

K-5 Computer Science

Teacher Notes

Domain Standard (Competency): Innovative Designer and Creator



The Teacher Notes were developed to help teachers understand the depth and breadth of the standards. In some cases, information provided in this document goes beyond the scope of the standards and can be used for background and enrichment information. Please remember that computer science encompasses both fundamental skills, such as computational thinking and digital citizenship, that all students should be introduced to in order to be viable citizens in a digital society as well as discrete skills that are endemic to specific career clusters.

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Innovative Designer and Creator

CSS.IDC.K-2.4: Use the Design Process (use, modify, create) with a variety of tools to identify and solve problems by creating new, modified, or imaginative solutions.

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CSS.IDC.3-5.4 Use a variety of technologies within a design process to identify and solve problems by creating new, useful, or imaginative solutions.

1. [Explore and practice a deliberate design process for generating ideas, testing theories, creating innovative artifacts, or solving authentic problems.](#)
2. [Select, evaluate, and use appropriate digital tools to plan and manage a design process](#)
3. [Modify, remix, or incorporate portions of an existing program into one's own work, to develop something new or add more advanced features.](#)



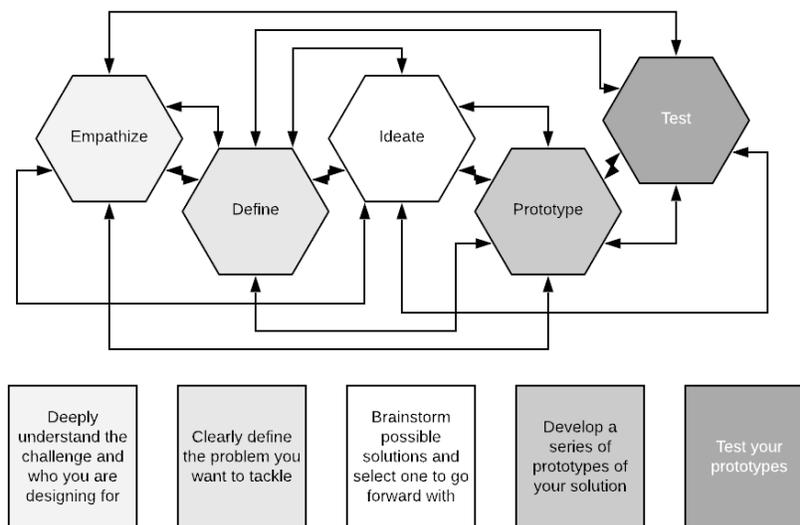
Innovative Designer and Creator - Overview

“I have a lot of plants and fish and a pet lizard and Venus flytraps. I have a whole ecosystem in my room, like a running waterfall and different lights and sensors set on digital timers.” - **Chris Pratt**

CSS.IDC.K-2.4: Use the Design Process (use, modify, create) with a variety of tools to identify and solve problems by creating new, modified, or imaginative solutions.

CSS.IDC.3-5.4 Use a variety of technologies within a design process to identify and solve problems by creating new, useful, or imaginative solutions.

Innovative design and creation is a multifaceted domain that spans across every content area. This domain and the related standards are offered explicitly within the computer science standards as ‘digital tools are essential in innovation, design, and creation in this digital age.’ The essential part of this standard is the use of digital tools within the processes already established in other disciplines such as the engineering design process (sometimes called design thinking), and the scientific method. The engineering design process is generally used to create or improve upon useful objects, but can also be used to create and improve upon methods and other intangibles. The design process is outlined below:



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Ask - Students can use the internet to research the problem. It is key that they understand how to find reputable sources on the Internet. It may be preferable to direct students to particular places to research.

Understand - Students can email and schedule video conferences with experts. Apps like Google Docs can help students organize the questions they would like to ask the experts. Zoom and Skype both have free options for video conferencing.

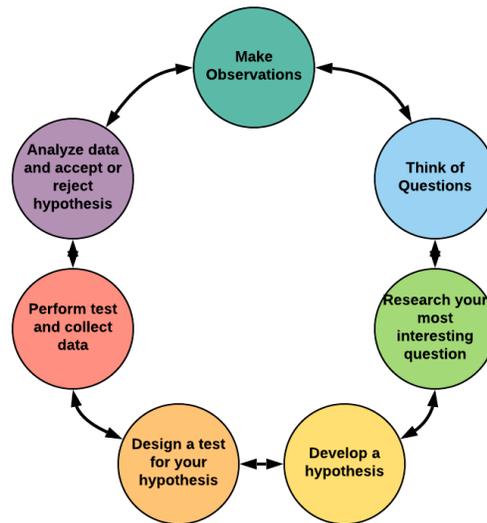
Imagine - There are many digital options for brainstorming and planning. Google and Microsoft have a suite of products that are general purpose and flexible. More specific options are available such as Lucidchart for diagramming and flowcharting, and CMAP for concept mapping.

Create - This depends on the final product. Processes can be written out and diagrammed in publishing software. If the solution is an app or game, students can use a product like Scratch or AppInventor. For advance projects students can use modeling software like TinkerCAD to develop 3D models that can be printed.

Test and Improve - Survey software such as Google Forms can help students collect data about how other people feel about their solution. Excel can track numerical data in other types of tests.

