



Year 3

# Mid- Term Plan: Computing

Term: Summer

**Unit Title:**  
**Scratch – printing the story**



### Key Themes / Vocabulary:

**X, Y, and Z Axes:** The directions of 3D space (Left/Right, Forward/Backward, Up/Down).

**Dimensions:** The size of an object, measured in **Millimeters (mm)**.

**Workplane:** The flat "ground" where we build our designs.

**Solid vs. Hole:** A shape that adds material vs. a shape that removes material.

**Group / Ungroup:** Combining multiple shapes into one single object (or separating them).

**Align:** A tool used to center or line up shapes perfectly with one another.

**Duplicate:** Copying an object (and repeating a pattern).

### Cross Curricular Links:

Curriculum

English – links with the Hugo Cabret text

### Overview:

The primary goal of this eight-week project is to guide Year 4 students through a complete iterative design cycle—from digital modeling to physical engineering—using the captivating, mechanical world of *The Invention of Hugo Cabret*. By progressing from basic 3D shape manipulation in TinkerCAD to designing precise, interlocking parts like gears and winding keys, students practically apply ISTE, CSTA, and UK National Curriculum standards. Ultimately, they bridge the gap between software and hardware, learning vital concepts like spatial reasoning, debugging, and mechanical tolerances as they 3D print and physically assemble their own working clockwork mechanisms.

#### ISTE Standards for Students

- **1.4.b (Innovative Designer):** Select and use digital tools to plan and manage a design process that considers design constraints and calculated risks. *(Using TinkerCAD to plan and manage the creation of the automaton parts).*
- **1.4.c (Innovative Designer):** Develop, test and refine prototypes as part of a cyclical design process. *(Testing how digital shapes align and refining the 3D models before printing).*
- **1.4.d (Innovative Designer):** Exhibit a tolerance for ambiguity, perseverance and the capacity to work with open-ended problems. *(Troubleshooting physical tolerances, like ensuring the printed key fits the gear).*
- **1.5.b (Computational Thinker):** Collect data or identify relevant data sets, use digital tools to analyze them, and represent data in various ways to facilitate problem-solving and decision-making. *(Analyzing dimensions in millimeters and understanding the slicing software's translation process).*

#### CSTA K-12 Computer Science Standards (Level 1B: Ages 8-11)

- **1B-CS-02 (Computing Systems):** Model how computer hardware and software work together as a system. *(Understanding the pipeline from TinkerCAD software to the Slicer software, and finally to the 3D Printer hardware).*
- **1B-CS-03 (Computing Systems):** Determine potential solutions to solve simple hardware and software problems using common troubleshooting strategies. *(Fixing errors in the slicing process or physical print).*
- **1B-AP-14 (Algorithms & Programming):** Observe intellectual property rights and give appropriate attribution. *(Properly saving, naming, and taking ownership of their personal digital files/designs).*
- **1B-AP-15 (Algorithms & Programming):** Test and debug a program or algorithm to ensure it runs as intended. *(Visually "debugging" the 3D model for floating parts, ungrouped holes, or incorrect measurements).*

## GB UK National Curriculum (Key Stage 2: Year 4)

### Computing

- **Design and Create:** Select, use and combine a variety of software (including internet services) on a range of digital devices to design and create a range of programs, systems and content that accomplish given goals. *(Using TinkerCAD to design 3D objects).*
- **Debugging:** Use logical reasoning to explain how some simple algorithms work and to detect and correct errors in algorithms and programs. *(Finding and fixing errors in their 3D models before exporting).*
- **Systems & Networks:** Understand computer networks, including the internet; how they can provide multiple services, such as the World Wide Web, and the opportunities they offer for communication and collaboration. *(Using cloud-based CAD software to create and export files).*

### Design and Technology (D&T)

- **Make:** Select from and use a wider range of tools and equipment to perform practical tasks (e.g., cutting, shaping, joining, and finishing) accurately. *(Assembling the 3D printed components).*
- **Evaluate:** Evaluate their ideas and products against their own design criteria and consider the views of others to improve their work. *(Reflecting on the success of their final printed clockwork mechanism).*
- **Technical Knowledge:** Understand and use mechanical systems in their products. *(Understanding and utilizing gears, keys, and interlocking mechanisms based on the automaton).*

