NELSON CENGAGE Learning

VCE UNITS 1 & 2

6TH EDITION

COMPUTING

SERIES EDITOR James Lawson
Therese Keane, Mark Kelly,
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Acknowledgements
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National Library of Australia Cataloguing-in-Publication Data
Lawson, James (James Austin), 1971– author.
Computing VCE units 1 & 2 / James Lawson, Therese Keane, Colin Potts, Anthony Sullivan, Mark Kelly.

6th edition.
9780170364744 (paperback)
Includes index.
For secondary school age.

Information technology--Study and teaching (Secondary)
Computer programming--Study and teaching (Secondary)
Victorian Certificate of Education examination.

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Printed in Australia by Ligare Pty Limited.
1 2 3 4 5 6 7 20 19 18 17 16

CONTENTS

PREFACE

This sixth edition of *Computing VCE Units 1 & 2* incorporates the changes to the VCAA VCE Computing Study Design that took effect from 2016.

This book looks at how individuals and organisations use, and can be affected by, information systems in their daily lives.

We believe that teachers and students require a text that focuses on the Areas of Study specified in the Study Design, and that presents information in a sequence that allows easy transition from theory into practical assessment tasks. We have therefore written this book so that a class can begin at Chapter 1 and work their way systematically through to the end. Students will encounter material relating to the key knowledge dot points for each Outcome before they reach the special section that describes the outcome. The Study Design outlines key skills that indicate how the knowledge can be applied to produce a solution to an information problem. These Preparing for Outcomes sections occur regularly throughout the book, and flag an appropriate point in the student's development for each outcome to be completed. The authors have covered all key knowledge dot points for the outcomes from the Units 1 & 2 course.

Our approach has been to focus on the key knowledge required for each school-assessed outcome, and to ensure that students are well prepared for these; however, there is considerable duplication in the Study Design relating to the knowledge required for many of the outcomes. We have found that, with an outcomes approach, sometimes we are covering material several times. For example, knowledge of a problem-solving methodology is listed as key knowledge for five different outcomes. In these cases, we have tried to cover the concept generally in the first instance, and specifically apply it to a situation relevant to the related outcome on subsequent encounters.

The authors assume teachers will help students to develop the required key skills within the context of the key knowledge addressed in this book and the resources available to them.

We have incorporated a margin column in the text that provides additional information, clarification of terms and reinforcement of key concepts. The margin column also includes activities related to the topics covered in the text, and a consideration of issues relevant to the use of information systems.

Outcome features are included at several points in the book, indicating the nature of the tasks that students are to undertake to complete the school-assessed Outcomes. The steps required to complete the Outcomes are listed, together with advice and suggestions for approaching the task. The output and support material needed for submission are described. Sample tasks and further advice relating to the outcomes are available at **http://computing1and2.nelsonnet.com.au.**

The chapters are organised to present the optimum amount of information in the most effective manner. The text is presented in concise, clearly identified sections to guide students through the text. Each chapter is organised into the sections described on pages **viii–xi**.

9780170364744

ABOUT THE AUTHORS

James Lawson is Head of Computing at Trinity Grammar School, and has taught VCE Computing since 1995. He has been an exam assessor for Computing, and has on a number of occasions presented at both the Victorian Information Technology Teachers' Association (VITTA, now known as Digital Learning and Teaching Victoria or DLTV) and the History Teachers' Association of Victoria (HTAV).

Dr Therese Keane is a senior lecturer at Swinburne University. Therese has worked in a variety of school settings where she taught IT and was the Director of ICT. She holds a Doctorate in Education focusing on ICT leadership in schools. Therese is a member of the ACS ICT Educators Board and a Committee Member on the DLTV and a former office holder in VITTA and the ICTEV. She has presented numerous seminars and workshops for teachers involved in teaching IT. Therese has written several textbooks in all units of VCE Information Technology since 1996. Therese's current work involves providing professional development to IT teachers, delivering workshops and presentations to secondary students and researching the use of technology and computers in schools for teaching and learning purposes.

Mark Kelly learned to program in FORTRAN in 1975, bought his first computer – a Tandy TRS-80 with 4KB of RAM – in 1978 and has been programming and researching IT ever since. He taught VCE IT for 20 years after 10 years teaching English and Psychology. At McKinnon Secondary College he was Systems Manager and author of Rupert, the college's student reporting database.

Colin Potts is Assistant Headmaster (Academic Programs) at Trinity Grammar School, and has taught computing classes for a number of years. He is also a former president of VITTA.

Anthony Sullivan has been teaching Commerce and Computing for more than 20 years. He has taught in both government and non-government settings in Australia and has also taught courses in international schools and schools in the United Kingdom. Anthony has presented at a range of conferences and events on VCE Information Technology and Computing and was a member of the VCE Information Technology Study Design Review Panel.

HOW TO USE THIS BOOK

Key knowledge

The key knowledge that is covered in each chapter is listed on the first page. The list includes key knowledge specified in the outcome related to the chapter.

For the student

The first page of each chapter includes an overview of the chapter's contents so that students are aware of the material they will encounter.

For the teacher

This section outlines how the chapter fits into the overall study of VCE Computing, and indicates how the material relates to the completion of outcomes.

Chapters

The major learning material in the chapter is presented as text, photographs and illustrations. The text describes in detail the theory associated with the stated outcomes of the Computing VCE Units 1 & 2 course in language that is clear and appropriate for students at this level. The photographs show actual hardware, software and other objects described in the text. Illustrations are used to demonstrate concepts that are more easily explained in this manner.

Throughout the chapter, glossary terms are highlighted in bold, blue text. They are defined at the end of the chapter, in Essential terms.

Margin column

The margin column contains further explanations that support the main text, weblink icons, additional material outside the Study Design, and cross-references to material covered elsewhere in the textbook. Issues relevant to information systems and computing in general that will promote classroom discussion are also included in the form of 'Think about Computing' boxes.

THINK ABOUT COMPUTING 1.1
What are some advantages and disadvantages of printed newspapers and online newspapers?

Chapter summary

The chapter summary at the end of each chapter is divided into two main parts to help you review each chapter.

Essential terms are the glossary terms that have been highlighted throughout the chapter.

Important facts are a list of summaries, ideas, processes and statements relevant to the chapter, in the order in which they occur in the chapter.

Test your knowledge

Short-answer questions are provided to help students when reviewing the chapter material. The questions are grouped and identified with a section of the text to allow the teacher to direct appropriate questions based on material covered in class. Teachers will be able to access answers to these questions at **http://computing1and2.nelsonnet.com.au**.

Apply your knowledge

Each chapter concludes with a set of questions requiring students to demonstrate that they can apply the theory from the chapter to more complex questions. Teachers will be able to access suggested responses to these applications at **http://computing1and2.nelsonnet.com.au**.

Preparing for the outcomes

This section appears at points in the course where it is appropriate for students to complete an outcome task. The information provided describes what the students need to do in the outcome, the suggested steps to be followed when completing the task, and the material that needs to be submitted for assessment.

NelsonNet

The NelsonNet student website contains:

- multiple-choice quizzes for each chapter

The NelsonNet teacher website also contains:

- answers for the Test your knowledge and Apply your knowledge questions in the book
- Sample SACs
- chapter tests
- practice exams for each unit.

Please note that complimentary access to NelsonNet and the NelsonNetBook is only available to teachers who use the accompanying student textbook as a core educational resource in their classroom. Contact your sales representative for information about access codes and conditions.

An open-access weblink page is also provided, for all weblinks that appear in the margins throughout the textbook. This is accessible at **http://computing1and2.nelsonnet.com.au**.

