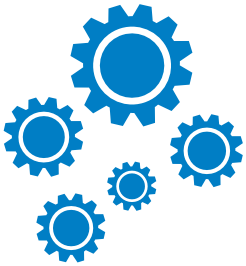
ATAL INNOVATION MISSION

NITI Aayog

LET'S TINKER!

A Handbook



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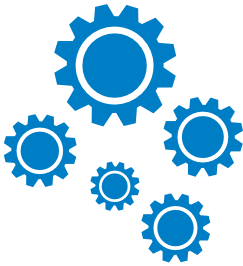

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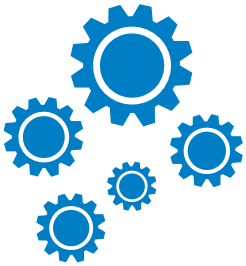

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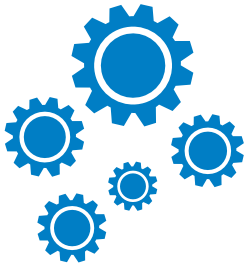


INTRODUCTION

Atal Tinkering Labs (ATLs) are designated 1500 sqft. spaces, with state-of-the-art facilities, set aside for creating something new, a space for innovating and providing solutions for problems faced by individuals and communities.

One of the larger aims of the ATLs is to create a pool of talent that is future ready, by introducing and exposing young innovators to essential world skills; to get them to think out of the box, and break boundaries—and make something unique in the process!

On a broader canvas, the objective is to help instil a 'maker' spirit in young people, by providing opportunities for working outside the classroom, using hands-on experimentation and collaboration with the latest technology, and designing it to provide much needed solutions. The program aims to bring the do-it-yourself culture to the forefront, encourage and motivate students to become solution providers and get engaged in self-learning that will not only lead to the development of higher order thinking skills, but may eventually lead to discoveries, innovations and inventions.

About the book

This book has been created keeping in mind these over-arching objectives of creating an innovation ecosystem in our country and providing opportunities to young minds to make them future skills ready.

The aim of this book is to provide the user - teachers & students with content which has been curated and collated as per the aim of the ATLs. The expectation is that schools can make use of this content as it is, and refer to it to begin with their tinkering journey. This content is not completely exhaustive; rather it aims to provide a direction to lead the students and teachers towards exploring their own interests & passion, raising their upper limits and creating multiple paths for further enhancement of their existing skill sets. The assumption is that users will continue to add more content in their labs in their quest for learning new things, and discovering novel concepts as they proceed to different levels.

The core guiding principles for this content are being objective and ensuring clarity of concepts along with providing ample hands-on activities for practical know-how.

Who is the audience for this book?

- ATL in-charge teacher and all other teachers
- Students in ATL schools
- Parents
- Mentors

How to use this book?

This book and its content have been collated and designed keeping in view that it can be used both in a Do It Yourself (DIY) mode by students and in facilitator mode by teachers.

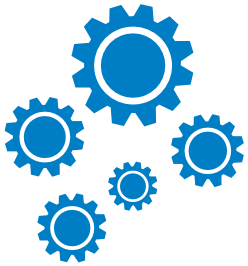
The objective is to give complete freedom to the students to run through the learning material on their own at their own pace, and also give the know-how to the teacher to take them through each and every aspect of the content. Towards this dual aim:

- There are five modules in all. Each module will have:
  - Presentations (PPTs) for explaining concepts
  - Activity cards for providing hands-on experience
  - Reference links and videos, both in an explanatory mode and for self-learning mode
- All presentations have speaker notes that can be used both by teachers and students to understand the concepts
- All PPTs, activity cards and reference links have been provided in a soft copy format also, along with this book for easy access

Suggested role of a facilitator

A facilitator could be any one from the school - the designated ATL in–charge teacher and/or the Innovation Coach.

The ATLs have been envisaged to be the hub for innovation, invention, making, tinkering and giving shape to ideas that solve local and global problems using technology. All this requires direction, resources – physical and otherwise, guidance and support at each and every step. Considering this is a novel concept and being initiated for the first time, it asks for a change in the mindset and openness to look at things and ideas differently. This also makes it imperative to provide necessary support to bring in these changes and make the program a success. The content has been designed and curated towards this very objective - to help teachers/facilitators to ignite a passion for learning, ideating and creating among students.



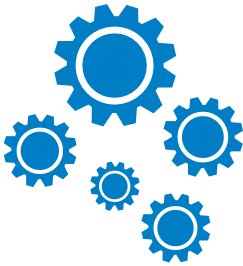
The expectations from facilitators are to:

- Communicate the essence of the ATL program - vision, mission and framework.
- Nurture innovative thinking by encouraging openness, flexibility and curiosity.
- Include participants from different backgrounds and with diverse interests. Innovation in the classroom will follow naturally.
- Respect and accept students' experience as core to innovative thinking - helping to innovate for contextual issues to further global ones.
- Motivate students to take ownership of their learning.

Suggested facilitation strategies and required skills

Engage students in an environment that is conducive to learning and creativity.

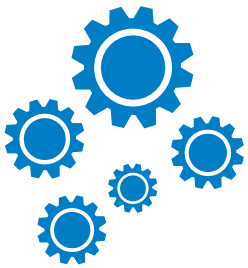
Expectations	Suggestive Strategies	Required Skillset
Communicate the essence of the ATL program	Read, understand and deliver the vision and mission of the ATL program	• Communication skills – verbal and non verbal
Motivate students to take ownership	To motivate students you will have to motivate yourself first - understanding what motivation is and how to motivate will help	• Communication skills • Social skills – self awareness
Respect and accept students' experience	Invite students to talk about their experiences in discussion/ open house - sharing experiences will make them more responsive	• Experiential learning • Emotional skills – empathy • Values - respect
Include participants from different backgrounds	Create teams with different skillsets and strengths	• Collaborative and cooperative learning • Promote inclusion in inclusive education
Identify your style	Observe and introspect, know your strengths, and accordingly deliver the content	• Ask questions, read, build your information • Create a group – collaborate online



Suggested logistics arrangements for sessions

We suggest arranging and providing for the following things to get optimum results from the learning sessions.

- Classroom/lab with audio and video equipment for showcasing videos and PowerPoint* presentations
- Appropriate seating arrangement for all participants
- Laptop/desktop for students as per the requirement of the content/sessions
- Internet access for all students as per the requirement of the content/sessions
- Basic stationery - pens, pencils, markers, post-it notes, and necessary equipments as mentioned in each module
- Print outs of all the activities to be conducted to be in place before the sessions

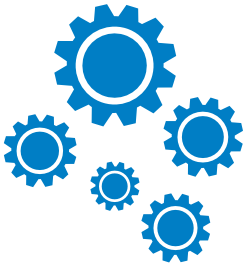


CONTENT OVERVIEW

The content has been divided into modules; each module helps to build a specific skillset and takes students closer to the overall objective of acquiring the appropriate skills and becoming a tinkerer – a creator, a maker - in simple words, a solution provider.

MODULE I	**DIGITAL LITERACY**
	This module is aimed to help understand the basics of using computers and becoming digitally safe
MODULE II	**IDEATION**
	In this module, the objective is to help in generating multiple ideas for a problem
MODULE III	**DESIGN THINKING**
	The content of this module would help in the process of refining ideas and giving them a proper shape
MODULE IV	**COMPUTATIONAL THINKING**
	Here the participants would get an overview of all the different kinds of hardware and software - sensors, boards etc. that can be used to convert the idea into a prototype
MODULE V	**PHYSICAL COMPUTING**
	This module will help in the hands-on/DIY activities – explain how the ideas generated can be made into a real-time project

Each of the modules has its own set of learning objectives and learning outcomes with a set of activities and resources for reference. Details of each of the modules are shared in a later section in this book.



