STEAM DESIGN

An Interactive Qualifying Project Report
Submitted to the Faculty of the
WORCESTER POLYTECHNIC INSTITUTE
in partial fulfilment of the requirements for the Degree of Bachelor of Science.

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Date: 29 April 2016

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Abstract

Our project team developed 16 educational resources for students ages seven to fourteen that link to the Design Museum in London and the United Kingdom curriculum. Our team researched educational materials, met with educational professionals, created lesson plans and museum visit materials, and evaluated our resources via a pilot programme. We then revised our materials based on our findings to assist the students' knowledge and interest in STEAM subjects (science, technology, engineering, art, and mathematics).

Executive Summary

Design education in the United Kingdom (UK) is currently in a state of crisis (D&T Association, 2016). Students in recent years have displayed a 10% decrease in interest in the subject of design and technology (Hutchinson & Bentley, 2011). Design is a method of problem solving applied to a product and results in aesthetic or functional improvement (Kane, 2002). Educational organisations associated with the UK government have made changes to how they measure school attainment as an attempt to improve a student's education, with the consequence of marginalising art and design subjects (D&T Association 2016). STEAM, which stands for science, technology, engineering, art, and mathematics, is the idea of implementing creative subjects into STEM (science, technology, engineering, and mathematics) programmes. However, STEAM is relatively new compared to STEM programmes and most educators have not implemented it into their classrooms (Boy, 2013). To compensate for the lack of creative approaches in STEM, third-party organisations, such as Children's British Broadcasting Company and the London Science Museum, have tried to incorporate a hands-on and more enjoyable approach to STEM learning. To achieve its vision of educating everyone about design, the Design Museum saw a need to develop educational resources to inform and engage students about the design process and to apply it to the students' schoolwork.

For our project, we created a set of educational resources for the Design Museum in London. Specifically, we created two sets of six lesson plans as part of a teacher pack for use in a classroom, one for key stage two (KS2) and one for key stage three (KS3) which include ages seven to fourteen, as well as museum visit resources for use before, during, and after a class's visit to the Design Museum. We structured our resources for use in STEAM programmes because the Design Museum's goal is to teach students how to apply design thinking to STEAM subjects. In this document, we detail our project methodology, results, conclusions, and recommendations.

In order to develop our educational resources, we created the following objectives: identify traits of teaching tools that teachers prefer, create museum visit materials and teacher packs based on the Design Museum's new exhibition, and finally assess the newly created lesson plan via a pilot programme, analyse the results, and adjust the material accordingly. We began our research by conducting several interviews with KS2 and KS3 teachers. From the interviews, we obtained

information about teacher preferences, as well as information on student behaviour. In addition to the teacher interviews, we learned about CREST Awards, observed several teaching styles, and met with Design Museum staff to discuss what traits we should include in our educational resources. The teachers we interviewed at both schools gave us unanimous feedback that group work was more engaging for students than individual work. The KS2 and KS3 teachers indicated the length of our activities should be between 30 - 60 minutes to fit into one class. The KS2 teachers suggested that our activities be hands-on. The KS3 teachers suggested establishing links to the UK curriculum within our activities.

We developed resources based on our research, teacher feedback, and discussion with the Design Museum staff. The resources consist of both teacher packs and museum visit material for KS2 and KS3. The teacher packs for KS2 and KS3 teachers include lesson plans, worksheets associated with the lesson plans, and supplementary materials necessary for the context of the lesson or activities. We developed six lesson plans, each with a separate version for KS2 and KS3. We modelled our lessons on our initial lesson, *Wibble, Wobble, Wiggle Chair*. After meeting with the Design Museum staff, we created the lesson plan to start with a story that would provide context for the lesson and include an object that would link directly to the Design Museum's permanent exhibition, "Designer, Maker, User." With the continuous feedback we obtained from the Design Museum staff, we identified the *Wibble, Wobble, Wiggle Chair* activity as a strong example of the Design Museum's ideal set of resources, noting the lesson plan's link to the theme of the exhibition.

