micro:bit *in* Wonderland
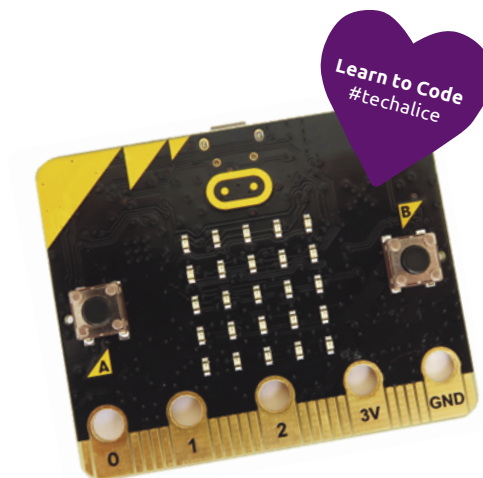
CODING & CRAFT

with the BBC micro:bit

Inspired by *Alice's Adventures in Wonderland*

For children aged 9+ and beginners of all ages

Foreword by The Micro:bit Educational Foundation

Learn to Code
#techalice

Dr Tracy Gardner & Elbrie de Kock

TECH AGE™ KIDS

ABOUT THE AUTHORS

DR TRACY GARDNER

Tracy first learnt to code on her Sinclair ZX Spectrum at the age of 10, this put her on the path to study Maths and Computing at the University of Bath where she won the Computing prize in her final year. Tracy Gardner has a Computer Science PhD which won a BCS Distinguished Dissertations award. She has worked as a software engineer and software architect, including working for 10 years at IBM.

Tracy has two children and now focuses on introducing technology to the next generation. She is a director of Tech Age Kids. She also develops educational content for the Raspberry Pi Foundation. Tracy has taught Computing to Key Stage 2 children (aged 7-11) and volunteered at a Code Club and CoderDojo.

ELBRIE DE KOCK

Elbrie de Kock has an Interior Design degree and has worked in a number of different industries in design and marketing.

Elbrie has three children. Her eldest son's passion for computer programming inspired her to find opportunities for kids to learn to code. She uses her creative background and newly developed technology skills to create projects that combine craft, coding and electronics.

Elbrie is a director of Tech Age Kids and develops events, workshops and content about creative technology. She volunteers at a Code Club, found the local CoderDojo and recently taught Computing in Primary Education.

ABOUT TECH AGE KIDS

Tech Age Kids is an online company that helps parents and educators find constructive and creative uses of technology for children and teens.

The company creates educational material and online content for techagekids.com, including approachable project ideas, news and reviews of the latest educational and creative technology products, as well as advice on digital parenting issues.

Tech Age Kids believes that modern children should develop skills in coding, electronics and design so that they can understand the present and shape the future.

The company supports the STEAM (Science, Technology, Engineering, Art and Mathematics), Maker and Digital Making movements.

To find out more about Tech Age Kids:

- Sign up to the mailing list for the latest articles from techagekids.com.
- Join the digital parenting group at facebook.com/techageparents to share experiences and learn from other parents.
- Follow on social media at Facebook, Twitter, Instagram and occasionally YouTube.
- Email at hello@techagekids.com.

TECH AGE KIDS™

FOREWORD

The original BBC micro:bit project was part of the BBC's 2015 **Make It Digital** season. The micro:bit was first conceived by the BBC as being for children to inspire them toward coding and digital creativity.

The original project was a genuine partnership led by the BBC but involving over 30 organisations, from small, regional charities through to major multinational corporations, all of whom shared the vision of encouraging children to become creators with digital tools rather than just users of technology.

There were already tools on the market but many of these were expensive (making them inaccessible to all); hard to be able to use quickly and easily; or, not particularly versatile.

The micro:bit was designed to be all of those things and, for the most part, does it very well.

One of the great things about having the BBC lead on the project is that they can tap into their massive collection of media assets to promote the micro:bit, so we had a plethora of materials created around programmes such as Doctor Who, Strictly Come Dancing etc. that helped to make the device appealing to the target audience of 11-12 year old children; however, the BBC project is now over; the reach of the micro:bit in terms of age of the students is now much broader; and, the global popularity of the micro:bit takes it into territories where people are not familiar with Strictly…and Doctor Who.

