

National School Curriculum
INSTRUCTIONAL GUIDE
FOR ICT
CLASSES XI & XII



Department of Curriculum and Professional Development
Ministry of Education, Royal Government of Bhutan



“Your parents, relatives, and friends would be very proud of what you have achieved. At your age, to have completed your studies is your personal accomplishment. Your knowledge and capabilities are a great asset for the nation. I congratulate you for your achievements. Finally, your capabilities and predisposition towards hard work will invariably shape the future of Bhutan. You must work with integrity, you must keep learning, keep working hard, and you must have the audacity to dream big.”

- His Majesty Jigme Khesar Namgyel Wangchuck

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Foreword

The erstwhile Royal Education Council (REC) developed an Adapted and Prioritized curriculum for schools so that students can continue learning during the disruptions caused by the COVID 19 pandemic since March 2020. With the commencement of the 2021 academic session, the new normal curriculum, later renamed as the National School Curriculum (NSC), was embraced as a paradigm shift of education from conventional knowledge-based learning to competency-based, open-source and experiential learning leveraged on digital technologies. In order to facilitate the effective implementation of the curriculum change, Instructional Guides were developed in all subjects, and the teachers were oriented through virtual and short contact modes as per the prevailing pandemic situations. The curricula were aimed at minimizing the learning loss for learners as it was designed for implementation in different situations - during school closure or during regular contact instructional hours.

While these measures served as a solution to problems brought about by the pandemic and the global changing trend in education, resilient and more dynamic curricula and instructions remain the current priority of the Government. In cognizance of some of the shortfalls in the provisional edition of Instructional Guides (IG), the Department of Curriculum and Professional Development reviewed and revised the existing Instructional Guides across all subjects with the aim of enforcing the competency-based learning, and making teaching-learning happen ‘anytime anywhere’ commensurate to inclusive education so that all learners are provided with the opportunity to learn at their pace and situation.

The revised Instructional Guides have drawn ideas and inspiration from various educational philosophies and principles, particularly the Delors Report, *Learning: The Treasure Within* (1996). The report prioritizes the development of the whole person and not just academic knowledge through the four pillars: “learning to know”, “learning to do”, “learning to be”, and “learning to live together”. Therefore, the New Curriculum and the Instructional Guide is an attempt to transform education from the teaching of “what” to learning of “how” and “why” towards empowering learners with the transversal competencies and the 21st century skills and preparing them to be lifelong learners.

It must be noted that the New Curriculum and the Instructional Guide are not just a response to the pandemic, but a culmination of the curriculum reform work for the last four years by the

Department of Curriculum and Professional Development. The school curricula are to be perceived as integrated and based on themes and problems that inspire learners to learn and to live in peace with our common humanity and our common planet. This has the potential for the development of a strong base of knowledge about one's self and about the world, finding the purpose of learning, and being able to participate in the social and political milieu. Thus, this initiative is envisaged to orient our educational process toward nurturing 'nationally rooted and globally competent citizens.

Wish all our learners and teachers life-enriching teaching and learning.

Tashi Delek

A handwritten signature in black ink, appearing to read 'Tashi Namgyal', written over a horizontal line.

Tashi Namgyal

Director

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Introduction

The National School Curriculum for the Information and Communication Technology (ICT) was developed for implementation in schools from the 2021 academic year. One significant change in the curriculum frameworks is the shift of focus from academic standards to competencies. Over the years, standards-based education has become a means of measuring content coverage and test readiness. The shift to competency-based education is aimed at developing and applying competencies - knowledge, skills and dispositions - to new and challenging situations. It emphasizes mastery of competencies to help our students successfully navigate their personal journeys in learning, living and working.

In school, students develop and apply ICT competencies through ICT subject-area content and learning experiences which provide opportunities for them to transfer their learning to situations and contexts even beyond the classroom. This shift permeates across the curriculum, pedagogy and assessment, and for this change to make a difference in learning, deliberate attempts must be made in all three aspects.

This instructional guide for the ICT curriculum is conceived with two objectives. The first purpose is to provide examples of how pedagogy and assessment are designed to help students develop the required ICT competencies. It also includes examples of curated online resources that can be used as reference materials for teachers, learning resources for students or assessment tools for use by teachers. The second purpose is to provide a reference for ICT teachers to facilitate the delivery of online lessons during emergencies. The guide contains distinct examples of pedagogy and assessment for non-contact online teaching.

The pedagogy, assessment and resources mentioned for every competency for all class levels are only meant to be suggestive. Teachers are encouraged to modify them, use innovative strategies or create new lessons that are relevant to their students and situations, and can help students develop and master the required competencies.

A salient feature of the guide is the conscious integration of ICT in teaching and learning. This may be in the form of blended learning during normal school settings, or fully online teaching during emergencies such as the current pandemic. The curated digital resources provided in the guide can be applied to both blended learning and online teaching depending on the instructional approach being used by the teacher.

Purpose of the Instructional Guide

The content in the instructional guide is aligned with the competencies and topics provided in the National School Curriculum for ICT. The instructional guide comprises competencies, topics, learning experiences, assessments and resources that will facilitate teachers to successfully deliver the ICT curriculum. Using a competency and corresponding topic as the pivot, learning experiences and assessments are written towards achieving the competency.

Learning experiences provide suggestive strategies and pedagogies for the delivery of the listed competencies. It has both contact and online teaching strategies. Contact teaching refers to a situation when schools are open, and teaching and learning take place face-to-face in a classroom. Teachers can apply a blended teaching approach for meaningful ICT integration and delivery of lessons. Online teaching refers to a situation where teaching and learning happen online during school closures due to emergencies like pandemics. In such a situation, teachers need to consider relevant pedagogies that are supported by technologies such as the ones given below:

1. Choose an online learning platform such as Google Classroom, Sherig LMS (under development), WeChat, WhatsApp, Telegram, etc. considering the ease of use and appropriateness of the tool for the students. This platform is to be used as a virtual classroom for presentations, discussions, sharing resources, assigning tasks, and assessment of learning.
2. For lesson delivery by teachers, consider the use of video conferencing tools such as Zoom and Google Meet for synchronous teaching, and creation tools such as Microsoft PowerPoint and Camtasia for asynchronous teaching.
3. For assessment purposes, consider the use of tools such as Google Forms and Kahoot to create quizzes, Google Docs, Google Sheets and Google Drawings in Google Classroom to assign tasks for students.
4. For the recording of student performance, consider the use of the grading feature in Google Classroom or spreadsheets such as Google Sheets and Microsoft Excel. The scores from these sources can be transferred to the student progress report as per the assessment criteria.

Suggestive pedagogies, assessments and resources for each competency are listed below. Teachers are advised to refer to the instructions given therein for their lesson planning and effective delivery of the ICT lesson to the learners.

Class Eleven

Students will be able to:

1. create a well-designed publication using desktop publishing software to communicate and present their creative works.
2. appreciate the benefits and limitations of ICT in society and make decisions related to technology for the positive development of the individual and the society.
3. develop a program using object-oriented concepts in a programming language for code efficiency and to facilitate easy maintenance and modification of existing code.
4. demonstrate the application of coding skills to create relevant GUI applications and appreciate the work of coders in contributing towards nation building by creating applications that are regularly used to avail services.

STRAND A – Technology Operation

COMPETENCY 1: Students will be able to create a well-designed publication using desktop publishing software to communicate and present creative works.

Overview:

Desktop publishing is the process of designing and laying out pages using a desktop computer. Through this competency, students will be able to design and layout of publications like newspapers, magazines, brochures, cards etc using a Microsoft publisher which is a Desktop Publishing software. In order to make a design elegant and intuitive, students will consider important design principles while publishing their work.

Through this learning experience, students will not only gain considerable competencies in using DTP software but their creativity and sense of aesthetics will also be sharpened. DTP skills will be a useful skill for students’ future careers in the field of design and publications.

Topics	Key Stage Standard	Objectives	Time
<p>Introduction to MS Publisher</p> <ul style="list-style-type: none"> ● Definition of Desktop Publishing (DTP) ● Types of publications <ul style="list-style-type: none"> ○ Newspapers, magazines, brochures, cards, certificates, etc. ● Features of MS Publisher <ul style="list-style-type: none"> ○ Master page, header and footer ○ Styles, page size ○ Margins and layout ● Designing and publishing ● Project - creating a DTP document <p>Design Principles in DTP</p> <ul style="list-style-type: none"> ● Fonts and colours contrast ● Objects, image, text and diagram alignments ● Layout and white space ● Balance and consistency 	<p>A5.1 Create a well-designed publication using a desktop publishing software.</p>	<p>11-A5.1.1 Create a publication using publishing software.</p> <p>11-A5.1.2 Apply design principles in publications.</p>	<p>560 mins (14 periods)</p>

Learning experiences:

- Make a PowerPoint presentation to introduce the concept of desktop publishing and different types of publications (book, newspaper, card, magazine, poster, etc.) that can be created by

using a Desktop Publishing (DTP) software. Explain the importance of DTP to design and publish well-formatted documents. Mention a list of career opportunities (graphic designer) in the field of computer design and layout. Then, ask students to take notes and share their understanding.