The scientific method can also be used in innovation and creation on it's own or as a part of the test and improve step of the engineering design process. The scientific method at an elementary appropriate level is outlined below:





Elementary students can learn and use the scientific method across the curriculum. Students can design experiments that may involve the creation of tools for performing the experiments and/or collecting data.

Here are some examples of how digital tools can be used in the scientific method.

Make Observations - Online videos can allow students to observe places and events not possible in a school setting.

Think of Questions - Software like Google Docs can help students keep track of questions and allow teacher and classmates to comment on questions and make suggestions.

Develop a hypothesis - Software like Google Docs can help students formulate their hypothesis and allow teacher and classmates to comment on questions and make suggestions.

Design a Test for your Hypothesis - Students can use planning software to help them design their test. Flowcharting software or storyboarding software can help students understand the steps they need to take and materials they may need to collect for the experiments.

Perform Test and Collect Data - Survey software and spreadsheet software can help students collect data.

Analyze Data and Accept or Reject Hypothesis - Survey software and spreadsheet software can help students analyze data.

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The National Academies Press in 2013 list the following Science and Engineering Practices that students need to know:

1. Ask questions (for science) and define (for engineering).
2. Develop and use models.
3. Plan and carry out investigations.
4. Analyze and interpret data.
5. Use mathematics and computational thinking.
6. Construct explanations (for science) and design solutions (for engineering).
7. Engage in argument from evidence.
8. Obtain, evaluate, and communicate information.

These are essential for all students to learn and understand, not just students who plan to become scientists and engineers. As technology continues to advance, science and engineering are becoming more a part of all of everyday life.



CSS.IDC.K-2.4.1

Use the Design Process (use, modify, create) with a variety of tools to identify and solve problems by creating new, modified, or imaginative solutions.

- 1. Understand that a model is used for developing and testing ideas for a diverse range of users.**

This first element is about the use of models to develop and test ideas. Students need to understand how models are made and how they are used. A model is a representation of an idea, object, event, process or system. Young students can be taught that models can be physical, or an idea.

An example of a physical model might be a volcano made out of plaster that can demonstrate how lava might flow down the sides using vinegar and baking soda. Physical models can be three dimensional or two dimensional. In the case of the volcano, the dimension of time is also added. 3D and 2D models with time added are called simulations. An example of an idea model is the scientific method. This is a model of a process that students can use to investigate the world around them. Design thinking is also an idea model. Both physical and idea models can be created in a computer as digital models.

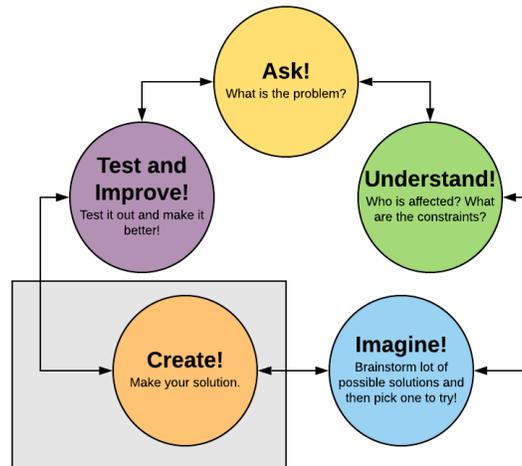
Digital examples of models with software examples for creating

2D		3D		Simulation	
Physical	Idea	Physical	Idea	Physical	Idea
Digital diagram of the parts of a plant	Digital diagram of the water cycle	Model of a building	Models of mathematical equations	Movements of the planets around the sun	Population growth models
https://www.getpaint.net/download.html	https://www.lucidchart.com	https://www.tinkercad.com/	https://www.pencil2d.org/	https://www.powtoon.com/home/	https://ccl.northwestern.edu/netlogo/

Models can be images/diagrams (2D or 3D) with or without text labels. Simulations can be animations, or multimedia. Many video games are actually playable, interactive simulations.



Students need to learn how to create models and simulations to develop and test their ideas. Prototypes are generally models or simulations so this is the creation aspect of the engineering design process:



Although using physical craft items and drawing materials have long been used with young children in model creation, as you can see in the chart above, digital computers and equipment have become valuable tools for creating and testing models. For example, Lego bricks are common for model creation, but now Lego has digital components that can be added and programmed in their Mindstorm EV3, WeDo, and Spike product lines. NetLogo is a programmable, agent based modeling platform created for students. MIT created the block based programming software system, Scratch, for kids to make digital creations. Scratch can be used to create models and simulations. The following page has information about simulations created in Scratch: https://en.scratch-wiki.info/wiki/Simulation_Projects . Digital drawing and image programs can be used to create simple models like diagrams.

Resource Links

<http://scienceonline.tki.org.nz/Teaching-science/Teaching-strategies/Teaching-with-models>

<https://ccl.northwestern.edu>

<https://scratch.mit.edu/>

<https://kids.kiddle.co/Simulation>

<https://i.materialise.com/blog/en/first-3d-model-in-sketchup-tutorial/>

<https://firealpaca.com/>



CSS.IDC.K-2.4.2

Use the Design Process (use, modify, create) with a variety of tools to identify and solve problems by creating new, modified, or imaginative solutions.