IMPLEMENTATION OF THE ATL PROGRAM

The Atal Tinkering Lab is a novel concept for our country. While there have been similar activities by some schools and organizations, the efforts and coverage have been sporadic and more individualistic in nature. With the Atal Innovation Mission (AIM) and the setting up of Atal Tinkering Labs in more than 500 schools across the country, the objective is to provide this opportunity to a much wider audience. The expectation is to have an impact on the entire education system in the country and lead our future citizens towards joining the global workforce as tech creators armed with skills for the future.

Towards this objective and expectation, it is essential to integrate the concept of Atal Tinkering Labs within our formal school education system. Considering that education follows a set path in our country, all of us together will have to identify transacts between the existing system, and the necessary and optimal flow of this new concept of tinkering.

To begin with here are some basic guidelines:

1. ATL is for all class/grade VI–XII students. Students from other grades/classes can also be exposed to ATL as per the discretion of the school.
2. All students must be briefed about ATL (basic Information along with a scheduled visit to the ATL in the school)

STEPS FOR IMPLEMENTATION

Step I - Rolling out the action plan

The first stage in the implementation process is to create a plan and arrange for necessary resources needed to make the plan successful. This would involve the following:

i. Please refer to the plan document created by your school management/Principal/ATL in-charge (if not done yet please refer to the plan document for establishing the ATL in the Operation Manual. A snapshot of the same has been given below for your reference.)

Plan Document for Establishing the Atal Tinkering Lab

School Name _____

City _____

State _____

Vision of the AIM-ATL
Fostering innovation ecosystem in India – Cultivate one million children child innovators in India

Functional Areas:

1. Physical space allocation/identification

_____

_____

_____

_____

2. Human resource allocation for ATL

_____

_____

_____

_____

3. Decide/identify technical resource – tools and materials

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_____

4. Design a focused and feasible time table

_____

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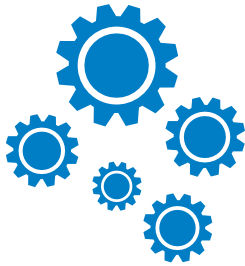


Recommended process

- Utilize zero periods/class teacher's periods for dedicated sessions for tinkering
- If there are no zero periods, please discuss and try to get them included in the time table in such a way that as and when needed, large numbers of students can undergo training/orientation
- Use block periods for continuous lab sessions – this would help provide the students ample time to work at a stretch
- Make a time table for after-school hours for school students and similarly, students from other schools

ii. Work on your existing school time table and make time for tinkering - for ATL. There should be predefined hours in a week when students would be allowed and expected to either visit the lab and/or be part of orientation sessions in their classroom itself. This would help to bring in regularity and uniformity.

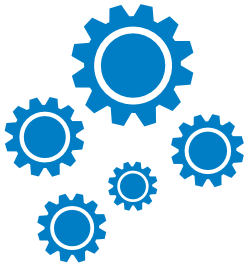
iii. Orient and train teachers other than the ATL in-charge

The ATL in-charge single-handedly may not be able to manage and would need support from other teachers to:

- Identify students for ATL from various sections and classes
- Provide basic orientation and logistic support for ATL visits
- Be available as a substitute teacher in absence of ATL in-charge
- Support in the ATL for various activities

Thus, it is imperative to involve other teaching staff also – provide them with the overall perspective and importance of the program and prime them to support by setting the expectations from the beginning itself.

Towards this aim, NITI Aayog will be sharing more information on the training plan for the selected teachers of the school.



Step II - Enrolling students in Atal Tinkering Labs

By now, your school has:

- A functional Atal Tinkering Lab
- A qualified Atal Tinkering Lab in-charge
- Other teaching staff trained to support the ATL

Now the next step is to get the main beneficiaries of the program on board – get students to join the tinkering lab – become part of it and start using the facility as has been envisaged. In general, all the students of the school in certain grades have to be oriented. While this has been mandated, there may still be a need for spreading awareness through various options. (To know more please refer to the Information Management section in the ATL Operation Manual)

For students from the community outside of school, a sustained focused effort has to be made by the ATL Advisory Committee, spearheaded by the ATL in-charge. (To know more please refer to the Information Management section in the ATL Operation Manual)

Recommended process

- Student identification and nomination needs to be a continuous process, and teachers will play a key role in it • Self-registration can be one of the options, post which the ATL in-charge along with other teachers can discuss and decide • Open communication between parents and teachers throughout the process is important
- Interesting sessions to be organized in the lab to generate curiosity towards the program and get the students attracted to make optimum use of the lab

To enrol students from the community:

- Invite neighbouring schools to participate in events held in your school
- Collaborate with NGOs working in the locality to identify, mobilize, and convince students and parents to allow their wards to get enrolled
- Seek help of local government bodies in identifying meritorious candidates or those with scientific bent of mind
- Prepare a separate time table for them for vacations and weekends to conduct block sessions as may be decided mutually

The next stage would be to integrate the program within the formal education scenario.

INTEGRATION OF THE ATL PROGRAM IN SCHOOLS

Now let's look at integrating the program in a school set-up.

With the aim to help in making the labs functional and to support the school, we recommend the following four level approaches:

Level 1 - Pre-Tinker Level

This is the first level – open for all the students in the school as per the mandate of the ATL Grant. The objective here is to create awareness, provide an orientation about ATL, fuelling interest and inspiring the students to take up tinkering.

Suggested process/ways

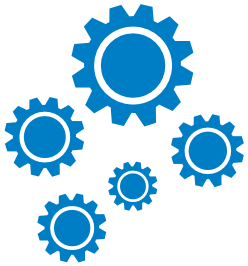
- Ensure all school students (Grade VI–XII) participate at this level
- Organise six sessions of one hour per batch spanning over introduction, orientation, ATL visit, pre-ideathon, idea generation and introduction to concept of design thinking
- Responsibility of this level lies with the class teacher and/or teachers selected by school authorities/Atal Advisory Committee

Level 2 - Tinker Club

This is the second level – open to selected interested students – selected through self-registration/ nomination by teachers. The objective is to have focused sessions and steer the students towards serious tinkering and innovation process.

Suggested process/ways

- Select students from the previous level on the basis of interest, previous experience, ideas generated, and students nominated by the teachers will join in at this level
- Organise two sessions of two hours per week for eight weeks and/or as per the time table decided by the school authorities/Atal Advisory Committee
- Students at this level will be introduced to computational thinking and will revisit the concept of design thinking along with DIY activities
- Responsibility of this level lies with the designated ATL in-charge teacher and/or teachers selected by school authorities/Atal Advisory Committee



Level 3 - Tinker Lab

This level would have small size batches - 30 each from different age groups. These students will work in the lab with the ATL in-charge working on specific ideas and projects.

Suggested process/ways

- Select students from the previous level on the basis of aptitude, interest, previous experience, passion, mindset, willingness, inequality facing, and ideas generated will join in at this level
- Students at this level will be revisiting the concepts of design thinking, computational thinking, and understand the concept of physical computing along with DIY activities
- This level may have at least three batches/cohorts based on age group; these students will work in the ATL for at least three months - Junior batch (12-14 years), Middle batch (14-16 years), Senior batch (16-18 years)
- All sessions will take place in the ATL under the guidance of ATL in-charge/Innovation Coach with support from external mentors and local maker communities

Level 4 - Post Tinker Lab

Students from any of the above three levels could be part of this level activities. These students are competent enough to create and tinker on their own with only supervisory support from the ATL in-charge. They are the self-driven, self-motivated ones who would be working on specific ideas and projects, and will be involved in creating solutions for local/global problems.

Suggested process/ways

- Select students here will be based on self-interest and passion
- All sessions will take place in the ATL under the guidance of ATL in-charge/Innovation Coach with support from external mentors and local maker communities
- Students would be working on real-time projects and engage in active prototyping on their own and/or in partnership/with support from other government programs – AIM's Incubators, other higher education universities, maker spaces, industry partners etc.
- This level is open ended, with no fixed duration
- These students can participate in external/internal competitions, challenges, innovation festivals etc.