Week / Lesson	Weekly Overview
Lesson 1	Week 1: Welcome to the Gare Montparnasse
Lesson 2	Week 2: Architecture of the Station
Lesson 3	Week 3: Enter Hugo Cabret
Lesson 4	Week 4: The Magic of Mechanisms
Lesson 5	Week 5: The Automaton's Key
Lesson 6	Week 6: Bringing the Machine Together
Lesson 7	Week 7: The Blueprint (Exporting & Slicing)
Lesson 8	Week 8: The Automaton Awakens

Week /Lesson	Learning Goal and Success Criteria	Teaching input and learning opportunities <i>Including lesson structure, key vocabulary and questioning</i>	Key questions	Differentiation/ Universal design <i>e.g. support, scaffolding and challenge, focus groups</i>	Resources
1	<p>ISTE: 1.4.b (Innovative Designer) - Selecting and using digital tools (TinkerCAD) to begin the design process.</p> <p>CSTA: 1B-AP-14 (Algorithms &amp; Programming) - Saving and naming files properly under their own accounts.</p> <p>UK NC: Computing (Design and Create) - Using software to create digital content.</p>	<p>Week 1: Welcome to the Gare Montparnasse Starter (10 mins): Students navigate to <a href="https://dyson-fereday.ovh/type/">https://dyson-fereday.ovh/type/</a> to practice their keyboard skills and hand positioning while the teacher ensures everyone is successfully logged into their devices and TinkerCAD accounts.</p> <p>Middle (35 mins): Exploring 3D Space. Discuss the 1930s Parisian train station setting. The teacher demonstrates dragging out a box, resizing it using the handles, and changing the camera view. Task: Students design a "Station Master's Luggage Tag" to exact measurements (e.g., 50mm x 30mm x 3mm) and add a basic shape on top.</p> <p>Plenary (10 mins): Spotlight on Precision. The teacher projects a piece of work from a student who demonstrated the key skill of the lesson: accurately resizing their luggage tag to the exact requested dimensions without warping or distorting the shape.</p>	<p>Stretch Question 1: If we make the luggage tag twice as thick, which axis (X, Y, or Z) are we changing? How might making it thicker affect how long it takes the 3D printer to build it?</p> <p>Stretch Question 2: Why is it important to type in exact measurements in millimeters (mm) rather than just clicking and dragging the shape until it "looks right"?</p>	<p>Support: Fine motor control with a mouse can be hard for Year 4s. The TA can guide a small group, providing a TinkerCAD template where the 50x30x3mm baseplate is already made and locked in place. They just focus on dragging their initial onto it.</p> <p>Stretch: Challenge students who grasp the controls quickly to use the "Scribble" tool to draw their own custom shape or signature for the tag, and have them add a small, grouped cylinder hole at the top so a real string could be threaded through it.</p>	<p><b>Digital Prep:</b> The "Support" group template file assigned in TinkerCAD (a 50x30x3mm locked baseplate).</p>
2	<p>ISTE: 1.4.b (Innovative Designer) - Continuing to use digital tools to manage a design process (creating grouped holes).</p> <p>UK NC: Computing (Design and Create) - Combining software tools (grouping/aligning) to accomplish a specific goal.</p>	<p>Week 2: Architecture of the Station Starter (10 mins): Typing practice at <a href="https://dyson-fereday.ovh/type/">https://dyson-fereday.ovh/type/</a>.</p> <p>Middle (35 mins): Holes and Grouping. The teacher demonstrates how turning a shape into a hole and grouping it with a solid shape "cuts" the object. Task: Students build a basic ticket booth or station archway, ensuring they use at least one grouped hole (e.g., cutting an arch out of a solid wall or a window out of a booth).</p>	<p>Stretch Question 1: We used a solid wall and a hole shape to carve out an archway. Can you think of a way to build the exact same archway using only solid shapes? Which method do you think is faster and why?</p>	<p>Support: Provide a digital file with a solid wall already created. Have the student focus purely on moving a pre-made "hole" shape into the wall and clicking "Group." Use the Play-Doh analogy to reinforce the concept.</p> <p>Stretch: Challenge students to create a multi-layered archway (an arch within an arch) or a ticket booth with a hollowed-out</p>	<p><b>Digital Prep:</b> The "Support" group template file assigned in TinkerCAD (a pre-made solid wall).</p>