Using feedback from our liaison, David Houston, we created our six lesson plans while simultaneously refining *Wibble, Wobble, Wiggle Chair*. The names and descriptions of each lesson plan are as follows: *The Valiant Vespa*, *Brains and Braun: Less but Better*, *Krazy Kettles and Trendy Teapots*, *From the Streets to the Schools*, *Simply Sugru*, and *Wibble, Wobble, Wiggle Chair*. *The Valiant Vespa* teaches students about design and transportation and has the student construct a balloon vehicle (Appendix G1, H1). *Brains and Braun: Less but Better* teaches students about industrial design and user interaction (Appendix G2, H2). *Krazy Kettles and Trendy Teapots* teaches students about user profiles, kettles, and teapots (Appendix G3, H3). *From the Streets to the Schools* teaches students about road sign standardisation and as part of this lesson students create a sign for their schools (Appendix G4, H4). *Simply Sugru* teaches students about fixing and improving objects based on aesthetics and functional design (Appendix G5, H5). Finally, *Wibble, Wobble, Wiggle Chair* teaches students about materials and

as part of this lesson students build a chair out of newspaper (Appendix G6, H6). There are two different versions of each of the lesson plans, one for KS2 and one for KS3.

In addition to the lesson plans, we created visiting materials, which include a pre-visit lesson plan, during-visit activity, and post-visit questions. We created our pre-visit and post-visit materials to last around 30 minutes, because the teachers indicated that they do not spend much time on the visit before or after class trips. The during-visit material, has separate versions for KS2 and KS3, relies on a booklet created by students in the pre-visit lesson, and asks two or three questions about specific objects in each section of the "Designer, Maker, User" exhibition. The post-visit material consists of several follow up questions about design and design concepts related to objects in the exhibition.

We wanted to pilot test all of our lessons, but because of time constraints, we were only able to pilot test both versions of *Wibble, Wobble, Wiggle Chair*, the first lesson we developed. Before the pilot test, we ran the *Wibble, Wobble, Wiggle Chair* activity twice ourselves to test timing and assess the difficulty level of the activity. After testing *Wibble, Wobble, Wiggle Chair*, we conducted two pilot programmes, one at a primary school and another at a secondary school. Each of the programmes finished with a student survey and a teacher interview. The student surveys and teacher interviews provided us with information on how to improve our resources beyond what we observed using our matrix. Using our pilot programme feedback, we revised our lesson plans accordingly.

We ran the secondary school programme at the school's science club with eight participating students, from ages eleven to fourteen, who worked in two teams of four students. We observed in our introduction that the lessons engaged students and they were willing to answer questions promptly and without losing focus. Seven of the eight students reported on their surveys that they enjoyed the activity. The teacher who ordinarily teaches the club observed our pilot session and suggested that we make several modifications to the lesson plan, but that overall, it was appropriate for the students' ages and not missing anything major.

At the primary school, we ran four lessons to four different classes, two of which were year three classes and two of which were year four classes. We observed from all four lessons that the students required a great deal of instructor help, especially the year three students. Like the KS3 teacher, the KS2 teacher who observed the lessons approved of the lesson plan and believed it was appropriate for the age range of her students, and matched her expectations on content, length, and organisation. While we determined that the pilot tests successfully engaged students in the lesson,

and that KS2 students were able to further improve their designs, we were unable to determine whether the KS3 students could improve their designs, and whether the KS2 students were able to understand and apply design concepts and techniques.

In our revision of *Wibble, Wobble, Wiggle Chair*, we allocated more time to the introduction due to the results from the pilot programme; we also allocated time to all the introductions of the other lesson plans after we determined that every lesson plan followed the structure of the *Wibble, Wobble, Wiggle Chair* lesson plan. We also rearranged the structure of the lesson plans to include the learning outcomes at the top of the page as indicated by the KS3 teacher. The KS2 teacher also suggested that we include pictures as supplementary materials for all of our lesson plans as our previous drafts were text-heavy. As a result, we included pictures that give the teachers a completed example activity in all the lesson plans. For some of the lesson plans, we added pictures of the objects that are in the exhibition.