- Mention a list of desktop publishing software such as Adobe Indesign, CorelDRAW, QuarkXPress and Microsoft Publisher that are widely used for designing common publications. Then, introduce MS Publisher and explain why it will be used for learning DTP in the school. Display a sample invitation card created in MS Publisher and demonstrate how to create it. Ask students to create a similar card in MS Publisher.
- Demonstrate the steps of using templates to create professional-looking documents such as calendars, postcards, flyers, invitations and brochures. Let students follow the steps to publish any of the documents using templates.
- Instruct students to explore the Internet to find out information about “Design Principles” in desktop publishing. Ask them to list the principles with examples and share them with the class. Some of the key design principles are consistency, contrast, alignment, white space, and balance as given in the weblinks below:
 - <https://99designs.com/blog/tips/principles-of-design/>
 - <https://wac.colostate.edu/resources/writing/guides/desktop/>
 - <https://www.birdvilleschools.net/cms/lib/TX01000797/Centricity/Domain/291/4%20p rinciples.pdf>
- Divide students into six different groups and assign them to create an invitation card, flyer, newsletter, poster, banner, and certificate respectively. Ask them to explore the Internet for design ideas and follow design principles to come up with the assigned document. Once they have finished, ask them to present it to other groups. Teachers may print the documents and display them in the class for comments and feedback.
- Share weblinks and online resources (video, ppt, pdf) on the Desktop publishing and MS Publisher through the online class platform for students to refer to and learn about Desktop publishing in MS Publisher. Ask students to take notes and share their understanding through the discussion forums.
- Conduct an online video conferencing lesson using Zoom or Google Meet on how to create different types of documents (newsletters, postcards, flyers, invitations, brochures, etc.) using MS Publisher. Explain and apply principles of good design in the document to make it look better and communicate effectively. Then, ask students to create any one of the documents on their own.
- Share two documents- one with good design and the other with poor design, on the same content to students through the class online platform. Ask them to evaluate and share which

document they like and why. Also, instruct them to share how they can improve the document that was not designed well.

Assessment:

- Maintain a record of students' participation in the class or group activities during the lessons on MS Publisher.
- Assign students to create publications (newsletters, postcards, flyers, invitations, brochures, etc.) using MS Publisher and grade their work based on the content, design principles and creativity.
- Evaluate students' presentation of their group work on creating a different publication (invitation card, flyer, newsletter, poster, banner, and certificate) using MS Publisher. Assess their work on both the content and delivery.
- Create an online quiz using Google Forms or Kahoot on the design principles of DTP. Maintain a record of their quiz scores.
- Use the class online platform to assign an individual task to create a birthday greeting card for their parents. Ask them to apply the design principles to make the card attractive and realistic. Students may print the card and give it to their parents on a special day. A copy of the card must be sent to the teacher for evaluation.

Questions:

1. What is DTP?
2. What are some of the features of MS Publisher?
3. List some design principles to be considered while designing?
4. Compare desktop publishing in MS Publisher and other tools such as Indesign. Which tool would you prefer to use in future?

Resources:

1. **Microsoft Publisher:** The weblinks explain what is desktop publishing, the uses of desktop publishing and how to create simple documents using Microsoft Publisher.
 - <https://ehlion.com/magazine/what-is-desktop-publishing/>
 - <https://support.microsoft.com/en-us/publisher?ui=en-US&rs=en-US&ad=US>
 - <https://edu.gcfglobal.org/en/publisher2010/>
 - <https://youtu.be/GggLhqblSOU>
 - <https://www.youtube.com/watch?v=-wICZMYq3X0>
2. **Design Principles in DTP:** The weblinks provide information on principles of layout and design that are required to be used in DTP to make documents look better.
 - <https://99designs.com/blog/tips/principles-of-design/>
 - <https://wac.colostate.edu/resources/writing/guides/desktop/>

- <https://www.brighthub.com/multimedia/publishing/articles/62539/>
- <https://www.birdvilleschools.net/cms/lib/TX01000797/Centricity/Domain/291/4%20principles.pdf>

STRAND C – Safety and Ethics

COMPETENCY 2: Students will be able to appreciate the benefits and limitations of ICT in the society and make decisions related to technology for the positive development of the individual and the society.

Overview:

As individuals and societies get driven by technology on a daily basis, they are greatly influenced by the technologies in both personal and professional work. Identifying the benefits and challenges of ICT will help students to reap the advantages of ICT and protect from its negative effects. Through the lessons under this competency, students will explore the emergent technologies like IoT, AI, Blockchain, and others. Students will be able to evaluate the impact of such technologies on societies and individuals, and also champion the safe and ethical use of ICT in their societies.

Online safety and ethics related to individuals or societies have become ever more important with the way we connect, communicate, learn, work and socialise in the digital environment. It is paramount that students become informed about the impact of ICT on society and become responsible users of technology.

Topics	Key Stage Standard	Objectives	Time
<p>Impact of ICT on Society</p> <ul style="list-style-type: none"> ● Positive Impacts <ul style="list-style-type: none"> ○ Entertainment, Media sharing ○ Communication, Community support ○ Innovation, Job market ○ Crowdfunding, Online learning ○ Medicine, E-commerce ● Negative impacts <ul style="list-style-type: none"> ○ E-waste, Digital divide, Health issues ○ Addiction, scam, etc. <p>Emerging Technologies</p> <ul style="list-style-type: none"> ● Definition 	C5.1 Evaluate the impact of ICT on society	<p>11-C5.1.1 Identify the impacts of ICT on society.</p> <p>11-C5.1.2 Evaluate the impacts of emerging technologies on society.</p>	240 mins (6 periods)

<ul style="list-style-type: none"> ● Examples of emerging technologies (IoT, AI, 5G, blockchain, robotics, biometrics, 3D printing, virtual reality, drones, etc.) ● Impacts of emerging technologies <ul style="list-style-type: none"> ○ Job opportunities, education, medicine, business, environment, etc. <p>Ways to Reduce Negative ICT Impacts</p> <ul style="list-style-type: none"> ● Benefits of reducing negative impacts ● Ways to reduce negative impacts. <ul style="list-style-type: none"> ○ reduce e-waste, recycle, online support communities, etc. ● Project - Awareness poster or video on the impact of ICT on society 		11-C5.1.3 Adopt measures to reduce the negative impacts of ICT on individuals and society.	
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Learning experiences:

- Divide students into groups and ask them to explore the Internet to find information on the impacts of ICT on society. Ask each group to make a PowerPoint presentation to share their findings and reflections. Instruct them to include the following points in the presentation.
 - What are the signs of technological advancement in society?
 - How is technology benefiting the Bhutanese society?
 - What are the problems caused by technology in Bhutanese society?
 - Is technology helping or hindering the Bhutanese society? Give examples.
- Make a PowerPoint presentation to explain emerging technologies (IoT, AI 5G, blockchain, robotics, biometrics, 3D printing, virtual reality, drones, etc.) and how they are expected to change the way we live and work in future. Discuss the possible impacts of these technologies on individuals, society and the world at large.
- Provide a scenario or a situation such as e-waste problems, fake accounts and news on social media, game and mobile addictions, online scams and piracy, etc to generate discussions on the negative impacts of technology on people and the environment. Encourage students to share their opinions and identify measures to reduce the negative impacts.
- Assign a project work to create awareness on the ways to reduce the negative impacts of technology on society and the environment. Ask students to come up with posters, videos or newsletters that can be shared on social media (Facebook, Instagram) in order to reach out to more people.

- Instruct students to explore the Internet to write a short report in Google Docs on the impacts of ICT on society. Ask them to list both the positive and negative impacts with examples. The following points may be included in the report.
 - Commonly used technologies in society.
 - Benefits and challenges of technologies in society.
 - Students' use of technology for learning and entertainment.
 - Negative impacts of technology on society and ways to reduce it.
- Share videos through the class online platform to explain emerging technologies and their positive impacts on society. Ask them to find out more about the emerging technologies from the Internet and share at least two technologies (AI, IoT, 5G, Drones) that are going to change the way we live and work in the future.
- Generate an online class discussion on the negative and positive impacts of technology on society. Ask students to share their opinions and respond to others' views on the topic. The discussion must help students to identify the challenges of technology and ways to reduce the negative impacts.

Assessment:

- Evaluate PowerPoint presentations created by students on the positive and negative impacts of technology on society.
- Assess the awareness posters, videos or newsletters created by students based on criteria(content, message, design, creativity, originality).
- Divide students into two groups and organise a debate competition on the topic “Technology is good for the society”. Encourage students to argue and critic on the topic with appropriate examples. Invite a few teachers as judges to evaluate students' understanding of the topic.
- Conduct an online interactive quiz on the impacts of ICT on society using tools such as Kahoot, Triventry, and Quizziz. Maintain a record of students' quiz scores.
- Assign students to create an awareness video or poster on the impact of technology on society. Ask them to submit their work through the class online platform for evaluation.
- Keep a record of students' participation in the online discussion that was initiated by the teacher for sharing views on the impact of technology on society. Award grades based on the quality and frequency of students' comments in the discussion.

Questions:

1. What are the impacts of ICT on Bhutan?
2. What are some emergent technologies?
3. What are the ways to reduce the negative impact of ICT?
4. As a student, what are some of your roles and responsibilities to reduce the impact of ICT on individuals and society at large?

Resources:

1. **ICT on Society:** The weblinks contain information on the positive and negative impacts of ICT on society.
 - <https://www.bbc.co.uk/bitesize/guides/zbxbkqt/revision/1>
 - <https://ajahana.wordpress.com/2012/06/27/the-positive-and-negative-impacts-of-ict-5>
 - <https://www.zurich.ibm.com/pdf/news/Konsbruck.pdf>
 - <https://www.digitaldetox.com/blog/the-19-negative-effects-of-technology-in-2019>
2. **Emerging Technologies:** The weblinks contain lists of top emerging technologies (AI, IoT, 5G, BlockChain, etc.) and how they are going to change the future.
 - <https://www.simplilearn.com/top-technology-trends-and-jobs-article>
 - <https://youtu.be/FconIXBtPOk>
 - <https://connect.comptia.org/content/infographic/2020-emerging-technology-top-10-list>
 - <https://www.weforum.org/agenda/2017/01/what-emerging-technologies-have-the-biggest-negative-consequences/>

STRAND D – Coding

COMPETENCY 3: Students will be able to develop a program using object-oriented concepts in a programming language. Object-oriented concepts facilitate code efficiency and easy modification of existing programs.

Overview:

After learning Python coding in classes IX and X, students, at this stage, will be able to develop applications that handle files and use relevant Python modules. Besides, students will also be able to include data structures like lists, Tuples and Dictionary in their code.