2. Modify an existing model for a specific purpose or for a specific group of users

The second element is about modification of existing models rather than students creating their own models from nothing. For digital models and simulations, this requires the use of appropriate editing software. The format of the digital file is especially important. Common formats can be edited by a variety of different software programs. However, some software programs use less common or even proprietary file formats that require a very specific software to edit.

Digital file format examples

	Text	Audio	Images	Video	Multimedia
Open file formats	.txt , .csv , .doc	.wav , .mp3	.jpeg , .jpg , .gif , .bmp	.mpeg , .ogg , .avi	.sb2 (must be opened in Scratch)
Proprietary file formats	.pdf (Adobe), no longer proprietary	.wma (Microsoft)	.psd (Adobe Photoshop)	.m4v (itunes)	.unity3D (Unity is a game creation software)

Students can be asked to change aspects of appearance that don't affect the meaning and functioning of a model or simulation, but perhaps increase understanding or appeal. Or they can be asked to make more profound changes. Two important aspects of modeling and simulation are resolution and fidelity. Resolution is the degree of detail and precision used in the representation of real world aspects in a model or simulation. Fidelity is the accuracy of the representation when compared to the real world. The two are not correlated; a model can have high resolution, but low fidelity and vice versa. Students should be aware of these, especially when editing the models and simulations of others. More age appropriate terminology may be detail (resolution) and closeness to real life (fidelity). Students could be asked to make changes that affect resolution or fidelity of a model or simulation.

Resource Links

<https://scratch.mit.edu/search/projects?q=simulator>

<https://ccl.northwestern.edu/netlogo/models/index.cgi>

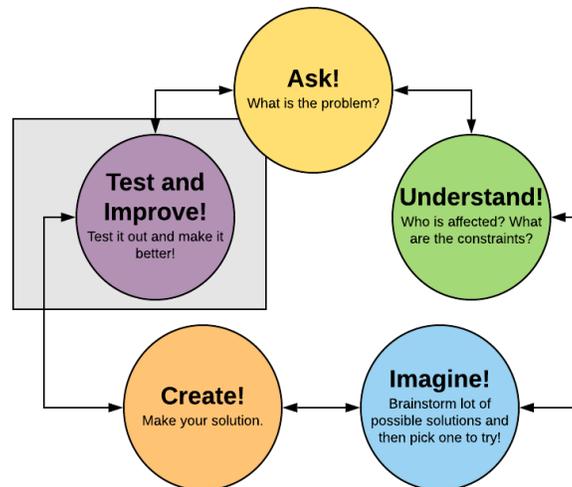


CSS.IDC.K-2.4.3

Use the Design Process (use, modify, create) with a variety of tools to identify and solve problems by creating new, modified, or imaginative solutions.

3. Create and test a model and analyze it from the perspective of an end user.

The third element involves testing and analyzing a model from the perspective of an end user. This is often referred to as usability (user interface or UI) or user experience (UX). Creating a model or simulation is the prototype step of the design thinking process. This element is the testing and improvement step of the design thinking process.



In testing and analyzing their models and simulations (prototypes), students need to be able to check for errors in content as well as errors in the technology. However, they also need to think about how others would experience the use of the model or simulation. There are two ways to approach this. The first is to ask the students to assess their model or simulation from the perspective of another. This may be difficult for younger children, but perspective taking should be introduced as early as possible to help foster empathy for others. Perspective thinking involves 1. Being able to put your own thoughts on hold to 2. use our knowledge and understanding of someone to figure out how the other person must be feeling or thinking. These both require cognitive flexibility (Galinsky, 2010). Doing the following can help students learn to take the perspectives of others.

- Model perspective taking. Take opportunities to share with students examples of seeing things from another point of view.
- Be open talking about, acknowledging, and respecting feelings to help students develop a vocabulary and comfort level with emotions.

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- Show students how to build cause and effect connections between people's actions and their motivations.
- Encouraging students to observe and evaluate other people's actions or behaviors.
- Discuss how actions affect others and have consequences.
- Encourage students to build community by engaging with others, collaborating, problem solving, and valuing their relationships with others.
- Create a caring and respectful classroom environment that values multiple perspectives.

The other way of assessing a model or simulation is to actually engage others in the testing process. Students can observe other students, teachers, parents, administrators using their model or simulation and ask them questions. They can then be asked to reflect on the experience.

Resource Links

<https://www.usability.gov/>

<https://www.nngroup.com/articles/usability-101-introduction-to-usability/>

<https://www.interaction-design.org/>

<https://uxplanet.org/>

https://www.canr.msu.edu/news/the_importance_of_perspective_taking_for_young_children

Galinsky, E. (2010). Mind in the making. *National Association for the Education of Young Children: Washington, DC*, 124.

<https://www.tolerance.org>



CSS.IDC.K-2.4.4

Use the Design Process (use, modify, create) with a variety of tools to identify and solve problems by creating new, modified, or imaginative solutions.