Each of these levels depicts a different set of competencies; requires different skillsets; needs different type of activities and various lengths of time duration.

For each level, a participation certificate can be given to all the students by the school. A template may be provided by NITI Aayog. More details will be shared later.

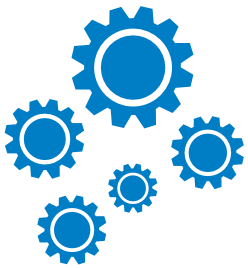
Tinkering Levels

	PRE-TINKER LEVEL 1	TINKER CLUB LEVEL 2	TINKER LAB LEVEL 3	POST TINKER LAB LEVEL 4
Goal	Inspire and ignite passion	Take participants from zero to tinker skills	Elevate the level of students from Tinkerer to Maker	Enable youth facing inequality to grow from Maker to Innovator and show Community Impact (Tech Creation to Tech Usage)
Audience	All school children (Grades VI-XII) interested in tinkering	Interested students	Select students - batches of 30 students to work in lab., minimum of three batches to be conducted in a year	Self-motivated students working on their own
Content	To be shared by AIM periodically	To be shared by AIM periodically	To be shared by AIM periodically	To be shared by AIM periodically
Duration	One month (flexible – as per the school schedule)	Two months. (flexible – as per the school schedule)	Three months per batch of 30 students	Open ended - may overlap with local festivals, grand challenge/showcases
Ownership	School teachers	ATL in-charge teacher	ATL in-charge supported by external mentors and maker communities	Students
Certification	Participation certificate for all students may be introduced	Participation certificate for all students may be introduced	Participation certificate for all students may be introduced	Participation certificate for all students/Advanced Badging may be introduced

Aptitude for creative thinking

Aptitude for innovation mind-set

Tech creation implementation



ALIGNMENT OF CONTENT WITH TINKERING LEVELS

The next step now is to align our content to these levels:

Levels	Core Objective	Suggested Alignment of Modules/content	Resources aligned with the module/ content
Level 1 – Pre-Tinker Level	Creating awareness about ATL Initiating the process of Ideation Understanding the concept of Design Thinking	• Digital Literacy • Digital Awareness program – cyber Safety • Ideation • Design Thinking	• Presentation about ATLs • Digital literacy online module • Digital wellness module • Presentation about Ideation • A set of questions for Ideation • Presentation: Introduction to Design Thinking • Presentation about stages of Design Thinking
Level 2 – Tinker Club	Understanding the concept of Computational Thinking and applying the same to real-time problems	Computational Thinking	Presentations • Introduction to Computational Thinking • Understanding flowcharts and algorithms • Understanding Sensors & Actuators and their applications • Understanding Circuits Revisit concepts & activities of Design Thinking
Level 3 – Tinker Lab	Understanding the concept of Physical Computing & applying the same to real-time problems	Physical Computing	Presentations • Let's get to know boards • Getting started guide part 1 • Getting started guide part 2 • Getting started guide part 3 Activity cards for Physical Computing Revisit concepts and activities of design thinking, computational thinking
Level 4 – Post Tinker Lab	Work on real-time projects using the learning from previous levels	Do It Yourself	Do It Yourself

LEARNING MODULES FOR ATAL TINKERING LABS

The following pages will take you through content curated and collated to be used in Atal Tinkering Labs.

The content specified here is suggestive in nature and not exhaustive by any means. We urge the facilitators/users to go beyond it and involve students in interesting activities. The content shared here is flexible and can be delivered in short (one hour) or long (three to four hours) sessions. It can also be adapted to be a one-time experience or spread over many weeks/months.

The main beneficiary of the Atal Tinkering Lab program is the children - the students. The entire program has been built for them and thus, it is imperative that the first activity should include an introduction of the program for them.

Towards this aim, we suggest making use of the first session to make them aware about the program - about the Atal Tinkering Lab – Atal Innovation Mission using a brief presentation detailing its background, objectives and expectations; give them an understanding of its importance; and to provide an overview of what is tinkering, and encourage them to become part of this journey of innovation and invention.

Note for the facilitator

- Please refer to Introduction to ATL – A presentation about ATL labs - first introduction for students provided in the pen drive

Module I - DIGITAL LITERACY

Learning Objective	Learning Outcome
• To enhance students' knowledge and skills in working with computers & other devices • To introduce them to the basics of internet and how to be safe while using it • To make students computer literate, thereby enabling them to create and innovate using technology	• Would have understood the basics of computers, and learnt how to use basic computer applications for collaboration like presentation, word processing, spreadsheets and multimedia applications • Would have become adept at using internet search, email and various social media platforms and will be able to communicate, collaborate and create things like resumes, flyers, invitations, budgets etc. through hands-on activities • Would have become cyber safe and will be able to protect themselves online

About Digital Literacy

Digital literacy is the ability to use information and communication technologies to find, evaluate, create, and communicate using both cognitive and technical skills.

It includes knowledge, skills, and behaviour involving the effective use of digital devices such as smartphones, tablets, laptops and desktop PCs for purposes of communication, expression, collaboration and advocacy. While digital literacy initially focused on digital skills and stand-alone computers, the focus has now shifted to network devices including the internet and social media.

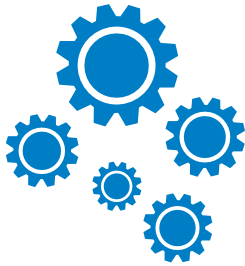
We recommend you to not confuse digital literacy with its earlier versions of computer literacy and digital skills. Computer literacy refers to knowledge and skills in using traditional computers, such as desktop PCs and laptops whereas digital skills is a little more contemporary term and includes the practical abilities in using digital devices, such as laptops and smartphones.

A digitally literate individual however possesses a much wider range of digital skills, knowledge of the basic principles of computing devices, and skills in using computer networks. The individual has the ability to engage in online communities and social networks and is able to find, capture, and evaluate information.[1]

In simple words, we can also define digital literacy as the ability of individuals and communities to understand and use digital technologies for meaningful actions within life situations.

We would like to share here that this is an optional module and can be referred and used as and when required or if the students feel a need for it.

[1]https://en.wikipedia.org/wiki/Digital_literacy



For the ATL initiative to be successful, it is imperative that the students have a prior knowledge or a certain degree of digital literacy as future projects would involve a lot of activities that would need them to use computers proficiently. In one of the later modules, they would be exposed to programming and connecting other technical components together to create projects and prototypes, and thus it is essential for them to have a working knowledge of using computers.

In order to determine the level of Digital Literacy in the class, we suggest asking students the following set of questions:

- Have you seen a computer? Do all computers look the same?
- Have you used a computer before?
- Have you heard about the internet? Have you used it before?
- Do you know how to create an email ID? Do you have an email ID?

Based on the responses, we would suggest you to share the details of the Online Digital Literacy Module.

Brief about the Online Digital Literacy module

Digital literacy is a necessity today to complement, and jointly contribute to development and growth with equity. Access to technology and the internet plays a huge role in driving personal growth, expanding livelihood opportunities, and enhancing incomes and productivity.

The module has been designed to give youth and adult learners the opportunity to improve their social and economic self-sufficiency through digital literacy. It teaches participants, with little or no prior computer experience, basic computer skills that are relevant and will be useful in their daily lives.

Brief about the Digital Wellness module

The internet today is an indispensable part of our lives. This makes it important for us to know not only how to protect ourselves but also be discerning about the online activities we participate in, what we read and watch, and how we conduct ourselves.

The internet opens several opportunities that you would never be able to avail otherwise. You can see places you have never travelled to, communicate with friends across the globe, get information on anything anytime, and create an online reputation that allows you to present yourself as you desire to be seen by the world. However, with all of these come risks. You may stumble across a website that displays inappropriate content, your email or social networking account could be hacked and misused, someone could misinterpret what you posted and respond with hurtful comments, or you could be embarrassed by photos or information that gets associated with your online profile. It is therefore very important to know how you can avoid risks and keep yourself safe on the web.