We observed that the lesson engaged both KS2 and KS3 students and the KS2 students were able to improve their designs given enough time in the lesson. However, since we did not investigate whether the students met the required learning outcomes we developed for each lesson plan, we cannot accurately say whether students were able to understand design concepts.

Logistical constraints limited the scope and depth of our pilot programmes. Therefore we recommend that the Design Museum conducts further pilot tests for both KS2 and KS3 lesson plans. We also recommend that the Design Museum investigate whether students can meet the required learning outcomes in our lesson plans. Additionally, the teachers at the secondary school informed us that teachers, especially experienced teachers, tend to ignore large parts of museum lesson plans if the museum they visit does not provide a corresponding presentation of some kind.

With regard to the lesson plan layout, teachers at the secondary school expressed a preference for black and white worksheets due to restrictions on photocopies and ink for printing. We recommend that the Design Museum take these preferences into consideration for the lesson plans, and develop simple designs with limited colour or special graphics. Additionally, we recommend that the museum brands all of its materials with its logo and colour scheme, as the teachers at the secondary explained that KS3 students prefer resources that are different from the brand of resources they usually have.

After interviewing both KS2 and KS3 teachers, we learned that teachers are not willing to devote much time to pre-visit and post-visit materials. We therefore concluded that our during-visit

materials would need the most content compared to the pre-visit and post-visit materials. We recommend that the Design Museum create resources in accordance with this feedback for any additional educational resources it creates in the future.

The results of our pilot programmes showed that while the hands-on activities in our lesson plans appeared to engage most students for most of the time, the activities might be difficult to run with only one teacher. The KS2 teacher who participated in the programme also noted that her KS2 students regularly receive long surveys after participating in other programmes, so we recommend that for future KS2 assessments include a longer set of questions than those we provided in our KS2 surveys. Finally, we recommend that the Design Museum investigate avenues to obtain accreditation for its educational resources to make them more appealing to teachers and school administrators. We believe that using our materials and recommendations as an example, the Design Museum will be able to continue the production of lesson plans for other various age ranges and other exhibitions.

Acknowledgements

Our team would like to acknowledge multiple individuals that were crucial to the completion of our project. We could not have completed our project without the help of our advisors, Professor Joel J. Brattin and Professor Lauren Mathews. Our advisors provided constructive criticism and suggestions throughout the entire project as well as motivation and guidance. We would also like to acknowledge Professor Dominic Golding and Professor Sarah Crowne for their advice and support.

Members of the Design Museum staff, specifically David Houston, Ellen Ferguson, Helen Charman, Eleanor Suggest, Alex Newson, and Mark Favis have all allocated many hours for our project. Specifically, David Houston and Ellen Ferguson provided continuous feedback and suggestions on how to improve our materials. We truly appreciate how supportive the Design Museum staff have all been.

We would like to thank Colville Primary School teachers Joyce Tackie, Ursula Parvex, Ellen Lydon, and Jagdeep Birdi for providing our team with information about educational lesson plans and the opportunity to pilot one of our lesson plans multiple times. We would also like to thank Northwood School teachers Dev Thaker, Jenni Lister, and Sinead Marry for also providing our team with information about educational lesson plans and the opportunity to pilot one of our lesson plans.

Our team would like to acknowledge Martin Webber, Maria Rossini, and Rachel Craddock for being willing to dedicate time to meet with our team and provide information on education materials. Our team appreciates everyone who has assisted with the completion of our project.

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Although all members of our team have contributed to all parts of our report, we have recognised three roles for each section: primary author, primary first reviser, and primary second reviser. The primary authors are members who created the initial draft of the section. The primary first revisers are the members who made the majority of edits before the first submission to the advisors. The primary second revisers are members who made the majority of edits as a response to the advisors' comments. All three roles contributed significantly to the completion of our report.

