Numeracy By Measure

Building the Workplace Measurement Skills of VET Practitioners

Bicycle Fitting

CYCLING MEASURES

Many jobs require workers to work with measurements. Measurement underpins the success and welfare of a modern workplace and touches almost every part of working life. To develop and sell products and services, to manage quality and safety, and to enhance productivity workplaces need to measure processes, products and performance.

The example used in this Snapshot is a job task performed by bicycle mechanics in a bicycle workshop. The job task involves interpreting and applying specifications to custom fit a bicycle. It includes understanding and working with a range of measures, including linear dimensions, space and shape, and torque.

The numeracy skills required include the ability to read, interpret and understand the mathematical information in written instructions and specifications (and/or oral if instructions are also given verbally) – the application of ACSF numeracy indicator .09, *identifying mathematical information and meaning in activities and texts*.

The numeracy skills also include the ability to use and apply a range of mathematical skills to undertake the task, including using tools to measure, estimate and reflect on and review the results – the application of ACSF numeracy indicator .10, *using and applying mathematical knowledge and problem solving processes*.

The numeracy skills also include the ability to record measurements and communicate orally with customers and supervisors – the application of ACSF numeracy indicator .11, *communicating and representing mathematics*.

Workers responsible for undertaking such measurement tasks must also have a range of other complementary skills, such as the skills to work safely (follow safety procedures, identify and report hazards)

and the skills to follow workplace procedures (identify what must be measured and what tools to use, how often and when, where and how it needs to be recorded, identify the need to take action and take appropriate action). Other skills may include those needed to explain measurement information to other workers, supervisors or customers.

THE CONTEXT

A bicycle mechanic needs to be able to interpret bicycle specifications and meet the requirements detailed on a job card to custom fit a bicycle to a customer. A video of a bicycle mechanic doing this task is shown at https://www.youtube.com/watch?v=JQ7fDjU4rWI .

To do the task, technical specifications and reports need to be used and understood to ensure the best fit. An excerpt from a bicycle set up report and examples of specifications illustrating the types of measurement information involved are shown on the next page.

The ability to use and interpret measurements using the following measurement tools is needed to complete this task:

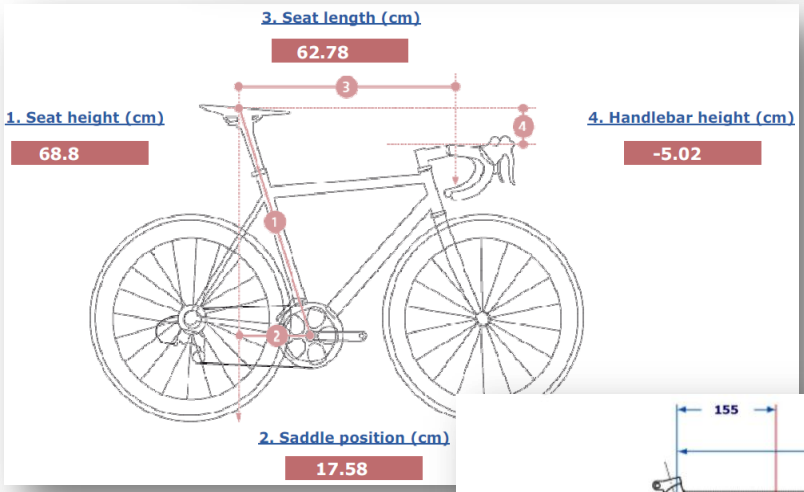
- A measuring tape for a range of lengths and dimensions.
- A spirit level for measuring the level of bicycle seats.
- A torque wrench for tightening the bolts and clamps on bicycles at the desired tension.