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OUTCOMES

OUTCOME	KEY KNOWLEDGE	REFERENCE
Unit 1 Area of Study 1 Outcome 1	**Data and graphic solutions** On completion of this unit the student should be able to acquire, secure and interpret data, and design and develop a graphic solution that communicates the findings of an investigation.	Chapter 1 and Chapter 2
Data and information	• types and purposes of qualitative and quantitative data	pp. 3–4
	• sources of, and methods and techniques for, acquiring and referencing primary data and information	pp. 5–9, 12–14
	• factors affecting the quality of data and information such as relevance, accuracy, bias and reliability	pp. 9–11
	• techniques for authorising the collection and use of data and information such as using consent forms	pp. 15–18
	• techniques for protecting the privacy of the providers of data and information such as de-identifying personal data	p. 19
Digital systems	• physical and software controls used to protect the security of stored data such as backing up, usernames and passwords, systems protection software and encryption	pp. 20–2
Interactions and impact	• Australian Privacy Principles relating to the acquisition, management and communication of data and information, including non-identification of individuals (principle 2), information only being held for its primary purpose (principle 6)	pp. 22–4
	• ethical dilemmas arising from data acquisition strategies	pp. 24–5
Approaches to problem solving	• types of graphic solutions suitable for educating, persuading and informing audiences	pp. 43–51
	• design tools for representing the functionality and appearance of graphic solutions such as input–process–output charts (functionality) and annotated diagrams/mock ups (appearance)	pp. 66–8
	• formats and conventions suitable for graphic solutions such as titles, text styles, shapes, lines and arrows, sources of data and legend, colours and contrasts	pp. 56–66
	• software functions and techniques for efficiently and effectively manipulating data to develop graphic solutions, and for validating data	pp. 31–42, 68–73
	• techniques for testing graphic solutions	pp. 68–73
Key skills	• frame an investigation inquiry	pp. 32–42
	• identify, legally and ethically acquire, and reference data and information from primary sources	pp. 78–9
	• devise and implement controls and techniques to minimise risks to the security and privacy of data and information	pp. 20–2
	• interpret selected data, identifying relationships and patterns	pp. 29, 78
	• select and apply appropriate design tools to represent the functionality and appearance of graphic solutions for particular purposes	p. 67
	• use software, and select and apply functions, formats, conventions, data validation and testing techniques to efficiently manipulate data and create graphic solutions	p. 69
Unit 1 Area of Study 2 Outcome 2	**Networks** On completion of this unit the student should be able to design a network with wireless capability that meets an identified need or opportunity, explain its configuration and predict risks and benefits for intended users.	Chapter 3
Digital systems	• applications and capabilities of Local Area Networks (LANs) and Wide Area Networks (WANs)	pp. 82–4
	• functions and characteristics of key hardware and software components of networks required for communicating and storing data and information	pp. 90–100
	• purposes of network protocols	pp. 101–4
	• strengths and limitations of wireless communications technology, measured in terms of data transfer rate, data storage options, cost, security and reliability	pp. 112–16
	• types, capabilities and limitations of mobile devices connected to networks	pp. 104–9
	• security threats to data and information communicated and stored within networks	pp. 116–18, 126
	• technical underpinnings of malware that intentionally threaten the security of networks	pp. 117–18

OUTCOME	KEY KNOWLEDGE	REFERENCE
Interactions and impact	• ways in which people, processes, digital systems and data combine to form networked information systems	pp. 84–90
	• legal requirements and ethical responsibilities of network professionals and users of networks with respect to social protocols and the ownership of data and information	pp. 122–4
	• risks and benefits of using networks in a global environment	pp. 124–6
Key skills	• describe the capabilities of different networks and wireless communications technology	pp. 132–3
	• compare the capabilities of a range of network components to support the communication and storage of data and information	pp. 132–8
	• apply design thinking skills when configuring a network solution with wireless capability, taking into account how data and information are transmitted and secured	pp. 132–8
	• apply systems thinking skills to predict risks and benefits of the implementation of a new or modified network solution with wireless capability for the users	pp. 132–8
Unit 1 Area of Study 3 Outcome 3	**Collaboration and communication** On completion of this unit the student should be able to apply the problem-solving methodology to create a solution using database management software, and explain the personal benefits and risks of interacting with a database.	Chapter 4 and Chapter 5
Interactions and impact	• applications of information systems in a range of settings	pp. 140–52
	• a detailed study in a particular field such as entertainment, agriculture, finance, sport, health, that focuses on: – the nature of a contemporary issue associated with the use of information systems – legal, social, environmental or ethical reasons for a contentious issue – types and capabilities of digital systems associated with the field and issue – key stakeholders such as individuals, organisations and governments, and their responsibilities – positive and negative opinions of each stakeholder about the issue	pp. 140–52
	• ways in which end-users can express opinions on websites about how information systems are used for particular purposes such as writing a review in a text box and a rating system	pp. 153–4
Data and information	• sources of, and methods and techniques for, acquiring and referencing primary data and secondary data and information	pp. 155–8
	• factors affecting the integrity of data, such as correctness, reasonableness and accuracy	pp. 158–9
Digital systems	• advantages and disadvantages of using cloud solutions, and using cloud computing for storing, communicating and disposing of data and information	pp. 159–60
	• impact of growth of mobile devices on website design	pp. 160–1
Approaches to problem solving	• visualising thinking tools and techniques for supporting reasoning and decision making when analysing issues and ethical dilemmas	pp. 142–4
	• key principles of information architecture	pp. 177–80
	• characteristics of effective user interfaces for mobile devices, for example useability, accessibility, tolerance, visibility, legibility, consistency, affordance	pp. 171–6
	• design principles that influence the appearance of websites	pp. 181–94
	• design tools and techniques for representing websites	pp. 195–204
	• formats and conventions suitable for websites	pp. 201–3
	• software functions and techniques for manipulating and validating data, and testing websites	pp. 205–8
	• tools and techniques for coordinating the tasks, people, digital systems resources and time required to create solutions	pp. 168–71
Key skills	• select and apply appropriate methods and techniques to acquire and reference data and information	pp. 155–8
	• use digital systems to document and monitor project plans when creating team solutions	pp. 168–71, 213–15
	• analyse the causes and effects of issues using visualising thinking tools	pp. 142–4
	• synthesise viewpoints to formulate a team's point of view	p. 183
	• evaluate cloud computing as a data storage solution	p. 165

OUTCOME	KEY KNOWLEDGE	REFERENCE
	• select and use digital system components appropriate to a team's needs	pp. 211–15
	• select appropriate design tools and represent the appearance and functionality of solutions, taking into account user interactions	pp. 213–15
	• recommend online techniques for encouraging end-users' support of published viewpoints	pp. 211–15
	• use web authoring software and select and apply functions and techniques to manipulate data and create solutions	pp. 213–15
Unit 2 Area of Study 1 Outcome 1	**Programming** On completion of this unit the student should be able to design working modules in response to solution requirements, and use a programming or scripting language to develop the modules.	Chapter 6
Data and information	• characteristics of data types and methods of representing and storing text, sound and images	pp. 225–8
Digital systems	• functions and capabilities of key hardware and software components of digital systems required for processing, storing and communicating data and information	pp. 219–24
Approaches to problem solving	• functional requirements of solutions	pp. 228–9
	• methods for creating algorithms such as identifying the required output, the input needed to produce the output, and the processing steps necessary to achieve the transformation from a design to a solution	pp. 228–35, 240–4
	• suitable methods of representing solution designs such as data dictionaries, data structure diagrams, object descriptions and pseudocode	pp. 229–35
	• characteristics of effective user interfaces, for example useability, accessibility, structure, visibility, legibility, consistency, tolerance, affordance	pp. 235–9
	• techniques for manipulating data and information	pp. 250–5
	• naming conventions for files and objects	pp. 230–1
	• testing and debugging techniques, including construction of test data.	pp. 244–9
Key skills	• interpret solution requirements	p. 260
	• select and use appropriate methods for expressing solution designs, including user interfaces	p. 260
	• apply techniques for manipulating data and information using a programming or scripting language	p. 260
	• devise meaningful naming conventions for files and objects	pp. 230–1
	• apply testing techniques using appropriate test data	p. 260
Unit 2 Area of Study 2 Outcome 2	**Data analysis and visualisation** On completion of this unit the student should be able to apply the problem-solving methodology and use appropriate software tools to extract relevant data and create a data visualisation that meets a specified user's needs.	Chapter 7
Data and information	• sources of authentic data in large repositories	pp. 264–7
	• factors influencing the integrity of data, for example accuracy, timeliness, authenticity, relevance	pp. 267–9
	• characteristics of data types and data structures relevant to selected software tools	pp. 269–71
Approaches to problem solving	• types and purposes of data visualisations	pp. 271–7
	• problem-solving activities related to analysing needs: functional and non-functional requirements and constraints	pp. 277–9
	• characteristics of file formats and their suitability to be converted to other formats	pp. 288–9
	• design tools for representing data visualisations	pp. 279–81
	• formats and conventions applied to visualisations to improve their effectiveness for intended users	pp. 281–2
	• functions of appropriate software tools to extract targeted data and to manipulate data when developing visualisations	pp. 282–7
	• criteria and techniques for evaluating visualisations	pp. 289–92