Python provides support for file handling as it is an important component of most software. File handling in simple terms means handling files such as opening the file, reading, writing, and many other operations. Using the modules in Python programming makes the code modular and manageable. Thus students' competencies in writing a code that handles files and using the modules make software efficient.

Topics	Key Stage Standard	Objectives	Time
<p>Python Data Structure (Continued from Class X)</p> <ul style="list-style-type: none"> List, Tuple, Set, Dictionary <p>File Handling in Python</p> <ul style="list-style-type: none"> Open, Read, Write <p>Module</p> <ul style="list-style-type: none"> User-defined module - create and use modules <ul style="list-style-type: none"> Built-in module Math module String module Random module 	<p>D5.1 Develop an application by applying object-oriented concepts of a programming language.</p>	<p>11-D5.1.1 Handle text files to manage data in Python programming.</p> <p>11-D5.1.2 Use built-in or user-defined modules to break down large programs into small manageable, reusable and organised files.</p>	<p>600 min (15 periods)</p>

Learning experiences:

- Use a projector to recapitulate the concepts of data structure in Python programming by demonstrating the use of the list, tuple, set and dictionary in a program. Then, assign a task for students to practice and understand more about the Python data structure.
- Create a PowerPoint presentation to explain the purpose of file handling (open, read, write, delete) in Python. Then, demonstrate how to manage files using Python programming. Ask students to read and write a file using Python programming.
- Ask students to come up with a short presentation on “Modules in Python”. Allow them to explore the Internet to find information. Instruct them to include the following points in their presentation.
 - Definition of Module in Python.
 - Why are modules used in Python?
 - What is the difference between built-in and user-defined modules?
 - What are the steps to create a user-defined module?
- Display output of a Python program such as Mathematical calculator, random password generator, guess the number game, rock-paper-scissors game, and temperature converter that uses built-in or user-defined modules. Then, demonstrate step-by-step to use modules to create the program. Ask students to apply the same steps to create other programs.
- Explain the built-in modules in Python such as math, string and random, and demonstrate how to use these modules in a program. Ask students to take notes and practice applying one of the modules in a program.

- Create and share videos to demonstrate various operations (access, change, add, remove, arrange, etc.) on the list, tuple, set and dictionary with examples. Then, assign a task related to list, tuple, set and dictionary for students to complete at home.
- Share weblinks on Python file handling (opening, reading, writing and closing) through the class online platform for students to read and learn about managing files using the Python program. Then, assign a Python activity that requires file handling methods.
- Share the weblinks (<https://www.programiz.com/python-programming/modules> and <https://realpython.com/python-modules-packages/>) through the class online platform for students to learn about Python modules. Ask them to answer the following questions after going through the weblinks.
 - What are modules in Python?
 - What are the advantages of modularizing code in large programs?
 - How do you import modules in Python?
- Ask students to explore free online courses to learn more about python data structure, file handlings, and modules. Ask them to enrol in the course and begin to learn independently.
- Teachers may instruct students to use the following online Python interpreters in case of failure to install the Python on their computers.
 - Repl.it: <https://repl.it/~>
 - Google Colab: colab.research.google.com
 - Programiz: <https://www.programiz.com/python-programming/online-compiler>
 - GDB Online: <https://www.onlinegdb.com/>

Assessment:

- Use rubrics to assess the programs related to module, data structure and file handling that are submitted by students. Award grades and give feedback to improve the programs.
- Conduct practical tests on Python data structures, file handlings, and modules.
- Observe and keep records of students' participation in discussions and group activities during lessons on Python modules, data structure, and file handling.
- Evaluate Python projects submitted by students through the class online platform. Send comments and feedback to improve the programs.
- Collect evidence of students' enrollment in online courses on Python modules and file handling. Ask students to submit certificates, screenshots, and practice codes to show the progress of their learning.

Questions:

1. What are the ways to handle files in Python?
2. What is a module in Python?

3. How can modules make the code efficient?

Resources:

1. **Python Data Structure:** The weblinks contain tutorials on lists, tuples, sets and dictionaries in Python. The links can be shared with the students to try out activities and learn independently.
 - https://www.w3schools.com/python/python_lists.asp
 - <https://www.edureka.co/blog/data-structures-in-python/>
 - <https://www.datacamp.com/community/tutorials/data-structures-python>
2. **File Handling in Python:** The weblinks contain tutorials on file handling in Python. The links can also be shared with students to explore further file handling.
 - https://www.w3schools.com/python/python_file_handling.asp
 - <https://www.programiz.com/python-programming/file-operation>
 - <https://www.guru99.com/reading-and-writing-files-in-python.html>
3. **Python Modules:** The weblinks explain how to create and use modules in Python. It also contains different project ideas that can be created using different modules in Python.
 - https://www.w3schools.com/python/python_modules.asp
 - <https://www.programiz.com/python-programming/modules>
 - <https://docs.python.org/3/tutorial/modules.html>
 - https://www.tutorialspoint.com/python/python_modules.htm
 - https://www.codementor.io/@abdullah_alawad/6-python-projects-for-beginners-160ffx38n2

COMPETENCY 3: Students will be able to develop a program using object-oriented concepts in a programming language. Object-oriented concepts facilitate code efficiency and easy modification of existing programs.

Overview:

Students will be able to implement Object-Oriented Programming principles like Inheritance, Polymorphism, Abstraction and Encapsulation. They will also define classes and instantiate objects.

As a part of learning experiences, students will be able to write efficient Python code using Object-Oriented Programming. They will also be able to understand that OOP reduces code redundancy, increases code reuse and enhances code readability. Since OOP is being used by most software development companies, students' exposure to OPP at stage will help them to build a good foundation in software development.

Topics	Key Stage Standard	Objectives	Time
Object-Oriented Programming <ul style="list-style-type: none"> ● Classes and objects ● Inheritance ● Polymorphism ● Abstraction ● Encapsulation 	D5.1 Develop an application by applying object-oriented concepts of a programming language.	11-D5.1.3 Apply object-oriented principles to create dynamic applications.	800 mins (20 periods)

Learning experiences:

- Explain the importance of classes and objects in programming. Then, demonstrate how to define a class and create instances of a class in Python programming. Ask students to complete simple tasks to create classes and objects.
- Use a sample project to explain attributes and methods to define the properties and behaviours of an object. Let students follow the process to create methods for class in Python.
- Create a PowerPoint presentation followed by a demonstration of the following concepts. Use examples and sample codes to illustrate the use of the following concepts in object-oriented programming. Allow students to take notes, ask questions and share their views on the OOPs.
 - o Inheritance - create a new class (child) from the existing class (parent) to inherit attributes and methods.
 - o Polymorphism - perform a single action in different ways.

- o Abstraction - shows only essential attributes and hides unnecessary information from the user to handle complexity.
- o Encapsulation - wrap data and function into a single unit (class) to restrict access to methods and variables.
- Divide students into groups and assign tasks for each group to use OOP concepts to develop programs such as car parking applications, school management applications, hangman games, budget applications, and others. Allow them to explore the Internet to get more information on creating different OOP programs. In the end, instruct them to make a class presentation on their completed program.
- Provide the weblink (<https://digitaldefynd.com/best-object-oriented-programming-python-courses/>) to free online courses on object-oriented programming in Python and ask students to enrol in the courses to enhance their understanding of OOP. Instruct students to maintain a note on key points (inheritance, polymorphism, abstraction, encapsulation) in OOP.
- Share online resources (video, ppt, pdf, tutorials) through the class online platform on the principles of Object-Oriented Programming and its importance in software development. Ask students to take notes and complete a simple program where they have to use classes and objects.
- Arrange a video conferencing lesson using Zoom or Google Meet to explain and demonstrate the use of classes and objects in Python programming. Explain the four principles (inheritance, encapsulation, abstraction and polymorphism) of object-oriented programming and show examples of their use in programs. Ask students to take notes and create programs such as car parking applications, school management applications, ATM simulations, hangman games and budget applications using classes and objects.

Assessment:

- Use rubrics to assess the tasks on classes and objects submitted by different groups. Award grades and give feedback to improve the programs.
- Conduct practical and theory tests on principles of object-oriented programming.
- Observe and keep records of students' participation in discussions and group activities during OOP lessons.
- Evaluate students' Python projects submitted through the class online platform on classes and objects. Share comments and feedback to improve the programs.
- Collect evidence of students' enrollment in online courses on OOP. Ask students to submit certificates, screenshots, and practice codes to show the progress of their learning.

- Conduct an online quiz using Google Forms or Quizizz to check students' understanding of concepts in object-oriented programming. Maintain a record of their score on the quiz.

Questions:

1. What are the underpinning philosophies of an OOP?
2. Differentiate between class and object.
3. How is OOP superior to Procedural programming?

Resources:

1. **Object-Oriented Concepts in Python:** The weblinks contain tutorials on object-oriented concepts in Python. It also contains ideas to develop applications using object-oriented concepts.
 - <https://www.programiz.com/python-programming/object-oriented-programming>
 - <https://realpython.com/python3-object-oriented-programming/>
 - https://www.digitalocean.com/community/tutorial_series/object-oriented-programming-in-python-3
 - <https://www.edureka.co/blog/object-oriented-programming-python/>
 - https://python-textbok.readthedocs.io/en/1.0/Object_Oriented_Programming.html
 - <https://youtu.be/bgATKeiNcL8>
 - <https://www.upgrad.com/blog/python-projects-ideas-topics-beginners/>
 - <https://medium.com/@gurupratap.matharu/object-oriented-programming-project-in-python-for-your-github-portfolio-d34feaf1332c>
 - <https://towardsdatascience.com/3-useful-projects-to-learn-python-classes-cf0076c36297>

COMPETENCY 4: Students will be able to create relevant GUI applications by applying coding skills and knowledge. They recognise and appreciate the roles of programmers in creating useful and efficient applications to solve problems.