This curriculum will make you aware of the benefits and dangers of using the internet; nurture a strong character through cyber wellness values; familiarize you with types of cyber threats, consequences and protective measures; prepare you to make responsible and informed decisions in cyberspace.

Note for the facilitator

- Please refer the students to the link for Digital Literacy - https://easystepsonline.intel.com/
- Please refer the students to the Digital Wellness curriculum in the pen drive

Module II - IDEATION

Learning Objective	Learning Outcome
• To introduce students to the concept of ideation • To encourage them to think out of the box, look at the world around them, identify problems and think of potential solutions	• Would have started to think over and above the everyday activities • Would know how to generate multiple ideas to solve one problem statement

About Ideation

"Ideation is the creative process of generating, developing, and communicating new ideas. These ideas can be understood as a basic element of thought that can be visual, concrete, or abstract."

"The process of coming up with an idea that can be turned into something valuable is called ideation."[2]

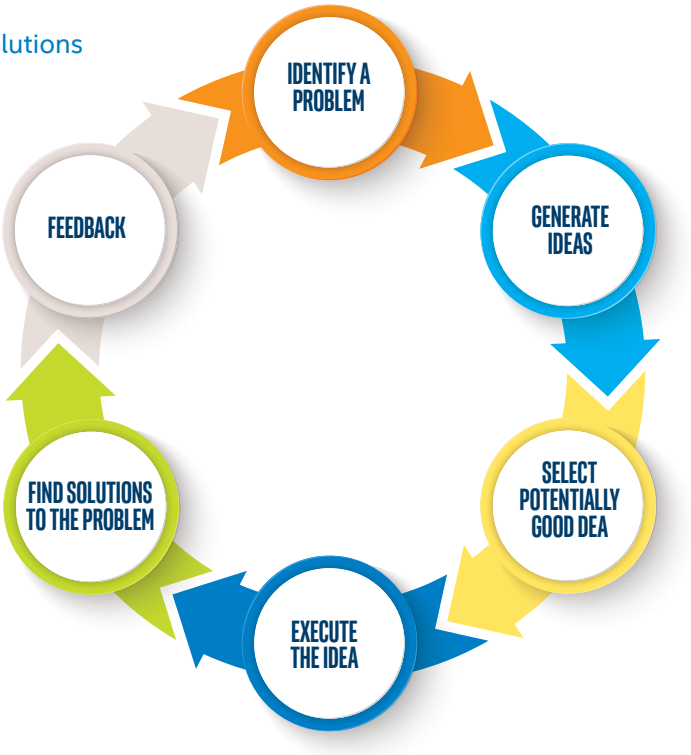
These are some of the simplest definitions for Ideation on the internet. For our purposes, we can further simplify it as:

Ideation is the first step towards tinkering - this is the step where a student will/should start thinking - about a new idea, a new concept, or a new solution to an existing or new problem.

The whole idea is to start thinking. Once the students become responsive and start sharing ideas, ask them to concentrate on, and identify one problem statement - any problem/issue that they would like to work on.

This, in brief, is the entire process of Ideation –
Identify a problem statement - look for probable solutions

Keep this as your mantra and get going!



Note for the facilitator

- Please refer to the Ideation presentation & suggested set of questions provided in the pen drive

[2]https://en.wikipedia.org/wiki/Ideation_(creative_process)

Module III - DESIGN THINKING

Learning Objective	Learning Outcome
• To introduce and expose the students to the concept of Design Thinking, • To enable them to practice and identify design opportunities through various phases with the help of hands-on activities	• Would have understood the concept of design thinking and its application for problem solving • Would have been exposed to various phases of Design Thinking, getting a deeper understanding of each one of them with real-time activities

About Design Thinking

In most of your sessions in schools, a typical scenario is where a teacher asks the students some questions and students answer these with the aim to give the 'right answer'. There is usually only one right answer and any other input is considered as a wrong one, and can bring in some kind of punishment for the students.

The process of Design Thinking (DT) is opposite to this kind of traditional teaching. While teaching DT, students are encouraged to explore real-world problems without easy solutions. They are expected to take charge of their own learning, work together in teams rather than individually and understand that there are no "right answers" to the greatest of challenges/problems.

In simple words - Design Thinking is a method for practical, creative resolution of problems, and creation of solutions. It is a form of solution-based or solution-focused thinking with the intent of producing a much needed/required solution for a problem.

While the approach to teach DT may be different we can find similarities in the way it is practiced. It doesn't differ much from the scientific method which is taught and used in schools under various subjects. Just like a science or a math's problem, DT also begins by stating a hypothesis and then, through various inputs, suggestions, and permutations and combinations that move toward forming a model or theory. The main difference is that inputs/suggestions in a DT process are all aimed towards solving the identified problem or filling the identified gap in a service/model/product etc.

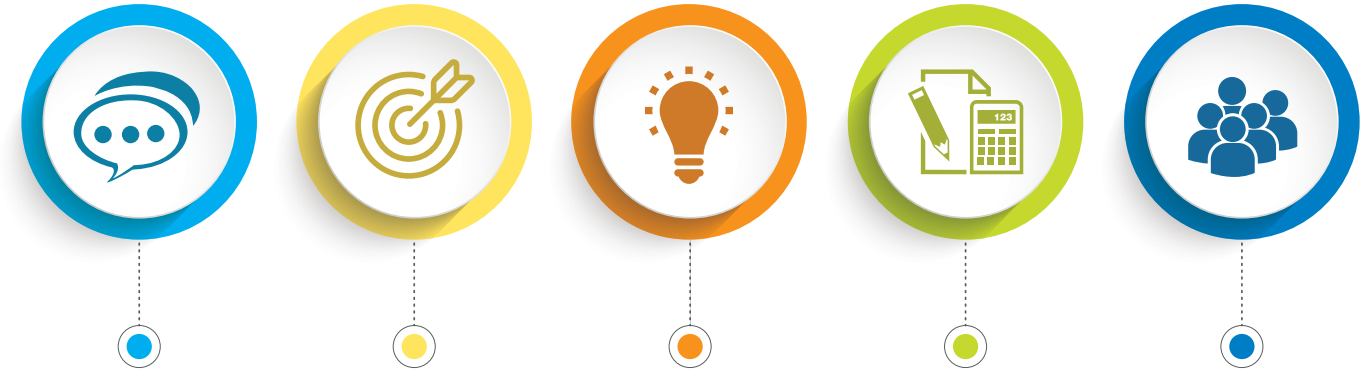
It includes "building up" ideas, with few, or no, limits at a stretch during a brainstorming session. This helps reduce fear of failure in the participant(s)/students and encourages the process of input and participation from all. The outcome of such a brainstorming phase is what we commonly refer to as "thinking out of the box".

For the purposes of tinkering & innovating toward the objectives of ATLs, the DT process can be defined through five distinct stages: empathize, define, ideate, prototype and test.

Within these five stages, problems can be framed, the right questions can be asked, more ideas can be generated, and the best answers can be chosen. These stages are not linear; can occur simultaneously and can be repeated as many times as required.

As you can see that the first three stages mentioned here - EMPATHIZE, DEFINE & IDEATE have been covered in the previous module on Ideation. The reason being that, as first time users, and audience we wanted to inspire and encourage you to start the thinking process.

Let's take a quick look at each of these stages



EMPATHIZE
Learn about the audience for whom you are designing

DEFINE
Construct a point of view that is based on user needs and insights

IDEATE
Brainstorm and come up with creative solutions

PROTOTYPE
Build a representation of one or more of your ideas to show to others

TEST
Return to your original user group and testing your ideas for feeback

Stage 1: Empathy

Empathy is the ability to put yourself in someone else's shoes to start "seeing" things through his/her eyes.