OUTCOME	KEY KNOWLEDGE	REFERENCE
Key skills	• analyse needs to define specific requirements	pp. 295–9
	• identify and extract, using software functions, relevant data from appropriate data sources	pp. 295–9
	• prepare data structures relevant to the software tools	pp. 295–9
	• interpret selected data, identifying relationships and patterns	pp. 295–9
	• select and apply appropriate tools to represent the design of selected visualisations	pp. 295–9
	• use appropriate software and select and apply functions, formats and conventions to manipulate the extracted data to create data visualisations	pp. 295–9
	• select appropriate techniques and apply criteria to determine the extent to which data visualisations meet users' needs	pp. 295–9
Unit 2 Area of Study 3 Outcome 3	**Data management** On completion of this unit the student should be able to apply the problem-solving methodology to create a solution using database management software, and explain the personal benefits and risks of interacting with a database.	Chapter 8
Data and information	• data sources and methods of data acquisition	pp. 308–10
	• characteristics of effective data collection tools and user interfaces for the purposes of entering data efficiently	pp. 310–12
	• characteristics of data types	pp. 307–8
Digital systems	• capabilities and limitations of database management software to manipulate data	p. 302
	• roles, functions and characteristics of hardware components used to input, store, communicate and output data and information	pp. 329–31
	• accidental and deliberate security threats to data and information stored within databases	p. 332
	• physical and software controls suitable for protecting the security of stored and transmitted data	pp. 333–5
Approaches to problem solving	• the structure of a database, including fields, records and tables	pp. 303–6
	• design tools for representing input forms to capture data and reports to meet specific needs	pp. 315–16, 318–19
	• design tools for representing the structure of databases	pp. 312–14
	• techniques for manipulating and validating data	pp. 316–18, 319
	• formats and conventions applied to create effective solutions	pp. 311–35
Interactions and impact	• applications of database systems in a range of settings	pp. 311–35
	• personal benefits and risks arising from the use of databases	p. 303
Key skills	• analyse needs or opportunities for database management solutions	pp. 311–35
	• use appropriate techniques to describe data types and database structures	pp. 311–35
	• identify and collect data from appropriate sources, using data collection tools that facilitate efficient data entry	pp. 343–4
	• apply suitable functions to validate and manipulate data efficiently	p. 340
	• construct queries to locate data that matches specific criteria	p. 340
	• apply formats and conventions to create effective forms and reports	pp. 343–4
	• evaluate the value of using a database system in fulfilling a personal need	p. 340

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PROBLEM-SOLVING METHODOLOGY

When an information problem exists, a structured problem-solving methodology is followed to ensure that the most appropriate solution is found and implemented. For the purpose of this course, the problem-solving methodology has four key stages: Analysis, design, development and evaluation. Each of these stages can be further broken down into a common set of activities as shown in Figure 1. Each unit may require you to examine a different set of problem-solving stages. It is critical that students understand the problem-solving methodology, because it underpins the entire VCE Computing course.

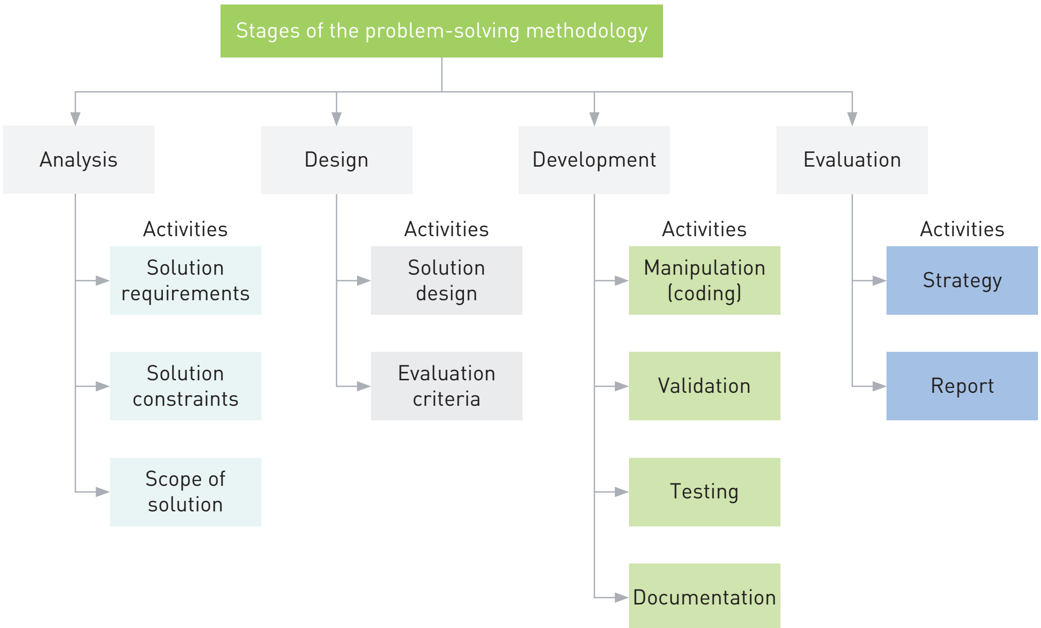

FIGURE 1 The four stages of the problem-solving methodology and their key activities.

Analyse the problem

The purpose of analysis is to establish the root cause of the problem, the specific information needs of the organisation involved, limitations on the problem and exactly what a possible solution would be expected to do (the scope). The three key activities are:

1. identifying solution requirements – features and functionality that the solution needs to include, information it must produce and data needed to produce this information
2. establishing solution constraints – the limitations on solution development that need to be considered. Constraints are classified as economic, technical, social, legal and related to useability
3. defining the scope of the solution – what the solution will and will not be able to do, as well as how the user will benefit.

Design the solution

During the design stage, generate an appropriate design idea. Criteria are also created to evaluate the solution's success once it has been implemented. The two key design activities are:

1. creating the solution design – it must clearly show a developer what the solution should look like and how its data elements should be structured, validated and manipulated. Tools typically used to represent data elements could include data dictionaries, data structure diagrams, input–process–output (IPO) charts, flowcharts, pseudocode (or structured English) and object descriptions. The following tools are also used to show the relationship between various components of the solution: storyboards, site maps, entity–relationship diagrams,

data flow diagrams, structure charts, hierarchy charts and context diagrams. Furthermore, the appearance of the solution needs to be planned so that overall layout, fonts and their colours, for example, can be represented. Layout diagrams and annotated diagrams (or mock-ups) usually fulfil this requirement. A combination of tools from each of these categories will be selected to represent the overall solution design

2. specifying evaluation criteria – during the evaluation stage, the solution is assessed to establish how well it has met its intended objectives. The criteria for evaluation must be created during the design stage so that all personnel involved in the task are aware of the level of performance that ultimately will determine the success or otherwise of the solution. The criteria are based on the solution requirements identified in the analysis stage.

Develop the solution

During this stage, the solution is created by the developers from the designs supplied to them. The 'coding' takes place, while the input data is checked (validation), the solution is tested and any user documentation is created. The four activities involved with development are:

1. manipulating or coding the solution – the designs are used to build the electronic solution. The coding will occur here and internal documentation will be included where necessary
2. checking the accuracy of input data by way of validation – manual and electronic methods are used; for example, proofreading is a manual validation technique. Electronic validation involves using the solution itself to ensure that data is reasonable. Electronic validation, along with any other formulas, always needs to be tested to ensure that it works properly
3. ensuring that a solution works through testing – each formula and function, not to mention validation and even the layout of elements on the screen, need to be tested. Standard testing procedures involve stating what tests will be conducted, identifying test data, stating the expected result, running the tests, stating the actual result and correcting any errors
4. documentation allowing users to interact with (or use) the solution – while it can be printed, in many cases it is now designed to be viewed on screen. User documentation normally outlines procedures for operating the solution, as well as generates output (like reports) and basic troubleshooting.

Evaluate the solution

Sometime after a solution has been in use by the end user or client, it needs to be assessed or evaluated to ensure that it has been successful and actually meets the user's requirements. The two activities involved in evaluating a solution are:

1. working out an evaluation strategy – creating a timeline for when various elements of the evaluation will occur and how and what data will be collected (because it must match the criteria created in the design stage)
2. reporting on the success of the solution – providing feedback to the user about how well the solution meets their requirements. This is based on the findings of the data gathered at the beginning of the evaluation stage when compared with the evaluation criteria created during the design stage.

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KEY CONCEPTS

Each VCE Computing subject contains four key concepts whose purpose is to organise course content into themes. These themes are intended to make it easier to teach and make connections between related concepts and to think about information problems. Key knowledge for each Area of Study is categorised into these key concepts, but not all concepts are covered by each Area of Study. The four key concepts are:

1. data and information
2. digital systems
3. approaches to problem solving
4. interactions and impact.

Data and information focuses on the acquisition, structure, representation and interpretation of data and information in order to elicit meaning or make deductions. This step needs to be completed in order to create solutions.

