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| **Da Vinci Bridge** | | | |
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| An activity to make a bridge where the parts are not joined together! | | | |
| **Subject(s):** Design & Technology  **Approx. time:** 60 - 90 minutes |  | | **Key words / Topics:**   * Member * Frame * Support * Test * Structure * Construction |
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| **Suggested Learning Outcomes** |  | |  |
| * To understand how forces can act on parts of a structure to make it stand without extra support or joining methods * To look at the work of an Engineer/designer Leonardo Da Vinci * To understand that teamwork can help towards a successful conclusion | | | |
| **Introduction** |  | |  |
| This is one of a set of resources designed to allow learners to use seasonal themes to support the delivery of key topics within design & technology and engineering. This resource is part of a group for the Summer that could be carried out either in school or at home. It involves the construction of a load bearing bridge structure made up of simple members. It is targeted at Year6 (P6/7 in Scotland) but would be suitable for other year groups.  Leonardo da Vinci lived over 500 years ago, from 1452 to 1519 in Italy. He is considered one of the most talented individuals ever to have lived. As well as being a famous artist, he thought up ideas vastly ahead of his own time, inventing a wide range of concepts including the self-propelled cart (car), the parachute, the helicopter, armoured fighting vehicles, the robotic knight, the use of concentrated solar power, diving equipment and the calculator. In the 1480’s he designed a bridge to allow soldiers to cross rivers – the amazing things about this bridge are that it could be transported in ‘flat pack’ form, assembled in under 10 minutes, and that the parts it comprised of were not physically joined to each other!  This activity is aimed at the high end of Key Stage 2 and should be carried out in pairs or small groups, as a minimum of two pairs of hands are needed along with some dexterity. | | | |
| **Purpose of this activity**  This is a challenging project to build a model of the da Vinci bridge. This activity could be used as a main lesson activity to teach learners about the use of simple construction techniques to assemble a working, load bearing, bridge which can then be tested to destruction.  This could also be used as one of several activities within a wider scheme of learning focussing on structures and Design for Living. | | | |
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| **Activity** |  | | **Teacher notes** |
| **Introduction (5 minutes)**  Teacher to explain that learners are going build and test to destruction a bridge made of simple members without any joining methods.  **What is required? (5-10 minutes)**  Class to discuss the importance of teamwork and be put into pairs. The need for testing should also be emphasised and the key terms of testing and testing to Destruction explained.  **Demonstration (15-20 minutes)**  With the assistance of a capable volunteer, teacher to demonstrate how to build the bridge using the steps shown in the presentation:   * Step 1. Make the shape shown in the presentation. Put the two end cross pieces A1 & A2 down first, then place the two side pieces B1 & B2 on top, then place the middle cross piece C1 on top. * Step 2. Carefully holding the central piece C1 in place, lift the end cross piece A1 a few mm. Slide the sidepieces B3 and B4 over the top of C1 and under A1. * Step 3. Carefully lift the cross piece A2 a few mm. Slide the side pieces B5 and B6 over the top of C1 and under A2. * Step 4. Carefully slide a new cross piece A3 under one end. Carefully lift the cross piece A3 a few mm. Slide the side pieces B7 and B8 over the top of A2 and under A3. * Step 5. Repeat the method in step 4 to extend the bridge: Carefully slide a new cross piece under the end. Carefully lift the new cross piece a few mm. Slide new side pieces over the top of the previous cross piece and under the new cross piece. Repeat until you have at least 6 cross pieces in place.   Demonstrate how to test the bridge, adding increasing weight until it fails. Compare the weight of the bridge to the weight it can support.  **Making the bridge (30-45 minutes)**  Teacher to hand out resources required for the task to learners.  Each member will need the rubber bands at each end and the learners can do this at this stage.  Learners to complete each step for themselves. The teacher presentation could be left on the whiteboard as a supporting guide as they do this.  **Plenary (5-10 minutes)**  Testing the bridge: Carefully put weights on the bridge to see how much it will support. Remember that the parts of the structure are not attached together! |  | | This activity could be carried out either in pairs or small teams. Ideally, a pre-made bridge should be shown to avoid confusion.  The members are numbered on the presentation and the group will need an explanation as to how to use this numbering system.  