The objective is to identify problems that others may be facing. The students need to see themselves in the user's shoes and empathize by seeing, thinking and feeling. As a facilitator, you need to guide them in doing so.

Stage 2: Define

Once the students have identified the problem and understood what the others must be facing, they need to clearly define the problem. The Point of View (POV) statement helps transition into the Define stage in Design Thinking. Guide students in understanding the three elements that make up Point of View - the user, need and insight.

Stage 3: Ideate

Using different ideation techniques, help students brainstorm, explore their creative potential and come up with solutions to challenges. Then aid them in identifying the best solution from a pool of ideas.

Stage 4: Prototype

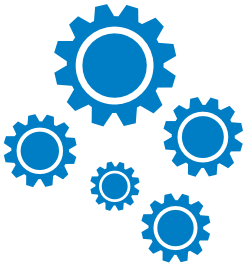
Students now need to validate the ideas generated. Help them trim things down, or marry thoughts and customize. The idea needs to become tangible. Also, you need to prepare students for feedback or suggestions from targeted users as well as for appreciation.

Stage 5: Test

Finally, testing will help determine what works and what does not. It may even land you and the students back at the drawing board! Or if the user likes the solution, then the process of design thinking can end. The best idea goes into execution.

Note for the facilitator

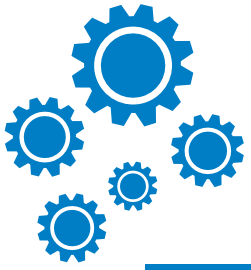
- Please refer to the presentations that will take you through the process of Design Thinking and its various stages in the pen drive provided along with the Activity Cards



Resources

To get some more inspiration, you may refer to the following:

Brief Description	Resource URL
Design Thinking	https://www.youtube.com/watch?v=a7sEoEvT8l8 https://www.youtube.com/watch?v=qyoZTUGzdGY
Design and Discovery – Full curriculum along with a facilitator's guide to understand the process of Design Thinking and series of DIY activities	http://www.intel.in/content/ dam/www/program/education/us/en/documents/K12/design-and-discovery/dd-full-curriculum-fg.pdf
An Introduction to Design Thinking Process Guide by Stanford University	https://dschool-old.stanford.edu/sandbox/groups/design-resources/wiki/36873/attachments/74b3d/ModeGuide-BOOTCAMP2010L.pdf?sessionID=1b6a96f1e2a50a3b1b-7c3f09e58c40a062d7d553
Design Thinking is a cyclical process that allows you to solve complex problems in a creative way	https://www.youtube.com/watch?v=3sOeSkTUTA0
Design thinking - IDEO Insights	https://www.youtube.com/watch?v=gPqjKOA1qlo
Empathize, Design, Ideate, Prototype, and Test to create something amazing with Design Thinking!	https://www.youtube.com/watch?v=QgLUxZtuXF4&feature=youtu.be
What is Design Thinking?	https://www.youtube.com/watch?v=Ee4CKIPkIik
How to brainstorm - individually/in a group	https://www.youtube.com/watch?v=Cll6AEzXh8c https://www.youtube.com/watch?v=aPnTPK0c53w https://www.youtube.com/watch?v=GLpZ6RZHyoM (resource for teachers)
Complex Systems Design Thinking (How to do it)	https://www.youtube.com/watch?v=WrdSkqRypsg
Design Thinking, How It works? (How to do it)	https://www.youtube.com/watch?v=pXtN4y3O35M&t=18s
Five Rules of Design Thinking (TED Talk) (Why and how to do it)	https://www.youtube.com/watch?v=TAV08bn5uEo&t=23s
Design Thinking with Elementary Students (How to do it)	https://www.youtube.com/watch?v=hvqST2ggvA0
Design Thinking - CEO of IDEO (How and why to do it)	https://www.youtube.com/watch?v=U-hzefHdAMk
Design Thinking, What, why and when? (TED Talk)	https://www.youtube.com/watch?v=Q80wUnju5YA&t=1s
The Launch Cycle: Design Thinking Framework for K-12 Students	https://www.youtube.com/watch?v=LhQWrHQwYTk
Design Thinking Animation	https://www.youtube.com/watch?v=uRtAzzitBmA
All about Learning and Design Thinking	https://www.youtube.com/watch?v=3sOeSkTUTA0
Design Thinking for Kids (Playlist)	https://www.youtube.com/playlist?list=PL6cG1WctJGLB3M-sassl6UPQ4yx_t2GLTG



Module IV - COMPUTATIONAL THINKING

Learning Objective	Learning Outcome
• To help the students to develop their ideas into a robust step-by-step solution using adequate technology • To introduce them to the concept of Computational Thinking - its key techniques/approaches • To give them an understanding of algorithms, flowcharts, sensors, development boards, programming through hands-on/DIY activities and exposure to various resources	• Would have understood the concept of Computational Thinking and its application for problem solving • Would know how to develop their ideas into flowcharts, algorithms and convert them into programming language • Would have undergone real-time hands-on projects using sensors, coding while understanding their multiple applications

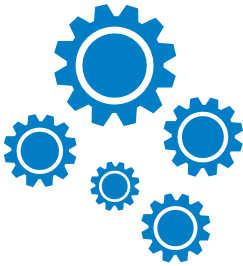
About Computational Thinking

Computers can be used to help us solve problems. However, before a problem can be tackled, the problem and the ways in which it could be solved needs to be understood. Computational thinking allows us to do this. It allows us to take a complex problem, understand what the problem is and develop possible solutions. These solutions can then be presented in a way that a computer, a human, or both, can understand.

Thinking computationally is not programming. It is not even thinking like a computer! Simply put, programming tells a computer what to do and how to do it. Computational thinking enables us to work out exactly what to tell the computer to do.

For example, if you agree to meet your friends somewhere you have never been before, you would probably plan your route before you step out of your house. You might consider the routes available and which route is 'best' - this might be the route that is the shortest, the quickest, or the one which goes past your favourite shop on the way. You'd then follow the step-by-step directions to get there. In this case, the planning part is like computational thinking, and following the directions is like programming!

Being able to turn a complex problem into one we can easily understand is a skill that is extremely useful. In fact, it's a skill you already have and probably use every day.



Let's take a look at two more examples:

Example 1	Example 2
Let's say you need to decide what to do with your group of friends. If all of you like different things, you would need to decide: • What you could do • Where you could go • Who wants to do what • What have you previously done that has been a success in the past • How much money you have and the cost of any of the options • How much time you have From this information, you and your friends could decide more easily where to go and what to do – in order to keep most of your friends happy. You could also use a computer to help you to collect and analyze the data to devise the best solution to the problem, both now and even in a future scenario.	Another example might occur when playing a videogame. Depending on the game, in order to complete a level you would need to know: • What items you need to collect, how you can collect them, and how much time do you have to collect them • What is the best route to complete the level in the quickest time possible • What kinds of enemies are there and their weak points From these details you can work out a strategy for completing the level in the most efficient way.

Both of the instances above show how computational thinking has been used to solve a complex problem.

