Helen Sau Ching Cheung, Alex Hok Lam Chan, Kenny Ka Lam Kwan
and Yoko Hirose

21 Developing Digital Literacy Using Mini-AI Games

Abstract: The use of digital technologies has transformed learning, teaching, and research Topics like digital humanities have emerged. Artificial intelligence (AI) after initial slow development is becoming embedded in all aspects of life, including education. Students and teachers at all levels are learning coding to use new information and communication technologies (ICT) effectively. Digital literacy has become an important consideration in ensuring that students and faculty have the knowledge and skills required to adopt new approaches and use the various technologies available effectively. Many novice library users lack experience and confidence in their abilities to use ICT effectively in their studies, and find it difficult to learn new techniques. This chapter discusses the need for digital literacy and describes work undertaken as part of an international initiative at the Hong Kong Sheng Kung Hui (HKSKH) Ming Hua Theological College Library (MH Library). Three mini-AI games containing fun elements and embedded library resources were developed as learning materials and used in an innovative library user education programme. The results of the programme have been positive. Participating students and library staff gained additional skills and knowledge in AI and other areas and showed interest in digital literacy.

Keywords: Digital literacy; Artificial intelligence; Programming languages (Computers); Digital humanities; COVID-19 (Disease)

Introduction

The Hong Kong Sheng Kung Hui (HKSKH) Ming Hua Theological College (MH College), serves the Anglican Church in the Province of Hong Kong and Macau following Hong Kong. The Anglican Communion in Hong Kong is known as Hong Kong Sheng Kung Hui (SKH), and also as the Hong Kong Anglican Church (Episcopal). It encompasses over one hundred schools including kindergarten, primary, and secondary schools, tertiary colleges, and churches in Hong Kong. MH College is a tertiary educational institution that provides degrees and diploma programmes, including two separate joint degree programmes with Charles Sturt University (CSU) in Australia and Virginia Theological Seminary (VTS) in the US. The MH College Library houses electronic resources and printed materials on the topics of

Christianity, theology, philosophy, church history and humanities. MH Library has participated in collaborative projects with others in their community and with Japanese parties since 2016.

The COVID-19 pandemic has changed lives, studies, and work models. In developing responses to rapidly developing new situations, MH Library has partnered with local and international parties on a project to work collaboratively to develop training programmes for library users to improve their information use skills in a digital world. The user education project was titled *Connect the World via Libraries* and emphasised online activities and digital experiences. The partners included the Library Fair Management Committee in Japan, RapidsWide in Japan, and the Libraries Research Group (LRG) at Charles Sturt University (CSU) in Australia. The Library Fair Management Committee in Japan is held annually and the exhibition is the largest trade show, information exchange, and exchange place in the library world. RapidsWide is a company providing consulting services for libraries and professional librarians in Japan and overseas. The LRG at CSU focuses on key issues affecting libraries and examines ways in which library and information services can be improved, and library collections enhanced, as well the role of libraries and librarianship in contemporary society.

The Project and its Aims

Librarians in universities, schools, and special libraries, students, faculty, and professionals in Hong Kong, Japan, and Australia are working together through international partnerships to develop a series of library programmes and activities emphasising online and digital experiences to improve the information skills and knowledge of library users. The experiences include tours and talks and the uses of ICT tools and are designed for worldwide online audiences. The project known as *Connect the World via Libraries* aims to:

– Develop new models for educating library users based on fun
– Develop students' digital literacy skills, including ICT skills and subject knowledge, and
– Enhance the visibility and role of librarians and libraries, focusing on the changing roles of librarians in the digital age.

This chapter is a description of a case study of one of MH Library's activities, the development of a mini-AI games programme for user education. Two presentations were made on the project with one at a forum at the Library Fair in 2022 and the second at an AI seminar IFLA mid-term meeting in Singapore in 2023.

Digital Literacy

With an ever-increasing digital environment, many people use technology widely in their daily lives, for study, work, and in their professions. There has been huge growth in online education and the pandemic saw an expansion of delivery of educational and training programmes online throughout the world. Libraries have seen significant growth in e-resources and in online information services. To use technology effectively, people must gain relevant skills. A high level of digital literacy has become essential for people to lead successful lives. Digitally literate people have more economic, educational, professional and social opportunities available to them. Kelly, McGrath and Hubbard in an excellent review of digital skills and coding pointed out "The skill and knowledge to use digital tools is essential both for individuals specifically and for communities generally to take advantage of the opportunities of these technologies" (2023, 488) and highlighted the work and suggestions of other writers (Hadziristic 2017; Roberts, Farrington, and Skerratt 2015; Townsend et al. 2013). "The more digital literacy people have and the higher their skill in using these technologies, the more digital opportunities they pursue" (Kelly, McGrath, and Hubbard 2023, 488). The much-reported digital divide of unequal access to digital technology has been studied in relation to children and young people. Demographic, use and expertise variables are significant factors and contribute to inclusion and exclusion (Livingstone and Helsper 2007). "For children and young people, it seems, the more literacy, the more opportunities are taken up" (Livingstone and Helsper 2007, 647).

Digital literacy has no single definition. In the mini-AI games programme under study, digital literacy is defined as the ability to search, locate, evaluate, and use information, and the use of technology applications effectively, ethically, and with creativity. The approach draws on ideas developed within the United States and Hong Kong (ALA 2021; Hong Kong 2024).