Digital systems focus on how hardware and software operate in a technical sense. This also includes networks, applications, the internet and communication protocols. Information systems have digital systems as one of their parts. The other components of an information system are people, data and processes.

Approaches to problem solving focuses on thinking about problems and ways of creating solutions. Computational, design and systems thinking are the three key problem solving approaches.

Interactions and impact focuses on relationships that exist between different information systems and how these relationships affect the achievement of economic and social goals. Three types of relationships are considered: people interacting with other people when collaborating or communicating with digital systems, how people interact with digital systems and how information systems interact with other information systems. This theme also looks at the impact of these relationships on information needs, privacy and personal safety.

UNIT 1

INTRODUCTION

VCE Unit 1 of *Computing* looks at how individuals and organisations use, and can be affected by, information and networked digital systems in their daily lives.

Throughout the unit, students will apply the design and development stages of the problem-solving methodology. They will acquire and apply the knowledge and skills to work with different data types to create solutions that can be used to persuade, educate, inform and entertain.

This unit also examines the role of networked information systems in the communication of data within a global environment and an exploration of mobile devices.

Several issues relating to the effect of information systems on students themselves are also examined and students are required to work collaboratively to examine these issues.

There are three outcomes to be completed in Unit 1.

AREA OF STUDY 1: DATA AND GRAPHIC SOLUTIONS

Outcome 1

You will collect your own data and information, and design and develop solutions that meet specific purposes using software to create a graphic solution. The information you produce should be in graphic form. You are only required to apply the design and development stages of the problem-solving methodology, but you should undertake your own investigation.

AREA OF STUDY 2: NETWORKS

Outcome 2

You must propose a networked information system with wireless capability for a specific purpose, and explain the security threats that exist within the networked information system. You must also explain the configuration of the network and suggest the risks and benefits of its use for intended users, including potential legal requirements and ethical responsibilities. Throughout this Outcome, you will explore the exchange of data and information within a networked information system. You will also learn the use of mobile devices within networks, and how the security of data and information exchanged within a network can be threatened.

AREA OF STUDY 3: COLLABORATION AND COMMUNICATION

Outcome 3

You will work in teams to design and develop a website that analyses a chosen contemporary issue and supports your team's point of view. In analysing an information systems issue, you will consider the tensions and conflicts between different stakeholders and then, using visualising thinking tools, explore your own opinions. You will manipulate acquired primary and secondary data and, optionally, develop graphical representations that form part of your website. You will also engage in project management and use digital systems to form and monitor plans.

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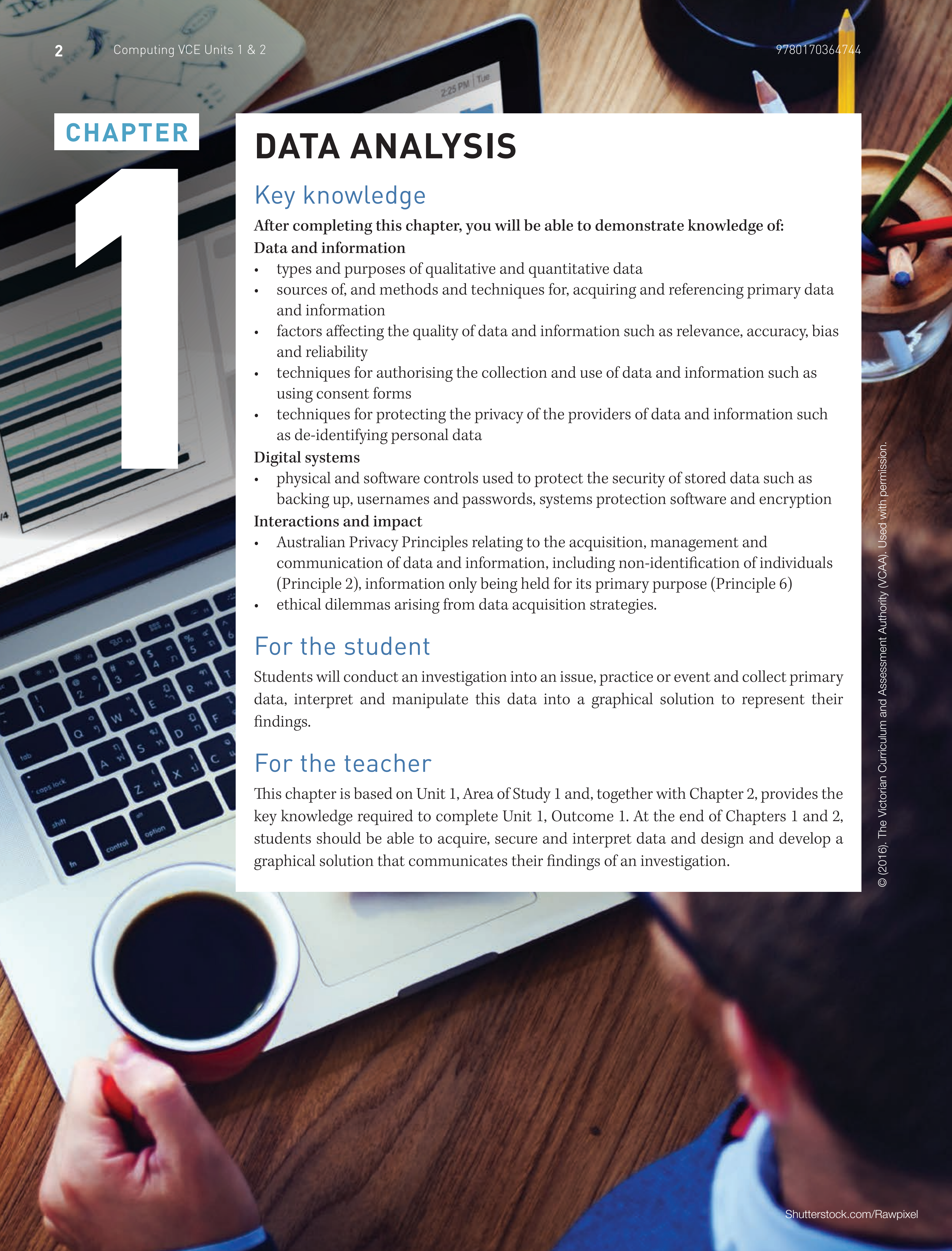

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CHAPTER 1

DATA ANALYSIS

Key knowledge

After completing this chapter, you will be able to demonstrate knowledge of:

Data and information

- types and purposes of qualitative and quantitative data
- sources of, and methods and techniques for, acquiring and referencing primary data and information
- factors affecting the quality of data and information such as relevance, accuracy, bias and reliability
- techniques for authorising the collection and use of data and information such as using consent forms
- techniques for protecting the privacy of the providers of data and information such as de-identifying personal data

Digital systems

- physical and software controls used to protect the security of stored data such as backing up, usernames and passwords, systems protection software and encryption

Interactions and impact

- Australian Privacy Principles relating to the acquisition, management and communication of data and information, including non-identification of individuals (Principle 2), information only being held for its primary purpose (Principle 6)
- ethical dilemmas arising from data acquisition strategies.

For the student

Students will conduct an investigation into an issue, practice or event and collect primary data, interpret and manipulate this data into a graphical solution to represent their findings.

For the teacher

This chapter is based on Unit 1, Area of Study 1 and, together with Chapter 2, provides the key knowledge required to complete Unit 1, Outcome 1. At the end of Chapters 1 and 2, students should be able to acquire, secure and interpret data and design and develop a graphical solution that communicates their findings of an investigation.

Understanding research

Some people consume research, and others produce research. Consumers of research spend a lot of time reading other people's research rather than conducting their own. On the other hand, producers of research investigate or explore an area that has relevance to them, interpret their data and then communicate their findings.

Producers of research often start with a theory or a research question, from which they generate a **hypothesis**, test the hypothesis and then interpret the results, as can be seen in Figure 1.1.