Also, many of the materials were brilliant projects but lacked a coherent process of learning behind them.

The **Micro:bit Educational Foundation** is a not-for- profit that was set up with the support of some of the original BBC project partners. We are only funded through a small royalty received from the sale of each device so, when it comes to driving our mission of "making every child an inventor", we rely very much on the support and enthusiasm of our user community to help with promotion, accessories, training and resources. When we were presented with the draft of this book it was a delight to explore. It is coherent, concise and comprehensive. It takes the readers on a learning journey but in a way that is full of fun activities, set in the context of a timeless story that is known and loved around the world.

Coding is a hugely important skill, one that will be increasingly in demand as we go further into this century. Young people are facing a future that, if they have the right abilities, will be exciting and full of opportunity as a high proportion of the jobs that will exist in 20, 30, 40 years' time do not exist today and they are likely to change jobs and careers multiple times during their working lives. But it's not just coding that will make a different, so will encouraging creativity as we will need people who will come up with the products and services that will lead to employment and profits. The micro:bit does both – providing people with the ability to learn code from simple drag-and- drop blocks through to full text coding but also being able to fiddle, have a go and to be able to make mistakes without the fear of breaking it.

By the time the reader has worked their way through all the activities in this book they will have got a good grasp of the principles of coding and computational thinking but they will have made things, been inspired to have a go at coming up with their own ideas and, most importantly, had fun.

The Micro:bit Educational Foundation

ACKNOWLEDGEMENTS

'For, you see, so many out-of-the-way things had happened lately, that Alice had begun to think that very few things indeed were really impossible.'

Lewis Carroll

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Companion website for
micro:bit in Wonderland
alice.techagekids.com

'"Why," said the Dodo, "the best way to explain it is to do it."'

GUIDE TO THIS BOOK

CODING & CRAFT FOR THE BBC MICRO:BIT

This book guides you through twelve coding and craft projects for the BBC micro:bit. The micro:bit is a small programmable computer that allows you to explore physical computing in a fun and interactive way.

The projects are designed for beginners to coding and the micro:bit. They are inspired by the story of *Alice's Adventures in Wonderland* written by Lewis Carroll.

Each chapter recreates objects and scenes from Alice's adventures providing, an imaginative backdrop for developing modern skills.

Children, teens and adults will learn to code the micro:bit and make games, wearable technology, animations, music and much more.

PROJECTS FOLLOWING ALICE

The projects are designed to be completed in order as you follow the story of *Alice's Adventures in Wonderland*. The story sets the stage for what you will create in each chapter.

You will learn new concepts and skills in each project and build on what you have learnt as you follow one project after the other.

Reading the story of Alice before you start with a project will inspire you to be creative and experiment with the micro:bit.

The original story of *Alice's Adventures in Wonderland* is available online or it's free to download and read on a device.
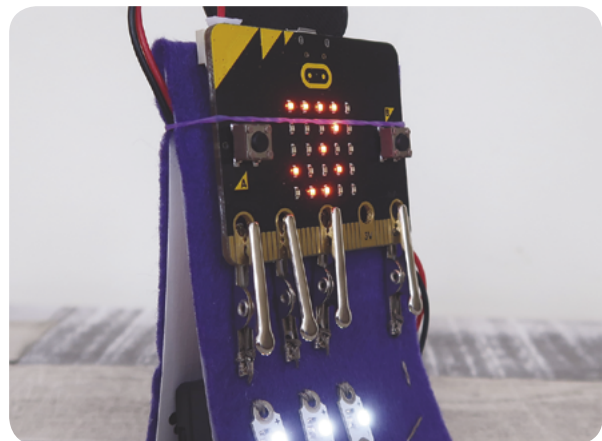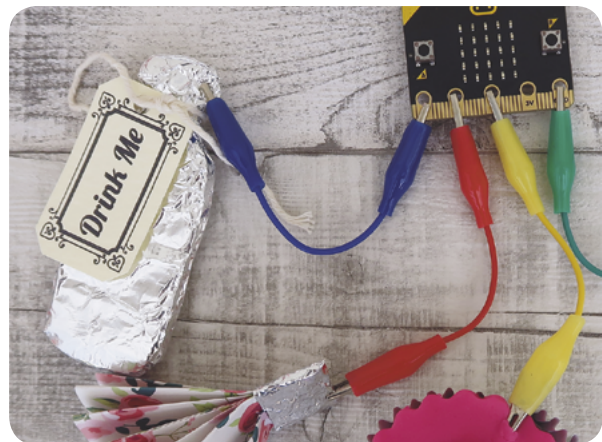
WHO THIS BOOK IS FOR

FOR BEGINNERS OF ALL AGES

This book is written for those who are new to coding, electronics and the micro:bit.