Artificial Intelligence, Digital Humanities and Library User Education

Artificial Intelligence

In general, AI is defined as: "It is the science and engineering of making intelligent machines, especially intelligent computer programs. It is related to the similar

task of using computers to understand human intelligence, but AI does not have to confine itself to methods that are biologically observable" (McCarthy 2007, 2).

Digital Humanities

Digital humanities was examined by Kirschenbaum who accepted that the definition provided by Wikipedia was a reasonable one:

> a field of study, research, teaching, and invention concerned with the intersection of computing and the disciplines of the humanities…[involving]investigation, analysis, synthesis, and the presentation of information in electronic form … (Kirschenbaum 2010, 1-2).

Wikipedia's current definition of digital humanities is slightly different:

> Digital humanities (DH) is an area of scholarly activity at the intersection of computing or digital technologies and the disciplines of the humanities. It includes the systematic use of digital resources in the humanities, as well as the analysis of their application. DH can be defined as new ways of doing scholarship that involve collaborative, transdisciplinary, and computationally engaged research, teaching, and publishing. It brings digital tools and methods to the study of the humanities with the recognition that the printed word is no longer the main medium for knowledge production and distribution (Wikipedia 2024).

AI is impacting on all areas of knowledge and has great potential in exploring teaching, learning, and research. There are many AI developments in digital humanities, such as the use of AI in archaeology and cultural heritage.

> The beginning of the 21st century marks an era of ubiquitous digital technology, big data, and artificial intelligence (AI). Even traditionally technology-hostile domains are now strongly assisted by innovations of advanced digital technology. Archaeology and cultural heritage belong to a particular domain that, although once technology-phobic, has rapidly become digital and advanced technology assisted (Pavlidis 2022, 26).

Library User Education

The aim of library user education is to help users gain skills in effectively using library resources and services (Harisanty, Diba, and Layyinah 2020; Onah et al. 2021). "Library User Education (LUE) is expected to have various positive effects on students' learning outcomes, research practices, and self-motivation for independent learning" (Liu et al. 2019, 9). Libraries of all types provide wide-ranging

educational programmes for their users ranging from online library guides in specific subject areas or on targeted topics online videos based on topical areas. The new learning environment based on information technology sets new challenges for teachers, student and librarians. Vast amounts of data collected by educational institutions about and for their students provide the basis for new approaches to learning, teaching and research in education. Library user education is intertwined with digital literacy to ensure that library users gain the skills and knowledge required to find and use information effectively in a digital age. Data mining, machine learning, and other techniques related to AI are being used for academic analysis and prediction (Gómez-Pulido et al. 2023). Libraries are responding to the changes in the educational environment and to new methods of teaching, learning and research and providing user education related to improved skills in the use of digital tools in all subject areas, including digital humanities, and in many techniques which can be used, including coding (Martin 2017; Prato 2017). In response to new ways of knowing, learning, and researching, the mini-AI games project of the MH Library aimed at developing an effective learning model for library user education and digital literacy which would build users' knowledge and skills in discovering, accessing, and using information effectively. The mini-AI games project of the MH library added digital humanities, coding, and AI approaches to information literacy training.

The Changing Roles of Librarians

Society and libraries are undergoing digital transformation. New needs are emerging. The roles and required skills of librarians are changing as they face the new challenges. The changed requirements are reflected in the titles of positions in libraries and in job duty statements with new types of librarians emerging, such as digital humanities librarians, digital scholarship librarians, and librarians in specific subject areas like science, technology, engineering and mathematics (STEM), and enhanced and redeveloped liaison librarian functions. The pedagogical role of librarians has come to the fore as they ensure that teachers and researchers acquire new digital skills which will prepare them for effective performance in new information contexts (Sanches 2019). Crucial digital literacy competencies for librarians include searching for and retrieving information across all information environments, using a wide variety of digital tools including AI, critical thinking, organising ideas, building knowledge collaboratively, and marketing. Professional development for librarians must address all these areas (Novo, Bastos, and Vasconcelos 2017). Since the introduction of computers into libraries, some librarians have

developed a knowledge of computer programming, or coding as it is frequently known. Programming languages used to be complex but with the development of simpler techniques, coding skills have become easier for librarians to acquire, and with digital developments and AI techniques, such skills have become more essential as part of the knowledge and skills base and many librarians are acquiring expertise in coding (de la Cruz and Hogan 2016).

Coding

By learning to code, learners not only acquire knowledge in the programming language itself, but also in building digital confidence, and enhanced creativity, critical thinking and problem-solving (Kelly, McGrath, and Hubbard 2022) with Woodward and Fayed suggesting that it should be at the centre of the curriculum (2016). Many novices experience difficulties with learning text-based programming languages, perhaps because of the learning environment or experience used (Mladenović, Boljat, and Žanko 2018). As a result, it has been suggested that block-based programming languages (BBPL) be used to develop students' coding skills with various articles reporting on the use of different languages. Scratch is one language (Resnick et al. 2009); MIT App Inventor is another (da Cruz Alves, Gresse von Wangenheim, and Rossa Hauck 2020); and mBlock is a third (Peng, Bai, and Siswanto 2020). Studies have shown the positive results of using BBPL for students, including the use of friendly interfaces, attractive graphics, and animation functions (Xinogalos, Satratzemi, and Malliarakis 2017). BBPL are effective as introductory programming languages. They have many advantages in improving learning because they avoid syntax errors and allow students to develop creative and logical thinking via block design and games and facilitate students' progression to text-based programming languages (Cárdenas-Cobo et al. 2021; Lin and Weintrop 2021; Simpkins 2014).