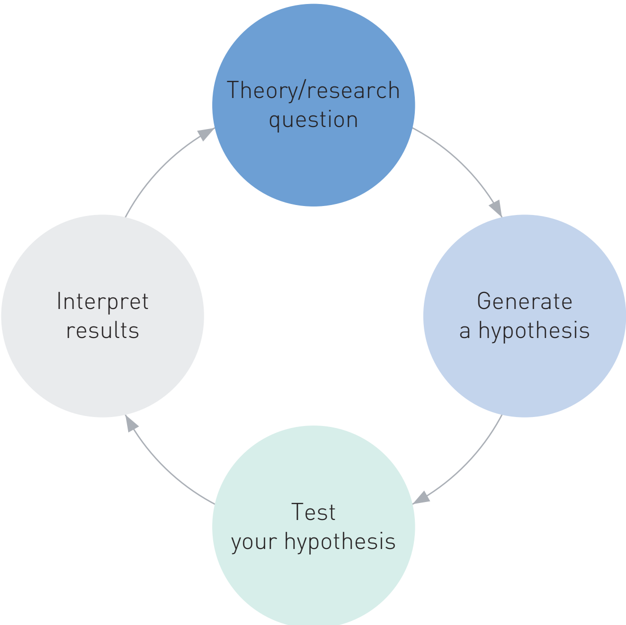

FIGURE 1.1 Producers of research often start with a theory or a research question; then they generate a hypothesis, test the hypothesis and interpret the results

Theories are usually general statements that describe something, provide an explanation of why something happens and can be applied to predict what will happen in the future. Theories are in principle falsifiable or disprovable; that is, they contain information about the sorts of events that, if they were to happen, would show the theory to be false. Some research questions are tied closely with theories. Research questions assist researchers to narrow the focus of the topic of investigation. For example, 'Do science and innovation boost our standard of living and contribute to economic growth?'

Hypotheses, on the other hand, are based on probabilities about what will happen according to the applied theory. Theories are tested by using data collection tools such as questionnaires and/or interviews, and then the results of the study will either confirm or disprove the hypothesis.

A scientific theory summarises a hypothesis that has been supported with repeated testing. A theory is valid as long as there is no evidence to dispute it.

Types of research

An approach to investigate the topic of interest is through quantitative or qualitative research.

Quantitative data is measurable and specific and therefore easier to chart or graph. At a simplistic level, quantitative data gathering is based on verifying theory through the use of statistics and largely numerical data, while qualitative data provides a more in-depth understanding. An example of quantitative data is:

> Of the teachers who teach mathematics to secondary school students (Years 7 to 10), 61 per cent have studied mathematics at university to at least second-year level.
>
> Benchmarking Australian Science, Technology, Engineering and Mathematics, Office of the Chief Scientist, November 2014, p.98

SPSS and MiniTab are statistical software packages used to analyse quantitative data.

When data has been gathered using surveys, focus groups, observation or other methods, quantitative data can be analysed by using software such as Excel, the Statistical Package for the Social Sciences (SPSS) and Minitab. This takes time and often involves hours of data entry, depending on the complexity of the data gathering instrument. For simple data gathering, online surveys such as SurveyMonkey allow users to create surveys and manage the collection and analysis of quantitative data. Most online survey software also permits **qualitative data** to be entered.

NVivo is a qualitative data analysis computer software package. It has been designed for qualitative researchers working with very rich text-based and/or multimedia information, where deep levels of analysis of data are required.

Qualitative data is harder to measure than quantitative data. You can gather qualitative data using instruments such as interviews, focus groups, video footage and observation. Generally, qualitative data needs to be recorded accurately and transcribed at a later stage. The analysis of the qualitative data is also quite different from that of quantitative data. With quantitative data, the researcher looks for themes or patterns through the use of numbers, while with qualitative data, the researcher establishes rich descriptions and finds themes through reading the text and classifying these themes. An example of qualitative data gathering is more descriptive:

> From 2003 to 2012, the mean PISA scores in mathematics declined, while the number of countries performing better than Australia increased. PISA also shows that Australian students' proficiency in mathematics is declining, with the proportion of low performers rising and the proportion of top performers falling.
>
> Benchmarking Australian Science, Technology, Engineering and Mathematics, Office of the Chief Scientist, November 2014, p.100

Advantages and disadvantages of quantitative and qualitative data

Participants are more willing to be part of a quantitative study as it is less demanding of them. Often, quantitative studies use questionnaires, which can capture a large sample size. Having a large sample size provides statistical validity, and helps to accurately reflect the population. Data is then interpreted, relationships identified and findings are then communicated. Conversely, because questionnaires do not have the provision to probe the participants further, the answers provided do not have as much depth and are at times superficial. If too much information were provided, researchers would be overwhelmed by the amount of data collected and would not be in a position to analyse it.

Qualitative research provides for rich, in-depth study of participants. Researchers can ask further questions, especially if something of interest arises. Generally, qualitative studies are small, and provide a narrative description of a sample group. Data gathering tools can include interviews and focus groups. However, because the sample size is small and the sample is not very random, conclusions may not generalise to a larger sample size; therefore, findings may be peculiar to a particular sample.

Data and information

Technically speaking, a datum is a single item of data; however, the term 'data' is commonly used and accepted as both the singular and plural forms of the word.

Information systems focus on both the transformation of **data** into **information** and the management of that information. Critical to using digital systems to solve information problems is an understanding of how data can be input to a computer and then manipulated to create meaningful information. The term 'data' refers to the raw, unorganised facts, figures and symbols fed to a computer during the input process. Data can also mean ideas or concepts before they have been refined. In addition to text and numbers, data also includes sounds, and images (still and moving).

Information is produced when data is manipulated by the computer's processor into a meaningful and useful form, thus becoming information. This can be achieved by organising the data and presenting it in a way that suits the needs of the intended audience. The information produced can be used to inform, entertain or persuade an audience.

Gathering data: Primary data and information

Sources

Primary sources are usually the **stakeholders** in a particular issue – the topic that you are investigating as part of your hypothesis. To question them or survey their opinions can provide different insights and often more in-depth data than information from **secondary sources**. The data will often be more up-to-date and can provide more unusual and important insights into issues, especially at the immediate local level, than secondary sources can, which often present overall conclusions and general summaries. When data is collected, often by non-stakeholders, they frequently use observation and measurement.

Techniques and methods

Collecting data from the stakeholders directly is usually conducted through methods such as surveys using questionnaires, and interviews. While the results of questionnaires are easy to present graphically, interview results often can only be presented as written summaries and conclusions. However, both require analytical discussions to interpret their meaning.

A **questionnaire** is usually a set of questions that ask for a response to be selected from a list of alternatives, such as A, B, C, D; or a range, either 1–5 or very low to very high. Such questionnaires can easily be given to many people, and are easily processed and analysed using computer-based methods since the answers are able to be recorded as numbers.

Another type of questionnaire provides space for short, focused free-form answers similar to those obtained from an interview about particular aspects of an issue; for example, 'Describe the feelings you have when you are playing your favourite computer game' (in an interview, this question would be followed up with 'Why?' or 'What part of the game causes these feelings?'). However, because of their free form, which does not lend itself to being recorded numerically, these answers tend to be more difficult to analyse.

Interviews are usually conducted face to face (technique), sometimes in groups, and can take a substantial amount of time. A major feature of an interview is the opportunity for in-depth follow-up and clarification questions that cannot be done with questionnaires, which are often answered in private. Interviews are very useful for eliciting the feelings, attitudes and opinions of people that are too complex to easily record in a questionnaire.

Other ways to collect data electronically include sensors such as traffic cameras, satellites and online sources, such as websites or data logs. The data collected can also be used for a variety of purposes, including describing, predicting and improving processes within an organisation, or for research.

ISSUE MH370 search: How new satellite data confirmed Malaysia Airlines plane was lost

[25 March 2014, Nick Miller, Europe correspondent] Sydney Morning Herald

British satellite company Inmarsat analyses seven, hourly pings sent by the missing Malaysian Airlines flight to determine its final resting place.

London: A new satellite tracking technique is what gave Malaysian Prime Minister Najib Razak enough confidence to announce that Malaysia Airlines flight MH370 went down in the remote south of the Indian Ocean.

British firm Inmarsat was behind an earlier analysis that indicated the plane had been flying in one of two big 'corridors', one in the northern hemisphere and one in the southern.

However last week it went back to its data and tried a new mathematical analysis, which concluded on Sunday.

The new analysis allowed them to discard the northern corridor, and focus more precisely on the southern route.

Based on this new information, Mr Najib announced on Monday that MH370's last known position was in the middle of the Indian Ocean, west of Perth.

UK firm Inmarsat was behind an earlier analysis of the path of missing flight MH370.

The nature of the pings indicated that the plane was still moving during that time.

'This is a remote location far from any possible landing sites,' he said. 'It is therefore with deep sadness and regret that I must inform you that … flight MH370 ended in the southern Indian Ocean.'

The aeroplane had Inmarsat's 'Classic Aero' satellite system, which collects information such as location, altitude, body heading and speed, and sends it through Inmarsat's satellites into their network.

This 'ACARS' (aircraft communications addressing and reporting system) was switched off or interrupted early in the flight, meaning no such information was available to track the plane.

