
- Evidence presented for assessment is authentic;
- Assessment decisions are accurately recorded;
- Evidence is appropriately annotated;
- Observation records contain sufficient detail for objective corroboration of decisions;
- Judgements are only made against the performance band statements.

3.3 Synoptic assessment

Synoptic assessment

'requires a candidate to identify and use effectively in an integrated way an appropriate selection of skills, techniques, concepts, theories, and knowledge from across the course content.'

'Level 3 Vocational Qualifications for 16-19 year olds. Technical Guidance for Awarding Organisations' DfE p14

The WJEC Level 3 Certificate in Statistical Problem Solving using Software qualification has been designed to require learners to develop their learning by working towards work related purposeful tasks. Learners will select and apply their learning in completion of these tasks.

The external assessment will give learners the opportunity to interpret and evaluate statistical output in a range of different contexts. In addition, the controlled assessment allows learners to reinforce their learning from all assessment criteria and content. Learners will use the problem solving cycle to plan how to solve a problem of their choice, identify and collect the data needed, process it and interpret the results. Learners will need to understand when it is appropriate to use different statistical techniques, present a clear account of the problem they are investigating, their planning and the interpretation of their results. The problem they choose to investigate could be related to another subject which they are studying or a job which they are interested in.

3.4 Standardisation

Centres are expected to standardise internal assessment decisions. This is the process by which centres ensure that all learners are judged to the same standard across different assessors, teaching groups and from year to year. Evidence of standardisation should be submitted with learner evidence.

Where more than one assessor is involved, the centre must appoint a Lead Assessor.

The role of the Lead Assessor is to:

- document all activities
- ensure that the assignment presented to learners is fit for purpose and complies with all controls
- ensure all assessors have appropriate documentation in place to support fair and valid assessment decisions
- ensure all assessment activities are in accordance with the task taking controls for the unit
- sample assessment judgements at appropriate times to ensure the performance bands are correctly and consistently applied
- provide feedback to assessors
- provide support to assessors on interpretation of performance band requirements.

4 GRADING

This is a unitised specification which allows for an element of staged assessment. Internally or externally assessed components may be re-taken once only (with the better result counting) before aggregation for the qualification award. Results for a component have a shelf-life limited only by the shelf-life of the specification.

Component grades (Pass, Merit or Distinction) will be awarded on the basis of the grading descriptors. Grading descriptors are provided to give a general indication of the standards of achievement likely to have been shown by learners awarded particular grades for assessment. The descriptors must be interpreted in relation to the content specified by the unit; they are not designed to define that content. The grade awarded will depend in practice upon the extent to which the candidate has met these overall. Shortcomings in some aspects of the assessment may be balanced by better performances in others. Learners who fail to achieve a Pass grade in a particular component will be awarded a U (unclassified grade) for that component.

Individual component results are reported on a uniform mark scale (UMS).

The UMS grade boundaries for the Level 3 Vocational Certificate in Statistical Problem Solving using Software are shown in the table below:

Assessment type	Raw Mark	Weighting %	UMS mark	UMS grade boundaries			
				D	M	P	N
Internal (Synoptic)	36	60	120	96	72	48	
External	35	40	80	64	48	32	24

Internally Assessed component

Performance bands have been written to enable learners to demonstrate their ability against the assessment criteria. There are no additional requirements to achieve higher grades.

Externally Assessment

The learning outcomes and assessment criteria listed in the table below will be assessed at every assessment opportunity.

The learning outcomes will be covered within the mark allocation as follows:

	Assessment Criteria	Marks	%
LO1	**AC1.1** Formulate a statistical investigation	**14 - 17**	**40 - 50**
	AC1.3 Plan how to collect data		
	AC1.4 Plan how to process the data		
	AC1.5 Justify the design of the statistical investigation		
LO2	**AC2.2** Evaluate the suitability of data collected	**2 - 5**	**5 - 15**
LO3	**AC3.3** Interpret the results of statistical output	**7 - 10**	**20 - 30**
LO4	**AC4.1** Draw conclusions from statistical output	**4 - 7**	**10 - 20**
	AC4.2 Evaluate the effectiveness of the problem solving method used		

Grading the qualification

The WJEC Level 3 Vocational Certificate in Statistical Problem Solving using Software qualification is reported on a four point scale: Pass, Merit, Distinction, Distinction*.

The attainment of learners who do not reach the minimum standard for a pass grade will receive a U (unclassified) grade and will not receive a qualification certificate.

Learners may only resit a component once, with the better result counting, before aggregation for the qualification award. A learner may retake the whole qualification more than once.

The qualification grade will be based upon the overall UMS mark and learners achievement in both components.