Overview:

Through the lessons under this competency, students will be exposed to GUI programming with Tkinter. Python with Tkinter is the fastest and easiest way to create GUI applications. Students will learn some of the essential features in Tkinter and develop applications. They will synthesise the knowledge and skills gained in GUI, problem-solving and standard python to build a project.

Besides, students will be able to experience the work of a full stack developer; front-end development using Tkinter and back-end development using standard python. The introduction

of Tkinter is to help students learn and apply object-oriented programming principles in a fun and project-based approach.

Topics	Key Stage Standard	Objectives	Time
GUI Programming with Tkinter <ul style="list-style-type: none"> ● Importing Tkinter module ● Creating Tkinter window ● Adding widget and standard attributes ● Using geometry managers to arrange the widgets ● Adding images in Tkinter <ul style="list-style-type: none"> ○ Pillow module ● Events and event handlers ● Project on Tkinter 	D5.3 Complete a project using a programming language to solve problems.	11-D5.1.4 Develop GUI application/game using object-oriented principles.	1400 mins (35 periods)

Learning experiences:

- Make a PowerPoint presentation to explain Graphical User Interface (GUI) programming with examples. Then, ask students to explore the different GUI modules (Kivy, PyQt, Tkinter, WxPython) in Python. Instruct students to find information on the following points.
 - What are different GUI modules in Python?
 - Which GUI module is popular and why?
 - What are the benefits of learning the Tkinter module?
- Demonstrate examples to show the differences between GUI and Command Line Interface (CLI). Show the steps to operate (create, delete, write, organize) files and folders by using both GUI and CLI to see clear differences (<https://www.geeksforgeeks.org/difference-between-cli-and-gui/>) between the two. While discussing the two interfaces, explain why we are learning the GUI (user-friendly, instant visual outputs) in Python.
- Show examples of Tkinter applications such as calculator, bio-data form, tic-tac-toe game, address book, etc. to the students and demonstrate how to create such applications. Explain different stages of application development (planning, coding, testing, documenting) to create the Tkinter applications. Consider discussing the following areas thoroughly.
 - Importing Tkinter module - `from Tkinter import *`
 - Setting the window
 - Adding widgets (button, label, entry, listbox, etc.) and arranging them (pack, place, grid)
 - Defining and calling functions (bind or command).
 - Adding events and event handlers

- o Event loop - mainloop()
- Divide students into groups and ask them to come up with a project in Tkinter. Allow them to explore the Internet to create the applications. The following components must be present in the application.
 - o Title and text
 - o Images
 - o Buttons
 - o User interaction
 - o Mathematical operations
- Assign a final project for students to develop an application in Tkinter. The project must require students to apply all the Tkinter concepts they have learned so far. The project will be the major part of the assessment under digital artefact evaluation.
- Share the following weblinks on Tkinter GUI programming through the class online platform for students to refer to and learn how to create GUI applications using the Tkinter library. Ask them to come up with a simple application and share it on the class online platform.
 - o <https://tkdocs.com/tutorial/>
 - o <https://www.javatpoint.com/python-tkinter>
 - o <https://pythonbasics.org/tkinter/>
 - o <https://www.youtube.com/watch?v=xuXYKhdoTsw>
 - o <https://www.geeksforgeeks.org/python-tkinter-tutorial/>
- Conduct several video conferencing lessons through Zoom or Google Meet to teach students on how to create a GUI application using Tkinter library. Cover the following topics during the lessons.
 - o What is Tkinter library?
 - o Benefits of using Tkinter library
 - o Importing Tkinter library
 - o Setting Tkinter window
 - o Adding widgets, images, events and functions
 - o Creating a simple GUI application in Tkinter
- Provide the weblinks to free online courses on Tkinter GUI programming. Ask students to enrol in the courses and learn how to create GUI applications individually. Encourage students to share their learning progress as well as doubts related to the course on the class online platform for support.

Assessment:

- Observe and maintain records of students' participation in the class and group discussions during the lessons on Tkinter. Identify students who are proactive and inactive to provide the necessary support to enhance their GUI programming skills.
- Evaluate students' applications or projects on Tkinter by using a rubric. Ask them to also present their work in the class for feedback and comments.
- Conduct practical class tests where students have to design a Tkinter application within a given time.
- Organise coding competitions on Tkinter programming within the class or school. Allow students to participate individually or in groups. Set criteria such as code correctness, creativity, originality, use of good programming practices, and design principles. Invite other teachers as judges to evaluate students' works.
- Maintain a record of digital artefacts related to Tkinter programming that are submitted by students through the class online platform. Provide necessary feedback and reinforcement.
- Conduct online quizzes using Google Forms or Kahoot to check students' understanding of GUI programming in Tkinter.
- Arrange video conferencing using Zoom or Google Meet for students to present their group project on Tkinter programming. Evaluate their works based on the quality of content and delivery.

Questions:

1. What is the use of Tkinter?
2. Differentiate between event and event handler?
3. Can we develop a complete application using Tkinter?

Resources:

1. **The Tkinter Tutorials:** The weblinks contain Tkinter documentation and tutorials with some sample projects. The links can be shared with students for them to practise and learn GUI programming in Python independently.
 - <https://docs.python.org/3/library/tk.html>
 - <https://pythonbasics.org/tkinter/>
 - <https://tkdocs.com/tutorial/>
 - <https://www.geeksforgeeks.org/python-tkinter-tutorial/>
 - <https://realpython.com/python-gui-tkinter>
 - <https://likegeeks.com/python-gui-examples-tkinter-tutorial/>
 - <https://www.datacamp.com/community/tutorials/gui-tkinter-python>
 - <https://www.javatpoint.com/python-tkinter>
 - <https://youtu.be/YXPYB4XeYLA>

- <https://youtu.be/VMP1oQOxfM0>
2. **Sample Tkinter Projects:** The weblinks contain sample projects in Tkinter that students refer for ideas for creating their projects.
- <https://timetoprogram.com/tkinter-project-ideas/>
 - <https://projectworlds.in/python-projects-with-source-code/hotel-management-system-python-tkinter-gui/>
 - <https://code-projects.org/c/languages/project/pythonprojects/>

Class Twelve

Students will be able to:

1. create games and applications by applying coding knowledge and skills to simulate a real-world application.
2. create a simple database to simulate a real-world application.
3. adapt documentation practices when writing programs to make maintenance and knowledge transfer easy for others.
4. analyse and visualise large data using coding knowledge and skill to communicate a message.
5. demonstrate the acquisition of coding knowledge, skills and good practices by creating a project to solve a problem.

STRAND D - Coding

COMPETENCY 1: Students will be able to design games and applications by applying coding knowledge and skills to simulate a real-world application.

Overview:

Under this competency, students will be able to develop simulations and games in Python. They will use object-Oriented programming in Python for business logic and Tkinter for GUI. In doing so they will use all the concepts that they have learned thus far.

Students get the opportunity to code for simulation and also to build real-life applications. It would solidify the concepts they have learned and boost their confidence in building software. Through creating games and real-life applications, students will be informed about the working of such applications and appreciate the role of coding behind every game or application.

Topics	Key Stage Standard	Objectives	Time
Developing Applications <ul style="list-style-type: none">● Simulating real-world applications using modules (random, string, time)<ul style="list-style-type: none">○ One Time Password (OTP) generation○ Teacher's timetable● Creating games<ul style="list-style-type: none">○ Quiz with score○ Text-based adventure game○ Tkinter games	D5.1 Develop an application by applying object-oriented concepts of a programming language.	12-D5.1.1 Develop applications (simulations and games) using modules in Python.	400 mins (10 periods)

Learning experiences:

- Instruct students to explore different Python modules (random, string, time) from the Internet. Ask them to use these modules to create programs such as timetable generator, password encryption, secret code generator, ATM simulator, and car parking application that simulate real-world applications. Then, ask them to share their projects in the class. Remind students to follow good programming practices and maintain documentation while developing the applications.
- Divide students into groups and provide them with sample text-based games created using Python modules. Ask each group to select one of the games and develop it. Remind them to consider the following points in their game.
 - Algorithm and flowchart
 - Relevant functions and methods

- o Game components (user interactives, score, level)
- o Good programming practices
- Show and play a Tkinter game such as rock-paper-scissors, snake game, matching game, bricks game, and guessing game in the class to attract students' attention and interest to create a similar game. Explain the codes and different components of the Tkinter game. Then, ask students to create a Tkinter game individually. Once they have finished developing the game, invite them to share the game and their experiences of developing it in the class for comments and feedback.
- Arrange a class discussion on the importance of key and mouse events in the development of games particularly in Tkinter (tic-tac-toe). Encourage students to share their experiences of playing games and using different devices (joystick, keyboard, mouse) to make the characters and objects move in the game. Relate those experiences on the mouse and key events to explain the importance of events to make games interesting, interactive and engaging.
- Share videos on how to create applications (simulation and games) in Python using different modules through the class online platform. Ask students to go through the videos and try to create an application on their own. Encourage students to share problems they encountered while developing their application through the class online forum.
- Share the weblink (<https://timetoprogram.com/tkinter-project-ideas/>) on how to create a Tkinter game through the class online platform. Ask students to go through it and create a similar application by following the sample projects.
- Conduct video conferences to demonstrate how to create games using Tkinter. Provide examples of Tkinter games and ask them to develop a similar game on their own.

Assessment:

- Use a rubric to evaluate applications and games developed by students in Python and Tkinter. Award marks and give relevant feedback.
- Observe and maintain a record of students' participation in discussions and group activities in the class.
- Conduct practical tests on developing games and applications using Tkinter. Use a rubric to evaluate the practical test.
- Evaluate projects on the development of applications or games submitted by students through the class online platform.
- Maintain a record of the number of Python applications created by students on their own and shared through the class online platform.

- Organise a coding competition on developing simulations and games using Tkinter. Invite all the students (open competition) and award prizes and certificates to the winners.

Questions:

1. What are the Python modules you have used in the simulation of OTP?
2. What are the processes you have followed in developing games?
3. Do you recommend Python for game development? why?