However the Classic Aero system still sent hourly 'pings' back to Inmarsat's satellite for at least five hours after the aircraft left Malaysian airspace, the company discovered.

These pings contained no data – they were just a simple 'hello' to keep the link open – however, their timing and frequency contained hidden mathematical clues.

The company looked at the 'Doppler effect' – tiny changes in the frequency of the ping signal, caused by the relative movement of the satellite and the plane (the Doppler effect is the reason why, for example, police sirens are a different pitch or frequency depending on whether they are travelling toward you or away from you).

This analysis allowed Inmarsat to map two huge 'corridors' for the plane's possible location, in big arcs stretching thousands of kilometres north and south of the point where the last radar contact with MH370 was made.

Australian and US experts took this information, added some assumptions about the plane's speed, and narrowed the southern option into an area of ocean that could be realistically searched.

Meanwhile, Inmarsat went back to its satellite data. Its new analysis found that the northern route did not quite correlate with the frequency of the pings from the plane – meaning the plane must have been heading south.

It also suggested that the plane had been travelling at a steady cruising altitude above 30,000 feet.

They compared satellite data from MH370 with that from previous Malaysian Airlines Boeing 777 flights, going back a few weeks, in order to better model the movement of the plane.

'This really was a shot in the dark,' Chris McLaughlin, senior vice president of external affairs at Inmarsat told the BBC. 'It's a credit to the scientific team that they managed to model this.

'Just a single "ping" can be used to say the plane was both powered up and travelling. And then by a process of elimination comparing it to other known flights and established that it went south.'

The UK's Air Accidents Investigation Branch also contributed to the analysis.

THINK ABOUT COMPUTING 1.1

1. List the various data sources used to search for the missing plane.
2. Why is there a need to use a variety of data sources to assist with locating the missing plane?
3. How has the data assisted with estimating the location of the plane?

Data collection methods

Before we can produce information, we first must start with data. Data collection methods such as surveys/questionnaires, interviews or observation provide a means of capturing data.

Surveys and questionnaires

Surveys and questionnaires are common methods used to collect data. They can provide data about what the respondents think is true, or their preferences for consumer goods and political parties. A questionnaire can be a quick way of gathering large amounts of data. Questionnaires and surveys need to be carefully designed, otherwise the participants' responses may not provide suitable data to analyse, rendering them useless. Questions used in a survey must be carefully worded so that the response will provide meaningful and useful data without the need for further clarification.

Focus groups

A **focus group** is the meeting of a small group of individuals who are guided through a discussion by a researcher. The focus group is carefully selected, so it fits a particular demographic and the researcher can obtain the necessary data through a guided discussion that probes the participant's attitudes about the topic. Focus groups often comprise five to 12 people and the discussion is loosely structured to encourage ideas to flow.

Interviews

Interviews are used to elicit the opinions and beliefs of people. They can be used to gather data for research projects. Interviews are usually conducted one-to-one in a quiet, relaxed atmosphere. They should be recorded, with permission of the interviewee, with easily used and unobtrusive audio equipment or video. Writing down the responses during the interview is not helpful to the interviewer or the interviewee. Collating and analysing information can be difficult and time-consuming, and may require the use of someone with expertise.

Open-ended and closed questions

Questions used on a survey and during an interview can be open-ended or closed. **Closed questions** limit the responses available to the respondent (Figure 1.2). They include 'Yes/No' boxes, multiple-choice questions, and scales on which the attitudes and beliefs are measured, such as 'strongly agree', 'agree', 'disagree' or 'strongly disagree'.

Closed (or closed-ended) questions are generally considered to be quantitative in nature. They are called 'closed' because the range of answers the participant can choose is limited. Closed questions are also known as quantitative, as the response options can be converted to numbers. For example:

How often do you feel that you are overworked with homework?
5 I always feel overworked
4 I sometimes feel overworked
3 I occasionally feel overworked
2 I feel overworked once in a while
1 I never feel overworked

Each of these options can have a value placed next to them. However, we do not talk in numbers and we shouldn't create surveys that only have numbers. Questionnaires and surveys should be thought of as a conversation between the person asking the questions and the person answering them.

Open-ended questions do not limit the answers that can be given by the respondent (see Figure 1.3). They should be worded so that the responses received are capable of correct interpretation. For instance, if you asked the question, 'How do you feel about the widespread use of computer games?', the responses would probably be too broad to be usefully categorised and analysed. The wording must therefore limit the scope of the possible responses to specific areas of interest: 'How has the playing of computer games affected the school results for your children?' Open-ended questions also allow for follow-up questions, which are called probing questions, such as 'Why?' or 'Please give an example'. Such questions tend to elicit more detail.

Open-ended questions allow people to answer the question as they want to. They are called 'open-ended' because participants are free to answer in any manner they choose. Unlike closed questions, there are no response options specified. They are qualitative because responses are considered and measured by feel rather than by numbers.

Closed questions are easier to develop, quicker to administer and answer, easier to collate and analyse, and can provide a large and balanced sample; however, they may not be useful for complex issues. In this case, open-ended questions may be needed as they elicit greater detail in the responses, can bring forth unusual ideas and can show links between various aspects of the issues.

Closed questions
1 How long have you shopped at this store?
2 How many times per week do you go shopping?
3 How much do you spend per week?
4 Which of the following sources of information most influences your purchasing habits?
• Advertising pamphlets delivered to the home
• Newspaper advertisements
• Television promotions
• Recommendations from friends
5 Do you use a computer? • Yes • No
6 What time of day do you normally go shopping?

FIGURE 1.2 Closed questions should be designed to elicit short, straightforward answers

Open-ended questions
1 What is your opinion of the games available from this store?
2 How influential do you think the advertising campaign has been?
3 What are some of the errors in data entry that you have observed?
4 Describe the most frustrating experience you have had when using the computer system.
5 What are some of the problems you experience in receiving information on time?
6 What changes would you recommend to improve the billing system?

FIGURE 1.3 Open-ended questions try not to limit the answers the respondent can give

Observation

Observation is a way of finding out about the world around us. Using our senses, such as sight, smell and hearing, we are able to pick up detailed information about our environment. However, as a method of data collection, observation is more than just looking or listening, as we can be selective about what we perceive to be most useful to us. Researchers engaged in observation attempt to learn what life is like for someone in a particular setting, while they remain an outsider. While observing, they make careful notes of what they see, record all accounts including conversations and interactions. Observation generally takes place in community settings such as classrooms or locations believed to have some relevance to the research questions. Observation is unlike other forms of data collection tools, as the researcher approaches participants in their own environment rather than having the participants come to the researcher.

Quality of data and information

One aspect of identifying relevant data from a given data set is ensuring that the data is usable. To be usable, data must be relevant, accurate, free from bias and reliable.

Relevance

To produce usable information, data must be relevant. For example, if a computing department in an organisation is evaluating PC-only software, then surveying people who only use a Mac is irrelevant. The data collected from Mac users would not be relevant to the overall data collection.

Data also needs to be processed while it is current, because decision making should not be based on outdated data.

Accuracy

Data that is entered into a computer must be accurate. Transcription is often a cause of error. Transcription errors occur when the person entering the data misreads the information through, for example, a lapse in concentration, being interrupted or pressing the wrong key. It is easy to make a mistake when entering a large amount of data, particularly numbers with many digits that may not contain spaces or punctuation to signify thousands. Clearly, if the data collected is incorrect, the information produced will be incorrect. If data has been gathered from a primary source, it is a good idea to check it against this. If data has been gathered from a secondary source and is suspect, it is worthwhile verifying the data using other secondary sources.

Freedom from bias

Bias can easily creep into data and make the information processed from it unreliable. Several influences can result in the introduction of bias into data: namely, vested interest, timing, small sample size, bias through sorting and bias through graphic representations.

Vested interest

Bias can enter data if the respondent to a survey or interview has a **vested interest** in the outcome of the research. A common example is celebrities who are paid to promote particular products in commercials or social media. It would be unreasonable to trust their statements that one product is better than others purely based on the fact that they are celebrities; they are only saying what they have been paid to say and may not necessarily be providing an independent judgement that has been derived from research or experience.

Timing

The timing of the data collection may also introduce bias. For example, you plan to survey a sample of the population for their views about Australia becoming a republic. The data you gather may be biased if, just prior to the survey being conducted, a royal tour takes place and there is extensive media coverage about the Royal Family. The timing of the data collection would introduce bias because it coincides with a significant event that could influence the responses.

Note too that bias is not restricted to data gathered from surveys or during interviews. For example, suppose that Qantas needed to decide whether to schedule two new weekly flights to New York. The decision could depend on the demand for existing flights. If the airline collected data from bookings made over a four-week period just before or during a significant event, the data gathered would be biased. Such data should not be relied on for making this decision because the influence of this event on customer demand is irregular and unlikely to occur again.