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1. Introduction

Currently, design in the United Kingdom (UK) is in a state of crisis (D&T Association, 2016). Design is a method of problem solving applied to a product and results in aesthetic or functional improvement (Kane, 2002). However, students' perception of the importance of design and technology as an academic subject has declined by 10% in the past several years, which reflects a general decline in student interest in design (Hutchinson & Bentley, 2011). The current government has made changes to how they measure school attainment with the consequence of marginalising arts subjects, (D&T Association 2016) including detailed qualifications and assessments (Oxford Cambridge and RSA, 2015), but this has resulted in little improvement.

STEAM, which stands for science, technology, engineering, art, and mathematics, is the idea of implementing creative subjects into STEM (science, technology, engineering, and mathematics) programmes. However, STEAM is relatively new compared to STEM programmes and most educators have not implemented it into their classrooms (Boy, 2013). To compensate for the lack of creative approaches in STEM, third-party organisations have tried to incorporate a hands-on and more enjoyable approach to STEM learning. For example, the London Science Museum has teacher packs with student activities, each of which has a specific scientific lesson associated with it. Similarly, the Children's British Broadcasting Channel (CBBC) has created teacher packs associated with the television programme *Live 'n' Deadly* (CBBC, 2014). By associating educational lessons with commonly viewed children's programmes, the CBBC has attempted to create an engaging model for STEM educators and their students.

The Design Museum has a vision for everyone to understand the value of design. In particular, the Design Museum seeks to explain that design is a way to solve problems as much as it is a craft for industrial processes (C. Eames & R. Eames, 1972), and is thus a way of thinking used in other disciplines. To achieve its vision, the Design Museum sees a need to develop educational resources to inform and engage students about the design process and to apply it to the students' schoolwork. The current material available on the museum's website presents activities for visitors to perform to further their appreciation and knowledge of design. However, the few worksheets that the Design Museum currently has are heavily text based, and therefore inadequate for a younger audience (Elley, 1992). In addition to having new resources aimed towards younger students, the

museum would also like to have material related to its new exhibition, "Designer, Maker, User," to improve each student's visit.

Our team developed resources, which are accessible both online through the Design Museum's website as well as in the Design Museum's shop, for key stages two and three to improve students' understanding of design. It is important that students begin learning about design at a young age so they can apply design thinking to their future education in a range of subjects. Therefore, the Design Museum wished to create educational resources based on STEAM and design. The Design Museum staff understood which material would be most effective for teachers and students, but lacked the time to create the material. We tailored the materials to inform and engage the students about how to apply design thinking to STEAM subjects by learning about and analysing design concepts. To develop these resources, we interviewed teachers, created the materials, and then modified the materials using feedback from our pilot programme. By having educational material directed to specific age groups and demographics of students, the Design Museum will be able to reach further and convey more information.

2. Literature Review

In this chapter, we present basic information needed to understand our project and the development of our educational resources. In order to understand the focus of our resources, first, we cover design and design thinking. Then, to understand the stakeholders and audience for whom we created the resources, we discuss different types of learning and learning strategies utilised by educators across the world, educational assessment, and current education in the United Kingdom. Finally, we review the Design Museum, its current facilities and its pre-existing resources available online.

2.1 Design and Design Thinking

Design is a nebulous term that is difficult to define. The definition of design given by the famous designer Charles Eames is that design is the arranging of elements to accomplish a particular purpose (C. Eames & R. Eames, 1972). This definition is consistent with the Design Museum's interpretation of design (D. Houston, personal communication, 23 February 2016). Traditionally, educators teach design as its own subject and it is often interchangeable with art in its use and

applications. However, certain organisations are pushing for educators to teach design as a way of thinking, of "tailoring the solution to the end user" (E. Ferguson, personal communication, 17 February 2016), so that the person using a product is in mind throughout its creation. In order to distinguish this paradigm, the Design Museum makes use of the term "design thinking."