To achieve a pass qualification grade learners must score a minimum of 80 uniform marks overall.

To achieve a Pass, Merit, Distinction or Distinction* learners must obtain:

- the minimum UMS mark for the qualification grade (see **Table:** UMS and qualification grade);

and

- a minimum of a pass grade in **both** components.

Table: UMS and qualification grade

Grade	Distinction*	Distinction	Merit	Pass	Max. Mark
Mark	180	160	120	80	200

5 UNITS

Unit: Statistical Problem Solving Using Software

Guided learning hours: 150

Aim and purpose

This unit focuses on the use of statistical software for problem solving. Learners will work with real data sets, using software to process the data, in order to solve problems.

Unit introduction

We live in the information age. There is an enormous amount of information available and we need tools to enable us to make use of it.

"*Drowning problems in an ocean of information is not the same as solving them.*"
(Ray E. Brown)

Market researchers ask questions to get information; scientists perform experiments to get information. It is essential to be able to use and interpret information to be able to make sense of problems and to solve them. Statistical methods are used by medical researchers, business people, psychologists, environmentalists and many others for just this purpose.

Here are some examples of the kinds of problems which are solved by statistical methods:

- In one year, 46% of students at a school pass an examination. This will vary from year to year. What range of percentage pass rates could be expected over the years?
- 11% of airline passengers do not turn up for their flights. Airlines often overbook flights to avoid empty seats. How many seats could a flight be overbooked by without too high a probability of having to turn away passengers?
- It has not rained in an area for a month. Is this due to natural variations in the weather or is there a tendency for the weather to be drier?

During the controlled assessment, you will use the problem solving cycle, plan how to solve a problem of your choice, identify the data needed, process it and interpret the results. You will not need to understand a lot of theoretical background or do calculations; statistical software will be used but you will need to understand when it is appropriate to use different statistical techniques and learn to interpret the results. You will work with real data sets, of appropriate size, using software to process the data, choosing appropriate methods and interpreting the results. The problem you choose to investigate could be related to another subject which you are studying or to a job which you are interested in. You will present a clear account of the statistical investigation, your results and evaluate the methods used. During the external examination you will have the opportunity to interpret statistical output, comment on the appropriateness of graphical representations, measures of location and statistical methods. You will interpret statistical results and evaluate the statistical methods used.
The skills you learn in this unit are used in a variety of contexts, for example, scientific research, business and research in social sciences, such as geography and sociology.

Learning outcomes	**Assessment criteria**	**Content**
The learner will:	*The learner can:*	
LO1 be able to design a statistical investigation	**AC1.1** formulate a statistical problem	**Formulate** • developing research questions • developing hypotheses (including formal notation H_0 vs H_1)
	AC1.2 explain a rationale for investigating a statistical problem	**Rationale** • purpose of investigation • inclusion of references

Learning outcomes	**Assessment criteria**	**Content**
The learner will:	*The learner can:*	
	AC1.3 plan how to collect data	**Plan** Identifying important factors when planning to collect data such as: • sample size and target population • variables - discrete - continuous - qualitative - quantitative • types of data • methods of collecting primary data - observation - experiment - interview - questionnaire • sources of secondary data - Internet - journals • population - census - problems of incomplete data • sampling methods - survey - random sampling and the need for a sampling frame - stratified sampling - systematic sampling - opportunity sample - cluster sample - possible bias

Learning outcomes	**Assessment criteria**	**Content**
The learner will:	*The learner can:*	
	AC1.4 plan how to process the data	Identifying important factors when planning to process data such as: **Graphical representations** • bar charts • box plots • histograms • scatter graphs • time series **Measures of location and spread** • mean, mode , median • standard deviation • interquartile range, range **Statistical methods** Explain methods used, such as: • regression and residuals • correlation coefficient and test for significance • time series, seasonal effects and trends • modelling using Binomial or Normal distributions • goodness of fit test • hypothesis testing or confidence intervals using the Normal distribution • hypothesis testing or confidence intervals using the *t*-distribution • tests of association such as the chi square test • work with categorical data • work with multivariate data • non-parametric methods (e.g. Wilcoxon signed rank test and Mann-Whitney test)

Learning outcomes	Assessment criteria	Content
	AC1.5 justify the design of the statistical investigation	**Justification** Explanation of the appropriateness of • Graphical representations used • Measures of location and spread used • Statistical methods used **Assumptions** Stating assumptions where appropriate. e.g. • Stating any assumptions when modelling using Binomial or Normal distributions • Stating any assumptions of normality when hypothesis testing or confidence intervals using the Normal distribution (shape of distribution, plotting probability plots, equal variances, use of Central Limit Theorem etc) • Stating any assumptions when hypothesis testing or confidence intervals using the *t*-distribution (sample data drawn are normally distributed and equal variances)