Small sample size

Choosing a sample size that is too small may also create bias. The sample size and composition must be suitable for the purpose of the data collection and, usually, a larger sample size leads to greater precision, provided the sample composition is suitably representative of the target population. The sample size must be big enough to make any conclusions drawn and information produced credible. For example, if you wanted to determine whether or not the school uniform should be changed, it would be remiss to only survey students in your class. Not only would this sample not be representative of the student body, but it would also not include other stakeholders, such as parents and school administrators. Similarly, if you wanted to gather sales data over a four-day period to predict monthly sales at a fish and chip shop, this time scale would not be sufficient to make a prediction. For instance, by choosing the four Mondays in the month, you may be selecting the quietest trading days in the week. If you pick the four Fridays in the month, you may be picking the busiest trading days. When selecting a sample size, you need to ensure that it is representative of the whole population.

Bias through sorting

The way in which you sort lists can introduce bias, although frequently this is unavoidable. A classroom teacher often consults a class list that is sorted alphabetically; for example, to select students for special tasks. The list is biased towards students whose surnames appear early in the alphabet and thus at the top of the class list. If you need to hire an electrician and consult a paper-based telephone book or an online directory, it is more likely that you will pick an early entry than one from the second page of listings. Bias of this type is difficult to avoid, so it is preferable to educate the user to recognise that the output has built-in bias and to encourage strategies to overcome that bias.

Bias through graphic representations

Bias can occur through your choice of graphic type, scale used and size chosen. Graphic representations should be sized proportionally to avoid overstating or trivialising the importance of one of the variables involved. For example, in Figure 1.4, a teacher has created a graph to show the heights of her students. The graph does not really give a clear picture of how the heights vary. The bars look as if they are all of similar height, so it is difficult to see the differences between them. In contrast, the different heights in Figure 1.5 are more distinct. This has been achieved by decreasing the scale of the vertical axis. The variation in the student heights looks much greater, even though the data has not changed. This graph makes it easier to see the small differences.

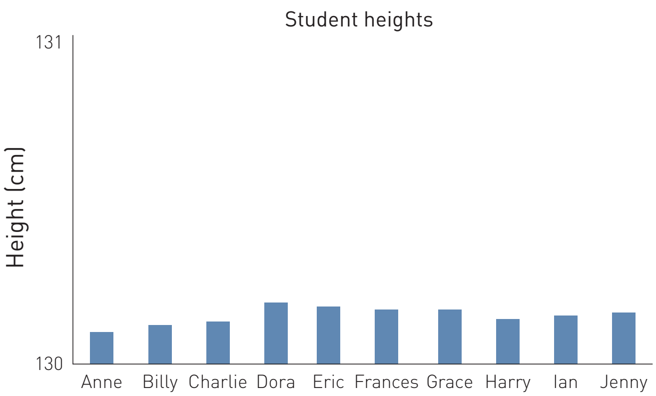

FIGURE 1.4 Column graph with little variation

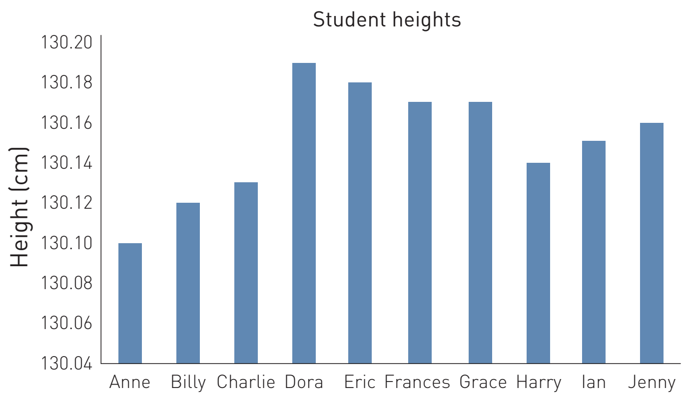

FIGURE 1.5 Column graph with greater variation

Reliability

The internet has made it easier for people to communicate their views and present information in a format that is easily accessible to others. There are many personal websites, homemade videos, wikis, podcasts, vodcasts and a plethora of unchecked information on the internet, and some of the views presented may not be widely accepted or proven to be accurate. Alternatively, there are many sources on the internet that are reliable such as the World Health Organization (WHO), Smithsonian, Australian Bureau of Statistics and universities.

THINK ABOUT COMPUTING 1.2

Find three reliable sources and describe in one paragraph the type of data they produce.

Referencing primary sources

Once primary data has been gathered, details need to be carefully recorded to enable appropriate referencing.

Interviews

For an interview, the following details need to be documented so that an interested person can go back to the source for checking, clarification and further information.

- Name of interviewee
- Date of interview
- Place of interview
- Qualification to be an interviewee – that is, whether the interviewee is a stakeholder in the issue and/or an expert about it

- Organisation to which the interviewee belongs (if relevant)
- Contact information for interviewee – phone number, address, email address, online chat handle
- How the interview was conducted; for example, in person, by phone, email or online chat
- Name and contact details of interviewer

Questionnaires

If you want to cite an individual response to a questionnaire or a survey, you need to record these details.

- Name of respondent
- When the questionnaire was completed
- Title of questionnaire
- Organisation to which the questionnaire belongs (if relevant)
- How the questionnaire was conducted – paper/online

Observation

For observation, the following details need to be recorded.

- The name of the person observed
- When the observation was conducted (date/time)
- Where the observation was conducted

Examples of referencing

Citations in a document help readers to find the source of the information and also assist students to avoid plagiarism. There are many ways to cite sources, such as providing footnotes, in-text citations or listing sources at the end of the document through a bibliography or references list.

Footnotes

Footnotes are listed at the bottom of the page on which a citation is made. Some academic disciplines prefer to use footnotes (notes at the foot of the page) to reference their writing. Although this method differs in style from the 'author, date' system, its purpose – to acknowledge the source of ideas, data or quotations without undue interruption to the flow of the writing – is the same. Footnotes are usually sequenced: series of numbers above the text (superscript) are placed in the appropriate part of the text to indicate the cited work and are matched at the bottom of the page after the footnote. A footnote lists the author, title and details of publication, in that order. Here is an example of a footnote:

> For example, in a 2009 article in the *Australian Financial Review*, journalist Jacqueline Maley wrote about the changing pattern of consumers' expenditure on leisure goods and services following the GFEC.[1]
>
> [1] Jacqueline Maley, 'Tough times bring home life's simple pleasures', *Australian Financial Review*, 7 September 2009, p. 3.

FIGURE 1.6 An example of a footnote: a superscript number is inserted in the body of the text; however, the full reference is provided at the bottom of the same page

APA

The American Psychological Association (APA) created a style guide to assist with academic writing such as publications, essays and books. The APA style is widely used and is one of the most common reference styles that students are expected to use. Citations within the text and their corresponding source details in a references list at the end of the work are necessary elements of the APA style. These show the reader where ideas and research have come from. Typically, when referencing using APA, the author's surname and the date of the publication are featured in the text. If quoting directly from the source, then the page number is also included. For example:

In some states, regimes of control on missions and reserves (a core element of the 'protectionist' system that dominated most of the twentieth century) continued into the 1970s or even 1980s. However, from the 1960s the dominant policy approach towards Indigenous Australians began to change, recognising, to some extent, Indigenous peoples' rights to preserve their cultures (Parbury 1999). Key events in this period included amendments to the *Commonwealth Electoral Act* in 1962 to give Indigenous people the vote in federal elections and the 1967 constitutional referendum, which meant Indigenous people would be counted in the national census (Attwood & Markus 2007) and the Commonwealth could legislate for them. By 1973, the new policy approach of Indigenous self-determination was introduced by the Federal Government (Sanders 2002). Along with the introduction of laws for equal wages, land rights and antidiscrimination in the 1960s and 1970s, these changes have sought to ensure fairer treatment of Indigenous Australians and better respect for their human rights.

Attwood, B. & Markus, A. 2007, *The 1967 Referendum: Race, power and the Australian Constitution*, Aboriginal Studies Press, Canberra.

Parbury, N. 1999, 'Aboriginal education: A history' in R. Craven (ed.), *Teaching Aboriginal Studies*, Allen & Unwin, Sydney, pp. 63–86.