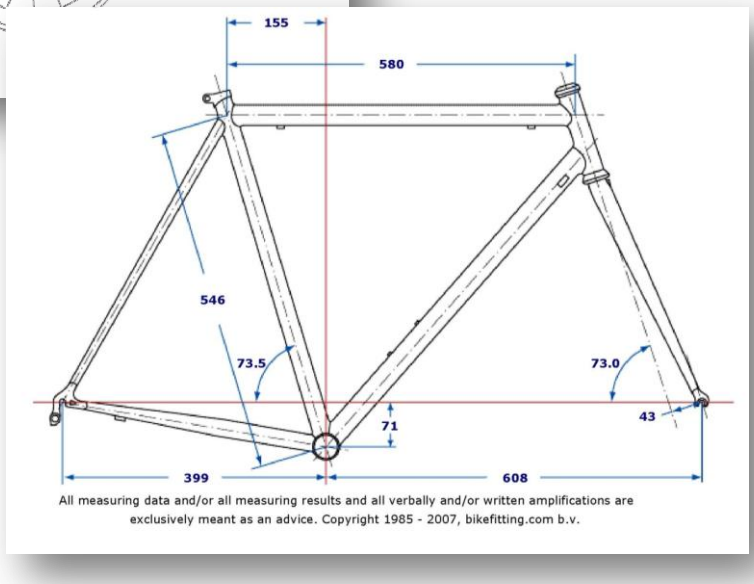
Anatomical data

	Measured data:	Resulting data:	Statistical data for a male of 1780 mm are:
Height	1780	1780	
Foot left	267	267	267
Foot right	267	267	266
Inseam	855	855	864
Torso	1435	580	586
Arm left		708	682
Top	1435		
Bottom	775		
Arm right		708	682
Top	1435		
Bottom	775		
Shoulder width	424	424	424

Miscellaneous

Sole thickness	11.5
Pedal height	16.2
Saddle middle	120
Seat tube angle	73.5





Images sourced from bikefitting.com and used with permission of Shimano Australia Cycling.

ACSF NUMERACY MAPPING

The process of mapping the numeracy skills demands of a job task to the ACSF is imprecise. That is, there is no absolute right or wrong. Professional judgement is needed. Consult the ACSF as you reflect on the numeracy skills mapping presented in this Snapshot. Do you follow and agree with the logic? What is your reasoning?

This task maps to a minimum of **ACSF numeracy level 3**, with the mathematical content mainly related to the focus area *Mathematical knowledge and skills: measurement and geometry*. There is also the requirement to perform a number of calculations with the measurements, so there are aspects of the focus area *Mathematical knowledge and skills: number and algebra* too. This means a worker needs to be at **exit** numeracy level 3 to successfully and competently undertake a task such as this – that is, they need to be working at ACSF numeracy level 4. There are some elements that map to ACSF level 4, helping to support the mapping to a **minimum** of ACSF numeracy level 3.

At level 3, the first indicator specifies that tasks at this level require the interpretation of mathematical information that may be partly embedded in a range of familiar and some less familiar tasks and texts. This is true in this case as a worker working as a bicycle mechanic will find these measurements familiar. However, the skills are applied across a range of different contexts and measures. Similarly, the second indicator describes the mathematical application aspects as using 'a variety of developing mathematical and problem solving strategies' while the third indicator describes the use of 'a combination of both informal and formal oral and written mathematical language and representation'.

To undertake the whole task requires the understanding and application of a range of measures and measurement activities mainly focused on linear dimensions with elements of other measures such as angles and torque. Individually some of the components of the task are at level 2, for example, taking height and width measurements. However, as the job task demands the combination of a range of measurement and mathematical skills and their application across a number of different but related processes, it requires using higher level skills at ACSF numeracy level 3.

In particular this applies to the second indicator and the application of a range of mathematical and problem solving strategies. These are summarised in the table on the next page.

ACSF numeracy indicator .10, *using and applying mathematical knowledge and problem solving processes*	
At ACSF numeracy level 2 this includes: • Selects and uses appropriate familiar mathematical problem solving strategies to solve problems in familiar contexts Relies substantially on hands-on (concrete) and real life materials, personal experience and prior knowledge to: • make estimations and check reasonableness of processes and outcomes in relation to the context	At ACSF numeracy level 3 this includes: • Selects from and uses a variety of developing mathematical and problem solving strategies in a range of familiar and some less familiar contexts Draws on a combination of hands-on, in-context materials, personal experience, mathematical and other prior knowledge to: • use developing estimation, and other assessment skills, to check and reflect on the outcome and its appropriateness to the context and task

At level 2 the specification of skills is limited. At level 3, however, there is a need to be able to select and use a 'variety of developing mathematical and problem solving strategies' and to check and reflect on the outcome and its appropriateness to the context and task. This job task requires mathematical knowledge and understanding to assist problem solving and reflection abilities in order to read and interpret specifications and fit the bicycle correctly.

Therefore, although there are some elements that map to level 2, collectively the requirements are ACSF numeracy level 3.

The following pages illustrate and explain the unpacking and mapping of three of the measurements skills required in this task (linear dimensions, space and shape, and torque) to the relevant ACSF numeracy indicators, focus areas and performance features.