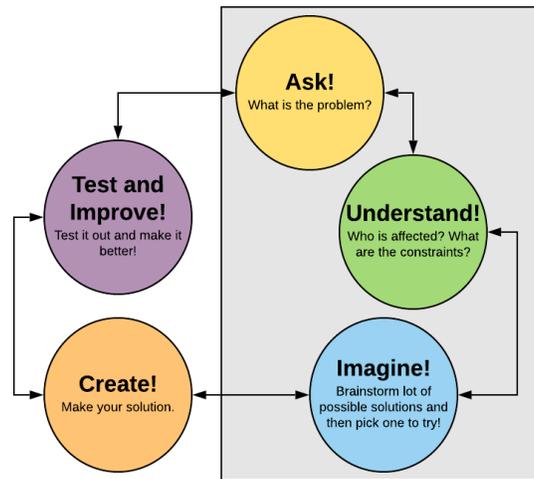
- 4. Recognize that innovation in technology meets a range of needs (3D printing, coding, robotics, drones, etc.).**

The fourth element involves helping students see the purpose of creation and innovation in technology as the benefit of society. Innovations in technology can solve problems and make the world a better place.

Innovation	Example of Societal Benefits
Drones	Search and rescue
Robots	Improved surgery
Artificial Intelligence	Improved medical diagnosis
Video Games	Scientific innovation (fold.it)
3D Printing	Housing after natural disaster
Quantum Computing	Advanced problem solving
Self Driving Cars	Reduction in accidents
Virtual Reality	Reduced training costs
Mobile Computing	Disease detection in remote areas
Internet of Things	Increased personal convenience
Digital Medical Devices	Less invasive medical treatment

Students can be encouraged to think about how their creations will be used by others as well as how they can be used to solve problems. This can be incorporated into any step of the design process, but especially fits well in the empathize and understand phases as well as the convergence portion of the imagine phase.





Resource Links

- <http://www.gamesforchange.org/>
- <http://www.oecd.org/innovation/>
- <https://www.unicef.org/innovation/>
- <https://www.goodnet.org/innovation>
- https://venturewell.org/activities_for_teaching_innovation/
- <https://www.dfcworld.com/SITE>
- <https://dschool.stanford.edu/resources>

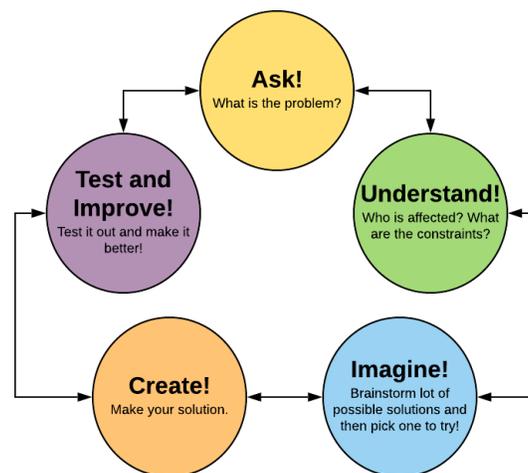


CSS.IDC.K-2.4.5

Use the Design Process (use, modify, create) with a variety of tools to identify and solve problems by creating new, modified, or imaginative solutions.

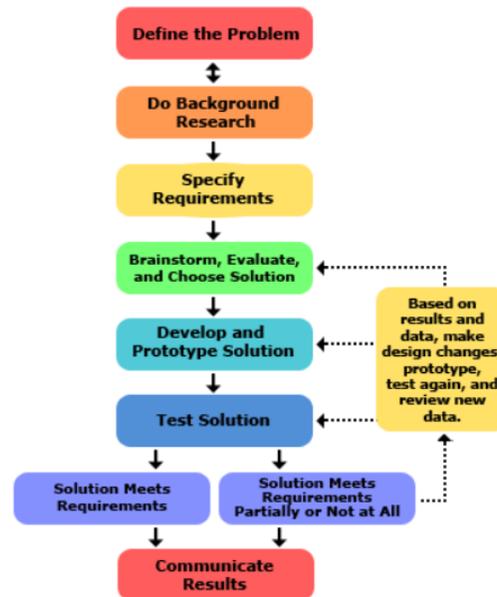
- 5. Understand that innovation follows a process such as system life cycle, engineering design (use, modify, create) or design thinking (empathize, define, ideate, prototype and test).**

The fifth element focuses on the entirety of the design process. This standard lists the design thinking process (empathize, define, ideate, prototype, and test) as well as engineering design (use, modify, create) and the system life cycle as possible models to use in the classroom to teach about design and creation. We've already discussed the process of design thinking:

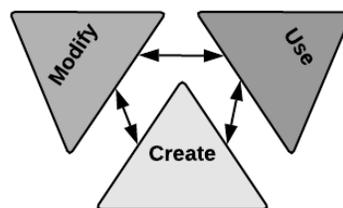


Design thinking works well when starting from nothing, but can also be used when modifying existing solutions. However this is only one conceptualization of the process. Science Buddies breaks down the steps as follows:

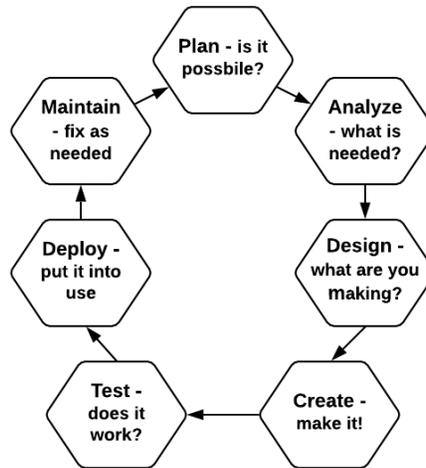




Another process that students might find helpful is the engineering design process of Create, Use, and Modify. This has the benefit of fewer steps for young learners, but is missing the important elements of empathizing and understanding users as well as any explicit mention of testing or reflection.