The Mini-AI Games Project Details

The broad aims of the project have already been stated. MH Library's involvement related to the development of a fun mini-AI games programme for user education which would develop digital literacy skills and knowledge and enhance the role of the library and its librarians. A demonstration and explanation of the coding elements used in the three mini-AI games can be found in the Appendix to this chapter. The three mini-AI games (Figure 21.1) were:

–   Book suggestions by facial expressions, built using mBlock
–   Learning Japanese with a shooting game, built using Scratch, and
–   SealFinder app for seal script characters, built using the MIT App Inventor (Figure 21.1).

The book suggestions game included recommendations of library books based on users' emotions, happy, bored, or surprised. The second game related to learning the Japanese language and the third game focused on understanding seal script characters, a formerly used style of writing Chinese languages.

Aims

The aims of the mini-AI games by MH Library were:
–   Develop a learning model incorporating gamification to enable students to develop digital literacy, basic coding skills, and subject knowledge
–   Promote library collections and library user education programmes, and
–   Use the mini-AI games as teaching materials for librarians and library staff to use as templates to edit and further develop their own apps and teaching materials.

Participants

The programme divided users into two groups: university students and high school students. The period from August 2022 to July 2023, the MH Library term, was held for programme delivery to the university students, while the period from the summer of 2023 focused on secondary school students. This chapter explores the learning outcomes of the university students who took part in the three mini-AI games, which the MH Library team designed and developed. The MH Library team consisted of a librarian, an IT officer, and student interns, who were university students from engineering, library and information sciences, and humanities subjects from four universities/colleges in Hong Kong.
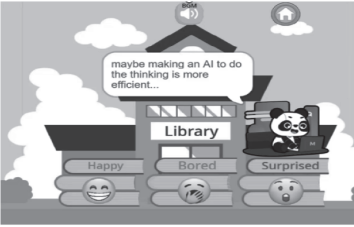
Design

The mini-AI games embed library user education in digital literacy, coding, and digital humanities to achieve learning goals. When students develop the mini-AI games, they learn and apply the following skills:

– Digital literacy: identify, search for, evaluate, and use information to develop the games
– Block-based programming languages: Scratch, mBlock, and App Inventor
– Basic programming concepts: variables, conditionals, loops and algorithms
– Subject knowledge: humanities and languages.
– MH library collections: students need to select library books for the book recommendation AI game. and
– Other skills: problem-solving, presentation, creativity, and collaboration.

1. Book suggestions by facial expressions, built using mBlock

Recommendation of library books based on users' emotions (happy, bored, or surprised).

2. Learning Japanese with a shooting game, built using Scratch

Learning basic Japanese through games.

3. SealFinder app for image recognition, built using App Inventor

Users can use this app to learn Seal Script (Chinese classical language), which is commonly shown as seal engraving in Chinese classical collections and Chinese artworks.
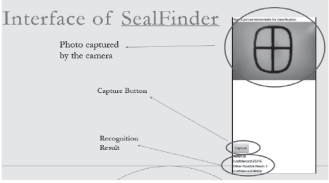
Figure 21.1: The three mini-AI games

The Learning Process

The first phase took place in August 2022. The MH Librarian provided on-the-job training to participating student interns, including digital literacy, such as searching for and evaluating information effectively, demonstrations of Scratch, mBlock, and App Inventor; and an introduction to digital humanities and library collections, including special collections in Chinese classical collections and Japanese books, to give students some ideas for the topics of the mini-AI games.

The second phase was held from September to November 2022. Student interns worked together to design and develop the mini-AI games. Two engineering students used App Inventor, Scratch, and mBlock to develop the games. Another five students from the humanities, the library, and information science provided assistance in preparing materials, such as booklists, and carried out usability tests. When the students had completed the prototypes of the mini-AI games, several librarians from universities and schools in Hong Kong and Japan provided feedback. Following the feedback, the MH Library team adjusted the mini-AI games.

The third phase commenced in November 2022. The mini-AI games programme is part of the international project *Connect the World via Libraries* and was presented online at the Japan Fair in November 2022. The MH Library team including the librarian and the student interns gave an online presentation to demonstrate the three mini-AI demo games to worldwide audiences. The presentation was in English, with Japanese subtitles added for Japanese speakers. Most of the online audiences were librarians, students, and faculty members in Asia, with some audience members from Australia, Europe, and North America. The presentation at the Japan Fair resulted in positive outcomes and feedback; for example, after the online event, a secondary school in Hong Kong used the mini-AI games as templates, adapting them for use on their library's open day.

The fourth phase was held from December 2022 to July 2023. The MH Library team enhanced and developed the final versions of the three mini-AI games and prepared how-to-use videos as teaching materials in English, Chinese, and Japanese, in cooperation with libraries in Hong Kong and Japan. A presentation was also made at an IFLA seminar on AI in Singapore in March 2023.

Outcomes and Lessons Learned

The mini-AI games programme works effectively as a creative learning framework for collaboratively building knowledge by combining elements of digital literacy including coding, with subject knowledge, and library collections. Intuitive blocks

of Scratch, mBlock, and App Inventor and add-on functions, such as the AI block in mBlock and image classifier in App Inventor, are helpful in building the skills and confidence learners need to take the first steps in coding. Overall, the programme benefitted students, librarians, and international partnerships.