LINEAR DIMENSIONS

In this job task, the understanding and use of linear dimensions underpins the process of fitting a bicycle correctly.

Misunderstandings of bicycle measurements and specifications could lead to poorly fitted bicycles and customer dissatisfaction and complaints.

The specification shown below provides an example of the range of accurate measurements the worker needs to be able to interpret.

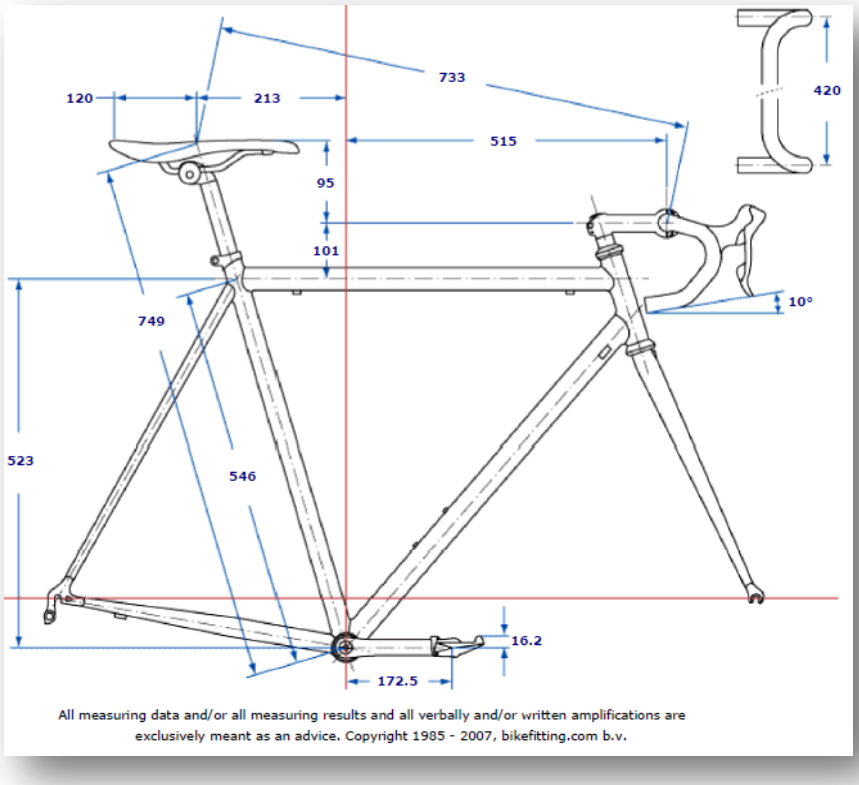


Image sourced from bikefitting.com and used with permission of Shimano Australia Cycling.

Working through this PD resource places you in the role of the learner.

The information below shows how the measurement of linear dimensions applies to this task and aligns to ACSF numeracy level 3.

ACSF numeracy indicator 3.09	
Focus areas and performance features	**Comment**
Explicitness of mathematical information • Interprets and comprehends a range of everyday mathematical information that is embedded in familiar and routine texts **Complexity of mathematical information** • Interprets and comprehends familiar and routine length measures	The worker needs to be able to read and understand different bicycle measurements in job cards, specifications and diagrams. Although these documents and diagrams are quite complex, for someone working in the bicycle industry these are familiar and routine.

ACSF numeracy indicator 3.10	
Focus areas and performance features	**Comment**
Problem solving processes including estimating and reflecting • Uses developing estimation, and other assessment skills, to check and reflect on the outcome **Mathematical methods and use of tools** • Selects and uses appropriate tools, hand held devices, computers and technological processes, e.g. uses a tape measure to measure dimensions of a window in mm **Mathematical knowledge and skills: number and algebra** • Calculates with whole numbers and everyday routine fractions, decimals and percentages **Mathematical knowledge and skills: measurement and geometry** • Measures, estimates and calculates length • Converts between routine metric units by applying understanding of common prefixes, e.g. milli, centi or kilo	The worker needs to be able to use a tape measure to measure all the relevant linear dimensions of the bicycle and check whether the values measured are accurate, realistic and appropriate and whether they match the specification. The worker must be able to measure with accuracy to the nearest millimetre. They must be able to also undertake relevant calculations to check differences and totals, such as for the handle height. The measurement involves the use of both centimetres and millimetres and therefore knowledge about metric conversions is assumed. The requirements to measure accurately and to check and review the measurements are clearly beyond level 2 and potentially even level 4.

