** Year 9 STEM Catapult Challenge**

**Challenge**

* Build a catapult from everyday materials that can fire a ping-pong ball accurately at a target.
* Design and 3D print a working catapult using Makers Empire software designed for distance.

**STEM Skills and concepts**

Students will:

* Learn the science and maths concepts behind catapults.
* Force, motion, levers, projectile motion, parabolic arcs, launch angles, accuracy and precision. Measurement and scale will also be important in design and building process.
* Use an engineering design process to create a solution to a problem.
* Use Makers Empire 3D modeling software to design a catapult.

**Staff**

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**Program: GROUPS Aaliyah, Bailey & Blake Lauren, Nikita & Wayne Cody Tarrant & Jay Lucy Mitchell & Josh**

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| **Week 5 Tem 4** | **Content** | **Reflection (Mostly from Jess some from Nick)** |
| **Lesson 1**  **( Wed L6)**  **Jess** | **Introduction- Engineer Design Process**  What is he engineering design process?  Students watch <https://www.teachengineering.org/k12engineering/designprocess>  Set **STEM project books** up for each group- *Copy of the Engineer Design Process*  Unpack the steps- matching the role description with the headings in their **STEM project books**  Setting the Scene- ***Tallest & Strongest Tower Challenge*** Page 2&3 **STEM project books**  **STEP 1 Identify the Need and constraints of the challenge & document in STEM project books**  Students need to use the Challenge of the Tallest & strongest tower and unpack the questions | I felt for students to get a true understanding of the design process they needed to apply this to a topic area first.  I used an example off of the engineering website - Tallest Tower and then added the complexity of the strongest & tallest. |
| **Lesson 2 (Thursday L2)**  **Jess** | ***Tallest & Strongest Tower Challenge- background research page 2&3* STEM project books**  Students working through in groups the Engineer Design Process on page 4  **STEP 2 Research the Problem** on page 5 (**STEM project books)** Students can find some information on strong shapes to help them with their designs and documents their reasoning for choosing certain shapes.  **STEP 3 Imagine- Develop possible solutions** on page 6  All members design their own sketch and label using the constraints- use mathematical reasoning to ensure they meet constraints. | Students were able ***to research strong shapes*** and also the limitation (constraints of the material) meant they had to think before the design- drawing how to apply the strongest shape with limited resources. |
| **Lesson 3**  **( Friday L6)**  **Jess** | **STEP 4 Plan- Select a possible solution** on page 7  Team compromise on a design after completing questioning in books.  **STEP 5 Construct Prototype** on page 8  Answer the reflection page in book  **STEP 6 Test & Evaluate** on page 9  Answer the reflection page in book & share with the class  **STEP 8 Communicate the design** on page 10  Answer the reflection page in book & share with the class | Students wanted to go straight to build- However making them all **sketch a design** label constraints on their sketch and then talk in their groups was a very valuable step. From here the group were able to compromise on 1 to make.  Constructing the prototype was interesting as they were making the design they realized issues I made some groups list changes as they went- I should of made all groups do this.  Testing was good all groups made it to this stage and watched whose was the strongest- and tallest was not the same. It was good to see them analyses why and reflect in booklet |
| **Week 6 Term 4** | **Content** |  |
| **Lesson 1**  **(9 Science/Mon L3)**  **Jess** | **Introduction**   * What is our final product?   + Catapult made out of everyday materials for an accuracy challenge.   + Catapult made using a 3D printer designed for a distance challenge. * What science, technology, engineering and math’s concepts will we be using?   + Science: force, motion, levers, projectiles, launch angles, accuracy, precision   + Technology: 3D printers, 3D design software   + Engineering: using the engineering design process   + Maths: measurement, scale * Working in groups of 2-3.   **GROUPS**  **Aaliyah, Bailey & Blake**  **Lauren, Nikita & Wayne**  **Cody Tarrant Jay**  **Lucy Mitchell & Josh**  What is he engineering design process? This is the process students will use to ultimately build a working catapult.  <https://www.teachengineering.org/k12engineering/designprocess>  Can we pull apart the engineering design process and have students use this lesson to get a good grounding in this process? **DONE this in week 5 to set the scene using the Engineer Design Process** | I found the students had the Engineer process down packed and could then use this (with their printed folder they were able to use the engineer design process with their Catapult Challenge**.)**  **Tanya printed Teachers pay Teachers resource called**  **STEM Catapult Challenge**  **This resource had some really good sheets to test catapults.**  **I** was able to get students to test their Paddle pop/straw catapult however ran out of time to compare this to the 3D printed version from Makers Empire**.**  I think the paddle pop/straw version gave students a chance to work out leavers ect. To build foundation for the Makers Empire addition |