Younger learners will require adult support, however learners from around 12 years, will be able to complete the projects independently.

It also provides a quirky way for older learners to have a gentle introduction to technology skills.

FOR GIRLS AND BOYS (AND ADULTS TOO)

As women in the technology industry, we wanted the projects to appeal to girls and encourage them to develop design and tech skills.

Being parents of boys, we didn't want to create a girls-only book. The projects have been tested with boys and girls and appeal to both.

Children don't divide neatly into stereotypical groups. Some girls will be fascinated by using real electronics components and some boys will love cross-stitch. Real children are a mix of skills and interests and sometimes they surprise you.

FOR FUTURE MAKERS

This book helps children who are drawn to computer screens to engage with technology in a creative way by exploring physical computing and developing their design and craft skills.

We also want to encourage children who enjoy art and design to add coding and electronics to their skill set.

It provides an opportunity for parents and teachers to also learn modern making and coding skills alongside their children.

WHAT YOU WILL LEARN

We hope learners and the adults supporting them will discover a love of making and develop essential design and computational thinking skills.

CODING

You will learn introductory computer programming (coding) in a drag and drop editor designed for beginners. Coding concepts, such as variables, selection and loops, are introduced in a practical way.

ELECTRONICS

You will learn the basics of working with a microprocessor (mini computer) and electronics components. You'll have an opportunity to work with LEDs (lights), buzzers, circuit wiring and more.

DESIGN & MAKING

You will learn design thinking and work with a variety of tools and materials that will develop your making and construction skills. There are opportunities to use tools such as craft cutters, laser cutters and 3D printers.

HISTORY OF TECHNOLOGY

You will discover fascinating facts about the history of technology during the time period when Lewis Carroll authored *Alice's Adventures in Wonderland*.

MAKING IT YOURS

You will learn the skills needed to eventually imagine, design and make your own projects by completing the **Challenges** and **Make It Yours** sections in each chapter.

WHAT YOU WILL NEED

EQUIPMENT AND MATERIALS

You will need:

- a **micro:bit** with a USB cable and battery pack (available as a starter kit);
- a **computer** to program the micro:bit (desktop/laptop/Chromebook/Raspberry Pi/mobile device);
- the makecode.microbit.org **editor** which is free to use and runs in a web browser or an app;
- **electronics** components (kits are available);
- **craft** materials (many of which you will already have at home or school); and
- a copy of the **book** *Alice's Adventures in Wonderland* (available as a free download).

Although you can do all the projects in this book with one micro:bit, it is useful to have an additional micro:bit so you don't have to take apart your favourite project immediately.

WEBSITE AND TEMPLATES

The alice.techagekids.com website accompanies this book and provides additional information, including a shopping list of equipment and materials from suggested retailers.

Templates are available on the website. Print on regular A4/letter size paper/card. When you print the templates make sure the print scale is 100% and the sheet is aligned centrally in both directions.

If you don't have access to a printer you can create your own designs.

> Technical terms will be defined in boxes such as this one!

HOW TO USE THIS BOOK

Each chapter tells you to read part of *Alice's Adventures in Wonderland* and provides a materials list specifying everything you need.

Read the story, gather materials and print templates before you start working on a project.

The materials in each project are organised into an **Essentials** list (basics you need to complete the project) and a **Get Creative** list (additional items that allow you to be more creative).

Use a storage box with compartments, like a sewing, craft, jewellery or tool box, to organise your resources and store accessories you've made.

ICONS IN THIS BOOK

We use icons throughout the book to highlight specific tasks or information.