Resources:

1. **Python Applications:** The weblinks contain examples of different applications and games that can be created in Python. Some of the common games are number guessing, text-based adventure games, dice rolling simulators, hangman, rock-paper-scissors, text-based calculators etc.
 - <https://www.upgrad.com/blog/python-projects-ideas-topics-beginners/>
 - <https://data-flair.training/blogs/python-project-ideas/>
 - <https://www.dataquest.io/blog/python-projects-for-beginners/>
2. **Tkinter Games:** The weblinks contain different Tkinter games and their codes for easy understanding and reference. Some common listed games are colour game, snake game, rock, paper and scissor, tic-tac-toe, etc.
 - <https://timetoprogram.com/tkinter-project-ideas/>
 - <https://www.pythonistaplanet.com/python-tkinter-project-ideas/>
 - <https://github.com/topics/tkinter-game>

COMPETENCY 2: Students will be able to build a simple database to simulate a real-world application.

Overview:

Databases management is an important component of a software application because large volumes of data can be stored in one place where multiple users can read and modify the data at the same time. Databases are searchable and sortable and the required data can be found quickly and easily.

Under this competency, students will learn SQLite and implement CRUD. They will be able to build applications using databases, front-end with Tkinter and back-end with standard python. In any software, these three components make a complete software application.

Database is one of the important components of a software application. It can either make or break a software application. Thus students' competency in database management leads to producing efficient, secure and reliable database systems.

Topics	Key Stage Standard	Objectives	Time
Database Management <ul style="list-style-type: none"> ● Definition of database ● Importance of database ● SQLite database ● CRUD (create, read, update, delete) Database Application <ul style="list-style-type: none"> ● SQLite database with Tkinter 	D5.1 Develop an application by applying object-oriented concepts of a programming language.	12-D5.1.3 Develop a database application using SQLite Python module. 12-D5.1.4 Use database in a Tkinter application.	1200 mins (30 periods)

Learning experiences:

- Mention some examples of database systems like BCSEA result system, EMIS, Online Banking system, health facility system, and Check Post Management System (CPMS) to explain the importance of database systems in storing, organising and managing large amounts of information. Discuss the following points with the students.
 1. Definition and purpose of database
 2. Benefits of the database management system.
 3. Examples of databases in Bhutan.
 4. Features of the database system (creating, storing, arranging, retrieving and managing data)
 5. Career opportunities related to database management skills.
- Make PowerPoint presentations to introduce the SQLite database. In the presentation, include the following points. Then, ask students to visit the weblink <https://www.javatpoint.com/sqlite-tutorial> to understand more about the fundamentals of SQLite.
 1. What is SQLite?
 2. Advantages of SQLite database (open source, user friendly, portable, reliable, light and fast)
 3. GUI tools for managing SQLite (SQLiteStudio - <https://sqlitestudio.pl/>, DB Browser for SQLite -<https://sqlitebrowser.org>, DBeaver - <https://dbeaver.io/>)
 4. Reasons for using SQLite in Python (lightweight, does not require a separate server)
- Use the SQLite Studio to demonstrate how to create a database and ask students to follow the steps to practice creating an SQLite database. Cover the following areas in the demonstration. Instruct students to follow and practice the demonstration of each area.
 1. Create a database
 2. Open database

3. Delete database
4. Create tables with appropriate data types, field sizes and identifiers.
5. Add, update and delete records

Reminders:

- o Explain data types in SQLite and demonstrate how to create columns with appropriate data types. Let students create tables with appropriate data types to store information such as student's details, marks, inventory, etc. and add appropriate records to the table.
- o Let students use GUI tools in SQLite database manager to create and insert records into the table and also use SQL commands to perform the same. Students may use both techniques but ask them to focus on SQL commands to understand the language for the database as it is essential in application development and business data analysis.
- o Demonstrate how to use a SELECT statement to make a simple query from a database or a complicated query against some criteria. Let students retrieve certain information(s) from the table based on the criteria.
- o Demonstrate the use of UPDATE and DELETE commands to update and delete values from one or more rows in the table. Let students follow the steps to update and delete records from the table.
- o Explain the importance of relational databases with relevant examples and introduce the concept of primary key and foreign key with their characteristics. Let students create appropriate tables and establish a relationship between the tables.
- o Demonstrate how to retrieve relevant data from multiple tables using INNER JOIN. Make students follow the steps to retrieve data from two or more tables.
- Demonstrate an activity such as student bio-data to show how to integrate SQLite in Tkinter. Link an SQLite database with Tkinter and demonstrate how to create, read, update, and delete students' records through the Tkinter interface. Then, make students practice database management by creating a simple database application in Tkinter.
- Divide students into groups and ask them to come up with database applications in Tkinter such as library management system, result system, class BMI records, etc. Encourage students to use proper tables and data fields in the database and also follow good design principles on the Tkinter interface. Students may refer to the following video and website for more ideas on the project.
 - o <https://youtu.be/YR3h2CY21-U>
 - o <https://covrisolutions.wordpress.com/2019/02/22/using-sqlite-with-tkinter/>

- Use the class online platform to share resources (video, ppt, pdf, websites) on how to link SQLite database to a Tkinter application for students to understand the concept of the database in a real-world application. Ensure that the following points are covered through the resources. Then, ask students to create a Tkinter application that manipulates the SQLite database.
 - Concept and advantage of database system
 - Concept of SQLite database and how to create one using GUI tools (SQLiteStudio, DB Browser for SQLite, DBeaver)
 - Integrating SQLite database with Tkinter application to simulate a real-world application.
- Provide the link to a free online course (<https://www.eduonix.com/courses/Web-Development/sqlite-for-beginners-learn-sql-from-scratch>) on SQLite to students. Let students enrol in the course and learn SQLite independently. Encourage them to keep track of their learning and explore the Internet or ask the teachers to clarify their doubts.
- Arrange a video conferencing lesson using Zoom or Google Meet to demonstrate how to link an SQLite database with a Tkinter application to simulate a real-world application. Then, ask students to create a similar application to test their knowledge and skill in database management.

Assessment:

- Observe and maintain records of students' participation in the class or group during lessons and activities on SQLite and Tkinter.
- Use a rubric to evaluate projects created by students on Tkinter applications that use SQLite database to simulate a real-world application. Provide marks and feedback for future improvements.
- Conduct tests (both practical and theory) on concepts and skills related to database and GUI applications in Python. Maintain records of their performance and provide feedback on areas that need improvements.
- Maintain a record of digital artefacts on SQLite and Tkinter applications submitted by students through the class online platform.
- Assign a task on Tkinter and SQLite database for students to complete at home by exploring the Internet. Ask them to submit the task through the class online platform for evaluation.
- Create an online quiz on SQLite and Tkinter using Google Forms or Quizizz and share it through the class online platform for the students to assess their learning.

- Announce coding competitions on Tkinter and SQLite database for students to participate individually or in groups. Provide a time frame of about a month for students to submit their entry project for evaluation and rating. Award prizes and certificates.

Questions:

1. Why do we need a Database?
2. What is SQLite?
3. How can you integrate SQLite and Tkinter?

Resources:

1. **Database Introduction:** The weblinks provide information on the concepts of databases with simple explanations and examples.
 - https://www.youtube.com/watch?v=fSWAkJz_huQ
 - <https://www.hachinet.com/blogs/what-is-the-database-the-importance-of-database-management>
2. **SQLite Database:** The weblinks contain tutorials on the SQLite database. The links may even be shared with students for them to refer to and learn independently.
 - <https://www.sqlitetutorial.net/>
 - <https://sqlite.org/docs.html>
 - <https://www.tutorialspoint.com/sqlite/index.htm>
 - <https://www.guru99.com/sqlite-database.html>
 - <https://www.javatpoint.com/sqlite-tutorial>
 - <https://youtu.be/byHcYRpMgI4>
3. **Database in Tkinter:** The weblinks contain tutorials on how to integrate SQLite database in Tkinter applications. It has examples and sample codes on how to link SQLite with Tkinter applications.
 - <https://pythonspot.com/python-database-programming-sqlite-tutorial/>
 - https://www.youtube.com/watch?v=YR3h2CY21-U&list=PLCC34OHNcOtoC6GglhF3ncJ5rLwQrLGnV&index=19&ab_channel=Codemy.com
 - https://www.python4networkengineers.com/posts/python-intermediate/create_a_tkinter_gui_with_sqlite_backend/

COMPETENCY 3: Students will be able to adopt good documentation practices when writing programs for maintenance and knowledge transfer.

Overview:

Documentation is an important phase in software building processes. Under this competency, students will learn techniques to solve a problem in a logical sequence. Some of the often used techniques are using flowcharts and algorithms. These techniques help in understanding the problem statements.

Software documentation explains the process of designing a solution to a problem. It also explains the various components which help the team develop to have the same understanding in solving a problem. The documentation also provides guides for the use of the software.

Topics	Key Stage Standard	Objectives	Time
Maintaining a Documentation <ul style="list-style-type: none"> ● Problem definition ● Plans, Flowchart, Algorithm ● Process, source codes, output 	D5.1 Develop an application by applying object-oriented concepts of a programming language.	12-D5.1.4 Maintain documentation of a project.	160 mins (4 periods)

Learning experiences:

- Create a PowerPoint presentation to explain the importance of writing algorithms and drawing flowcharts for any program/software application. Show diagrams and examples (<https://www.edrawsoft.com/algorithm-flowchart-examples.html>) to highlight the benefits of algorithms and flowcharts before writing the codes. Relate how these components help to maintain a record of the program for future reference. Ask students to take notes and clarify their doubts.
- Provide a list of Python programs such as guess the number, quiz, tic-tac-toe, etc. and ask the students to come up with the algorithm and flowchart for the problem. Ask them to share their algorithm with other students for peer assessment. Then, ask them to start to code the programs following the algorithm and flowchart, and maintain a record.
- Show sample documentation of a program and discuss its various components to give detailed information about a project. Ask students to create a documentation of a project they have created. Instruct students to follow the format given below for their project documentation.
 1. Title and introduction of the Project.
 2. Software Requirements (Python modules)

- o Python Coding
 - o Flowchart
 - o Algorithm
 - o Source Code
 - o Output
3. Conclusion
 4. References
- Assign a task for students to maintain documentation of a project using the format given by the teacher. Ask them to use Word or Google Docs to prepare the project report. Students may print and submit it to the teacher for evaluation. Use a rubric (content, language, design, creativity) to evaluate the project report.