Learning outcomes	Assessment criteria	Content
LO2 be able to evaluate the suitability of data collected	**AC2.1** collect relevant data	**Relevant data collection**
	AC2.2 evaluate the suitability of data collected	**Practical considerations** - difficulty in obtaining sampling frame - difficulty in obtaining certain types of data **Suitability** • samples may be unrepresentative of target population - sample size - bias - errors - source • inputting data into software could have led to errors • questionnaires can give incorrect data due to misunderstanding of questions • sometimes people lie • for measurement data, there may be rounding or use of different units

Learning outcomes	Assessment criteria	Content
LO3 be able to process data	**AC 3.1** use statistical software	**Suitable software** Any *suitable* software e.g. Excel, Minitab **Using software** Efficient use of suitable statistical software to process data e.g. • Inputting data • Plotting graphs (individual and multi-plotting to compare) • Calculating descriptives • Full use of statistical tools to test assumptions for statistical tests • Full use of statistical tools to carry out statistical tests
	AC3.2 use statistical methods to process data	**Processes** • cleaning raw data • outliers • anomalies • graphical representations • measures of location and spread • statistical methods • acknowledgement of limitations
	AC3.3 interpret the results of statistical output	**Interpretation of:** • processing the raw data • graphical representations • measures of location and spread • statistical methods

Learning outcomes	**Assessment criteria**	**Content**
The learner will:	*The learner can:*	
LO4 be able to communicate the results of a statistical investigation	**AC4.1** draw conclusions from statistical output	**Conclusions** • clearly stated conclusions • relating the conclusion to the original problem
	AC4.2 evaluate the effectiveness of the problem solving method used	**Evaluate** • considering whether the research questions/hypothesis has been addressed adequately • commenting on the strengths/weaknesses of the design and execution • state improvements to the design with reference to the four stages of the problem solving cycle (plan, collect, process and discuss) **Validity/Reliability** • different samples might lead to different conclusions • consider the appropriateness of the model, for example: - if the data were assumed to follow a Normal distribution, is that assumption justified? - if you are using secondary data and have assumed that you are working with a random sample, could that assumption be incorrect? **Recommendations for further research**

Learning outcomes	**Assessment criteria**	**Content**
The learner will:	*The learner can:*	
	AC4.3 present outcomes of an investigation	**Methods of presentation** Written report Electronic presentations Oral presentation **Formatting** • appropriate use of margins, font, tables etc • clear headings • appropriate statistical summaries and graphs included in text or appendices • raw software output labelled in appendices • relevant diagrams and graphs labelled and referred to in the text • clear referencing of papers/books/websites where appropriate • clear written language • conclusions are stated clearly

Learning outcomes	Assessment criteria	Performance bands		
		Band 1	**Band 2**	**Band 3**
LO1 Be able to design a statistical investigation (14 marks)	**AC1.1** Formulate a statistical problem	Formulates an appropriate research question and refers to hypotheses. *Limited clarity.* *Hypothesis not formally stated.* (1)	Formulates an appropriate research question and hypotheses formally stated. (2)	
	AC1.2 Explain a rationale for investigating a statistical problem	Gives a basic rationale for investigating a statistical problem. (1)	Gives a logical rationale for investigating a statistical problem. *Some parts may be detailed.* (2)	Gives a clear and detailed rationale for investigating a statistical problem. (3)
	AC1.3 Plan how to collect data	Basic plan explaining the important factors that need to be considered when planning to collect data. *Low level explanations.* *Some parts of the plan may be omitted.* (1)	Plan explaining the important factors that need to be considered when planning to collect data. *Some parts of the plan are detailed.* (2)	Clear and detailed plan explaining the important factors that need to be considered when planning to collect data. (3)
	AC1.4 Plan how to process data	Basic plan containing explanations of which graphical representations, measures of location and spread and statistical methods are to be used. *Low level explanations.* *Some parts of the plan may be omitted.* (1)	Plan containing explanations of which graphical representations, measures of location and spread and statistical methods are to be used. *Some parts of the plan are detailed.* (2)	Clear and detailed plan containing explanations of which graphical representations, measures of location and spread and statistical methods are to be used. (3)

Learning outcomes	Assessment criteria	Performance bands		
		Band 1	**Band 2**	**Band 3**
	AC1.5 Justify the design of the statistical investigation	Basic justification of the appropriateness of the graphical representations, measures of location and spread, and statistical methods that are to be used. Any assumptions made are stated. *Low level justifications. Some justifications or assumptions may be omitted.* (1)	Justification of the appropriateness of the graphical representations, measures of location and spread, and statistical methods that are to be used. Any assumptions made are stated. *Some justifications and/or assumptions are detailed.* (2)	Clear and detailed justification of the appropriateness of the graphical representations, measures of location and spread, and statistical methods that are to be used. Any assumptions made are clearly stated. (3)