- **Read** a chapter in *Alice's Adventures in Wonderland.*

- *Quotes from the story.*

- **Print** a template on card or paper to make the project.

- **Visit** the website for more information alice.techagekids.com.

- **Play** or test your code in the editor simulator.

- **Download** your program from the editor and transfer it to the micro:bit.

- **Warning:** Take note of a safety message.

- **Troubleshoot** your code or electronics.

- **Tip,** hint or signpost to help you along.

- **Think** or challenge to extend your understanding.

'"Curiouser and curiouser!" cried Alice'

NOTES FOR ADULTS

Additional material, like lesson plans and workshop plans are available for this book.

🌐 **Visit** alice.techagekids.com

PARENTS

We hope that parents will enjoy sharing the story and working on the projects with their children.

We know that some parents are nervous about their lack of knowledge when it comes to technology. For those parents, this is an opportunity to learn alongside your child and overcome that fear of the unknown.

TEACHERS

The projects in this book develop skills that are central to Computing and Design & Technology subjects. They can be used to deliver parts of the UK National Curriculum and the US Common Core.

The micro:bit and the additional materials used are inexpensive and readily available from educational suppliers.

The projects are ideal for cross-curricula lessons, linking with history, music, physical education, drama and, of course, English.

CLUBS, LIBRARIES AND MAKERSPACES

It's great fun to complete these projects in a workshop setting with a group of learners. The projects can be completed intensively during a holiday club or camp, or spread out over several weeks in a regular STEM/STEAM club.

The literary basis for the projects makes them a great fit for a library which is developing a makerspace or encouraging digital skills.

Makerspaces often attract adults who mix craft and technology to make theatre props or role play accessories. These projects are an engaging way to develop those interests in the next generation. Access to a laser cutter, craft cutter and 3D printer gives plenty of opportunity to extend the projects.

SHARING ON SOCIAL MEDIA

Learn to Code #techalice

We'd love to see what you make. At the end of each chapter there's a purple heart to remind you to share your project on social media.

Remember when sharing to keep your personal information private.

Take note of the age restrictions on social media platforms, children should ask a responsible adult to share their creations online.

🖧 **Find** Tech Age Kids on Facebook, Twitter and Instagram and share your projects using the hashtag *#techalice*.

'…and she set to work very carefully'.

THE BBC MICRO:BIT

MEET THE SMALL COMPUTER

The BBC micro:bit is a small, programmable computer that has built-in inputs and outputs, with the capability to connect more. You can use it to make a wearable device, cool gadgets, useful science equipment and creative craft and coding projects.

The BBC micro:bit is the result of a collaboration of over 30 partners led by the BBC (British Broadcasting Corporation).

The Micro:bit Education Foundation (microbit.org) is now responsible for the future of the micro:bit.

The micro:bit measures about 4x5cm and can be powered from a battery pack with 2 AAA batteries.
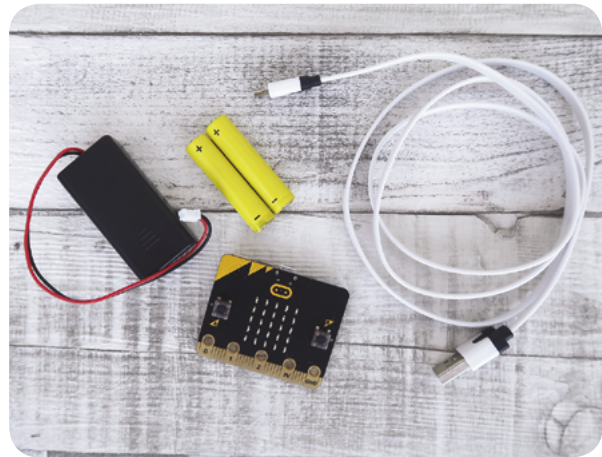
MICRO:BIT FEATURES USED IN THIS BOOK

The features of the micro:bit used in this book are:

- ♣ the display—a matrix of 25 red LEDs;
- ♣ the A and B input buttons on the front and the reset button at the back;
- ♣ the built-in accelerometer (motion sensor) and magnetometer;
- ♣ the input/output pins for connecting additional electronics components; and
- ♣ the sound output.