		Plenary (10 mins): Spotlight on Grouping. The teacher projects a student's design who successfully and cleanly grouped a hole to create a functional architectural feature, explaining how this "subtractive" manufacturing works.	Stretch Question 2: What do you think happens if you group a hole with another hole? What happens if you group a hole that is only halfway pushed inside your solid wall?	inside and a functional service window, requiring multiple alignments and groupings.	
3	<p>ISTE: 1.4.b (Innovative Designer) - Planning and managing the first component of their automaton prototype.</p> <p>UK NC: Computing (Design and Create) - Using the Workplane tool to design specific 3D content.</p>	<p>Week 3: Enter Hugo Cabret Starter (10 mins): Typing practice at <a href="https://dyson-fereday.ovh/type/">https://dyson-fereday.ovh/type/</a>.</p> <p>Middle (35 mins): The Workplane Tool. Introduce The Invention of Hugo Cabret and his job keeping the station clocks running. The teacher demonstrates dropping a temporary Workplane on top of a cylinder. Task (Final Project Part 1): Students design their own custom Clock Face by creating a flat cylinder and using the text/number shapes on the new workplane to design the dial.</p> <p>Plenary (10 mins): Spotlight on the Workplane. The teacher showcases a student who flawlessly used the Workplane tool to ensure their numbers are sitting perfectly flush on the surface of their clock face, rather than floating above or sinking too deep.</p>	<p>Stretch Question 1: Why do we need the Workplane tool to put numbers on the clock face? What problems would we run into if we just dragged the numbers up into the air using the Z-axis arrow?</p> <p>Stretch Question 2: If your clock numbers stick up too high from the base, what mechanical problems might that cause if real clock hands were trying to spin over them?</p>	<p>Support: Placing 12 numbers evenly is time-consuming and can cause frustration. Have students needing support focus on dropping the Workplane and only placing the 12, 3, 6, and 9 on their clock face.</p> <p>Stretch: Ask students ready for a challenge to design custom 3D clock hands pointing to a specific time. They must group the hands and use the Align tool to perfectly center them on the dial.</p>	<p><b>Media:</b> A physical copy of <i>The Invention of Hugo Cabret</i> book, or the movie trailer cued up and ready to play on the projector.</p> <p><b>Digital Prep:</b> The "Support" group template file (with a basic cylinder ready for the Workplane).</p>
4	<p>ISTE: 1.4.b (Innovative Designer) - Designing with constraints (creating uniform gear teeth).</p> <p>CSTA: 1B-AP-15 (Algorithms &amp; Programming) - Using algorithmic thinking via the Duplicate &amp; Repeat function to execute a pattern.</p>	<p>Week 4: The Magic of Mechanisms Starter (10 mins): Typing practice at <a href="https://dyson-fereday.ovh/type/">https://dyson-fereday.ovh/type/</a>.</p> <p>Middle (35 mins): Duplicate and Repeat. Discuss Hugo's notebook and how gears work. The teacher demonstrates the Duplicate &amp; Repeat tool (Ctrl+D / Cmd+D) combined with rotation. Task (Final Project Part 2): Students design a functional Gear with evenly spaced teeth and a perfectly centered hole cut out of the middle.</p>	Stretch Question 1: The computer algorithm copied your exact rotation to make the gear teeth. If we wanted fewer teeth on our gear, how would we need to change the angle of our very first rotation?	Support: The Ctrl+D (Duplicate & Repeat) function requires holding keys and dragging simultaneously, which is a high cognitive load. The TA should run a mini-clinic on this. To simplify the task, have them make a simple 4-tooth gear (creating a cross shape) rather than a complex 12-tooth gear.	<b>Physical Prop (Highly Recommended):</b> A physical gear, a wind-up clockwork toy, or an old mechanical clock to pass around so students can physically see how gear teeth mesh together.