Questions:

1. Explain the importance of documentation?
2. Define problem definition.

Resources

1. **Maintaining a Project Documentation:** The weblinks explain how to write algorithms and draw flowcharts for documenting a Python program. The links also explain why we have to maintain documentation for programs.
 - <https://www.edrawsoft.com/explain-algorithm-flowchart.html>
 - <https://realpython.com/documenting-python-code/>
 - <https://www.sitepoint.com/writing-software-documentation/>

COMPETENCY 4: Students will be able to analyse and visualize data using appropriate coding skills and knowledge for making informed decisions.

Overview:

Data science is a field of study that deals with vast volumes of data using modern tools and techniques to find unseen patterns, derive meaningful information, and make informed decisions. Under this competency, students will be able to use NumPy which is a module in Python for numerical computation as a part of data science. Some of the foundational concepts like arrays, indexing and slicing, operation, search, sort and filter will be covered.

Data science is gaining popularity over the years and allowing students to explore data science concepts using these modules in making sense of data will build students’ competency. NumPy would help students be able to draw a lot of insights out of the data at their disposal. Further, they will be able to see the benefits of data science and get encouraged to delve deeper into it in their college years.

Topics	Key Stage Standard	Objectives	Time
<p>Data Analysis in Python</p> <ul style="list-style-type: none"> ● Introduction to Numpy <ul style="list-style-type: none"> ○ Numpy Arrays (0D,1D,2D,3D) ○ Array indexing and slicing ○ Operations on array ○ Search, sort and filter on array ● Python Editor (Jupyter Notebook) 	D5.2 Develop a program to analyse and visualize data using a programming language.	12 -D5.2.1 Analyse data using NumPy or Pandas library in Python	600 mins (15 periods)

Learning experiences:

- Explain the basic steps involved in the process of data analysis (defining, collecting, cleaning, analysing, interpreting) and why it is important to follow proper steps of data analysis. Ask students to visit the website (<https://learn.g2.com/data-analysis-process>) for additional information. Then, ask students to answer the following questions.
 - What do you understand by data analysis?
 - Why is it important to analyse data?
 - What are some of the career opportunities in the field of data analysis?
 - How is data analysis related to Big Data and Machine Learning?
- Ask students to visit the website (<https://www.simplilearn.com/introduction-to-data-science-with-python-article>) to understand the concept of data science with Python. List the different Python libraries (Pandas, NumPy, Matplotlib, SciPy, Scikit-learn, Seaborn) for data analysis and visualization

and explain how each library contributes to working with data. Instruct students to take notes and ask questions.

- Make a demonstration using the projector to introduce the NumPy library in Python and explain its functions in analysing data. Then, demonstrate the following points step-by-step with examples to make students understand the use of the NumPy library for data analysis. Ask students to practice the use of the NumPy library after the teacher's demonstration.
 - Create different types of NumPy arrays (0D, 1D, 2D,3D) using array().
 - Perform basic operations (add, subtract, divide, multiply) and statistical operations (max, min, mean, median, mode, standard deviation).
 - Perform array indexing and slicing to extract an element or range of elements.
 - Use functions such as sort, search, and filter to arrange and extract elements from an array.

Reminder:

- Follow the strategy of making students first do the calculation manually and then put it in codes for better understanding.
 - Use concepts of matrices to explain the shape of ndarray(multi-dimensional array).
 - Demonstrate how operations in the NumPy array are easier and faster compared to operations in the Python list. This highlights the benefits of using NumPy.
 - Remind students of the importance of logical and arithmetic calculation in data analysis and that they must have a good background in Mathematics.
 - Use relevant real-world examples such as examination result analysis, students' height and weight analysis, students' time spent on social media analysis, etc. to show the use of NumPy for data analysis.
- Share the website (<https://realpython.com/numpy-tutorial/>) on the NumPy tutorial for students to refer to and get introduced to data science in Python. Ask students to go through each lesson and practice the codes on their computers.
 - Introduce Jupyter Notebook (<https://jupyter.org/>) for students to show how it helps to easily visualise data and output during data analysis. Allow students to use Jupyter Notebook for data analysis using NumPy. For example, ask them to find the maximum, minimum and mean of a 1D array in Jupyter Notebook.
 - Assign a project work where students have to use the NumPy library to analyse a set of relevant data. Allow them to explore the Internet in order to complete the project work. Ask them to submit their work after a given period of time.

- Share the following websites for students to learn more about the NumPy library for data analysis. Ask them to enrol in some of the courses to expand their knowledge of Python NumPy.
 - <https://www.mooc-list.com/tags/numpy>
 - <https://www.udemy.com/course/python-numpy-fundamentals/>
 - <https://www.freecodecamp.org/news/the-ultimate-guide-to-the-numpy-scientific-computing-library-for-python/>
- Use the class online platform to share resources (video, ppt, pdf, websites) on NumPy library in Python for students to understand the concept of data analysis. Ensure that the following points are covered through the resources. Then, ask students to conduct a simple data analysis using NumPy functions.
 - Concept and importance of data analysis.
 - Advantages of NumPy for data analysis in Python.
 - Online Jupyter Notebook (<https://jupyter.org/try>) for easy coding and visualisation.
 - Simple data analysis (1D and 2D array) using NumPy.
- Conduct video conferencing lessons using Zoom or Google Meet to demonstrate how to perform simple data analysis using NumPy. Cover the following points during the video lessons.
 - Jupyter Notebook
 - NumPy arrays
 - Array indexing and slicing
 - Mathematical and statistical operations on NumPy arrays
 - Search, sort and filter functions in NumPy

Assessment:

- Observe and maintain records of students' participation in the class or group during lessons and activities on data analysis in NumPy.
- Use a rubric to evaluate projects on data analysis performed by students on relevant topics. Provide marks and feedback for future improvement.
- Conduct class tests (practical or theory) on concepts and skills related to data storage, data arrangement, data operation and analysis using NumPy. Maintain records of their performance and provide feedback on areas that need improvement.
- Create an online quiz using Google Forms or Kahoot on data science and data analysis in NumPy. Conduct the interactive quiz in the class by displaying the questions using a projector.
- Maintain a record of the number of data analysis projects on NumPy that are completed by students individually from home and shared through the class online platform.

- Assign an individual task on data analysis in NumPy for students to complete at home by exploring the Internet. Ask them to submit the task through the class online platform for evaluation.
- Announce an online competition on data analysis in NumPy. Invite all students to participate in the competition. During the competition, provide a set of data with instructions to analyse the data on certain aspects and set a time frame of about 2 hours to complete the task. Award prizes and certificates to the winners.

Questions:

1. What advantages does Numpy have over the core Python in numerical computation?
2. List some of the operations in NumPy.
3. How would you use NumPy?

Resources:

1. **Introduction to NumPy:** The weblinks contain videos, codes, examples and links on data analysis using Python Numpy. The weblinks can help students to take a beginners course in NumPy.
 - <https://numpy.org/doc/stable/user/whatisnumpy.html>
 - <https://scipy-lectures.org/intro/numpy/index.html>
 - https://www.w3schools.com/python/numpy_intro.asp
 - <https://www.tutorialspoint.com/numpy/index.htm>
 - <https://cs231n.github.io/python-numpy-tutorial/>
 - <https://youtu.be/QUT1VhiLmmI>
 - <https://www.datacamp.com/courses/intro-to-python-for-data-science>
 - <https://www.freecodecamp.org/news/the-ultimate-guide-to-the-numpy-scientific-computing-library-for-python/>

COMPETENCY 5: Students will be able to analyse and visualise data using coding skill and knowledge for making informed decisions.

Overview:

Students will be able to load datasets, clean, analyse and draw a corpus of insight by using Pandas. Pandas is an important Python module for data science. Students will also be able to use another Python module named Matplotlib. It is used in visualising the dataset.

The exposure to NumPy, Pandas and Matplotlib would help students make decisions in choosing a career/course in data science in future. Students can explore independently in the field of data science and etch out a living.

Topics	Key Stage Standard	Objectives	Time
<p>Data Analysis in Python</p> <ul style="list-style-type: none"> ● Introduction to Pandas <ul style="list-style-type: none"> ○ Data structure in Pandas ○ Loading and saving file ○ Cleaning data ○ Analysing data ○ Finding relationships <p>Data Visualization in Python</p> <ul style="list-style-type: none"> ● Introduction to Matplotlib <ul style="list-style-type: none"> ○ Types of charts ○ Creating charts from NumPy and Pandas data 	D5.2 Develop a program to analyse and visualise data using a programming language.	<p>12 -D5.2.1 Analyse data using NumPy or Pandas library in Python</p> <p>12-D5.2.2 Plot graphs for a set of data using Matplotlib library in Python</p>	1000 mins (25 periods)

Learning experiences:

- Make PowerPoint presentations to introduce Pandas and its function in data analysis. Cover the following points in the presentation. Then, ask students to visit the website (<https://www.w3schools.com/python/pandas>) to explore and understand more about the Pandas library for data analysis.
 - What is the Pandas module in Python?
 - Why do you use Pandas for data analysis?
 - What can Pandas do?
 - Examples of how Pandas is used to analyse a set of data.
- Demonstrate how to install Pandas and import it (import pandas as pd) in a Python program. Let students install Pandas on their computer and use it to create a simple program such as to store and display a series of student marks to calculate mean marks.

```
import pandas as pd
marks = [75, 60, 80]
myvar = pd.Series(marks)
print(myvar)
print("Mean:", myvar.mean())
```
- Use Pandas library to demonstrate how to analyse a series of data sets. Ask students to follow each step demonstrated by the teacher to perform data analysis. In the demonstration, cover the following areas. Then, instruct students to follow and practice the demonstration in each area.
 - Data structures in Pandas
 - Series - creating series from list, dictionaries and NumPy arrays