FIGURE 1.7 An example of APA-style citation: the author's name and date of publication are inserted in the body of the text; the full reference is provided in the references list at the end of the document

Within the main body of the document, any reference to the publications will need to be cited. As illustrated in Figure 1.7, when using the APA style, the format usually follows author-date-page where the author's last name, the year of the publication, and the page number of the quote are referenced. These are all separated by commas, and are placed within parentheses following the text. The page number is preceded by a lower case 'p' with a period (full stop) after it; for example, (Parbury, 1999, p. 65).

For more detailed information, visit the APA website.

EndNote is a commercial reference management software, used to manage bibliographies and references. It is similar to a database and is used to keep all references in one place. EndNote also integrates with MS Word, so that references can be easily inserted into the text with minimal effort, as shown in Figure 1.8. Alternatively, MS Word has its own built-in referencing capabilities that will allow you to create a bibliography and manage your sources without the need of additional software.

For more information, visit the EndNote website.

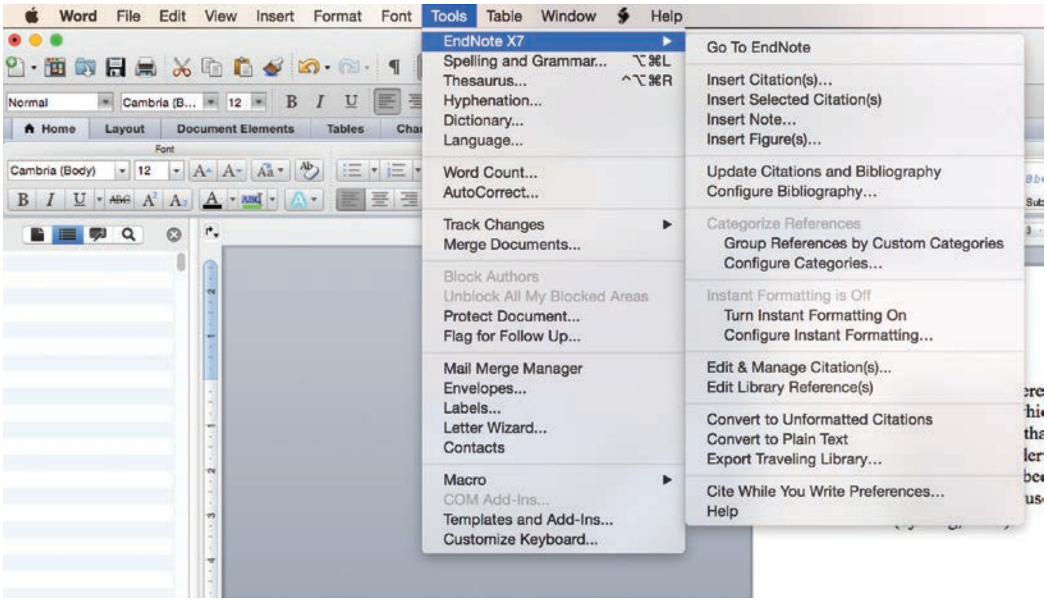

FIGURE 1.8 EndNote integrates easily into Microsoft Word

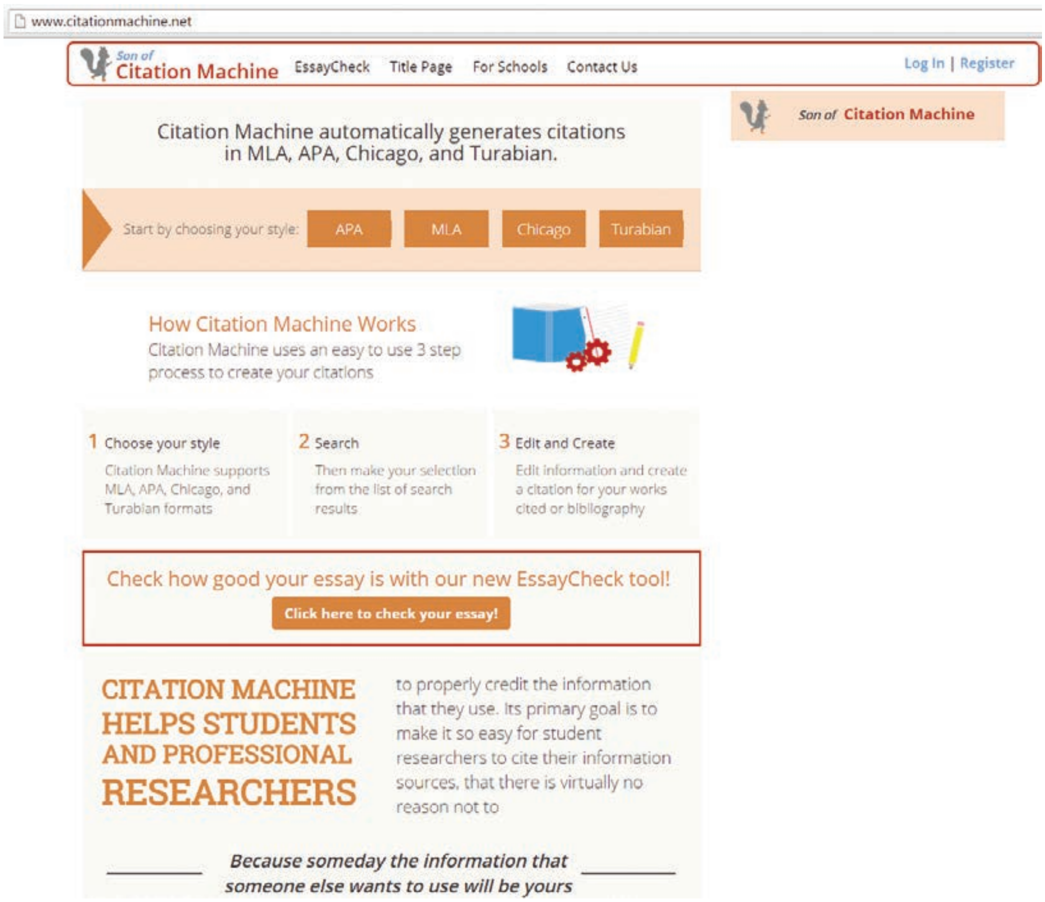

FIGURE 1.9 The Citation Machine can be used by students to assist with referencing

http://www.citationmachine.net

The free Citation Machine website, shown in Figure 1.9, generates citations in APA style. It can assist students to generate references in the appropriate format.

Seeking permission

Permission must be sought for collecting any data or information that involves people, because of privacy laws such as the Australian Privacy Principles (APPs). For example, to photograph or film individuals or groups, you should obtain permission. The organisation or individual who wants permission needs to let the people photographed or filmed know the purpose of the photographs or film and what it may be used for. Permission is usually provided in written form and is often known as consent. Permission needs to be sought because a photograph or video image in which an individual can be identified is considered to be personal information. Pictures of people can be used in advertisements, or for marketing purposes, and sometimes pictures can be used thoughtlessly and depict people in a false light.

Participants in any research need to be informed about what the research entails. They need to know what they are required to do and how much of their time it will take, and how often they will be required. All details of the research need to be given so that participants can make an informed decision to participate. For example, when researchers want to conduct a questionnaire, they need to specify how much time it will take (for example, 20 minutes) and how many times the questionnaire will need to be completed. Participants need to know whether the questionnaire will be paper-based or electronic, and how they will get access to it. All these details need to be explicitly stated so that each participant has a clear understanding before agreeing to take part. Participation needs to be voluntary. The researchers cannot put pressure on the participants or use coercion, or provide financial or other incentives for them to participate. Participation in research needs to be voluntary and informed.

In universities, research that involves people or animals cannot begin until researchers obtain ethics clearance. Each university has an ethics committee established and they follow the guidelines set out by the National Health and Medical Research Council (NHMRC). Before obtaining ethics clearance, the researcher/s must demonstrate that they have followed correct procedures and processes before collecting data to ensure that all risks have been addressed, and that it is established that participation is informed and voluntary.

Consent forms

One method of obtaining permission for research purposes is to use consent forms. **Informed consent** by all research participants is necessary. This means that before agreeing to participate in research, they are aware of what the research involves, the time required from them and the possible risks that may arise. Participation in research not only has to be informed, but also voluntary; that is, participants are not pressured to be involved and have the capacity to make their own decisions based on their understanding of the research.

You must obtain consent when interviewing or observing participants, creating questionnaires or surveys or collecting any type of data.

Consent forms should have the following information clearly listed.

- The title of the project
- The name of the researcher
- What the project is about and why it is being undertaken
- What is required from the participants in terms of time, effort, resources and costs
- The rights and interests of the participants – that they freely consent to be involved in the research and can withdraw at any time without having to provide a reason
- A statement of whether the participant's identity will be preserved