	UK NC: D&T (Technical Knowledge) - Understanding and designing mechanical systems (gears).	Plenary (10 mins): Spotlight on Algorithmic Design. The teacher highlights a student who mastered the Duplicate & Repeat tool, showing the class how the computer remembers the pattern to create perfectly spaced gear teeth.	Stretch Question 2: Why must the hole in the centre of our gear be perfectly aligned in the middle? What would happen to the automaton's movement if the hole was even 2mm off-centre?	Stretch: Introduce these students to a Compound Gear (a small gear stacked precisely on top of a larger gear). They must group both gears and ensure the centre hole cuts cleanly through both layers.	
5	<p>ISTE: 1.4.c (Innovative Designer) - Developing the prototype by considering physical interactions.</p> <p>ISTE: 1.5.b (Computational Thinker) - Using digital tools to analyze mathematical data (calculating millimeter tolerances for the key shaft).</p> <p>UK NC: D&amp;T (Technical Knowledge) - Understanding interlocking mechanical systems.</p>	<p>Week 5: The Automaton's Key</p> <p>Starter (10 mins): Typing practice at <a href="https://dyson-fereday.ovh/type/">https://dyson-fereday.ovh/type/</a>.</p> <p>Middle (35 mins): Complex Shapes &amp; Tolerances. Discuss the missing heart-shaped key that brings the automaton to life. The teacher shows how to combine basic shapes (cylinders, boxes) to make complex ones (a key handle). Task (Final Project Part 3): Students design a Winding Key. They must ensure the shaft is slightly smaller (by 1-2mm) than the hole in their gear to account for physical tolerance.</p> <p>Plenary (10 mins): Spotlight on Engineering Thinking. The teacher shares the work of a student who creatively combined basic shapes for their key handle and, crucially, can confidently explain the mathematical tolerance they used for their key shaft.</p>	<p>Stretch Question 1: We made the key shaft slightly smaller than the gear hole so it would fit. What would happen in the real world if we made it exactly the same size? What if we made it 5mm smaller?</p> <p>Stretch Question 2: Look at the complex shape you built for the key handle. How will the 3D printer build the parts of the handle that hang over empty space? (This gets them thinking about gravity and 3D printing supports!)</p>	<p>Support: Write the exact millimetre dimensions required for the key shaft on the whiteboard so they don't have to calculate the tolerance gap themselves. Let them build a simple square or circular handle instead of a heart.</p> <p>Stretch: Challenge them to design an ornate "Skeleton Key" handle. This requires them to use grouped holes to create negative space (empty gaps) inside their handle design.</p>	<b>Teacher Note:</b> Have your specific key shaft dimensions ready to write clearly on the whiteboard (e.g., "Gear hole = 10mm, Key shaft must = 8mm!").
6	<p>ISTE: 1.4.c (Innovative Designer) - Testing and refining prototypes in the digital space.</p> <p>CSTA: 1B-AP-15 (Algorithms &amp; Programming) - Testing and</p>	<p>Week 6: Bringing the Machine Together</p> <p>Starter (10 mins): Typing practice at <a href="https://dyson-fereday.ovh/type/">https://dyson-fereday.ovh/type/</a>.</p> <p>Middle (35 mins): Digital Assembly. The teacher opens a blank TinkerCAD workspace and shows how</p>	Stretch Question 1: You've found a gear floating above your baseplate. Instead of deleting it and starting over,	Support: The TA acts as the "Building Inspector," sitting with students 1-on-1 using a physical paper checklist (e.g., 1. Is it flat on the floor? 2. Is it all grouped?). Provide a	<b>Printed Resource:</b> Paper "Building Inspector" checklists for the TA to use while roaming (e.g., <i>Is it flat? Is it grouped?</i> ). <b>Digital Prep:</b> The "Support" group template file (a