- o DataFrames - creating dataframe from series
- o Using data from external files (excel, csv, json) and saving it after modification.
- o Data cleaning using Pandas functions
 - o Clearing empty cells (dropna), duplicates records (drop_duplicates), wrong data, and wrong record with formats
- o Data analysing using functions
 - o Filter, sort and group data
 - o Statistics (count, mean, median, mode, std, min, max)
- o Finding relationships
 - o Correlations

Reminder

- o Explain Pandas series by creating it from list and dictionaries. Then allow students to create different series from the list and dictionaries they have already created before.
- o Demonstrate and explain how to create a Pandas DataFrame from lists, dictionaries and NumPy arrays. Mention the difference between series and dataframe. Let students use DataFrame to organise data in rows and columns with proper labels.
- o Demonstrate how to import and export data from external files (excel, csv, and json). Make students import a data set from Excel, perform the analysis and export. Students must understand that Python can analyse data from other sources which is a fast and efficient way of collecting data.
- o Demonstrate how to access, modify, add, sort, filter, and delete a given set of data. Then, provide sample data for students to perform various operations for data analysis and interpretation.
- o Demonstrate with examples the process of cleaning data such as cleaning missing data, wrong format, wrong data, outliers, and duplicates. Provide sample data for students to analyze and perform data cleaning. Ask them to save the cleaned data and perform statistical analysis.
- Make a PowerPoint presentation on the data visualization using charts and diagrams. Share the weblink (https://www.sas.com/en_us/insights/big-data/data-visualization.html) to explain the importance of data visualization such as comprehending information quickly, identifying relationships and patterns, communicating the story/message to others, and pinpointing emerging trends.
- Introduce data visualization in Python by using the Matplotlib library. Demonstrate and explain the following points to make students understand and perform data visualization using Matplotlib.

- o Installing Matplotlib (pip install matplotlib). Let students install Matplotlib on their computer and use it to create a simple chart such as a line plot from a given data.
- o Types of plots/charts
 - Line, bar, pie chart, scatter plot, box plot and histogram
- o Creating charts based on data from Pandas and NumPy
 - Labels, titles, legends, colours
- o Interpretation
- Provide the following weblinks to online courses/tutorials on Pandas and Matplotlib to students.
- Ask them to enrol in the course and learn independently to expand their knowledge of data analysis and visualisation in Python.
 - o <https://ourcodingclub.github.io/tutorials/pandas-python-intro/>
 - o <https://www.kaggle.com/learn/pandas>
 - o <https://digitaldefynd.com/best-matplotlib-courses/>
 - o <https://datacarpentry.org/python-ecology-lesson/08-putting-it-all-together/index.html>
 - o <https://problemsolvingwithpython.com/06-Plotting-with-Matplotlib/06.00-Introduction/>
 - o <https://www.freecodecamp.org/news/python-data-science-course-matplotlib-pandas-numpy/>
- Assign a major project for the students on data analysis and visualisation using Pandas and Matplotlib. Allow students to explore the Internet for ideas and solutions to make their project relevant and accurate. Teachers may also provide sample data sets for students to perform analysis and visualisation. Ask students to make a presentation of their findings from the project using charts and graphs.
- Share online resources (video, ppt, pdf, websites) on Pandas and Matplotlib library in Python through the class online platform for students to understand data analysis and visualisation. Cover the following points in the resources for the students to learn on their own. Then, ask students to perform an analysis of a small data set using Pandas and create an appropriate chart in Matplotlib.
 - o Installation and introduction to Pandas library
 - o Advantages of using Pandas library for data analysis
 - o Difference between Pandas and NumPy
(<https://www.javatpoint.com/pandas-vs-numpy>)
 - o Simple data analysis using Pandas functions
 - o Data representation in charts using Matplotlib

- Conduct video conferencing lessons using Zoom or Google Meet to demonstrate how to perform data analysis and visualisation using Pandas and Matplotlib. Cover the following points during the video lessons.
 - Jupyter Notebook
 - Data structure in Pandas (series, dataframe)
 - Importing and exporting the external files for data analysis
 - Data cleaning, analysing and representation in graphs

Assessment:

- Observe and maintain records of students' participation during lessons and activities on data analysis and visualisation using NumPy and Matplotlib.
- Evaluate students' major projects on data analysis and visualisation based on a rubric. Check whether they have followed the process (data collection, cleaning, analysis, interpretation) of data analysis and representation. Provide marks and feedback for future improvement.
- Conduct practical or theory tests in the class on data analysis and visualisation in Pandas and Matplotlib. Evaluate their works and provide feedback for improvement.
- Create an online quiz using Google Forms or Triventy on data analysis and visualisation. Conduct the quiz in the class by dividing students into groups. Awards prizes to the winners.
- Assign an online task on data analysis and visualisation using Pandas and Matplotlib based on the Excel data shared through the class online platform. Ask students to complete at home and get support from the Internet when they come across problems. Make them submit the task after a week for evaluation.
- Maintain a record of the number of projects on data analysis and visualisation completed by students on their own and shared through the class online platform.
- Share a set of questions (MCQ, fill in the blanks, true or false, etc.) on Pandas and Matplotlib through the class online platform for students to answer and submit within a given time.

Questions:

1. Differentiate between Pandas and Numpy.
2. What are the features of Pandas?
3. Where can you use Pandas, Numpy and Matplotlib?

Resources:

1. **Pandas Library:** The weblinks contain videos, codes, examples and links on data analysis using Pandas in Python. The weblinks may even be shared with students for them to refer to and learn independently.
 - <https://pandas.pydata.org/docs/>

- <https://www.w3schools.com/python/pandas/default.asp>
- <https://www.dataquest.io/blog/pandas-cheat-sheet/>
- https://www.tutorialspoint.com/python_pandas/index.htm
- <https://www.kaggle.com/learn/pandas>
- <https://youtu.be/UB3DE5Bgfx4>
- <https://www.datacamp.com/community/tutorials/pandas-tutorial-dataframe-python>
- <https://realpython.com/pandas-python-explore-dataset/>
- <https://www.educative.io/blog/python-pandas-tutorial>
- <https://www.learnatasci.com/tutorials/python-pandas-tutorial-complete-introduction-for-beginners/>

2. **Matplotlib Library:** The weblinks contain videos and information with examples on how to use the Matplotlib library in Python to visualise data.

- <https://matplotlib.org/stable/index.html>
- <https://youtu.be/wB9C0Mz9gSo>
- <https://youtu.be/yZTBMMdPOww>
- https://www.w3schools.com/python/matplotlib_intro.asp
- <https://www.edureka.co/blog/python-matplotlib-tutorial/>
- <https://www.tutorialspoint.com/matplotlib/index.htm>
- <https://ourcodingclub.github.io/tutorials/pandas-python-intro/#matplotlib>
- <https://queirozf.com/entries/pandas-dataframe-plot-examples-with-matplotlib-pyplot>

COMPETENCY 6: Students will be able to demonstrate the acquisition of coding knowledge, skills and good practices by creating a project that solves a problem.

Overview:

At the end of the Python coding journey for the last couple of years, students will be able to develop a software application as a kind of a final project. The project will be the culmination of knowledge, skills and competencies over a year of coding. The project would include analysing the problem statement, designing, coding, testing, maintaining and documentation.

Major projects would help students solidify the concepts learned and gain confidence in developing applications. The project will also help students assess their knowledge and skills in Python coding and help them to make informed decisions on enhancing their programming skills.

Topics	Key Stage Standard	Objectives	Time
<p>Major Project in Python</p> <ul style="list-style-type: none"> • Demonstration of coding skill in Python • Relevant topic • Documentation (process) and application (product) 	D5.3 Complete a project using a programming language to solve problems.	12-D5.3.1 Develop a relevant project using coding knowledge and skills.	240 mins (6 periods)

Note: By this point, students would have completed procedural and object-oriented programming in Python. They would have learned about algorithms, flowcharts, data structure, database (SQLite), GUI application (Tkinter), data analysis and visualisation (NumPy, Pandas, Matplotlib) in classes XI and XII. In the final stage, students have to demonstrate their knowledge and skill in Python programming by doing a major project and maintaining documentation of the project.

Learning Experiences:

Give a major project for students to do individually within a given period of time. Remind students to consider the following instructions to complete the project:

1. Select a topic/problem statement for the project. It can be in any one of the following areas.
 - o Simulating real-world applications using object-oriented concepts.
 - o Developing games in Tkinter.
 - o Designing database applications using Tkinter and SQLite.
 - o Data analysis and visualisation in Python using NumPy, Pandas, Matplotlib.

2. Write algorithms and flowcharts wherever required to give a clear picture of the solution to the problem.
3. Develop the project using appropriate Python modules and object-oriented concepts. Follow good programming practices and design principles (in the case of GUI application).
4. Maintain proper documentation of the project.
5. Submit the project for assessment and reporting.

Assessment:

Evaluate students' final projects (program and documentation) that are collected after a given period of time. Consider the following areas to evaluate the projects.

1. Relevancy of the project title or problem statement of the project.
2. Correctness of the algorithm and clarity of flowchart.
3. Functionality and readability of the codes.
4. Evidence of following good programming practices (commenting and code optimizing)
5. Completeness and clarity of report (introduction, conclusion, references).

Questions:

1. List some of the challenges of developing applications using Python.
2. What are the steps you have followed to understand the problem statement?
3. Why do we need documentation?
4. Maintain a journal of your learning experience in Python coding. Based on the experience, list down some of the areas of achievement and improvement. Reflect on the key skills and knowledge gained from your coding experience for the last couple of years.