This brings us to the four key techniques of computational thinking:

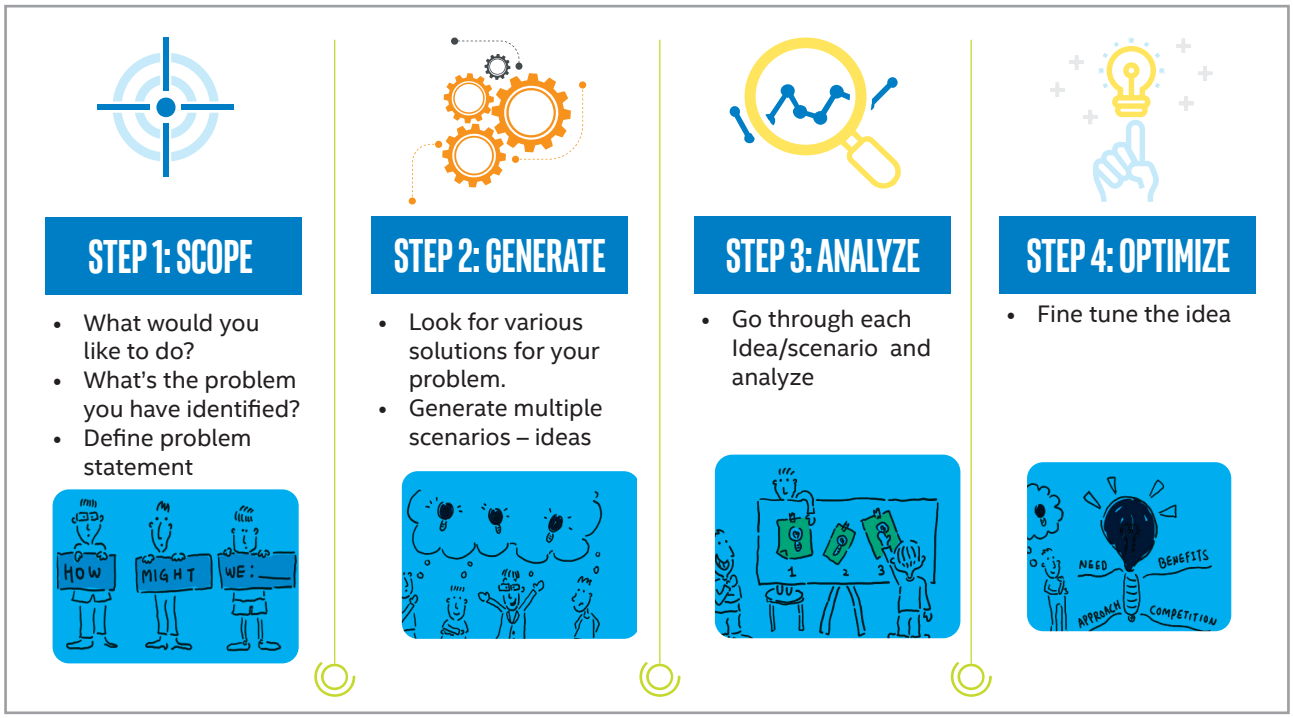
1. **Decomposition** - breaking down a complex problem or system into smaller, more manageable parts (e.g. where to go, how to complete the level)

2. **Abstraction** - focusing on the important information only, ignoring irrelevant detail (e.g. weather, location of exit)

3. **Pattern recognition** – looking for similarities among and within problems (e.g. knowledge of previous similar problems used)

4. **Algorithms** - developing a step-by-step solution to the problem, or the rules to follow to solve the problem (e.g. to work out a step-by-step plan of action)

A closer look will show that you may have worked through some parts of these techniques in Ideation and Design Thinking modules. Here is a quick snapshot:



So in this module we will concentrate on

1. **Algorithms and flowcharts** - developing a step-by-step solution to the problem, or the rules to follow to solve the problem
2. Getting introduced to **hardware/software** - understand their usage and learn how to put the idea generated through Ideation and detailed through Design Thinking into action by taking it to a computer and learning to give it a real-time shape
3. Learning the basic concept of **Programming**

Understanding Algorithms and Flowcharts

An algorithm is a plan, a set of step-by-step instructions to solve a problem.

If you can tie shoelaces, make a cup of tea, get dressed or prepare a meal, then you already know how to follow an algorithm. In an algorithm, each instruction is identified and the order in which they should be carried out is planned. Algorithms are often used as a starting point for creating a computer program, and they are sometimes written as a flowchart.

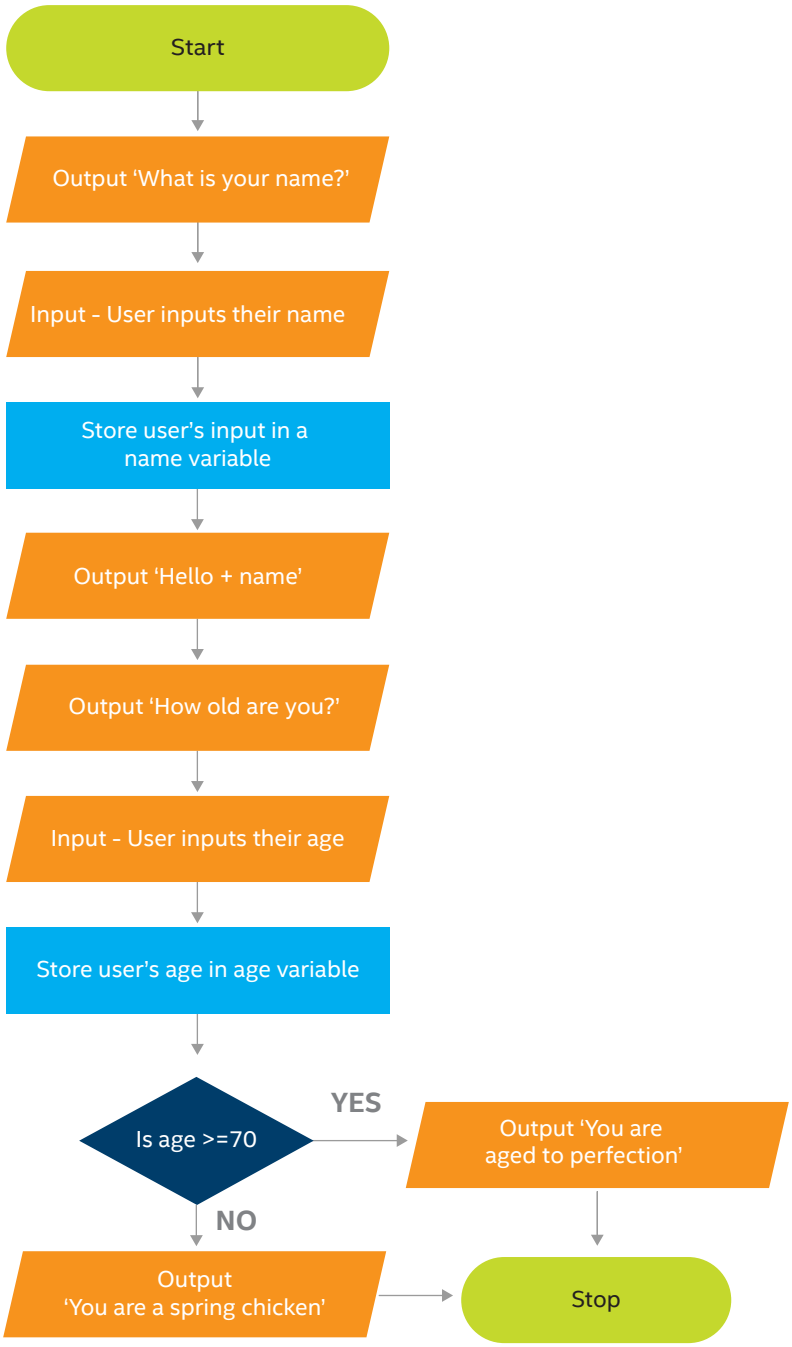
If we want to tell a computer to do something, we have to write a computer program that will give the computer step-by-step instructions on what we want it to do, and how we want it to do it. This step-by-step program will need planning, and to do this we use an algorithm.

Computers are only as good as the algorithms they are given. If you give a computer a poor algorithm, you will get a poor result. Algorithms are used for many different things including calculations, data processing and automation.

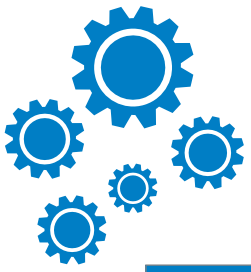
Representing an algorithm: Flowcharts

A flowchart is a diagram that represents a set of instructions. Flowcharts normally use standard symbols to represent the different instructions. There are few rules about the level of detail needed in a flowchart. Sometimes flowcharts are broken down into many steps to provide a lot of detail about exactly what is happening. Sometimes they are simplified, so that a number of steps occur in just one step.