Learning outcomes	Assessment criteria	Performance bands		
		Band 1	**Band 2**	**Band 3**
LO2 Be able to evaluate the suitability of data collected (4 marks)	**AC2.1** Collect relevant data	Relevant data collected. (1)		
	AC2.2 Evaluate the suitability of data collected	Basic evaluation of the suitability of the data collected, including references to any practical considerations and making comments on validity and reliability. *Evaluations may be straightforward with limited reasoning.* *Some evaluations may be omitted.* (1)	Evaluation of the suitability of the data collected, including references to any practical considerations and making appropriate comments on validity and reliability. *Some evaluations are detailed.* (2)	Clear and detailed evaluation of the suitability of the data collected, including references to any practical considerations and making valid and well-reasoned comments on validity and reliability. (3)

Learning outcomes	Assessment criteria	Performance bands		
		Band 1	**Band 2**	**Band 3**
LO3 Be able to process data (9 marks)	**AC 3.1** Use statistical software	Basic use of statistical software tools to process data. *Limited use of statistical software. tools.* (1)	Efficient use of statistical software tools to process data. *Some advanced tools are used.* (2)	Efficient and consistent use of advanced statistical software tools to process data. (3)
	AC3.2 Use statistical methods to process data	Basic processing of data using statistical software including graphical representations, measures of location and spread, and statistical tests. Reference to outliers and anomalies where appropriate. *Limited output produced.* *Minor errors.* *Some processing may be omitted.* (1)	Processing of data using statistical software including graphical representations, measures of location and spread, and statistical tests. Reference to outliers and anomalies where appropriate. *Variety of output produced.* *Some processing is detailed.* (2)	Accurate processing of data using statistical software including graphical representations, measures of location and spread, and statistical tests. Reference to outliers and anomalies where appropriate. (3)
	AC3.3 Interpret the results of statistical output	Interprets the statistical output including the interpretation of processing the raw data, graphical representations, measures of location and spread and statistical methods. *Low level interpretations.* *Some interpretations may be omitted.* *Some inaccuracies in the interpretations.* (1)	Accurately interprets the statistical output including the interpretation of processing the raw data, graphical representations, measures of location and spread and statistical methods. *Some interpretations are detailed.* (2)	Accurately interprets the statistical output including the interpretation of processing the raw data, graphical representations, measures of location and spread and statistical methods. (3)

Learning outcomes	Assessment criteria	Performance bands		
		Band 1	**Band 2**	**Band 3**
LO4 Be able to communicate the results of a statistical investigation (9 marks)	**AC4.1** Draw conclusions from statistical output	Draws conclusions from output from statistical software. *Low-level conclusions.* *Conclusions may be correct but the relationship to the original problem is not explained.* (1)	Draws correct conclusions from output from statistical software and the relationship to the original problem is explained. *Some conclusions detailed.* (2)	Draws correct and reasoned conclusions from output from statistical software and the relationship to the original problem is clearly explained. (3)
	AC4.2 Evaluate the effectiveness of the problem solving method used	Basic evaluation of the effectiveness of each stage of the problem-solving method used, making comments on validity and reliability. *Evaluations may be straightforward with limited reasoning.* *Some evaluations may be omitted.* (1)	Evaluation of the effectiveness of each stage of the problem-solving method used, making appropriate comments on validity and reliability. *Some evaluations are detailed.* (2)	Clear and detailed evaluation of the effectiveness of each stage of the problem-solving method used, making valid and well-reasoned comments on validity and reliability. (3)

Learning outcomes	Assessment criteria	Performance bands		
		Band 1	**Band 2**	**Band 3**
	AC4.3 Present outcomes of an investigation	Presents an investigation with limited clarity. Including: Formatting (margins, fonts, tables etc). Clear headings. Appropriate statistical summaries and graphs included in text or appendices. Raw software output labelled in appendices. Relevant diagrams and graphs labelled and referred to in the text. Clear written language. Clear referencing of papers/books/websites where appropriate. *Limited clarity.* *Limited formatting.* *Some factors may be omitted.* (1)	Presents an investigation with clarity and effectiveness. Including: Formatting (margins, fonts, tables etc). Clear headings. Appropriate statistical summaries and graphs included in text or appendices. Raw software output labelled in appendices. Relevant diagrams and graphs labelled and referred to in the text. Clear written language. Clear referencing of papers/books/websites where appropriate. *More emphasis on formatting text than on formatting the statistical output for clarity.* *Some factors may be omitted.* (2)	Presents a well-presented and formatted investigation with clarity and effectiveness. Including: Formatting (margins, fonts, tables etc). Clear headings. Appropriate statistical summaries and graphs included in text or appendices. Raw software output labelled in appendices. Relevant diagrams and graphs labelled and referred to in the text. Clear written language. Clear referencing of papers/books/websites where appropriate. (3)

Assessment

Assessment is via a controlled assessment and an external examination.