The elastic bands are necessary to stop the structural members sliding over each other, which would result in the structure collapsing. If the surface of the structural members is rough, they may not be needed. If larger structures are built, small divots can be marked in the members at the contact points (for example, using a hand file) to allow the members to ‘key’ together. Fitting the bands in advance of the demonstration will save time.  Instead of the dowel rods, thicker dowel or craft sticks could be used – there are examples of this made by learners on the final slide of the presentation.  There is a definite technique to building the bridge in steps 2 to 5 – lift, slide in pieces along the longer side, slide in under piece. With some practice this can be completed very quickly, but it can take a few attempts to learn. Practicing in advance will enable the demonstration to be completed quickly.  At step 1, the order of assembly is important – the forces at the points where the structural members are in contact with each other will hold the bridge together.  At step 2, B3 and B4 should be flush against the existing side pieces (B1 & B2). Approximately 50% of each rod should extend past the cross piece (A1). The rods should each be in contact with the elastic bands, to stop them sliding.  At step 3, B5 and B6 should be flush against the existing side pieces. Approximately 50% of each rod should extend past the cross piece (A2). The centre of the structure should now be supported just off the ground.  At plenary, In the example, a cup was used and slowly filled with plastic beads until the bridge failed. Alternatively, small weights (from science resources) could be used.  A record could be kept of the bridge destruction loads to encourage future users of the activity. |
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| **Differentiation** |  | |  |
| **Basic** |  | | **Extension** |
| * Members could be colour coded and numbered. * The shape at step 1 could be manufactured in rigid form, i.e. with parts glued in place. |  | | * Collapse and rebuild the bridge against the clock. * Investigate other designs from Leonardo DaVinci that could have a modern application. |
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| **Resources** |  | | **Required files** icon-docicon-pdficon-ppt |
| * 16 pieces of dowel rod (or craft sticks). * 32 small elastic bands |  | | icon-ppt Teacher presentation – DaVinci bridge |
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| **Additional websites** |  | |  |
| * Boy teaches his dad to build a Leonardo da Vinci Bridge large enough to support a person. <https://www.youtube.com/watch?v=QKdQV2q5PRk> * Video showing the step-by-step construction of a similar bridge from wide strips of wood <https://www.youtube.com/watch?v=EMEAGocg3Xg> * Time lapse video showing students at Missouri's Truman State University building the bridge on a larger scale. <https://boingboing.net/2017/04/13/students-build-working-version.html> * An American Museum shows off its DaVinci exhibition. <https://www.youtube.com/watch?v=b7hylqLxvPQ> Video is 24:15mins but the bridge is discussed at 13:25mins | | | |
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| **Related activities (to build a full lesson)** |  | |  |
| **Starters** (Options)   * Ask the learners if they would ever stand on a bridge where the parts were not connected together. * Show the video of the boy and his father building the bridge <https://www.youtube.com/watch?v=QKdQV2q5PRk>. | | **Extension** (Options)   * Collapse and rebuild the bridge against the clock. * Investigate other designs from Leonardo DaVinci that could have a modern application.   **Plenary** (Options)   * Learners could reflect on what they have learnt and discuss any practical applications of this method of construction. The introduction slide has some useful information here in the Notes section. | |
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| **The Engineering Context** film |
| * Construction design has to be strong and yet easy to assemble. Engineers design constructions that are both. * The Armed forces and Disaster relief agencies need structures that can be built quickly and with minimal materials. * Using scale models is a development tool used by many areas of Engineering. |

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| **Curriculum links** | |
| **England: National Curriculum**  Design & Technology   * KS2 2a, 2B, 4a | **Northern Ireland Curriculum**  Technology & Design   * KS2 Contributors to the Economy and Environment, work independently and as a member of a team; develop perseverance, initiative and flexibility. * Art and Design: use modelling or construction to make three-dimensional work |
| **Scotland: Curriculum for Excellence**  Technologies   * TCH 1-09a, TCH 2-10a, TCH 2-12a | **Wales: National Curriculum**  Design and Technology   * KS3 Skills: Making 1, 2, 3, 4 |
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| **Assessment opportunities** |
| * Informal teacher assessment of practical skills through observation of learners. |