	<p>debugging the digital model (checking for floating parts).</p> <p>UK NC: Computing (Debugging) - Detecting and correcting errors in their 3D models before finalizing.</p>	<p>to import/copy previous parts together. Task (Final Project Part 4): Students create a Baseplate with upright "pegs". They align their gear and clock face onto these pegs to ensure everything fits digitally, checking that Z=0 for the base.</p> <p>Plenary (10 mins): Spotlight on Alignment &amp; Debugging. The teacher projects the file of a student who successfully aligned all their digital components perfectly, specifically praising them for checking all camera angles to ensure no parts were floating in mid-air.</p>	<p>what is the most precise mathematical way to bring it exactly down to the floor (Z=0)?</p> <p>Stretch Question 2: When checking your final assembled model, why is it crucial to rotate the camera and look from the sides and bottom, rather than just checking it from the top-down view?</p>	<p>baseplate with the mounting pegs already attached.</p> <p>Stretch: Peer Debugging. Pair up students who have completed their assembly early and have them swap computers. They must "stress test" their partner's file, looking for floating parts or misalignments, and write a quick bug report before fixing it.</p>	<p>baseplate with mounting pegs already attached).</p>
7	<p><b>ISTE:</b> 1.5.b (Computational Thinker) - Representing data in various ways (translating 3D shapes into 2D sliced G-code).</p> <p><b>CSTA:</b> 1B-CS-02 (Computing Systems) - Modeling how software (TinkerCAD/Slicer) and hardware (3D Printer) work together as a system.</p> <p><b>UK NC:</b> Computing (Systems &amp; Networks) - Understanding how cloud-based platforms communicate and export files for local hardware use.</p>	<p>Week 7: The Blueprint (Exporting &amp; Slicing) Starter (10 mins): Typing practice at <a href="https://dyson-fereday.ovh/type/">https://dyson-fereday.ovh/type/</a>.</p> <p>Middle (35 mins): Slicing and Hardware. The teacher demonstrates the slicing software (e.g., Cura), showing how the 3D model is cut into 2D layers (G-code) for the printer. Task: Students perform a final visual "debug" of their files to ensure they are flat on the build plate, then independently export their final designs as .STL files to a shared class folder.</p> <p>Plenary (10 mins): Spotlight on File Management. The teacher praises a student (or small group) who correctly double-checked their design for printer readiness, successfully exported the .STL file, and named it clearly without needing teacher intervention.</p>	<p>Stretch Question 1: The slicing software shows us the "infill" (honeycomb pattern) inside the solid shapes. Why doesn't the 3D printer just print everything 100% solid plastic?</p> <p>Stretch Question 2: The slicer turns our 3D model into 2D layers. If we told the slicer to make each 2D layer twice as thick, what would happen to the quality of our print, and what would happen to the printing time?</p>	<p>Support: Provide a visual prompt card specifically for the Export -&gt; .STL workflow. The teacher or TA handles importing their files into the Slicer software, allowing the student to just watch the magic of the layers preview.</p> <p>Stretch: Let confident students open the Slicing software (like Cura) themselves. Have them experiment with changing the "Infill Density" slider (e.g., from 15% to 30%) and ask them to report back to the class on how it changed the estimated print time.</p>	<p><b>Software:</b> Ensure your 3D Slicing software (e.g., Ultimaker Cura or PrusaSlicer) is installed, updated, and tested on the Teacher PC.</p> <p><b>Printed Resource:</b> Visual prompt cards for the specific group doing the "Export -&gt; .STL" workflow on their own.</p> <p><b>Digital Prep:</b> A shared network folder or Microsoft Teams assignment set up to receive 20 .STL files.</p>
8	<p>ISTE: 1.4.d (Innovative Designer) - Exhibiting a tolerance for ambiguity and working with</p>	<p>Week 8: The Automaton Awakens Starter (10 mins): Typing practice at <a href="https://dyson-fereday.ovh/type/">https://dyson-fereday.ovh/type/</a>.</p>	<p><b>Stretch Question 1:</b> Now that you have your physical</p>	<p>Support: Provide sentence starters for their</p>	<p><b>The Prints:</b> All the completed, physically printed components organized into</p>

	<p>open-ended problems (troubleshooting the physical assembly).</p> <p>CSTA: 1B-CS-03 (Computing Systems) - Determining potential solutions to solve hardware problems (figuring out why a key didn't fit and how to fix it).</p> <p>UK NC: D&amp;T (Make) - Selecting and using tools to perform practical assembly tasks.</p> <p>UK NC: D&amp;T (Evaluate) - Evaluating their physical product against their own design criteria and reflecting on the outcome.</p>	<p><b>Middle (35 mins): Physical Assembly &amp; Reflection.</b> The 3D printer is running in the background. Students receive their printed components (Baseplate, Clock Face, Gear, Key). Task: Students physically assemble their mechanisms and test if the key turns the gear. They then complete an "Inventor's Log" reflecting on the success of their design.</p> <p><b>Plenary (10 mins): Spotlight on Evaluation.</b> Instead of focusing purely on a "perfect" print, the teacher highlights a student who wrote an excellent, critical reflection—especially praising a student who identified exactly why a part was too tight or too loose and what they would change in TinkerCAD next time to fix it.</p>	<p>print, what is the biggest difference you notice between the physical object in your hand and the digital object on your screen?</p> <p><b>Stretch Question 2:</b> If you were hired by the Paris train station to mass-produce this clockwork mechanism thousands of times, what is the very first thing you would change in your TinkerCAD design to make it better, stronger, or faster to print?</p>	<p>"Inventor's Log" reflection to guide their thinking (e.g., "My key fit into the gear because..." or "If I did this again, I would change...").</p> <p>Stretch: Give these students a pair of digital calipers. Have them physically measure their printed gear and key, and compare those physical measurements to the digital measurements on their TinkerCAD screen to calculate if the plastic shrank or expanded during printing.</p>	<p>zip-lock bags for each student (Baseplate, Clock Face, Gear, Key).</p> <p><b>Printed Resource:</b> Copies of the "Inventor's Log" reflection sheet.</p> <p><b>Stretch Resource:</b> 1 or 2 pairs of Digital Calipers for the stretch group to measure their physical prints.</p>
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