The internally assessed component will be externally moderated through a summative controlled assessment. All assessment must be conducted under controlled assessment conditions. Section 3.2 of the specification details the principles involved in internal assessment. WJEC has produced a model assignment for this unit which is available through the WJEC secure website.

The externally assessed component will be externally set by WJEC each series and externally marked. WJEC has produced sample assessment materials for this component which are available on the WJEC Statistical Problem Solving Using Software website.

Guidance for delivery

It is important that learners recognise that the knowledge, understanding and skills they develop are vocationally relevant. There are a number of ways this can be achieved:

- arranging visits to workplaces, for example for a masterclass on using statistical software
- arranging talks by visiting speakers, for example a statistician giving examples of scenarios where they have used statistical methods
- carrying out a practical activity based around a work-based scenario such as evaluating the quality of data collected

The following are examples of approaches to delivery which could be used to enhance the learning and understanding of the vocational importance of statistical problem solving.

Example 1

A representative of a manufacturing plant could provide learners with quality control data. Learners identify additional information requirements and conduct research remotely. They then work in small groups to implement statistical techniques to process the data. Learners present their findings to the manufacturer's representative who compares their findings with those of the learners.

Example 2

A local environmental group is concerned that the cold and often unsettled summer weather over the last few years has caused the decline in the numbers within different species of the butterfly population. The environmental group wants to be able to identify and publish information that identifies whether there is an association between climate and the number of species. Learners may wish to identify other causes of reduction such as the destruction of habitats by human activities, for example intensive farming.

Example 3

Learners work with lecturers and students from a university. Learners are presented with historical health related data. Learners work with a mentor from the university to investigate current data and draw conclusions on differences over time.

Example 4

A local authority has made changes to bin collections; for example moving to fortnightly collections or installing chips in bins to monitor waste. The authority wishes to know whether recycling has increased significantly following the change. Learners work with data about recycling to investigate and present conclusions clearly to the authority.

Making contacts

- Examples of organisations that may be approached to provide help include: private sector companies that have a commercial interest in analysing data such as retailers
- Pressure groups that rely on information and data to lobby policy makers such as Greenpeace
- Organisations with public responsibilities such as the NHS
- The Royal Statistical Society https://www.rss.org.uk/
- The Royal Statistical Society Centre for Statistical Education http://www.rsscse.org.uk/
- Office for National Statistics http://www.ons.gov.uk/
- StatsWales https://statswales.wales.gov.uk/

Resources

Books

Statistics: The art and science of learning from data, by Agresti and Franklin (Pearson, ISBN**:** 978-0131357464)

AS Statistics by Brace et al (Hodder ISBN 978-0-340-94052-5)

Advancing Maths for AQA: Statistics 2 & 3 by Williamson and Buque (Heinemann ISBN: 978-0435513405)

Statistics: Concepts and Controversies by Moore and Notz (W H Freeman and Co ISBN: 978-0716786368)

Websites

http://www.dartmouth.edu/~chance/ Chance website: teaching in a way that helps students understand statistics in the news

http://lib.stat.cmu.edu/DASL/ Data and Story Library: real data sets to illustrate specific statistical techniques

http://www.gapminder.org/ Gapminder: presents world statistics in an interesting and informative way

http://www.straightstatistics.org/ Straight Statistics: journalist and statisticians encouraging understanding of statistics

http://www.amstat.org/news/blastland_bbcprimer.cfm Michael Blastland helps understanding of statistics in the news

http://www.stars.ac.uk/ statistics using real data sets related to other disciplines; worksheets for different IT packages are available

http://www.coventry.ac.uk/ec/~styrrell/excel.htm Using Excel

http://www.mei.org.uk/?section=resources&page=onlineresources An extensive online resources from Mathematics in Education and Industry to help with the teaching and learning of mathematics (including statistics) from Key Stage 4 to postgraduate level.

6 ENTRY PROCEDURES

WJEC Level 3 Vocational Certificate in Statistical Problem Solving using Software will be available for certification from June 2017.

Thereafter, each qualification will be available for certification each June.