A simple program could be created to ask someone their name and age, and to make a comment based on the program represented as a flowchart would look like this:



Source: http://www.bbc.co.uk/education/guides/zpp49j6/revision/3



Note for the facilitator

- Please refer to the presentation on Computational Thinking - Flowcharts and Algorithms in the pen drive provided
- Please ensure all the participants/students solve the exercises given at the end of the presentation. Students can be encouraged to come with problems and solutions for the same via flowcharts and algorithms.

Understanding Sensors and Actuators, and their applications

Here you will learn about different kind of sensors and their applications.

Imagine a human body without its five basic senses. It will not be able to interact with its surroundings, and it will not be able to produce any reaction. Similarly in the world of computers we have sensors – to help know the input/output for any selected process/program.

In the broadest definition, a sensor is an electronic component, module, or subsystem whose purpose is to detect events or changes in its environment, and send this information to other electronics, frequently a computer processor. A sensor is always used with other electronics, whether as simple as an electric light or as complex as a computer.

Sensors come in variety of shapes and sizes, and they sense a very large variety of things, from heartbeats to air pressure, from brightness to heat - there is a sensor to measure almost everything. And if there isn't a sensor specific to your requirement, you can mix and match a variety of sensors to accomplish what you need.

Actuators are basically things that produce an action. They are like the hands and legs of a person, and they come in various forms and shapes. Electromagnets, relays, DC motors, servo motors etc. are a few examples of commonly used actuators.

Note for the facilitator

- Please refer to the Computational Thinking presentation about sensors and actuators provided in the pen drive
- Please ensure all the participants/students solve the exercises given at the end of the presentation. Students can be encouraged to come with problems and solutions for the same via flowcharts and algorithms.

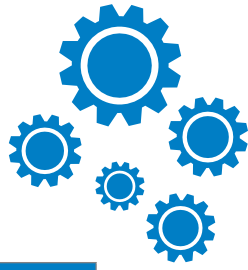
Understanding Circuits

This will help you to understand what are circuits and different kind of circuits.

In electronics, a circuit is a path between two or more points along which an electrical current can be carried.

A circuit is a closed loop that electrons can travel in. A source of electricity, such as a battery, provides electrical energy in the circuit. Unless the circuit is complete, that is, making a full circle back to the electrical source, no electrons will move.[3]

[3]http://www.qrg.northwestern.edu/projects/vss/docs/power/2-whats-a-circuit.html

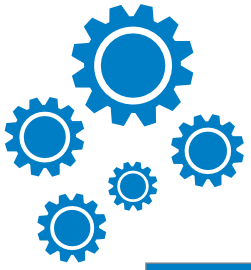


Note for the facilitator
• Please refer to the Computational Thinking presentation on Circuits • Please ensure all the participants/students solve the exercises given at the end of the presentation. Students can be encouraged to come with problems and solutions for the same via flowcharts and algorithms.

Resources

To get some more inspiration, you may refer to the following:

Brief Description	Resource URL
Computational Thinking and Thinking about Computing	https://www.cs.cmu.edu/afs/cs/usr/wing/www/talks/ct-and-tc-long.pdf
More about Computational Thinking	Computational Thinking (In-depth Explanation) https://www.youtube.com/watch?v=C2Pq4N-iE4I Computational Thinking from code.org https://www.youtube.com/watch?v=injJWiSA0pw Abstraction Computational Thinking https://www.youtube.com/watch?v=jV-7Hy-PF2Q
Know more about Single Board Microcontrollers	https://en.wikipedia.org/wiki/Single-board_microcontroller
All about Circuits	http://www.build-electronic-circuits.com/free-electronic-circuits/ http://www.dummies.com/programming/electronics/how-to-build-a-simple-electronic-circuit/ Basic Electricity: Current, Resistance and Ohms Law https://www.youtube.com/watch?v=NfcgA1axPLo Basic Tutorial on Introduction to Circuits by Khan Academy (Tutorial) https://www.youtube.com/watch?v=3o8_EARoMtg There is a course on Circuit Physics by Khan Academy. It's very good for beginners. (Playlist for Circuit Physics Course) https://www.khanacademy.org/science/physics/circuits-topic How to Use Breadboard https://www.youtube.com/watch?v=6WReFkfrUIk Paper Circuit (How to do it) https://www.youtube.com/watch?v=BwKQ9Idq9FM Build your own USB charger - a step-by-step guide http://www.build-electronic-circuits.com/wp-content/uploads/2017/lm/How-To-Build-A-Portable-USB-Charger.pdf



Brief Description	Resource URL
All about Sensors	https://www.electrical4u.com/sensor-types-of-sensor/ https://www.engineersgarage.com/articles/sensors https://www.youtube.com/watch?v=q1xNuU7gaAQ
What's an Algorithm?	https://www.youtube.com/watch?v=6hfOvs8pY1k https://www.youtube.com/watch?v=Da5TOXCwLSg
Algorithm in Pseudo Code, Flow Diagrams and Programming	https://www.youtube.com/watch?v=HhBrkpTqzqg https://www.youtube.com/watch?v=XDWw4Ltfy5w
An Overview of Flowchart	https://www.youtube.com/watch?v=uCNliFuKG8I
Real-life Algorithms – Paper Airplanes	https://www.youtube.com/watch?v=AWqo8Gxtrjs
Electronic Components	Simple Guide to Electronics (Tutorial) https://www.youtube.com/watch?v=6Maq5IyHSuc Basics of Coils (Part 1) (Tutorial) https://www.youtube.com/watch?v=kdrP9WbJIb8 Basics of Coils (Part 2) (Tutorial) https://www.youtube.com/watch?v=XCnI6ZOYKes How does a Transistor Work? (Tutorial) https://www.youtube.com/watch?v=IcrBqCFLHIY
Making the Motors Work	D.C. Motor Working (Tutorial) https://www.youtube.com/watch?v=LAtPHANEfQo&t=65s Stepper Motor Working (Tutorial) https://www.youtube.com/watch?v=TWMai3oirnM

Module V - PHYSICAL COMPUTING

Learning Objective	Learning Outcome
• To provide hands-on experience of basic coding, using sensors for various activities and getting to work with microcontroller boards	• Would have understood the basics of computers, and learnt how to use basic computer applications for collaboration like presentation, word processing, spreadsheets etc.

About Physical Computing

Physical Computing is building/designing/creating/making interactive systems that use different kinds of software and hardware to sense and respond to an external stimuli – which could be a program, a problem statement, a need, an issue or simply an Idea. In simple words - physical computing is a process where all the input and output devices work together as a single entity on the direction of a brain like object that could be a microcontroller board of a kind.

Physical computing takes a hands-on approach, which means spending a lot of time building circuits, soldering, writing programs, building structures to hold sensors and controls, and figuring out how best to make all of these things talk to each other and give the desired output. Smart automotive traffic control systems, factory automation processes, washing machines, fitness equipment found in homes, offices and industry – these are all things that make use of physical computing.

In essence, this is the stage where all that we have learnt in the previous module will be used and put together to finally reach the objective of making a prototype and/or working project.

By now, you would have gone through the process of:

- Design thinking - generated ideas - identified problems - used flowcharts/algorithms to depict the problems etc.

And understood about the following:

- Sensors
- Circuits

Now let's put it all together and start creating/making!