Design thinking is when designers think about the final function of a product throughout the design process. In his book *The Sciences of the Artificial*, Herbert Simon (1996) uses the invention of the clock as an example of design thinking. Before technology, humans used sundials to tell time, but were only efficient at telling time in sunny climates. Due to this constraint, designers created the mechanical clock. The designer kept in mind the function for the user in less sunny climates when creating the mechanical clock, and was able to create a product that people could use in a wide range of climates (Simon, 1996).

Design thinking consists of two processes: learning about design and learning through design, where the first process is preparation for the latter. Learning about design involves understanding the principles, and the vocabulary associated with analysing design without doing any designing. Design analysis of an object includes the analysis of its appearance, materials, use, and expression of ideas (Charman, 2010). For someone using design thinking, design analysis is comparable to gathering background information for a project. Learning through design is the practise of creating an object using design - the planning, manufacturing process, materials involved, and evaluation of the finished product's design. Brainstorming is also a key component to learning through design, which Alex Osborn coined in the 1930s to promote creativity. Brainstorming includes: gathering information, formulating ideas, and critiquing the ideas presented. Brainstorming leads to creative thinking and group collaboration (Robson, 2002).

To improve upon the cycle of design, organisations like the Design Museum advocate the importance of incorporating ideas and experiences in everyday life into this design process, especially with students in STEM fields. As a result, the Design Museum uses the method through which students learn about design in its workshops "designerly learning." Designerly learning is a term that has evolved from the "designerly way of knowing," which includes creating products based on observations of pre-existing products. Designers observe the functions of objects and then create new objects based on their observations (Cross 2006). We can use the modern-day smartphone to explain designerly learning. The designer of the smartphone observed the functions of a telephone and combined it with the functions a computer. As part of teaching students how to

use its experiences through designerly learning, the Design Museum wants to teach them to do so even outside of the museum's workshops, so that they may apply what they have learned to other subjects within STEAM (Charman, 2010).

2.2 Types of Learning and Learning Strategies

Students generally learn material in one of three different ways: informal, nonformal, or formal learning. Informal learning is learning through everyday life (Smith, 2002). Some of the key mechanisms of informal learning include, but are not limited to, voluntary interactions, conversations, and exploration. Some examples of lessons presented in an informal learning manner are learning from daily experiences, from parental instruction, or from a workplace (La Belle, 1982).

Nonformal learning is learning through educational activities separate from the formal classroom setting (Smith 2002). Despite being semi-structured, students learn using this method outside of the classroom because of its flexibility. For example, museum educators use this type of learning to present information to students about exhibitions, which guides the students' thought process. When children participate in nonformal learning, it is often used as a method of developing them into active participants of society (La Belle, 1982).

Formal learning is a structured and sequenced system with one or more planned outcomes, often presented in a classroom setting. A curriculum or syllabus usually sets expectations and a plan of action for teachers to follow. This is the most common form of learning in a traditional classroom, spanning from primary school to university (Smith, 2002). Educators engaged in formal learning use one or more of several approaches in the classroom. Active learning occurs when meaningful activities engage students and encourage them to apply critical thinking instead of simply absorbing information from an educator or document (Thompson, 2013; Prince, 2004). Learning that is not active, comparatively, is not as beneficial to the development of the learners' personalities and may even affect their academic achievement and intellectual development (Mohammadjani & Tonkaboni, 2015). However, when incorporating hands-on activities and experiential learning in lesson plans, students generally remember the content they learn better (Furman & Sibthorp 2013). As a result, active learning strategies are often more effective at satisfying and engaging learners. Cooperative learning, for example, is a technique that relies on students exchanging and thinking critically about their ideas collectively in order to reach further individual understanding of a topic.

Different strategies when approaching a task can help students re-examine their own way of thinking and consider different views, which may be applicable to other problems (Coates, 2009).