ACSF numeracy indicator 3.11	
Performance features	**Comment**
Written mathematical language • Uses a combination of both informal and formal written mathematical language and symbols and general language to document and report on the mathematical and problem solving process and results **Oral mathematical language** • Uses a combination of both informal and formal oral mathematical and general language to present and discuss the mathematical and problem solving process and result **Complexity of mathematical symbolism, representation and conventions** • Uses a combination of both formal and informal symbolism, diagrams, graphs and conventions relevant to the mathematical knowledge of the level: e.g. 1.25 m = 1250 mm	The worker needs to be able to record a wide range of measurement information about different linear dimensions. This includes a range of formal written and more technical representations including 'both formal and informal symbolism and conventions'. Examples include the appropriate use of different marks and annotations to show the meanings of each dimension. The worker must also be able to discuss the results and how they were obtained with supervisors, customers and other workers, which involves using a range of both informal and formal oral mathematical language in relation to linear dimensions.

Working through this PD resource will support you to confirm and strengthen your measurement teaching skills.

SPACE AND SHAPE

In this job task another important skill required of the bicycle mechanic is to interpret and understand shape and space concepts in relation to angles, rotations, and placement in vertical and horizontal space. The worker needs to be able to read and understand the specifications and diagrams, and what they mean in relation to adjusting, setting and fitting a bicycle accurately. For example, as shown in the video, there is the need to use a spirit level to keep the seat horizontal when fitting the seat correctly to its specifications. Misunderstandings of space and shape in relation to the bicycle measurements and specifications could lead to poorly fitted bicycles and customer dissatisfaction and complaints.

The diagram below shows examples of specifications related to angles.

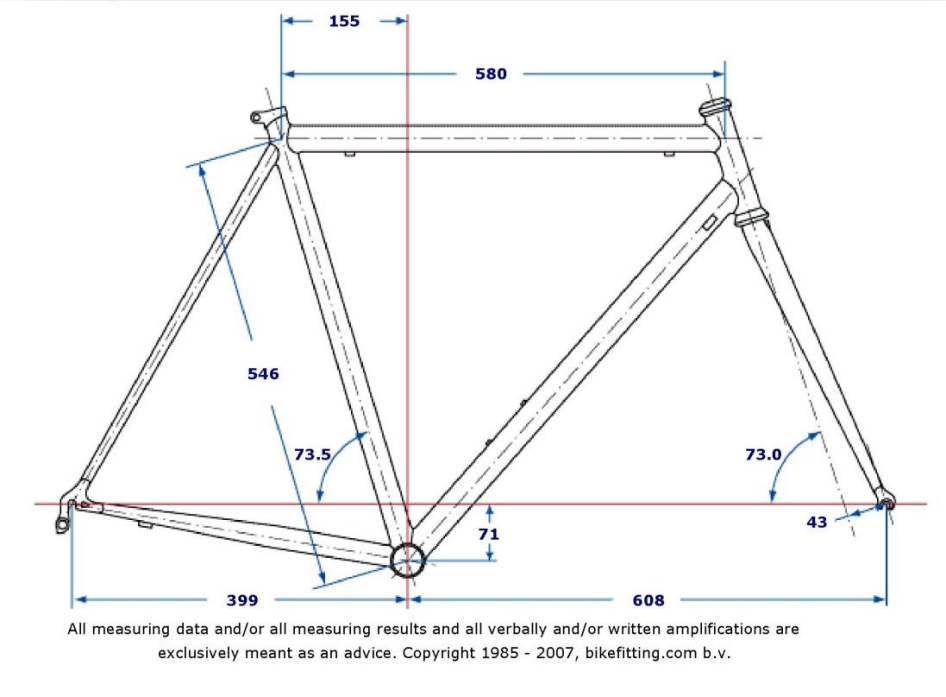


Image sourced from bikefitting.com and used with permission of Shimano Australia Cycling.

The information below shows how the measurement of space and shape applies to this task and aligns to ACSF level 3.