USING YOUR MICRO:BIT SAFELY

The micro:bit is designed to be used in creative projects, as with any electronic device use it with care to prevent damage and stay safe.

The projects are suitable for beginners and are intended to be completed alongside an adult or with adult supervision. The projects are undertaken at your own risk.

📑 **Read** the micro:bit safety advice at microbit.org/guide/safety-advice.

Also, check alice.techagekids.com for any updated advice before you begin.

The tips below are not a substitute for reading the safety advice, however, we want to highlight some key points:

- ♣ Projects combine craft and tech activities. It's important that you have a tidy workspace. Make sure that materials don't unintentionally touch the micro:bit.

- ♣ When you are not using the micro:bit, unplug the device and put it away.

- ♣ Only hold the micro:bit by its edges when it's in use. You can use a case for some projects—make sure it's easy to remove.

- ♣ The micro:bit is designed to run cold. If yours is hot, stop using it and check the safety advice.

- ♣ None of the projects require you to connect crocodile clips to the micro:bit pin marked 3V (power supply pin).

PROGRAMMING THE MICRO:BIT

MAKECODE EDITOR

You'll use the Microsoft MakeCode Block Editor, with drag and drop code blocks, to program the micro:bit.

You can find a guide on how to program the micro:bit at microbit.org/guide/quick/.

The editor is free and doesn't require installing as it runs in a web browser or as a Windows 10 app. It runs on a Windows, Mac or Linux laptop or desktop computer. It also runs on Chromebooks, Raspberry Pi computers and Android or iOS devices.

⊕ **Go** to makecode.microbit.org.

In the editor you'll find an on-screen micro:bit (simulator), sections containing code blocks and a coding area where you'll drag blocks to program the micro:bit.
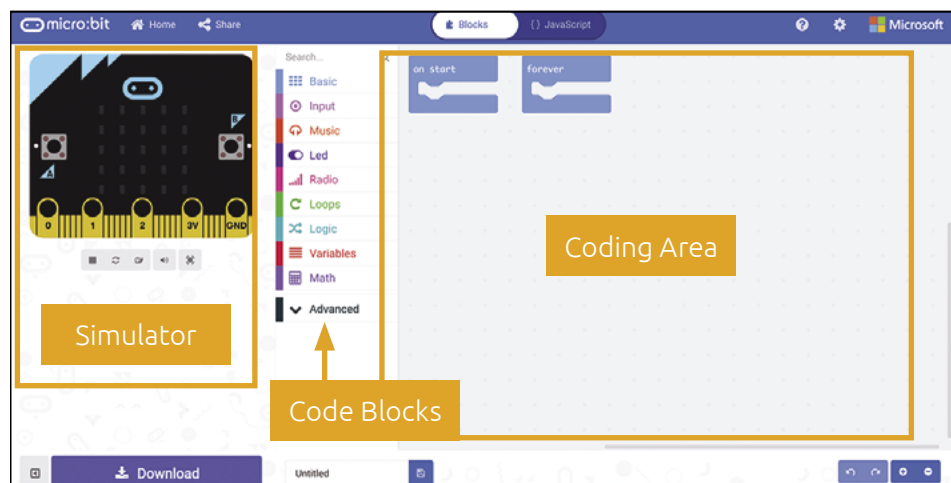
CODE BLOCKS

Code blocks are colour-coded and categorised in sections, such as Basic, Input, Loops, etc. Each code block name in this book is colour-coded to give you a clue in which section of the editor to find it.

For example, show leds is a blue code block found in the Basic section. Sometimes you need to click ...More in a section to see more blocks in that category.

If you can't find a block, use **Search** to help.

Code blocks will snap together when you drag them closer to each other. When a code block is greyed-out in the coding area, it is inactive.
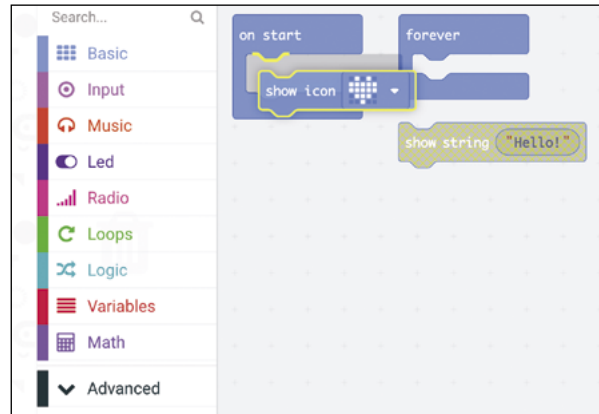
SIMULATOR

The editor has an on-screen micro:bit which allows you to test your program in the browser without a real micro:bit.