Student Benefits

When developing the SealFinder app, students have to search for and access accurate seal script images as training data. In the beginning, students sourced incorrect script images from an unreliable website. With the guidance of the librarians, the students became aware of the importance of using reliable e-resources and how to evaluate information. The students also enhanced their knowledge of citation styles, referencing, and plagiarism.

The humanities students and library and information science students involved in this project, who were novices in programming and coding, learned concepts such as variables, loops, and algorithms. To overcome the limitations of BBPL, such as the accuracy and functions of mini-AI games, text-based programming languages, such as Python, were required. This motivated the engineering students involved in the project to progress, learn more source code, and create advanced functions, such as deep learning. They also enhanced their problem-solving skills, such as debugging.

Students expanded their knowledge in humanities subjects via the mini-AI games and learned about Chinese classical language through the seal script characters and also learned Japanese. The students acquired knowledge about the library collections by, for example, selecting the library collections as source material for the book suggestion AI game.

Other student skills were enhanced. They gained skills in graphics and creativity, which are necessary to create the interface, storyline, and dialogue of the games. They also learned to work independently and as members of a team. Their writing skills improved along with public speaking, through making presentations to online audiences.

The Changing Role of the Librarian

The mini-AI games programme under study makes evident the multiple roles of librarians as instructors in digital literacy, academic writing, citation styles, and referencing skills for students, as researchers, designing and evaluating the programme, an as teammates when developing the games with students. To adapt

to new technology, librarians must shape multiple skills in various areas, such as coding and research, actively market library services, design innovative user education programmes, and adopt the role of lifelong learners.

International Partnerships

Through international partnerships, librarians can provide learning materials for the programme in three languages: English, Chinese, and Japanese. This could benefit and attract people from around the world to join the programme. Librarians, faculty, professionals, and students from various countries and locations can share knowledge, expand learning experiences and research areas, and develop a global framework for developing essential skills, such as digital literacy and coding skills.

Conclusion

Ensuring digital literacy for all in today's high tech big data environment is essential. Digital humanities is an important component of today's academic environment and students and librarians alike require sophisticated ICT skills to participate actively in teaching, learning, and research activities. Educational programmes for library users and professional development activities for librarians can provide opportunities for gaining the knowledge and skills required. The study of coding is one way of gaining skills in digital literacy to be applied in various environments, and studying the skills has many other benefits related to personal and professional development. The mini-AI games under study have enabled the development of a model combining digital literacy, coding, digital humanities, and library collections for user education with positive outcomes. This study has shown that BBPL are useful as an introduction to coding, to the AI world, and to creating apps. BBPL are also useful in the digital transition that facilitates learners' progression to advanced coding languages. Libraries of all types can provide BBPL workshops to a wide range of library users, not only for children and young people, but also for adults. Library schools and professional associations providing training should consider adding BBPL courses to library and information science programmes for librarians.

Acknowledgments

References

American Library Association (ALA). 2011. "Digital Literacy." Office of Information Technology Policy (OITP). Digital Literacy Task Force. https://alair.ala.org/handle/11213/16260.

Cárdenas-Cobo, Jesennia, Amilkar Puris, Pavel Novoa-Hernández, Águeda Parra-Jiménez, Jesús Moreno-León, and David Benavides. 2021. "Using Scratch to Improve Learning Programming in College Students: A Positive Experience from a Non-WEIRD Country." *Electronics* 10, no. 10: 1180. https://doi.org/10.3390/electronics10101180.

da Cruz Alves, Nathalia, Christiane Gresse von Wangenheim, and Jean Carlo Rossa Hauck. 2020. "Teaching Programming to Novices: A Large-Scale Analysis of App Inventor Projects." In *2020 XV Conferencia Latinoamericana de Tecnologias de Aprendizaje (LACLO),* 1–10. Ithaca: IEEE. https://doi.org/10.1109/LACLO50806.2020.9381172.

de la Cruz, Justin, and Joshua Hogan. 2016. " 'Hello, World!': Starting a Coding Group for Librarians." *Public Services Quarterly* 12, no. 3: 249–256. https://doi.org/10.1080/15228959.2016.1197082. Available at http://hdl.handle.net/20.500.12322/auc.rwwlpub:0009.

Gómez-Pulido, Juan A., Young Park, Ricardo Soto, and José M. Lanza-Gutiérrez. 2023. "Data Analytics and Machine Learning in Education." *Applied Sciences* 13, no. 3: 1418. https://doi.org/10.3390/app13031418.

Hadziristic, Tea. 2017. *The State of Digital Literacy in Canada: A Literature Review.* Toronto: Brookfield Institute for Innovation + Entrepreneurship. Working paper. https://brookfieldinstitute.ca/wp-content/uploads/BrookfieldInstitute_State-of-Digital-Literacy-in-Canada_Literature_WorkingPaper.pdf.

Harisanty, Dessy, Aulia Farah Diba, and Khoirotun Layyinah. 2020. "The Effectiveness Program of User Education at University of Malaya's Library*." Library Philosophy and Practice (e-journal)*: 4227. https://digitalcommons.unl.edu/libphilprac/4227.

Hong Kong. Education Bureau. 2024. "Information Literacy for Hong Kong Students: Learning Framework." https://www.edb.gov.hk/attachment/en/edu-system/primary-secondary/applicable-to-primary-secondary/it-in-edu/information-literacy/il_learningframework/informationliteracyforhongkongstudentslearningframework(2024)_eng.pdf.