ACSF numeracy indicator 3.09	
Focus areas and performance features	**Comment**
Explicitness of mathematical information • Interprets and comprehends a range of everyday mathematical information that is embedded in familiar and routine texts	The worker needs to be able to read and understand the specifications and diagrams related to angles, and what they mean in relation to fitting a bicycle accurately. The texts to be understood are relatively routine to a bicycle mechanic and this fits in more closely with the descriptions for level 3, rather than for levels 2 or 4. Although the specifications and diagrams look quite complex, for someone working in the bicycle industry these are routine.

ACSF numeracy indicator 3.10	
Focus areas and performance features	**Comment**
Problem solving processes including estimating and reflecting • Using developing estimation, and other assessment skills, to check and reflect on the outcome and its appropriateness to the context and task **Mathematical methods and use of tools** • Selects and uses appropriate tools, hand held devices **Mathematical knowledge and skills: measurement and geometry** • Identifies and estimates common angles, e.g. as a rotation with a full turn = 360° and recognition of right angles as 90°	The worker needs to be able to translate the specifications and diagrams and use a range of problem solving and practical measurement skills in relation to angles and the use of the spirit level. This involves a range of estimations in particular, and then minor and precise adjustments in relation to understanding about angles, rotations and placement in vertical and horizontal space.

ACSF numeracy indicator 3.11	
Focus areas and performance features	**Comment**
Written mathematical language • Uses a combination of both informal and formal written mathematical language and symbols and general language to document and report on the mathematical and problem solving process and results **Oral mathematical language** • Uses a combination of both informal and formal oral mathematical and general language to present and discuss the mathematical and problem solving process and result **Complexity of mathematical symbolism, representation and conventions** • Uses a combination of both formal and informal symbolism, diagrams, graphs and conventions relevant to the mathematical knowledge of the level	The worker needs to be able to record information about angles using 'both formal and informal symbolism and conventions'. Examples include the appropriate use of different marks, symbols and annotations to show the meanings of different angles. They must also be able to discuss the results and how they were obtained with supervisors, customers and other workers, which involves using a range of both informal and formal oral mathematical language in relation to angles, rotations and placement in vertical and horizontal space.

TORQUE

With the development of more sophisticated materials for the construction of bicycles, such as carbon which is light but brittle, it is important not to overtighten bolts and attachments such as seat posts, handlebars, and cranksets. An accurate way to judge and control the tightening of all attachments is essential, especially for professional bicycle fitting.

Torque is the measure of turning force that relates to how loose or tight a nut or bolt is. Torque has dimensions of force times distance. The metric unit for measuring torque is the Newton metre (Nm) where Newton is the unit of measurement for force and metre the unit of measurement for distance.

The measuring instrument used for controlling exactly how much torque is used to tighten a part is called a torque wrench. Below is an example of a torque wrench showing the Vernier scale used for setting torque levels.

Although seemingly a relatively minor part of the job task, the understanding of torque, the units of Newton metre (Nm) and the correct use of the torque wrench, including the Vernier scale commonly used on torque wrenches, is quite crucial. This requirement is above ACSF numeracy level 3, as the measurement of torque using a torque wrench and the units are not standard or common measures. This, along with the requirements of all the other tasks, helps to make this task require a **minimum** of **exit** ACSF numeracy level 3 skills.

ABOUT THIS RESOURCE

Numeracy by Measure: Building the Workplace Measurement Skills of VET Practitioners is a professional development resource to support the development of VET practitioner numeracy proficiency skills and numeracy training skills. It has been developed in response to a National Centre for Vocational Education and Research (NCVER) report titled *Seeking the N in LLN*. This report found that there may be a need to increase the capacity of the vocational education and training (VET) workforce to meet the numeracy skills needs of existing workers in Australia. A copy of the full report is available for download at www.ncver.edu.au.

Numeracy by Measure: Building the Workplace Measurement Skills of VET Practitioners includes a Guide with professional development activities and six Snapshots exploring different workplace numeracy skills based on measurement. This is one of the Snapshots.

Measurement topics covered in the Snapshots include:

- Bicycle Fitting
- Cabinet Fitting
- Health Monitoring
- Shoe Fitting
- Smallgoods Packing
- Tyre Wall Markings

VET practitioners interested in increasing their awareness of numeracy skills in the workplace may also like to access the companion resources *Numeracy in Focus: Building VET Practitioner Awareness of Numeracy in the Workplace* and *Numeracy in Practice: Building Workplace Numeracy Proficiency and Training Skills of VET Practitioners*.

Numeracy by Measure, *Numeracy in Practice* and *Numeracy in Focus* are available for download from www.oggiconsulting.com/resources/.

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