The System Life Cycle is conceptualized differently as needed and is generally used in software system development. It generally consists of the steps of Planning, Analysis, Design, Implement, Test, Deploy, and Maintain. The System Life Cycle is more for a product or process that is being developed to be put into use as it includes the actual implementation and maintenance steps.



The System Life Cycle could be taught in the context of the creation of classroom processes that are then put into place and maintained throughout the year. These could be stored in a Google Doc and be edited as needed.

Resource Links

- <https://www.noodle.com/articles/what-the-design-process-can-teach-kids>
- <https://knowwithoutborders.org/design-thinking-for-kids/>
- <https://www.linkengineering.org/EngineeringDesign.aspx>
- <https://www.sciencebuddies.org/science-fair-projects/engineering-design-process/engineering-design-process-steps>

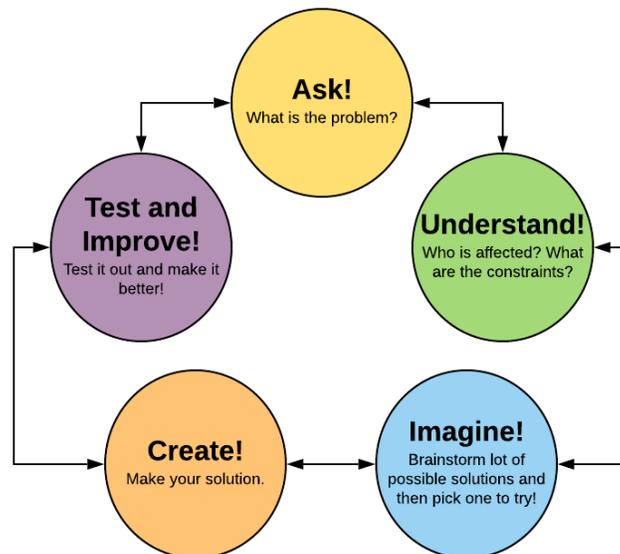


CSS.IDC.3-5.4.1

Use a variety of technologies within a design process to identify and solve problems by creating new, useful, or imaginative solutions.

- 1. Explore and practice a deliberate design process for generating ideas, testing theories, creating innovative artifacts, or solving authentic problems.**

This first element is about utilizing all the steps of a design process for creating artifacts and solving problems. This diagram gives the steps of design thinking in elementary friendly language:



Asking and understanding help teach students the importance of empathizing and taking the perspectives of others. We have to consider all affected parties when designing. The imagine step teaches students the important skills of divergence (brainstorming) and convergence (developing criteria and using it to make a selection). Only then does the actual creation process begin and it doesn't end with a finished product. Students must learn to test and analyze their solution and reflect on their findings. They need to determine if their solution can be improved or if it needs to be scrapped and the process started again with another solution option.

There are other available conceptualizations and plenty of resources online for utilizing design thinking in the elementary classroom. The process can be taught on its own with digital technology artifacts as the primary goal in a computer special area course. It can also be taught

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within other subject area content utilizing digital technology or not. It is especially useful for teaching students to develop solutions to real problems in the world while learning standard content. Design for change uses the following process:



FEEL



IMAGINE



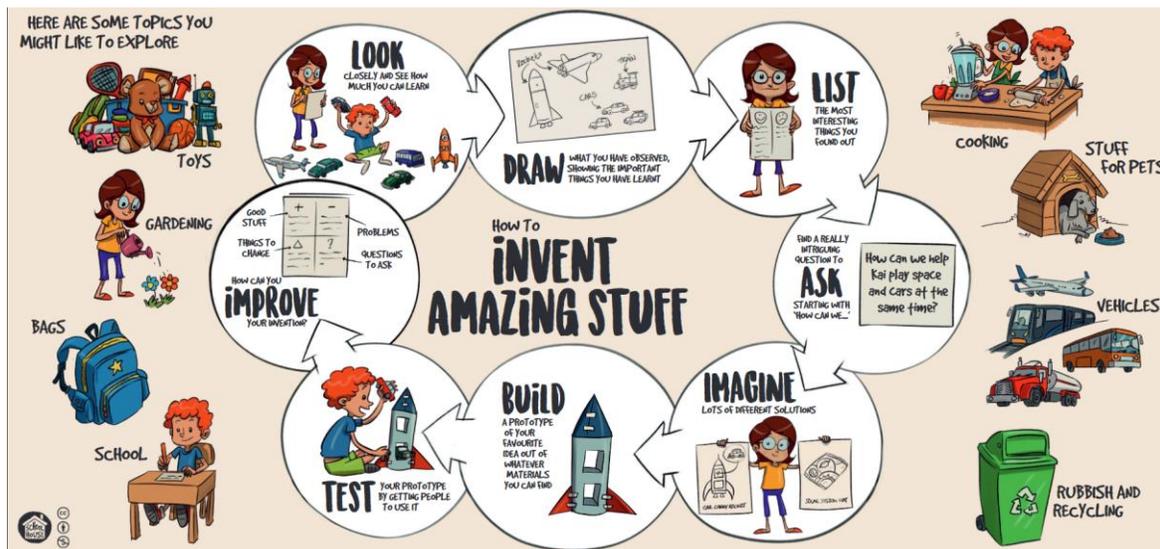
DO



SHARE

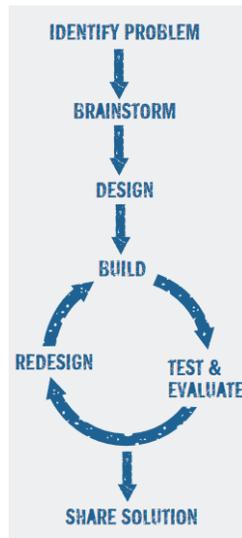
<https://www.dfcworld.com/SITE>

This a great site to learn about student projects from around the world. The Schoolhouse Centre for Educational Innovation in Australia has the following visualization of design thinking:

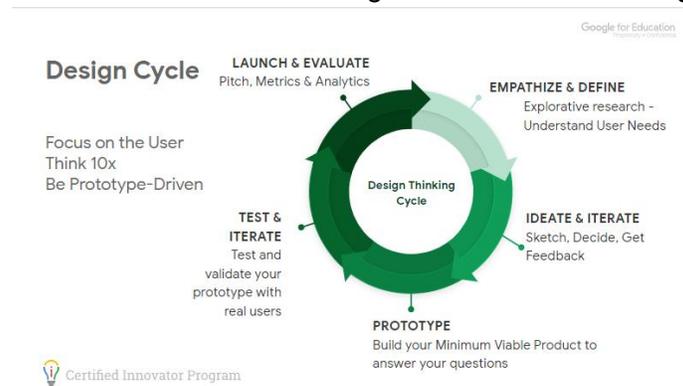


They provide a design thinking toolkit at: <http://schoolhouse.edu.au/2016/09/design-thinking-with-kids-educators-toolkit> . The Public Broadcasting System (PBS) has a program called The Design Squad. To support educators and parents, they have created a website with educational resources for teaching design: <https://pbskids.org/designsquad/parentseducators/index.html> . It includes guides, videos, and lesson plans. They also have games for kids: <https://pbskids.org/designsquad/games/> . They provide the following steps for the Design Thinking process:





The Google for Education Certified Innovator Program describes the design cycle as:



Google Certified Educators can become Certified Innovators which centers on the Design Process: https://teachercenter.withgoogle.com/certification_innovator . The Interaction Design Foundation offers low cost training in design topics, including design thinking. They have the following conception of the design thinking process:



<https://www.interaction-design.org/literature/article/what-is-design-thinking-and-why-is-it-so-popular>

Design Thinking in Schools is a curated map of schools utilizing design thinking: <https://www.designthinkinginschools.com/> . This is an excellent resource to find a partner school

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for collaborative projects. Stanford University has a school devoted to Design Thinking and provides resources for K-12: <https://dschool.stanford.edu/resources> . One of the resources is a K-12 Lab Wiki for Creative Problem Solving: <https://dschool-old.stanford.edu/groups/k12/> . There are even competitions for design thinking: <https://www.thedesignkids.org/competitions> .

All of these resources can help guide you in implementing project based learning with your students where curriculum and content is learned through the process of developing potential solutions to real problems. This helps prepare students for a future of active engagement in creating a better world. It also helps students learn essential soft skills such as persistence and resilience. Not all of their solutions will work. It is important for students to learn to be comfortable with failure. One way to do this is to use the F.A.I.L acronym - First Attempt In Learning. Design Thinking is a cyclical process with absolutely no expectation of getting it right on the first, second, or even third try. Failure should be seen as a vital part of the learning process, not something to be avoided.

Resource Links

<https://www.dfcworld.com/SITE>

<http://www.agencybydesign.org/thinking-routines-tools-practices>

<http://www.ideaco.org/>

<https://www.teachersguild.org/approach>

<https://www.learningisopen.org/toolkit/design-thinking/>

https://pbskids.org/designsquad/pdf/parentseducators/DS_Act_Guide_complete.pdf

<https://designthinkingforeducators.com/>

<http://kidsthinkdesign.org/worldofdesign/index.html>



CSS.IDC.3-5.4.2

Use a variety of technologies within a design process to identify and solve problems by creating new, useful, or imaginative solutions.

2. Select, evaluate, and use appropriate digital tools to plan and manage a design process

The second element focuses on tools that can be used to plan and manage a design process. These can include whiteboards and notebooks, but, depending on the availability of tablets or laptops, this is also a good opportunity to teach students to use one of the many software solutions for managing projects. Google Docs and Google Sheets are a simple option that simply mimic physical whiteboards and notebooks. Google Slides can be used in presentations. However, Common Sense Education has vetted several software options for use in Design Thinking appropriate for elementary students. Their suggestions are presented in the table below:

Tool	Common Sense Description	Cost
Popplet	A compact, simple organizational tool for minimalist presentation	Free, paid
Mural	Multifaceted interactive whiteboard promotes collaboration	Free, free to try, paid
Paper by WeTransfer	Beautifully designed digital sketchbook for any age	Free
The Noun Project	Think in pictures with vibrant visual language everyone can understand	Free
Mindmeister	Powerful mind mapper aimed at adults, simple enough for older kids	Free, paid
Stormboard	Collaborate, brainstorm in real time with easy-to-use online whiteboard	Free, free to try, paid
Explee	Build slick, engaging whiteboard animations with Web-based tool	Free, paid

I would also suggest the free project management tools: <https://trello.com/> and <https://kanbanflow.com> .