Kelly, Wayne, Brian McGrath, and Danielle Hubbard. 2023. "Starting From 'Scratch': Building Young People's Digital Skills Through a Coding Club Collaboration With Rural Public Libraries." *Journal of Librarianship and Information Science* 55, no. 2: 487–499. First published online May 3, 2022. https://doi.org/10.1177/09610006221090953.

Kirschenbaum, Matthew. 2010. "What is Digital Humanities and What's it Doing in English Departments?" *ADE Bulletin* 150: 1–7. https://www.uvic.ca/humanities/english/assets/docs/kirschenbaum.pdf.

Lin, Yuhan, and David Weintrop. 2021. "The Landscape of Block-Based Programming: Characteristics of Block-Based Environments and How They Support the Transition to Text-Based Programming." *Journal of Computer Languages* 67: 101075. https://doi.org/10.1016/j.cola.2021.101075.

Liu, Qianxiu, Bradley Allard, Patrick Lo, Qingshan Zhou, Tianji Jiang, and Hiroshi Itsumura. 2019. "Library User Education as a Window to Understand Inquiry-Based Learning in the Context of Higher Education in Asia: A Comparative Study Between Peking University and the University of Tsukuba." *College & Research Libraries* 80, no. 1: 8–31. https://doi.org/10.5860/crl.80.1.8.

Livingstone, Sonia, and Ellen Helsper. 2007. "Gradations in Digital Inclusion: Children, Young People and the Digital Divide." *New Media & Society* 9, no. 4: 671–696. https://doi.org/10.1177/1461444807080335. Available at https://eprints.lse.ac.uk/2768/1/Gradations_in_digital_inclusion_%28LSERO%29.pdf.

Martin, Crystle. 2017. "Libraries as Facilitators of Coding for all." *Knowledge Quest* 45, no. 3: 46–53. Available at https://eric.ed.gov/?id=EJ1125376.

McCarthy, John. 2007. "What is Artificial Intelligence?" http://www-formal.stanford.edu/jmc/whatisai.pdf.

Mladenović, Monika, Ivica Boljat, and Žana Žanko. 2018. "Comparing Loops Misconceptions in Block-Based and Text-Based Programming Languages at the K-12 Level." *Education and Information Technologies* 23, no. 4: 1483–1500. https://doi.org/10.1007/s10639-017-9673-3. Available at https://www.researchgate.net/publication/321332296_Comparing_loops_misconceptions_in_block-based_and_text-based_programming_languages_at_the_K-12_level.

Novo, Ana, Glória Bastos, and Ana Isabel Vasconcelos. 2017. "Effects of a Virtual Learning Environment on Librarians' Information Literacy and Digital Literacy Competences." In *Information Literacy in Everyday Life, 6th European Conference, ECIL 2018, Oulu, Finland, September 24–27, 2018, Revised Selected Papers*, edited by Serap Kurbanoğlu, Sonja Špiranec, Yurdagül Ünal, Joumana Boustany, Maija Leena Huotari, Esther Grassian, Diane Mizrachi, and Loriene Roy, 655–664. Springer International Publishing. https://doi.org/10.1007/978-3-319-52162-6_64. Available at https://www.scribd.com/document/353050896/10-1007-2F978-3-319-52162-6-64.

Onah, Jude Chidike, Ebubechukwu Arinze Okonkwo, Nwando Ogochukwu Eseni, and Fatima O. Momohjimoh. 2021. "Adopting Flipped Classroom Model for Effective Library User Education in Nigerian Universities: Challenges and Strategies." *Library Philosophy and Practice (e-journal)*: 5028. https://digitalcommons.unl.edu/libphilprac/5028.

Pavlidis, George. 2022. "AI Trends in Digital Humanities Research." *Trends in Computer Science and Information Technology* 7, no. 2: 26–34. https://doi.org/10.17352/tcsit.000048.

Peng, Li Hsun, M. H. Bai, and I. Siswanto. 2020. "A Study of Learning Motivation of Senior High Schools by Applying Unity and mBlock on Programming Languages Courses." *Journal of Physics. Conference Series* 1456, no. 1: 012037. https://doi.org/10.1088/1742-6596/1456/1/012037.

Prato, Stephanie C. 2017. "Beyond the Computer Age: A Best Practices Intro for Implementing Library Coding Programs." *Children & Libraries* 15, no. 1: 19–21. https://doi.org/10.5860/cal.15n1.19.

Resnick, Mitchel, John Maloney, Andrés Monroy-Hernández, Natalie Rusk, Evelyn Eastmond, Karen Brennan, Amon Millner, et al. 2009. "Scratch: Programming for All." *Communications of the ACM* 52, no. 11: 60–67. https://doi.org/10.1145/1592761.1592779.

Roberts, Elisabeth, John Farrington, and Sarah Skerratt. 2015. "Evaluating New Digital Technologies through a Framework of Resilience." *Scottish Geographical Journal* 131, no. 3–4: 253–264. https://doi.org/10.1080/14702541.2015.1068947.

Sanches, Tatiana. 2019. "Changing Roles for Research and Information Skills Development: Librarians as Teachers, Researchers as Learners." In *Information Literacy in Everyday Life*, *6th European Conference, ECIL 2018, Oulu, Finland, September 24–27, 2018, Revised Selected Papers*, edited by Serap Kurbanoğlu, Sonja Špiranec, Yurdagül Ünal, Joumana Boustany, Maija Leena Huotari, Esther Grassian, Diane Mizrachi, and Loriene Roy, 462–471. https://doi.org/10.1007/978-3-030-13472-3_44.