Centres planning to offer this qualification must be registered as an accredited WJEC centre. For details on the application and accreditation, centres should contact WJEC.

Entries for the June series must be submitted no later than 21 February.

Unit entry

Entry for individual components must be made by submitting the relevant components codes as indicated on the website.

Qualification entry

Learners will be entered for the qualification when entering for aggregation (cash-in). Aggregation does not take place automatically: it is necessary to enter the relevant code for aggregation to take place.

7 EXTERNAL MODERATION

The consistency of assessment practices and decisions across centres will be assured through the external moderation of a sample of work.

Each centre will have access to a consultative moderator. The consultative moderator will be available to discuss assessment requirements with centres.

For each series where learners are entered, centres will submit a sample, according to the formula below.

Total number of candidates	*Work to be submitted (Numbers relate to alphabetical order)*
1 – 10	All
11 - 19	1st and every second (1, 3, 5, 7 etc.) **plus** the lowest scoring* folder and additional folders as necessary (reflecting the spread of marks) to make a total sample of 10
20 - 45	1st and every fifth (1, 6, 11, 16 etc.) **plus** the lowest scoring* folder and additional folders as necessary (reflecting a spread of marks) to make a total sample of 10
46 - 99	1st and every eleventh (1, 12, 23, 34 etc.) **plus** the lowest scoring* folder and additional folders as necessary (reflecting a spread of marks) to make a total sample of 10

** The score is based upon the points the learners obtain for each of the units being submitted for moderation.*

Centres should ensure they keep all learner portfolios not sent to the moderator in their possession for two months after the closing date for sending samples for moderation. WJEC may require all portfolios for moderation and centres must be able to comply immediately with such a request.

Centres should submit a sample that includes:

- the controlled assignment brief used to set the assessment activity
- a controlled assessment activities sheet completed and signed by the assessor to confirm that the controls for the unit, including authenticity of evidence, have been applied
- completed mark record sheets outlining which performance bands are met by the evidence
- all evidence produced by learners in completion of the controlled assessment, annotated appropriately by the assessor.

Moderators will review all evidence presented to ensure standards are aligned. Evidence will be judged against the following criteria:

- Task setting – were tasks set within the controls set by WJEC in the model assignment?
- Task taking – is there evidence that tasks were completed under the controlled conditions set out in the model assignment?
- Performance bands – does the evidence support assessor's judgement of a learner against national standards?
- Annotation – is the evidence produced by learners appropriately annotated?
- Authentication- is it clear that the evidence submitted was authentically produced by the learner?
- Standardisation – is there evidence of effective standardisation/internal quality assurance within the centre?

Timetable

Samples of work must be submitted for external moderation, and related mark sheets returned to WJEC by 5 May for the June series. Centres will need to ensure that internal submission dates are set sufficiently in advance of this to allow for authentication, assessment and standardisation.

Feedback

The outcome of moderation will be to either accept or amend a centre's assessment decisions. Guidance on actions needed before re-sitting of specified units at a subsequent moderation series will be also be provided.

Feedback will be provided through a centre moderator's report for each certification title, covering the units entered by the centre and will be accessible through WJEC secure website. The report will address the criteria referred to above.

A Principal Moderator's report will be provided for each series.

8 AWARDING AND REPORTING

Awarding and reporting of results in WJEC Level 3 Vocational Certificate in Statistical Problem Solving using Software will take place in August of each year.

A **Qualification Certificate,** issued at a later date, will confirm the

- Title
- Level
- Grade of qualification
  (Level 3 Pass, Level 3 Merit, Level 3 Distinction, Level 3 Distinction*)
- Component titles contributing to the qualification.

9 ACCESS and SPECIAL CONSIDERATION

Qualifications at this level often require assessment of a broad range of competencies. This is because they are vocational qualifications and prepare candidates for a wide range of occupations and higher level courses.

This specification has been designed to offer fair access for all and to minimise the need to make reasonable adjustments for learners who have particular requirements. It is expected that normally, individual learners' abilities, interests and needs will be appropriately catered for by centres through:

(a) the choice of units and qualifications available, and

(b) the potential for personalisation of controlled assessment.

If there are any queries about the use of this flexibility inherent in the specification to meet learners' needs, or about the use of reasonable adjustments, centres should contact WJEC.

Reasonable adjustments are made for disabled candidates in order to enable them to access the assessments. For this reason, very few candidates will have a complete barrier to any part of the assessment. Information on reasonable adjustments is found in the Joint Council for Qualifications document *Regulations and Guidance Relating to Candidates who are eligible for Adjustments in Examinations.* This document is available on the JCQ website (www.jcq.org.uk).