Note for the facilitator

The following presentations will take you through the process:

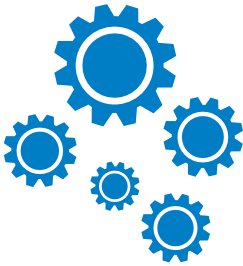
- Please refer to the following presentations and activity cards provided in the pen drive
  - Presentation - Physical Computing – Let's get to know boards - will give you an overview of different types of boards
  - Presentation - Physical Computing – Getting Started Guide Part 1 - will take you through the process of programming a board
  - Presentation - Physical Computing – Getting Started Guide Part 2 - a mini book for learning to program a board with simple DIY activities
  - Presentation - Physical Computing – Getting Started Guide Part 3 - will take you through the process of connecting sensors with board
  - Activity cards 1 – 5 - each of the activity card will give an understanding of how to work with a different set of sensors - LDR, Flex, Water Level, Soil Moisture, MQ Gas Sensors; each has a step-by-step process to follow and get the desired output
- Please ensure all the participants/students solve the exercises given at the end of the presentation.

To take you further in your journey to become an innovator, listed below are five sample activities that are completely DIY. It's time to be completely on your own and make something. These activities should be able to help you to do just this.

List of five completely DIY activities

Activities	Key Objective of the Activity
Alcohol Test	Check the consumption of alcohol amongst drivers to avoid accidents
Earthquake Test	Create a monitoring system to detect the chances of earthquakes in the near future
Heart Monitor Test	Measure heartbeat using a pulse sensor and Genuino 101*
Smart Irrigation Pump Test	Create a smart irrigation pump that can be controlled using a mobile app
Water Quality Test	Detect water quality to make sure people drink clean water

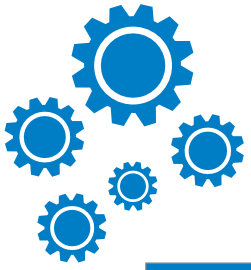
Happy Tinkering!



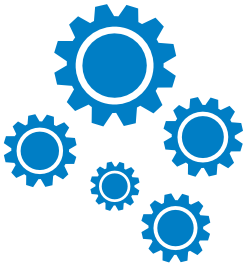
Resources

To get some more inspiration you may refer to the following

Brief Description	Resource URL
Physical Computing	https://www.youtube.com/watch?v=TAlsEZEcSis https://www.youtube.com/watch?v=8npwSASQqyk
Arduino Getting Started	https://www.youtube.com/watch?v=grU7eNPBRxk&list=PLT6rF_I5knP-f2qlVFlvH47qHvqvzkknd&index=1
More about Arduino*	Why Arduino? (Ted Talk by Arduino Founder) https://www.ted.com/talks/massimo_banzi_how_arduino_is_open_sourcing_imagination Anatomy of an Arduino Board https://www.arduino.cc/en/Guide/BoardAnatomy Arduino IDE https://www.arduino.cc/en/Guide/Environment Arduino Tutorials Playlist (Very useful for beginners, highly recommended) https://www.youtube.com/playlist?list=PLA567CE235D39FA84 What all we can do with Arduino? https://www.youtube.com/watch?v=grU7eNPBRxk&list=PLT6rF_I5knP-f2qlVFlvH47qHvqvzkknd&index=1 Arduino Basic Hardware Overview and Fundamental Code Commands https://www.youtube.com/watch?v=BtLwoNJ6klE
	Programming Raspberry Pi* https://www.youtube.com/watch?v=eObSqbe9aqU
Physical Computing into Wearable Technology (Maker Story)	https://www.youtube.com/watch?v=LwOLbbPcduM&t=10s
Learn about Switches	Push Buttons for Arduino https://www.youtube.com/watch?v=1C-3P_hmd70
Using Motor Driver Shields with Arduino	L298N using Motors with Arduino https://www.youtube.com/watch?v=nZdrWQcpb9E Stepper Motor with Arduino using L293D https://www.youtube.com/watch?v=nZdrWQcpb9E
How Servo Motor Works	https://www.youtube.com/watch?v=gviUtLsHDtg
Learn about Soldering Iron	How to Solder basics https://www.youtube.com/watch?v=BxeDkcAa4Fs Common Soldering Mistakes | Soldering https://www.youtube.com/watch?v=igqkhkff6cw http://www.dummies.com/programming/electronics/what-is-soldering-and-how-do-you-use-solder-tools/

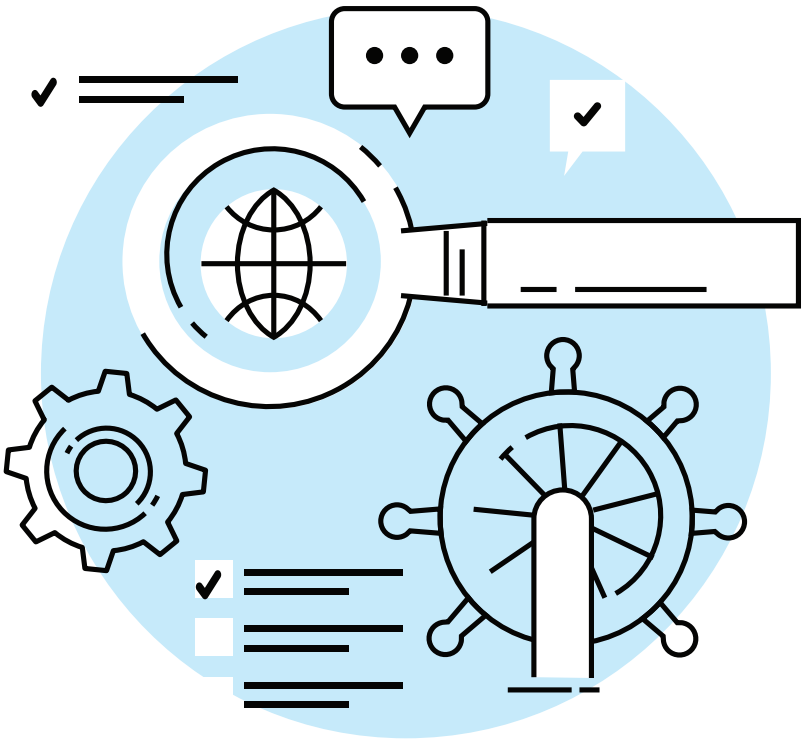


Brief Description	Resource URL
Tutorials showing usage of different types of sensors with Arduino Boards	Gas Sensors with Arduino https://www.youtube.com/watch?v=BIf_mpnsZvY Smoke and Gas Sensors https://www.youtube.com/watch?v=YgEOnZ-7i8o Calibrating with MQ2 Gas Sensors https://www.youtube.com/watch?v=YgEOnZ-7i8o Thermistor for Temperature Sensing https://www.youtube.com/watch?v=9opuvLXAetI Force Sensor with Arduino https://www.youtube.com/watch?v=1p8AE_QA8qQ Barometric Pressure Sensor with Arduino https://www.youtube.com/watch?v=s8e1eEqktm4 Ultrasonic Sensors (Very interesting project, it explains how radar works) https://www.youtube.com/watch?v=kQRYIH2HwfY GPS with Arduino https://www.youtube.com/watch?v=dy2iygCZTIM
Get inspired with series of ideas of DIY	http://www.instructables.com/tag/type-id/category-technology/channel-arduino/



LIST OF ALL RESOURCES IN SOFT COPY FORMAT

S.NO	Module	Presentation/Activity Card
1	Introduction to Atal Tinkering Lab	Introduction to Atal Tinkering Lab
2		Plan document for establishing Atal Tinkering Lab
3	Digital Literacy	Online Digital Literacy module
4		Digital Wellness Curriculum
5	Ideation	Ideation – An Introduction
6		A set of questions
7	Design Thinking	An Introduction
8		Different Stages of Design Thinking
9		Activity Cards for Design Thinking
10		List of online resources for self-learning
11	Computational Thinking	Understanding algorithms and flowcharts
12		Understanding Sensors & Actuators and their applications
13		Understanding Circuits
14		List of online resources for self-learning
15	Physical Computing	Let's get to know boards
16		Getting Started Guide Part 1
17		Getting Started Guide Part 2
18		Getting Started Guide Part 3
19		Activity Cards for Physical Computing
20		DIY Activity Cards
21		List of online resources for self-learning




ATAL INNOVATION MISSION


सत्यमेव जयते
NITI Aayog