Simpkins, N. K. 2014. "I Scratch and Sense But Can I Program?: An Investigation of Learning with a Block Based Programming Language." *International Journal of Information and Communication Technology Education* 10, no. 3: 87–116. https://doi.org/10.4018/ijicte.2014070107. Available at https://oro.open.ac.uk/39215/1/21_VisualProgrammingInvestigationInlineImagesRevised.pdf .

Townsend, Leanne, Arjuna Sathiaseelan, Gorry Fairhurst, and Claire Wallace. 2013. "Enhanced Broadband Access as a Solution to the Social and Economic Problems of the Rural Digital Divide." *Local Economy* 28, no. 6: 580–595. https://doi.org/10.1177/0269094213496974.

Wikipedia. 2024. "Digital Humanities." Last edited March 18. 2024. https://en.wikipedia.org/wiki/Digital_humanities.

Woodward, John R., and Marwan Fayed. 2016. "Why Everyone Should Have to Learn Computer Programming." *The Conversation*, July 13, 2016. https://theconversation.com/why-everyone-should-have-to-learn-computer-programming-62328.

Xinogalos, Stelios, Maya Satratzemi, and Christos Malliarakis. 2017. "Microworlds, Games, Animations, Mobile Apps, Puzzle Editors and More: What is Important for an Introductory Programming Environment?" *Education and Information Technologies* 22, no. 1: 145–176. https://doi.org/10.1007/s10639-015-9433-1.

Appendix: Demonstration and explanation of coding elements in three mini-AI games

How the authors of the mini-AI games define the basic programming concepts in their works:

Variables, conditionals, loops, and algorithms

Variables

Variables are abundant in all kinds of programmes. A name is first assigned to the variable, and then the variable is used to store values that will be referenced and manipulated in the programme. Variables can also be used to label data in order to enhance the readability of the code. Declared variables can be used throughout the computer programme.
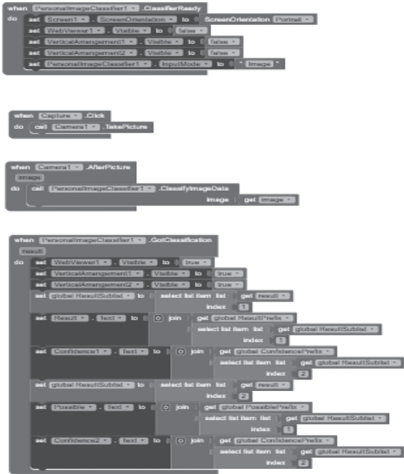
Conditionals

Conditionals are one of the control methods in a programme. Conditionals are used to instruct the computer programme to execute a command if some given conditions are fulfilled. The most common and entry-level conditional statements are if–conditionals and if–else–conditionals. If the condition is fulfilled, the result 'True' is returned and the command will be executed. Otherwise, the result 'False' is returned and the command will not be executed. To increase the number and complexity of the judging conditions, the conditional statements can be nested, that is, enclosed inside other conditional statements to include more layers of judging conditions.

Loops
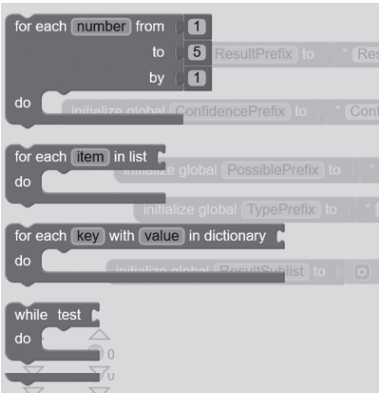
A loop is another control method in a programme. The operation of a loop is a continuous cycle of certain procedures. Common loops include for–loop and while–loop: for–loop is a loop with a counter that will operate a number of times based on its parameters; and while–loop is a loop with conditions that will operate continuously as long as the conditions are fulfilled.

Algorithm

An algorithm is the structure and problem-solving approach of one procedure or even the whole programme. Depending on the complexity of the algorithm, it can be a combination of variables, conditions, and loops. Any set of steps of logical statements, such as codes, that aims to solve a certain problem or achieve a certain goal can be referred to as an algorithm.

Integrative feature

Applications are created for users. The user interface is important for users to be able to utilize the functions. The user interface is an integration with graphic design and programming functions where the code is written to control the components of the app.
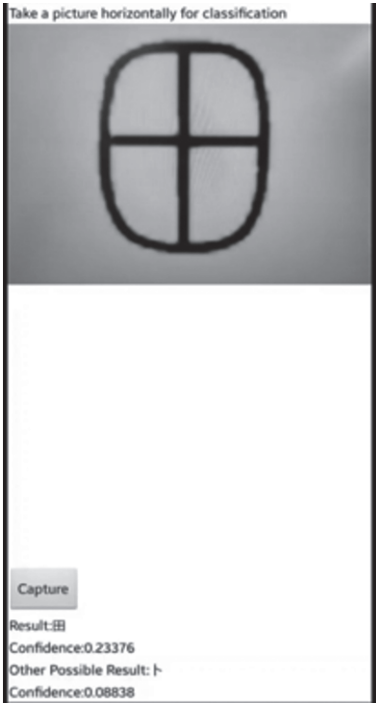
i) Book suggestions by facial expressions, built mBlock
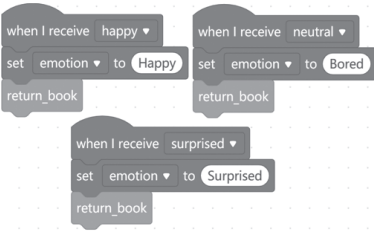
Interface   Block coding
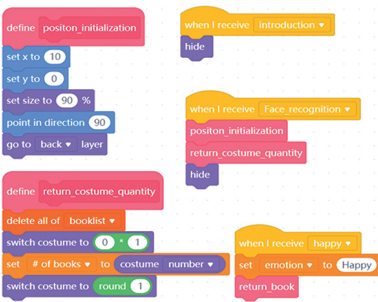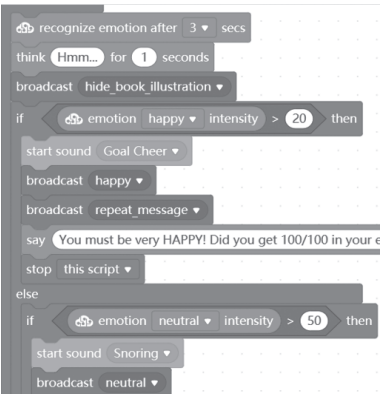
Variables