You can, for example, click button **A** and **B** and move your cursor over the on-screen micro:bit to tilt it left and right.

When you use the on shake code block SHAKE appears on the micro:bit in the editor. You can click the button to run the program in the simulator.

The buttons under the micro:bit will (from left to right) run your program, restart your program, slow everything down (snail icon), mute the sound and show the on-screen micro:bit in full-screen mode.

Some micro:bit functionality can't be tested in the simulator, so you need to learn how to download and transfer your program to your micro:bit.
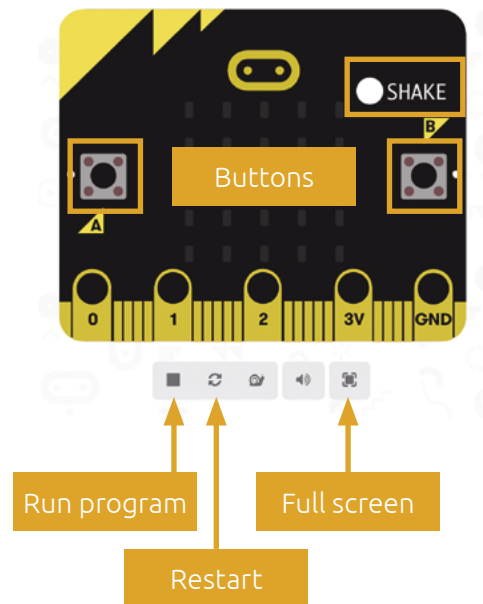
SAVING AND TRANSFERRING FILES

The first project, LATE!, is specifically designed to familiarise yourself with the editor and transferring **.hex** files to your micro:bit.

SAVE YOUR PROGRAM

Projects are automatically saved in the browser. Give your project a name to easily find it again otherwise it will be saved as *Untitled* in the bowser.

Click `Download` to save your program to your computer. The *.hex* file will save to your `Downloads` folder on your computer.

You can import projects by clicking the `Import` button on the right of the home screen.

Select `Import File` to upload a saved *.hex* file. Browse your folders to find your downloaded *.hex* file.

🖧 **Important:** The editor just creates a *.hex* file, it doesn't transfer it to the micro:bit unless you have paired it!

TRANSFER TO THE MICRO:BIT

When using the micro:bit with a computer it will appear as a drive in your file explorer when you connect it with a data and power micro USB cable.

Transferring the *.hex* file to the micro:bit works differently with different browsers and operating systems.

You can just drag and drop the downloaded *.hex* file into the `MICROBIT` drive on your computer.

🖧 **Tip:** The first project in this book walks you through transferring *.hex* files to your micro:bit using a simple method that works in a Google Chrome browser.

A '**.hex**' file stores your program and editor layout information in a format that can be read by the micro:bit and the MakeCode editor.
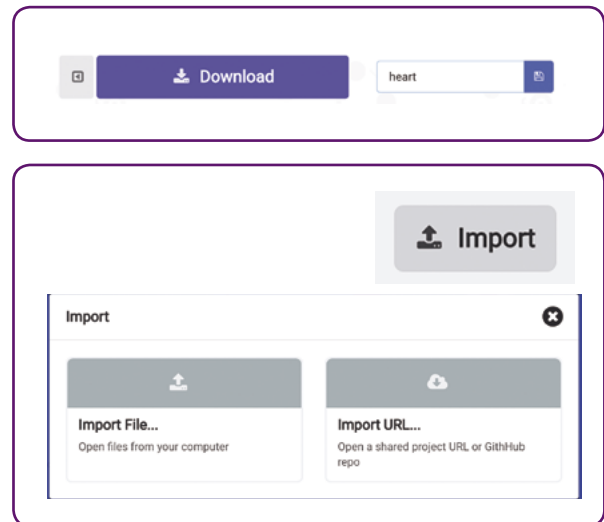
💬 *'Alice was beginning to get very tired of sitting by her sister on the bank, and of having nothing to do …'*

'"Oh, I've had such a curious dream!" said Alice, and she told her sister, as well as she could remember them, all these strange adventures of hers ...'