| **Lesson 2**  **(9 Math/Mon L5)**  **Tanya** | **History**  Catapults through history – provide a variety of links to catapults through history. Have students divide into 3 groups (4 to a group) and spend some time researching a specific type of catapult. Why were they developed? When were they developed? How were they developed? How have they evolved (eg planes slingshotting off aircraft carriers)?  Using only static diagrams explain to the class how it works.   * When developing the task for this lesson try to identify a role for each person so that during the presentation everyone has a role to play.   This is one idea we could come up with something better to develop students understanding of catapults, how they work and why they were used.  Ballista - <https://www.youtube.com/watch?v=F5usIwYoss4>  Mangonel - <https://www.youtube.com/watch?v=yi4p8ZR4n28>  Trebuchet - <https://www.youtube.com/watch?v=9-Hwxw4fgqk>  Catapult physics - <https://www.real-world-physics-problems.com/catapult-physics.html> | 2 lessons |
| **Lesson 3**  **(9 Math/Tue L3)**  **Tanya** | **Teach science and math concepts associated with catapults.**  Force, motion, levers, projectile motion, parabolic arcs, launch angles, accuracy and precision. Measurement and scale will also be important in design and building process.  Resources linked to the science and maths of catapults - <https://www.teachengineering.org/lessons/view/cub_catapult_lesson01>  <https://www.real-world-physics-problems.com/catapult-physics.html> | Year 9 students struggled with applying scale and basic measurement when using Makers Empire software. What they saw on their screen (their model) looked big but in actual fact was showing items only 2mm thick (which would break when printed). Students did not use measurement tools at all well and were surprised at how small their catapults were when printed despite have access to measurement tools in the software which told them exactly what size the parts of their catapult and the size of the overall catapult was. Teaching how to apply these concepts needs to be teacher lead and very specific at the beginning. Students demonstrated some laziness and lack of care by not investigating measurements properly and relied on what they saw on the screen as being “good enough” even though in reality it was not. |
| **Lesson 4**  **(9 Math/Wed L4)**  **Tanya** | **Teach science and math concepts associated with catapults.**  Force, motion, levers, projectile motion, parabolic arcs, launch angles, accuracy and precision. Measurement and scale will also be important in design and building process. |  |
| **Lesson 5**  **(9 Science/Wed L6)**  **Jess** | **Teach science and math concepts associated with catapults.**  Force, motion, levers, projectile motion, parabolic arcs, launch angles, accuracy and precision. Measurement and scale will also be important in design and building process. |  |
| **Lesson 6**  **(9 Science/Thur L2)**  **Jess** | **Build a catapult for accuracy (create, engineer, test, redesign)**  Build a catapult from everyday materials that can fire a ping-pong ball accurately at a target.  **Two catapult activities – choose 1**  <https://www.teachengineering.org/activities/view/cub_catapult_lesson01_activity1>  <https://www.teachengineering.org/activities/view/cub_simp_machines_lesson04_activity1>  **Resources**  Each group needs:   * Paddle pop sticks * Straws * Rubber bands * Plastic spoons * Ping pong balls * Masking tape * 15.2 x 15.2cm cardboard squares (strong/thick) * Paper for brainstorming   To share with the entire class:   * targets made of cardboard or foam core board (10 points, 50 points, 100 points and 200 points) | All groups made this stage, however, one group really didn’t finish the testing. However having the groups test together meant they could see the results of the other groups and give them some examples**.**  I kept them in the same groups. Maybe we could have changed them. The one good thing is they could have shared what they found with more teams. |
| **Lesson 7**  **(9 Science/Fri L6)**  **Jess** | **Build a catapult for accuracy (create, engineer, test, redesign)**  Continue task - Build a catapult from everyday materials that can fire a ping-pong ball accurately at a target. | We ran out of time to redesign - but I think this would have been very valuable process- before Makers empire to reinforce the ideal size of their pieces etc. Maybe need 3 lessons for this section. |
| **Week 7 Term 4** |  |  |