The facial expression of the user is used as an input variable for book recommendations.
AI is used to determine the facial expression of a library user. The pre-trained weight of typical facial expressions is deployed to determine the user's facial expression, which in turn is used to recommend books in the corresponding category.
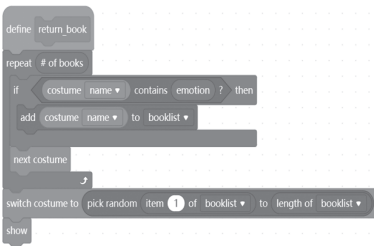
Conditional if–statements

The main structure of the book recommendation is composed of if–statements, which control the output for each facial expression.

Loops

A loop is used to construct the sorting algorithm, as explained below. The purpose of a loop is to execute a certain range of a code or a function multiple times with specified criteria fulfilled. Here, since the sorting algorithm must be checked among all the books in the booklist, the loop is used to repeat the process until the checking of the entire booklist is complete.

Sorting algorithm
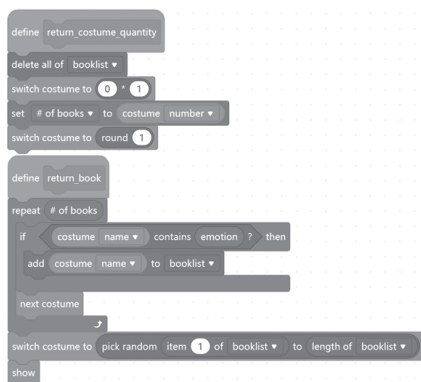
A sorting algorithm is applied to categorise the books into their corresponding facial expressions.

The programme uses a name-matching sorting technique to categorise every book in the booklist. For example, if books in the "happy" category are required, the sorting algorithm will be executed to sort all the "happy" books in the booklist. To enlist a book into a specific category, its name must be renamed with a specified format: (emotion) + (index).

Integrative
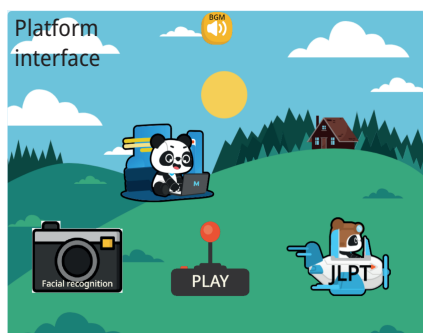
In the integration of several elements into a single unified platform, the book recommendation feature is part of the whole project. Individual features are integrated into a single platform to mimic the offering of library services via a library platform, such as the library website.

It is necessary to apply programming concepts with flexibility and consistency.

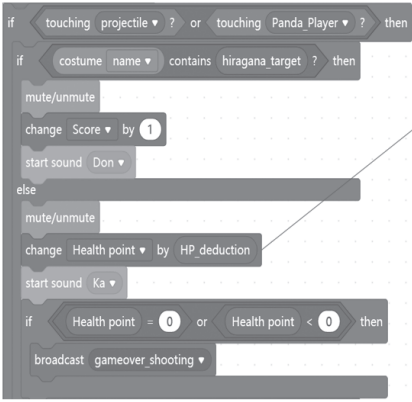**ii) A shooting game for learning Japanese, built using Scratch**

Interface

Block coding
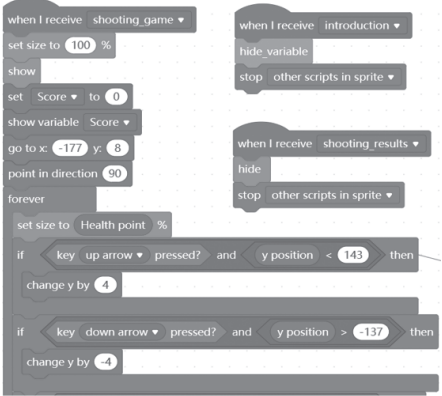
Variables

Variables are abundant in any kind of programme. The picture here shows one of several uses of variables in the shooting game.

Variables here include the score, health points, and health points (HP) deductions, which are important parameters in the game. The meaning of individual variables is as their name suggests. Throughout the gameplay, the value of the abovementioned variables will change and affect the gameplay experience.