10 POST-RESULTS SERVICES

If a centre wishes to query the outcome of the moderation and/or examination process this must be done formally by the head of the centre, notifying WJEC within 21 days of the publication of results.

The sample of work submitted for moderation will be reviewed by a moderator/examiner not involved in the original process, and the centre informed of the outcome.

Should the centre not be satisfied with the outcome of the review, there is provision for an appeal to WJEC.

11 CLASSIFICATION CODES

Every specification is assigned a national classification code (discounting code) indicating the subject area to which it belongs. The classification code for this specification is XXXX.

Centres should be advised that where learners take two qualifications with the same classification code, performance indicators for the centre will show that they have only achieved one of the two qualifications. The same view may be taken if learners take two specifications that have different classification codes but have significant overlap of content. The discounting system affects the calculation of performance measures for a school in the performance tables. It does not alter the awards an individual learner has achieved or limit the qualifications they can take.

Learners who have any doubts about their subject combinations should check with the institution to which they wish to progress before embarking on their programmes.

Information on performance points can be obtained from (www.education.gov.uk) and/or DAQW (www.daqw.org.uk).

APPENDICES

Appendix 1- Unit Structure

Unit title

The unit title summarises in a concise manner the content of the unit.

Guided learning hours (GLH)

Guided learning time represents only those hours in which a tutor is present and contributing to the learning process. In some organisations this is known as 'contact time'. This time includes lecturers, supervised practical periods and supervised study time.

Aim and purpose

The aim and purpose provides a brief and clear summary of the unit. It also indicates the applied purpose for the unit.

Unit Introduction

This is written to the learner and gives a summary of the unit content. It sets the vocational context of the unit and highlights the purpose of the learning in the unit.

Learning outcomes

Learning outcomes state what the learner should know, understand or be able to do as a result of completing the learning in the unit.

Assessment Criteria

The assessment criteria specify the standard a learner is expected to meet to demonstrate that the learning outcomes of that unit have been achieved.

Unit content

The indicative content defines the breadth and depth of learning for an assessment criterion. It is expected that all the indicative content will be delivered during the programme of learning. It is not required to assess every aspect of the content when assessing the unit. Learners will be expected to apply the knowledge, understanding and skills acquired through the learning to the specifics of the assessment context.

In some learning outcomes unit content is given as an example (e.g.). This is used to exemplify the content only and learners can use any examples that they are taught in their summative assessments.

For some assessment criteria, no content is specified. Centres can determine the content to be learned based on local circumstances.

Performance Bands

These are used to determine the summative unit grade. Performance bands do **not** add additional requirements to the assessment criteria. Performance bands are used to determine the grade for a unit.

Assessment

WJEC Level 3 Vocational Certificate in Statistical Problem Solving using Software is assessed through controlled internal assessment or external assessment. This section of the unit summarises assessment requirements.

Guidance for delivery

This gives the tutor some ideas on how to deliver the units in a vocational setting consistent with the philosophy of the qualification and intent of the unit. A minimum of three sample contexts are provided for each unit. The guidance also gives ideas of vocational settings for the unit and suggests possible contacts that could be made in the delivery of the learning.

Resources

This identifies useful resources to help in the delivery of the learning. Many of the resources listed are suitable for using with learners.

Appendix 2- Grade Descriptors

Grade descriptors are used by WJEC to set grade boundaries for each component. Grade descriptors give a general indication of the levels of attainment likely to be shown by a representative learner performing at each boundary. An Award meeting involving experienced examiners and teachers will be required to set the following grade boundaries for each component. The following grade boundaries will be set at the Award meeting:

- Distinction/Merit;
- Merit/Pass;
- Pass/ungraded

Grade descriptors are interpreted in relation to the content outlined in the specification; they are not designed to define that content. Once grade boundaries have been set by WJEC learner marks are then converted to UMS marks.

The following grade descriptors are based on the grade descriptors for GCE Mathematics.

Distinction/Merit

Learners recall or recognise almost all the statistical facts, concepts and techniques that are needed, and select appropriate ones to use in a wide variety of contexts.

Learners use graphs, sketches and diagrams, all with high accuracy and skill. They use statistical language correctly and proceed logically and rigorously through extended arguments. When confronted with unstructured problems they can often devise and implement an effective solution strategy. If errors are made in their calculations or logic, these are sometimes noticed and corrected.

Learners recall or recognise almost all the standard models that are needed, and select appropriate ones to represent a wide variety of situations in the real world. They correctly refer results from calculations using the model to the original situation; they give sensible interpretations of their results in the context of the original realistic situation. They make intelligent comments on the modelling assumptions and possible refinements to the model.