| **Lesson 8**  **(9 Science/Mon L3)**  **Jess** | **Makers Empire software**  **Done prior to this lesson**  Nick create Makers Empire accounts for students. Students need to join the “7-12 Home Class” (class code: 557bird) Nick will add students to the “STEM Catapult Challenge” class.  Provide enough coins/tokens for students to buy required objects in Makers Empire to build a catapult.  **Lesson**  Familiarisation lesson with Makers Empire. Students have not used before – Nick to lead and provide activities.  Show example model of catapult created using Makers Empire.  **Nick will need to be released for this lesson.** | Nick I really appreciated the opportunity for you to share the tools on the program and show students how to manipulate object shapes etc.  The activity with create a snow man gave them opportunities to use a range of shapes etc. |
| **Lesson 9**  **(9 Math/Mon L5)**  **Tanya** | **Continue familiarization lesson if required.**  **Design Brief 3D Catapult (Use Year 9 STEM Catapult Challenge Task Sheet)**  What is the challenge? Work through the constraints and requirements with students.   * In groups of 2-3 design a catapult that will launch an object the greatest distance. * Design the catapult using Makers Empire. * The catapult must have a minimum of 2 parts that require connection in some way. * The catapult must sit on a base no larger than 10cm x 10cm. * Students can decide to print parts using either the UP Mini 2 or UP Plus printers.   Students design own catapult in same groups as the first catapult.  **Nick will use a NIT to be available for this lesson.** |  |
| Lesson 10  (9 Math/Tue L3)  Tanya | Students design own catapult  **Nick will use a NIT to be available for this lesson.** |  |
| **Lesson 11**  **(9 Math/Wed L4)**  **Tanya** | Students design own catapult  **Nick will use a NIT to be available for this lesson.** |  |
| **Lesson 12**  **(9 Science/Wed L6)**  **Jess** | Students design own catapult  **Nick will use a NIT to be available for this lesson.** | Students used this to continue to complete catapult designs. One thing that was frustrating is not all finished. This was with students using extra lessons from outdoor education (3 extra lessons). |
| **Lesson 13**  **(9 Science/Thur L2)**  **Jess** | Begin printing catapult designs  **Nick will print for students** | Some students completed in the allotted time with the extra OED lessons while some students did not successfully get their catapult printed. |
| **Lesson 14**  **(9 Science/Fri L6 )**  **Jess** | Print catapult designs  **Nick will print for students** |  |
| **Week 8 Term 4** |  |  |
|  | Print catapult designs  **Nick will print for students** | Some students did test their catapults for distance – this was in an OED lesson – Blake, Tarrant, Josh and Jay all tested. Those who did not print did so for different reasons - some students did not get them completed or completed them but there were faults with design meaning they did not work as they thought they would. Next time we should print those that were not going to work so students could physically see why they would not work. This is an important part of the reflection process. Students went on camp this week so did not get the opportunity to reflect strongly on this which is a significant part of the process. |
|  | **Students on camp this week so missed Wed – Friday.** |  |
| **Week 9 Term 4** |  |  |
| **Lesson 1**  **(9 Science/Mon)**  **Jess** | Distance challenge; Testing and reflection of 3D models required. | Testing the catapults and recording the results fell away at the end of this term. The design process not fully completed by students for either catapult. Some testing occurred but deep reflection and redesign did not. Redesign with 3D models not possible as the year finished. |
| **EXTENSION** | This could be incorporated into the time frame of this project but may need more time. Students collect data to discover Parabolic Properties - <https://courtneyelmendorf.weebly.com/uploads/2/5/9/6/25961883/catapults_and_parabolas_presentation.pdf> A copy of this PDF is with the other program materials. |  |

**Resources**

Paddle pop sticks

Straws

Rubber bands

Plastic spoons

Ping pong balls

Masking tape

15.2 x 15.2cm cardboard squares (strong/thick)

Paper for brainstorming

Computer suite 1 - **book**

STEM classroom - **book**

Makers Empire software

3D Printers

Filament

**STEM Catapult Challenge**

**This resource had some really good sheets to test catapults.**

<https://www.teachengineering.org/lessons/view/cub_catapult_lesson01>

Students learn about catapults, including the science and math concepts behind them, as they prepare for the associated activity in which they design, build and test their own catapults. They learn about force, accuracy, precision and angles.

<https://www.teachengineering.org/activities/view/cub_catapult_lesson01_activity1>

Students experience the [engineering design process](https://www.teachengineering.org/k12engineering/designprocess) as they design and build accurate and precise catapults using common materials. They use their catapults to participate in a game in which they launch Ping-Pong balls to attempt to hit various targets.

**The Engineering Process description- cut up and take off the headings- stick under correct headings**

**(refer to page 1 Engineer Design Process publisher page)**