Conditionals
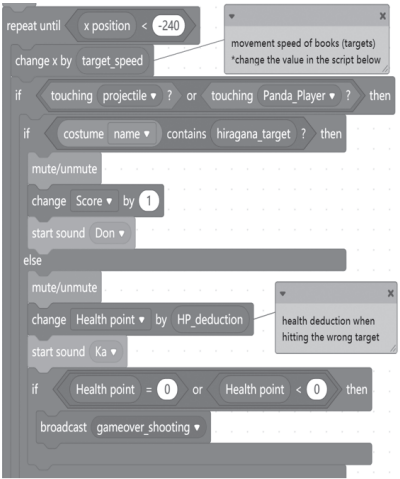
The use of nested if–statements is involved on multiple occasions in the shooting game, for example in the hit detection and timer. Nested statements, in which the output is judged by more than one condition, are common.

Algorithm
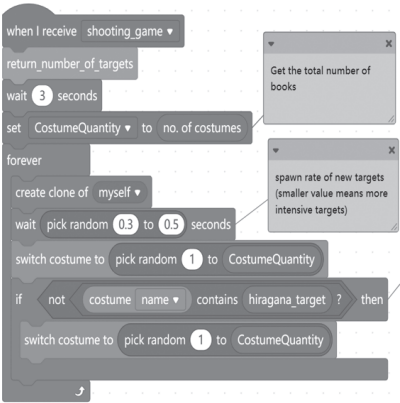
A sorting algorithm is used to control specific types of books in the book list. In the shooting game, the spawn probability of target books is enhanced around 2.5 to 3 times that of non-target books, so players can become more attached and kept busy in their gameplay. The particular type of each book is sorted in every unique game to increase the respective spawn probability.
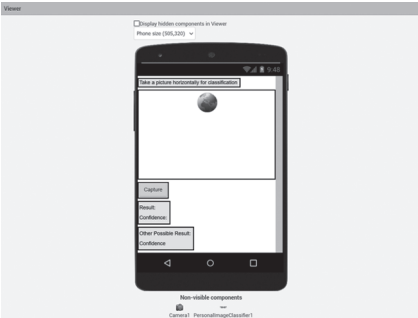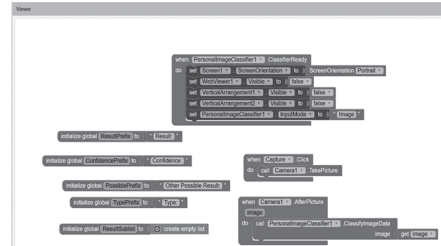
Integrative
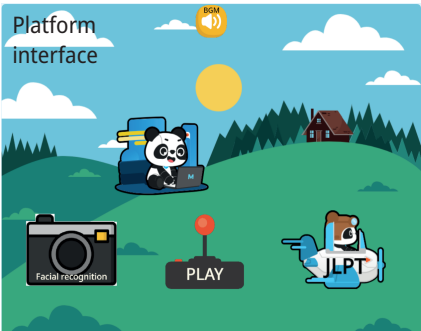
The integration of computer knowledge, art, and creativity in game development are interdisciplinary skills that are crucial to making any product appealing to users.

iii) Seal Finder, built using App Inventor

1. Interface Design

2. Block coding

Coding elements demonstrated in the Seal Finder App

Variables – photo input and data output

The photo captured using a phone camera is an independent variable and acts as an input to the app so that the programme can read the photo and generate the recognition result.
The recognition result is a dependent variable that is a list of results, including the confidence of different possible instances of recognition.

Conditionals – workflow control
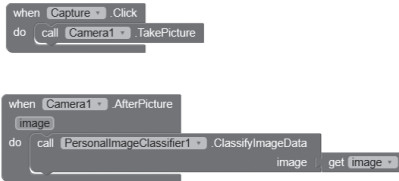
The workflow of the app is controlled by the when function in App Inventor and is similar to if–conditionals. The if–conditionals are used to decide which action the app should perform next.

Algorithm – Greedy algorithm
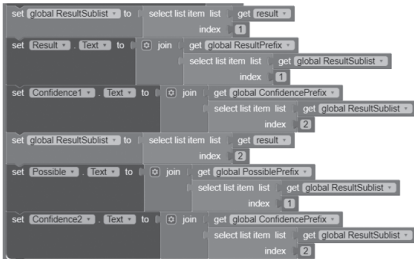
The algorithm of the app uses a Greedy algorithm to give the best result in each layer of the decision-making condition. Each instance of text recognition goes through a chain of decision-making processes and eventually returns the result with the highest level of confidence. After the classification process, only two results with the highest level of confidence will be shown.

The algorithm can run efficiently, as the decision-making process is simple, and so this algorithm is common. However, the algorithm may not produce the optimal solution because it makes decisions before validating all solutions and may miss better possible solutions.

Integrative functions – User Interface (UI)
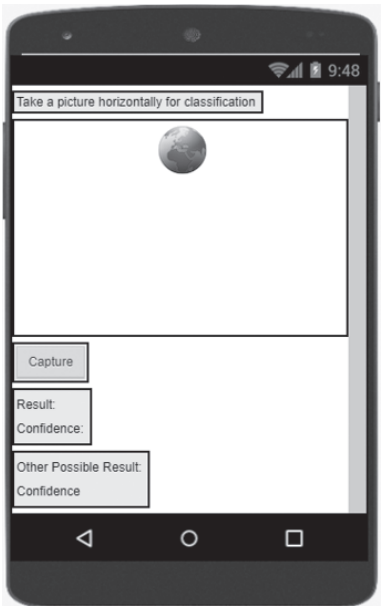
The elements in the user interface are integrated with programming blocks, where the blocks determine the behaviour of different parts on the screen, such as buttons and text.