ADDITIONAL PROJECTS
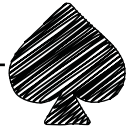
MORE PROJECTS FOR YOUR BBC MICRO:BIT

Finished all of the projects? Below are some extra challenges that allow you to make use of the skills you have developed. Some of these projects allow you to extend projects in the first few chapters with skills that you have learnt later in the book.

- ♣ Create animated watch hands for your pocket watch.
- ♣ Use `if..else` blocks instead of just `if` blocks in the Drink Me, Eat Me project.
- ♣ Use play dough or real mushroom halves to create inputs to grow and shrink Alice by one pixel at a time using a variable to keep track of her height.
- ♣ Add a sneeze sound effect to the Pepper Box project. Which musical notes sound most as a sneeze?
- ♣ Add sound to projects that didn't have sound, such as the Lobster Quadrille or the Cheshire Cat animation.
- ♣ Sew more e-textiles accessories to make inputs for projects. Sew the cake, bottle and mushroom with conductive thread and press-studs.

- ♣ Improve on your animations or add animations to projects that didn't have any.
- ♣ Make a wearable for the Lobster Quadrille with a LED that flashes in time with the beat.
- ♣ Use binary to light up LEDs to count to 7 to show the Queen's anger levels.
- ♣ At the very end of *Alice's Adventures in Wonderland,* the cards all fly up into the air. Can you use the on free fall event block to detect when the micro:bit is falling and scroll the text **The End**? Be careful not to drop the micro:bit.
- ♣ Use the story to inspire your own project to make a new game, gadget, wearable, animation, prop or decoration.

FREE BONUS PROJECTS

Find three additional bonus projects for *micro:bit in Wonderland* on the website.

🌐 **Web:** alice.techagekids.com.

They are perfect for workshops or taster projects for beginners to the micro:bit and digital making.

SHARE YOUR PROJECTS

Parents and teachers don't forget to share your thoughts and the children's creations on social media using the hashtag *#techalice*.

🌐 **Find** us on: 📘 🐦 📷 📌 G+ ▶️

Note: If you're not old enough to post online, ask an adult for help. Remember to keep your personal information safe.

A PERSONAL NOTE FROM THE AUTHORS

We hope you've enjoyed our trip down the rabbit hole. We've certainly enjoyed sharing our love of craft and tech with you in Wonderland.

We encourage you to keep making things that are fun, useful, entertaining, beautiful and curious.

Use the skills you've learnt in this book to make things that appeal to your style and interests.

Remember that it's okay if projects don't turn out as planned. You often learn the most when things go wrong or take an unexpected turn. Enjoy the adventure.

Keep the wonder and maybe we'll see you through the looking-glass one day soon.

Happy digital making,

Elbrie and Tracy

NEXT BOOK IN THE SERIES

MICRO:BIT THROUGH THE LOOKING-GLASS

Continue your adventure with the BBC micro:bit in Wonderland. *"... It's a plan of my own invention. You may try it if you like."* said the Knight. Join Alice as she enters Wonderland again through the looking-glass in the drawing room.

The second coding and craft project book, *micro:bit through the Looking-Glass*, builds on skills learnt from Book 1 in the *micro:bit in Wonderland* series.

The book introduces slightly more complex coding concepts and electronics but is still suitable for beginners aged 9 and over.

The projects provide an opportunity to work with a servo motor and programmable multicoloured LED lights and further develop craft and making skills using construction toys, e-textiles and papercraft.

The book offers an opportunity to learn more about wearables, electronic games, e-textiles, electronics circuits, animation, science, usability and much more.

Inspired by Through the Looking-Glass, and What Alice Found There

micro:bit through the **Looking-Glass**
CODING & CRAFT
MORE MAKER PROJECTS

Dr Tracy Gardner
Elbrie de Kock