You may need to work with your IT department to unblock any blocked sites and/or install software.

Resource Links

<https://www.common sense.org/education/top-picks/design-thinking-tools-for-students>



CSS.IDC.3-5.4.3

Use a variety of technologies within a design process to identify and solve problems by creating new, useful, or imaginative solutions.

- 3. Modify, remix, or incorporate portions of an existing program into one's own work, to develop something new or add more advanced features.**

The third element involves using portions of the work of others in the students' creations. This will require students to understand intellectual property rules. Students will need to understand trademark, copyright, patent, and fair use.

According to the United States Patent and Trade Office:

- **Patent** - "A patent for an invention is the grant of a property right to the inventor, issued by the United States Patent and Trademark Office. Generally, the term of a new patent is 20 years from the date on which the application for the patent was filed in the United States or, in special cases, from the date an earlier related application was filed, subject to the payment of maintenance fees. U.S. patent grants are effective only within the United States, U.S. territories, and U.S. possessions. Under certain circumstances, patent term extensions or adjustments may be available." Patents usually require a lawyer to file and are expensive. Patent holders can sue others for using their work without permission.
- **Trademark** - "Trademarks identify the source (maker or provider) of products and services. Trademarks are usually words, designs, or a combination of words and a design." Other types of trademarks include colors, sounds, scents, and the way a product looks!" Trademarks identify a brand and companies that hold a trademark can sue others for using their trademark without permission.
- **Copyright** - "Copyright is a form of protection provided to the authors of 'original works of authorship' including literary, dramatic, musical, artistic, and certain other intellectual works, both published and unpublished...The copyright protects the form of expression rather than the subject matter of the writing. For example, a description of a machine could be copyrighted, but this would only prevent others from copying the description; it would not prevent others from writing a description of their own or from making and using the machine." Someone using copyrighted work without permission can be sued by the copyright holder.



<https://www.copyright.gov> describes fair use as: “Fair use is a legal doctrine that promotes freedom of expression by permitting the unlicensed use of copyright-protected works in certain circumstances. [Section 107 of the Copyright Act](#) provides the statutory framework for determining whether something is a fair use and identifies certain types of uses—such as criticism, comment, news reporting, teaching, scholarship, and research—as examples of activities that may qualify as fair use.” Descriptions of the four factors to be considered for fair use can be found at: <https://www.copyright.gov/fair-use/more-info.html>

Students should also learn about the open source movement which allows people to get credit for their work while making it free and available for others to use and (in some cases) modify. The Creative Commons is one non-profit organization facilitating open sharing of intellectual and digital property by providing a licensing framework: <https://creativecommons.org> .

“Creative Commons is a nonprofit organization dedicated to building a globally-accessible public commons of knowledge and culture. We make it easier for people to share their creative and academic work, as well as to access and build upon the work of others. By helping people and organizations share knowledge and creativity, we aim to build a more equitable, accessible, and innovative world.”

The Wikimedia Commons allows users to share work that is licensed under Creative Commons: https://commons.wikimedia.org/wiki/Main_Page . The page includes a search function. Google search includes a way to find images that can be used in other works by doing an image search, selecting Tools, selecting Usage Rights, and then making a labeled for reuse selection.

There are a number of licenses available for open source software including: [Apache License](#), [BSD license](#), [GNU General Public License](#), [GNU Lesser General Public License](#), [MIT License](#), [Eclipse Public License](#) and [Mozilla Public License](#). Open source software allows users to see the code and in most cases allows the code or portions of the code to be reused in other projects. Some project like Scratch allows users to share code from their projects so others can use and remix it.

It's important to reiterate with students that new creations can be made from the work of others, but should have significant original contribution in order to not be considered plagiarism. This is especially essential in the modern world where so much content is available on the Internet.



Resource Links

<https://lawforkids.org/intellectual-property>

<http://www.copyrightkids.org/>

<https://www.uspto.gov/>

<https://opensource.org/>

https://en.wikipedia.org/wiki/Open-source_software#Open-source_software_licensing

https://commons.wikimedia.org/wiki/Main_Page

<https://creativecommons.org/>



Related Vocabulary

K-2:

F.A.I.L - First Attempt In Learning

Frustrated - feeling annoyed or angry because something is not the way you want it

Model - a representation of an idea, object, event, process or system

Simulation - a model that changes over time

Persistence - Trying again and again, even when something is very hard

Try - attempt to do something

Resolution - the degree of detail and precision used in the representation of real world aspects in a model or simulation (detail)

Fidelity - the accuracy of the representation when compared to the real world (lifelike)

Innovation - new ideas, methods, or products

Prototype - model or simulation to test a concept or process

Modify - make changes

3-5:

Convergent Thinking - evaluating ideas by some sort of criteria to select an idea to move forward with

Deliberate Design Process - A methodology for problem solving; a series of steps used to solve a problem and design a solution. For example, human centered design process, project-based learning, engineering design processes, scientific method

Design Thinking - A process for creative problem solving that involves understanding who you are designing for, generating many possible solutions, and selecting one to prototype and test

Divergent Thinking - coming up with many different possible ideas



References

<https://code.org/curriculum/docs/k-5/glossary>

<https://www.iste.org/standards/for-students>

NGSS Lead States. (2013). *Next generation science standards: For states, by states*. Washington, D.C.: The National Academies Press.

