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VCE UNITS 1 & 2

6TH EDITION

COMPUTING

SERIES EDITOR James Lawson
Therese Keane, Mark Kelly,
Colin Potts, Anthony Sullivan

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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.

Keane, Therese, author.
Potts, Colin, author.
Sullivan, Anthony Bernard, author.
Kelly, Mark John, author.

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Cengage Learning Australia
Level 7, 80 Dorcas Street
South Melbourne, Victoria Australia 3205

Cengage Learning New Zealand
Unit 4B Rosedale Office Park
331 Rosedale Road, Albany, North Shore 0632, NZ

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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**.

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.

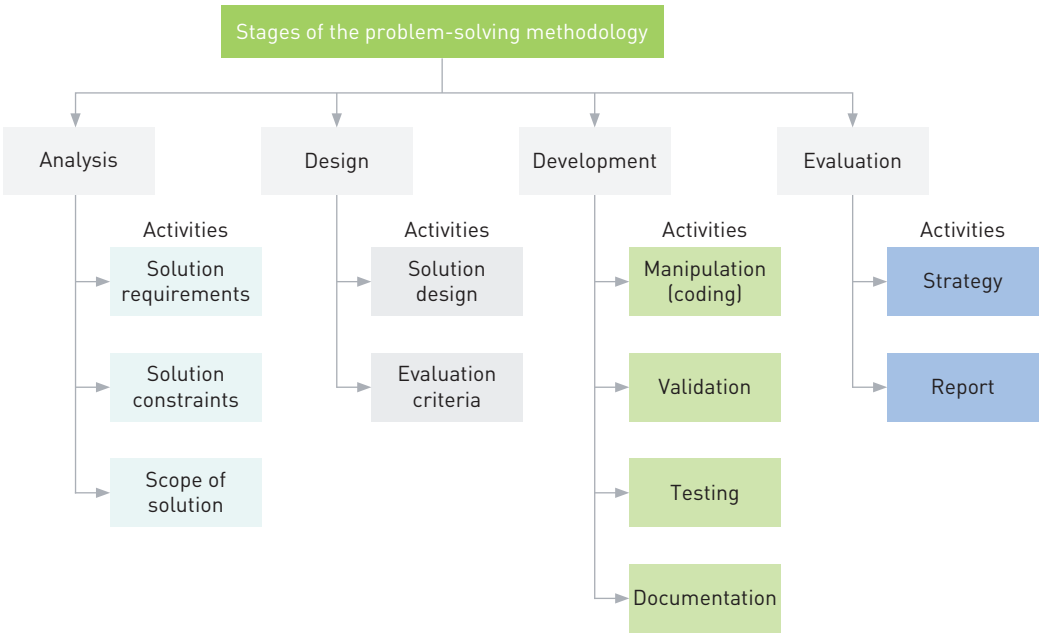

FIGURE 1 The four stages of the problem-solving methodology and their key activities.

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.