Annexure

Annexure 1: Class-wise period and time allocation

The period allocation for classes PP to XII ICT curriculum are as per the revised instructional time allocation notified by the Ministry of Education in March 2020.

Class	No. of Periods per Week (40 mins per period)	Total Period in Year (30 weeks)	Total Time (in mins)
PP	2	60	2400
I	2	60	2400
II	2	60	2400
III	2	60	2400
IV	2	60	2400
V	2	60	2400
VI	2	60	2400
VII	3	90	3600
VIII	3	90	3600
IX	3	90	3600
X	3	90	3600
XI	3	90	3600
XII	3	90	3600

Annexure 2: Key stage-wise assessment matrix

The table below provides an overview of assessment weighting for five key stages. Assessment at each key stage is broken down into four modes of assessment as specified in the ICT Curriculum Framework.

Sl#	Assessment Area	Mode	Classes PP-III	Classes IV-VI	Classes VII-VIII	Classes IX-X	Classes XI-XII
			Weighting %	Weighting %	Weighting %	Weighting %	Weighting %
1	Participation and completion of classwork. (face-to-face or online) <i>(Formative assessment)</i>	Observation, Conversation	10	10	10	10	10
2	Participation and completion of homework. (face-to-face or online) <i>(Formative assessment)</i>	Observation, Conversation	10	10	10	10	10
3	Planning, research, documentation, creation and presentation of digital artefacts including coding projects. <i>(Formative assessment)</i>	Assessment of Digital Artefacts	80	60	50	40	30
4	Theory and/or Practical Test (unit, mid-term and annual exams) <i>(Summative assessment)</i>	Testing	0	20	30	40	50
Total			100	100	100	100	100

Annexure 3: Breakdown of assessment weightings in two terms

The table below provides the breakdown of weightings in four areas of ICT assessment for two terms. ICT teachers are required to keep a daily record of observations and conversations with learners during and after school, provide projects or tasks to create digital content, and conduct examinations at the end of each term.

Key Stage	TERM I				TERM II			
	Class Activity (observation & conversation)	Home Activity (observation & conversation)	Digital Artefacts (digital products)	Testing (examinations)	Class Activity (observation & conversation)	Home Activity (observation & conversation)	Digital Artefacts (digital products)	Testing (examinations)
I	CFA			-	CFA			-
II	5	5	20	10	5	5	40	10
III	5	5	20	10	5	5	30	20
IV	5	5	10	20	5	5	30	20
V	5	5	10	20	5	5	20	30

Annexure 4: Progress report format for key stage V

At the end of the year, students' record of formative and summative assessment in ICT will be reflected in the progress report given below. To complete the report, ICT teachers are required to maintain a record of assessments carried out through observation, conversation, digital artefacts and testing in two terms.

SUBJECT WISE ACADEMIC TRANSCRIPT							
Subject	TERM I			TERM II			GRAND TOTAL (Total I + Total II)
	CA	Mid Term Examination	Total I	C A	Annual Examination	Total II	
Dzongkha							
English							
ICT							
Business Mathematics							
Economics							
History							
Geography							
Rigzhung/Agriculture for Food Security							
	Percentage			Percentage			
	Position			Position			
	Attendance			Attendance			
	Total no. of students			Total no. of students			
Signature of Parent/Guardian:				Signature of Parent/Guardian:			
Signature of Class Teacher:				Signature of Class Teacher:			
The detailed criteria for the continuous assessment (CA) and the examinations for each subject should be based on the guidelines provided in the syllabus/guidebook for each subject.							

Annexure 5: Sample digital artefacts

SAMPLE DIGITAL ARTEFACT

ICT Curriculum | Class XI

Title: ATM Simulation

Artefact Number: 1

Tools to use: OOP in Python

Objective:

- Write algorithm and flowchart for creating an ATM application.
- Apply basic principles of OOP to simulate an ATM.

Instructions:

1. Use Python to create an application to simulate an ATM. In the application, include the features of a real ATM such as checking **balance**, **withdrawal** of cash, **depositing** cash and **exiting** the system.
2. Create its algorithm and flowchart for the ATM application.
3. A sample working of the ATM is given below for reference.

Areas of assessment:

- Algorithm and flowchart
- Use of different features in the application (balance, withdrawal, deposit, exit)
- Programming logic and algorithmic analysis
- Code readability and efficiency

Sample Output:

```
-----  
WELCOME TO  
BANK OF BHUTAN  
ATM SERVICES  
-----  
Please enter your pin: 1000  
Press 1 to view the Balance  
Press 2 to Withdraw  
Press 3 to Deposit  
Press 4 to Exit  
Enter your selection: 1  
-----  
Your account balance is Nu. 0  
-----  
Press 1 to view the Balance  
Press 2 to Withdraw  
Press 3 to Deposit  
Press 4 to Exit
```

```
Enter your selection: 2
Enter amount to withdraw: 500
Please confirm your withdrawal amount of Nu.500.0
Type yes or no: yes
Verifying withdrawal ...
- - - - -
Sorry! Insufficient balance.
Please Deposit first.
- - - - -
Press 1 to view the Balance
Press 2 to Withdraw
Press 3 to Deposit
Press 4 to Exit
Enter your selection: 3

Enter the amount to deposit: 5000
Please confirm your deposit amount of Nu.5000.0
Type yes or no: yes
Successfully deposited
- - - - -
Your new balance is Nu.5000.0
- - - - -
Press 1 to view the Balance
Press 2 to Withdraw
Press 3 to Deposit
Press 4 to Exit
Enter your selection: 1
- - - - -
Your account balance is Nu. 5000.0
- - - - -
Press 1 to view the Balance
Press 2 to Withdraw
Press 3 to Deposit
Press 4 to Exit
Enter your selection: 4
- - - - -
THANKS FOR CHOOSING BOB
VISIT AGAIN!
- - - - -
```

SAMPLE DIGITAL ARTEFACT
ICT Curriculum | Class XI

Title: Poster on Saving Water

Artefact Number: 2

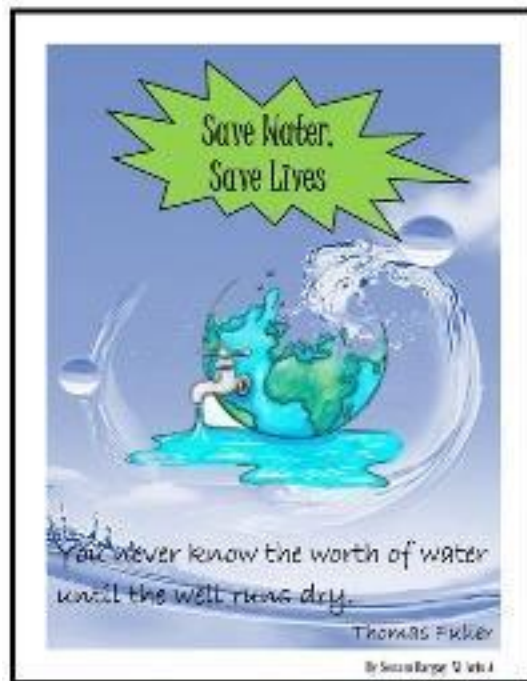
Tools to use: Microsoft Publisher

Objective:

- Use text and images to create an awareness poster.
- Apply design principles to make the poster look attractive and meaningful.

Instructions:

1. Use Microsoft Publisher to design a poster on the theme “World Water Day- Save Water for a Cleaner Future” . A sample poster is given for reference.
2. Your poster must have features such as use of relevant images and text, clear message relevant to the theme, colour contrast and combination and creative design elements.



Areas of assessment:

- Good design and layout.
- Relevant graphics and texts used.
- Creative elements.
- Clarity of message on the theme.

SAMPLE DIGITAL ARTEFACT
ICT Curriculum | Class XII

Title: Students Result in Management System

Artefact Number: 1

Tools to use: SQLite and Tkinter

Objective:

- Design a GUI-based result system using Tkinter Python library.
- Create a database using SQLite to link to the Tkinter application.

Instructions

1. Design GUI interface using Tkinter to display students' marks in each subject. A sample is given below for reference.
2. Use the SQLite database to store the marks entered by the students.
3. Retrieve the marks stored in the database and use them to calculate the percentage.
4. Use logic and python conditions to determine pass/fail status based on the criteria. For example, the students must pass in both English and Dzongkha, and can fail in any of the other subjects to get pass remarks.
5. Create a function to view the result from the database by entering their roll number.
6. Follow proper programming practices and good design principles to create the application. Write project documentation in the end.

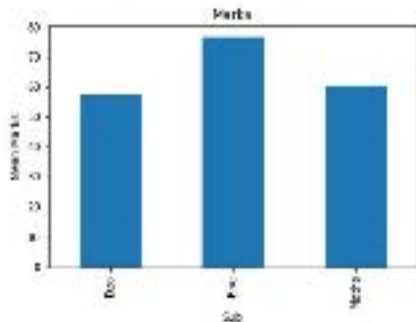


Areas of assessment:

- Overall function of the result system and its design
- Link to database system
- Creativity of the project
- Documentation of the project

5. Use Matplotlib to create a bar chart for the mean marks.

```
meanMarks.plot(xlabel="Sub", ylabel="Mean Marks", kind = 'bar', title="Marks")  
plt.savefig('C:/Users/178626/Desktop/178626/Marks', dpi=100, format='png', title="Mean Marks")
```



6. Find correlation between students' performance in three subjects.

```
failed_df.corr()
```

	Dzo	Eng	Maths
Dzo	1.000000	-0.019401	-0.353788
Eng	-0.019401	1.000000	0.042665
Maths	-0.353788	0.042665	1.000000

7. Write a short report on the data analysis of students' performance in three subjects with suggestive interventions based on the result of the data analysis. For example, write about the correlation between the subjects and what it means.

Areas of assessment:

- Creating data frames and importing data from an external file.
- Data cleaning using different methods.
- Data analysis using different Pandas functions.
- Data representation in Matplotlib.
- Report on data analysis and interpretation.