Learners comprehend or understand the meaning of almost all translations of common realistic contexts. They correctly refer the results of calculations back to the given context and usually make sensible comments or predictions. They can distil the essential statistical information from extended pieces of prose having statistical content. They can comment meaningfully on the statistical information.

Learners make appropriate and efficient use of contemporary calculator and computer technology and other permitted resources, and are aware of any limitations to their use. They present results to an appropriate degree of accuracy.

Merit/Pass

Learners recall or recognise most of the statistical facts, concepts and techniques that are needed, and usually select appropriate ones to use in a variety of contexts.

Learners use graphs, sketches and diagrams, all with a reasonable level of accuracy and skill. They use statistical language with some skill and sometimes proceed logically through extended arguments. When confronted with unstructured problems they sometimes devise and implement an effective and efficient solution strategy. They occasionally notice and correct errors in their calculations.

Learners recall or recognise most of the standard models that are needed and usually select appropriate ones to represent a variety of situations in the real world. They often correctly refer results from calculations using the model to the original situation; they sometimes give sensible interpretations of their results in the context of the original realistic situation. They sometimes make intelligent comments on the modelling assumptions and possible refinements to the model.

Learners comprehend or understand the meaning of most translations of common realistic contexts. They often correctly refer the results of calculations back to the given context and sometimes make sensible comments or predictions. They distil much of the essential statistical information from extended pieces of prose having statistical content. They give some useful comments on this statistical information.

Learners usually make appropriate and efficient use of contemporary calculator and computer technology and other permitted resources, and are sometimes aware of any limitations to their use. They usually present results to an appropriate degree of accuracy.

Pass/Ungraded

Learners recall or recognise some of the statistical facts, concepts and techniques that are needed, and sometimes select appropriate ones to use in some contexts.

Learners and use graphs, sketches and diagrams, all with some accuracy and skill. They sometimes use statistical language correctly and occasionally proceed logically through extended arguments.

Learners recall or recognise some of the standard models that are needed and sometimes select appropriate ones to represent a variety of situations in the real world. They sometimes correctly refer results from calculations using the model to the original situation; they try to interpret their results in the context of the original realistic situation.

Learners sometimes comprehend or understand the meaning of translations of common realistic contexts. They sometimes correctly refer the results of calculations back to the given context and attempt to give comments or predictions. They distil some of the essential statistical information from extended pieces of prose having statistical content. They attempt to comment on this statistical information.

Learners often make appropriate and efficient use of contemporary calculator and computer technology and other permitted resources. They sometimes present results to an appropriate degree of accuracy.

Appendix 3 – Use of calculators

In the examination the following rules will apply.

Calculators must be:

- of a size suitable for use on the desk,
- either battery or solar powered
- free of lids, cases and covers which have printed instructions or formulas.

Calculators must not:

- be designed or adapted to offer any of these facilities:
  - language translators,
  - symbolic algebra manipulation,
  - symbolic differentiation or integration,
  - communication with other machines or the internet.
- be borrowed from another learner during an examination for any reason.
- have retrievable information stored in them including, (but not limited to):
  - databanks,
  - dictionaries,
  - mathematical formulae,
  - text.

The learner is responsible for the following:

- the calculator's power supply,
- the calculator's working condition.

Appendix 4 – Skills Mapping

Personal, Learning and Thinking Skills (PLTS)

PLTS	***Statistical Problem Solving using Software***
Independent enquirers	✓
Creative thinkers	✓
Reflective learners	✓
Team workers	✓
Self managers	✓
Effective Participators	✓

KEY SKILLS AND ESSENTIAL SKILLS (WALES)

Application of Number

	Statistical Problem Solving using Software
Understand numerical data	✓
Carry out calculations	✓
Interpret results and present findings	✓

Communication

	Statistical Problem Solving using Software
Speaking and listening	✓
Reading	✓
Writing	✓

ICT

	Statistical Problem Solving using Software
Use ICT systems	✓
Find, select and exchange information, using ICT	✓
Develop and present information, using ICT	✓

Improving own Learning and Performance

	Statistical Problem Solving using Software
Set targets using information from appropriate people and plan how these will be met	✓
Take responsibility for your learning, using your plan to help meet targets and improve your performance	✓
Review progress and establish evidence of your achievements	✓

Problem Solving

	Statistical Problem Solving using Software
Explore a problem and identify ways of tackling it	✓
Plan and implement at least one way of solving the problem	✓
Check if the problem has been solved and review your approach to problem solving	✓

Working with Others

	Statistical Problem Solving using Software
Plan work with others	✓
Seek to develop co-operation and check progress towards your agreed objectives	✓
Review work with others and agree ways of improving collaborative work in the future	✓