<https://techterms.com/>

<https://www.lucidchart.com/>

<https://cmap.ihmc.us/>



Grade by grade progression

Kindergarten

Description of Innovative Designer and Creator for kindergarten:

In kindergarten, students screen time should be minimized. This is according to research that suggests visual development can be impaired by excessive screen time. However, students at this age will enjoy problem solving using age appropriate digital toys and robots as well as drawing and writing on touchscreens or using a drawing tablet. However, at this age students can still learn the design process, with non-digital tools if necessary.

Some artifacts that kindergarteners can create include 2D models that consist primarily of a diagram with or without labels.

Sample activity: Have students use drawing software to draw a model of the classroom.



First grade

Description of Innovative Designer and Creator for first grade:

In first grade, screen time can be increased. Students will benefit from active learning projects that help them practice their fine motor skills which are still developing at this age. There are robotic products developed just for younger ages that would be excellent uses of grant funds, donations, or PTA requests (if available). Ozobot, Wonder Workshop, Sphero, Learning Resources Code & Go Mouse Activity Set, Primo Toy's Cubetto all have products that are suitable for young children.

Some artifacts that first graders can create include 2D models; robots with age appropriate hardware and software such as Lego WeDo; paper circuit creations using a product like Chibitronics.

Sample activity: Have students use paper circuits to image products that don't currently exist and create a model.



Second grade

Description of Innovative Designer and Creator for second grade:

In second grade, students are continuing their development of fine motor skills. There are robotic products developed just for younger ages that would be excellent uses of grant funds, donations, or PTA requests (if available). Ozobot, Wonder Workshop, Sphero, Learning Resources Code & Go Mouse Activity Set, Primo Toy's Cubetto all have products that are suitable for young children.

Some artifacts that second graders can create include 2D Models; robots with age appropriate hardware and software such as Lego WeDo; paper circuit creations using a product like Chibitronics.

Sample activity: Have students research the best ways to reach different destinations around the school by developing a to scale model of the school. If available, students can use Ozobots to help.



Third grade

Description of Innovative Designer and Creator for third grade:

In third grade, students are beginning to be ready for more advanced tools like the Lego Spike and EV3 robots as well as Microbits. They will still benefit, however, from working with tools made for younger students. Third graders also have enough literacy to begin to develop software using block-based programming in an environment such as Scratch. Students can also begin to use the Internet to help them research their designs.

Some artifacts that third graders can create include 2D Models; robots with age appropriate hardware and software such as Lego Spike and EV3; paper circuit creations using a product like Chibitronics; 3D Models; simple interactive media such that could be created using Scratch or Google Sites.

Sample activity: Create an interactive story in Scratch that teaches others about rocks (this is a GA science standard for 3rd grade)



Fourth grade

Description of Innovative Designer and Creator for fourth grade:

In fourth grade, students are eligible to compete in robotics competitions such as First Lego League which includes robot design and programming, teamwork, and a research project. More sophisticated problem solving can be introduced and students can do more advanced research on real world problems. The development of fine motor skills makes it possible for students to manipulate smaller components, although some students will struggle. Kits like those from Sparkfun come with projects for learning the platform but have a lot of potential for expansion using common and inexpensive materials.

Some artifacts that fourth graders can create include 2D Models; robots with age appropriate hardware and software such as Lego Spike and EV3; microcontroller and circuit projects such as those that can be created using Arduino or Raspberry PI; paper circuit creations using a product like Chibitronics; 3D Models; simple interactive media and software such that could be created using Scratch or Google Sites; wearables and e-textiles.

Sample activity: Teach students how to create a scale model

(https://www.teachengineering.org/activities/view/build_a_scale_model) . This activity can bring in important math concepts. Two ideas include planning a garden and rearranging the furniture in the classroom.



Fifth grade

Description of Innovative Designer and Creator for fifth grade:

In fifth grade, students are getting ready to move to middle school. They are able to use more sophisticated tools and funds would be well spent on Microcontroller kits (Arduino or Raspberry Pi). The Internet is full of instructions on how to use them to build a wide variety of projects. See <https://create.arduino.cc/projecthub/projects/tags/kids> and <https://raspberrytips.com/projects-for-kids/> . Students need to build problem solving and soft skills along with technology skills. Communication and teamwork are essential.

Some artifacts that fifth graders can create include 2D Models; robots with age appropriate hardware and software such as Lego Spike and EV3; microcontroller and circuit projects such as those that can be created using Arduino or Raspberry PI; paper circuit creations using a product like Chibitronics; 3D Models; simple interactive media and software such that could be created using Scratch or Google Sites; wearables and e-textiles. Students can also take on research projects that use spreadsheets and other software to collect and analyze data and present the results to interested parties.

Sample activity: Have the students play a variety of simulation games like Monopoly, Cookie Tycoon, Lemonade Stand, Zoo Tycoon, etc. Have the students work in groups to create a board game or card game that is a simulation. They can use drawing software to create the board and cards or they can use specialized software like Card Maker: <https://sourceforge.net/projects/card-maker/>

