Bridging the Gap between DT and Physics: Stress Testing Materials

Authors: Andrew Smith, Charlie Murphy, Kate Baxter, Liam Jordan, and William Lee.

Introduction: The aim of this project was to create a workshop for the design & technology department at St Anselm's school with a more scientific approach. St Anselms follows the AQA exam board for GCSE D&T and so the project was centred around this age group and the workshop subject chosen was Material testing. Understanding materials is an important part of both physics and D&T GCSE and so a clear link between the two subjects could be made. A presentation, set of worksheets, student-led practical and teacher demonstration were created to explore materials properties, compressional and tensile strength.

PRESENTATION AND WORKSHEETS

The presentation was designed to give an introduction to the subject matter and briefly cover the content needed for the student to fulfil the workshop successfully. The graphic design is clear and concise for the content to be understood. The presentation touched on scientific terminology on describing the material, equations that students might come across in physics and an in -depth description of the uses and properties of the materials they would cover in the worksheets and practical. Lastly, an introduction and hints and tips section for the practical was designed to guide the class.

The worksheets have three separate parts for the students to complete. The initial worksheet is a review of the students' knowledge of terminology, so they have a base copy of information moving forward during and past the workshop. Next, a thought experiment into which material would be better suited for different roles; this allows for open-ended answers and an exploration into a deeper understanding of practical applications of material properties.

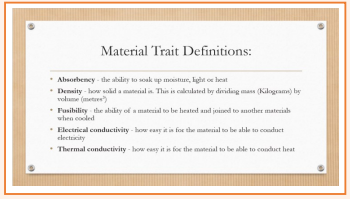

Figure 1: Example of a slide from the instructor led presentation

STUDENT PRACTICAL AND WORKSHEET

The student-led practical is inspired by physics lessons where an idea is presented, a theory on what will happen is decided and a test is carried out to determine the hypothesis. The practical is designed to be easy and low cost to create, using scrap material that would be readily available in the school workshop. The setup is a simple device that holds the material between two clamps and a mass is placed in the middle of the material to be increased until there is a break. Materials is a very visual science and so the results are instant and interesting for the students, showing them the properties instead of simply being told. An emphasis on compressional and tensile strength was implemented and explained, where an understanding of how materials could break depending on their properties, and examples were keyed up following the experiment to explain these ideas in more depth.

The final worksheets were designed to be followed alongside the student practical. It is clearly laid out with instructions, useful information and diagrams, a table of results to fill in and an analysis and conclusion section. The students are required to make a series of hypothesis which they will have to review at the end of the experiment. The analysis includes a look into identifying appropriate graphs for material relationships and choosing the appropriate material for different situations based upon practical knowledge. The idea is for a progression from theoretical knowledge to practical understanding through direct testing from the first through to the last worksheet, leading the student to develop their knowledge on how to better understanding material properties.

Finally, there are reflective aspects where the student must review whether their hypothesis was correct, how they could change the experiment in the future and their opinion on the success of the experiment, just like one might do for a scientific lab report

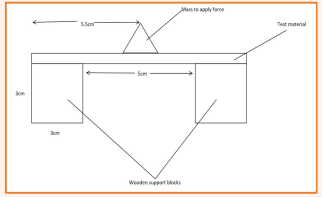

Figure 2: Lay out of the student practical experiment

INSTRUCTOR PRACTICAL

The instructor-led practical was implemented with the thought of showing student material testing on a more industrial level. A number of prototypes were made, using equipment available at the school, before the best model was decided to be as seen in figure 3. It applies compressional strength to strong material to see the level of force required to break. There is also concentration on safety concerns with a protective screen in place. This practical also encourages the student to think about what might happen before the experiment, as this reflective thinking is proven to help with remembering what they see [1].

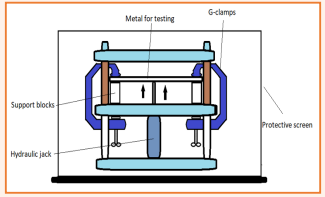

Figure 3: Diagram of instructor lead experiment

Conclusion: The workshop aims were met through choosing the adaptive subject of material testing, using a variety of different media to explain more complex scientific concepts and implementing key scientific methodology through practical and analysed examples. The use of GCSE study material, such as bitesize and the AQA curriculum [2], allowed for a layout of a specific knowledge set and information. The use of several different media types would allow all types of different learners to engage with the subject matter [3]. A Hypothesis followed by practical experimentation is a key part of scientific learning and so it was important to implement this aspect into a DT class to create a more physics orientated learning approach. The questions and thought processes are designed to leave open-ended questions for the student to explore, as they allow for more advanced reflective thinking [4].
The limitations of this workshop are mostly in the materials available for the students to test and the feasibility of the final instructor-led demonstration. By relying on scrap material for the testing it might mean the students don't get to experience a variety of material in the case, and if non-scrap materials are used this might jump up the cost of the workshop making it unfeasible for large year groups to carry out. To combat this the workshop would have to be timed for when the appropriate materials are available. The instructor-led demonstration is relying on information supplied by the school about old equipment so there is an uncertainty of whether the equipment would be useable for the demonstration. It would have been beneficial to have tested the equipment in person and have built a demonstration from a trial and error process rather than a series of prototypes which may not work. To build on this workshop in future, another experiment could be designed to test another property discussed in the presentation and worksheets.

References

[1] "Defining Reflection: Another Look at John Dewey and Reflective Thinking." Teachers College Record, vol. 104, no. 4, June 2002, pp. 842–866, www.researchgate.net/publication/240645823_Defining_Reflection_Another_Look_at_John_Dewey_and_Reflective_Thinking, 10.1111/1467-9620.00181.Accessed 31 Mar. 2020.
[2] "GCSE Design and Technology - AQA - BBC Bitesize." BBC Bitesize, www.bbc.c o.uk/bitesize/examspecs/zby2bdm. Accessed 31 Mar. 2021.
[3] Akram Awla, Hawkar. "Learning Styles and Their Relation to Teaching Styles." International Journal of Language and Linguistics, vol. 2, no. 3, June 2014, p. 241, www.researchgate.net/publication/275567766_Learning_Styles_and_Their_Relation_to_Teaching_Styles, 10.11648/j.ijll.20140203.23. Accessed 31 Mar. 2020.
[4] Machado, Rui Seabra, and Pâmela Billig Mello-Carpes. "The Use of an Open-Ended, Student-Led Activity to Aid in the Learning and Understanding of Action Potential." Advances in Physiology Education, vol. 42, no. 2, 1 June 2018, pp. 324–328, 10.1152/advan.00101.2017. Accessed 25 Feb. 2021.

University of Kent