The ability for students to approach their thoughts from new angles motivates them to consider alternate solutions. A study that examined 20 teachers (McMillan, 2016) found that a lack of students' motivation is a problem for many students in completing assessments (in this case, accountability tests in mathematics, science, language arts, and social studies). Personal satisfaction of the learner is often a motivator. Subjects that interest a student are more likely to pique her motivation to learn and explore. The reason students are not motivated to learn is that they do not enjoy the methods that teachers use. A study conducted on a sample of students in grade four, ages nine to ten, found that engaged students score higher on assessments. In particular, the study found that the students had significantly higher grades and satisfaction when instructors used cooperative learning methods rather than lectures (Mohammadjani & Tonkaboni, 2015).

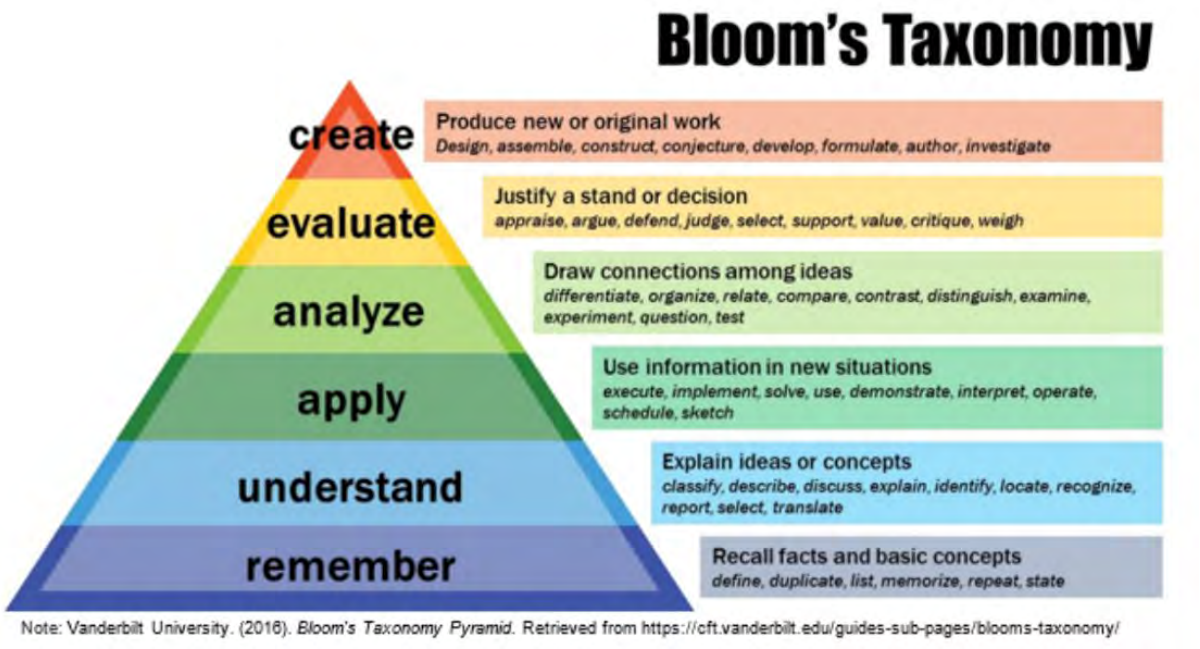
Other types of active learning strategies include team-based learning and project-based learning. Educators can combine learning strategies to increase the effectiveness of their lesson plans. In team-based learning students spend most of the class time in persistent workgroups (Michaelsen & Sweet, 2011). Team-based learning has four important elements: permanent teams, peer evaluation, organised preparation for the activities, and activities that promote thought and team development (Michaelsen & Sweet 2011). The need for persistent teams only allows group or team-based learning activities on the course or module level. Several accrediting agencies of schools that use team-based learning have commended those schools for promoting exemplary teaching practices. Team-based learning correlates with increased test performance, attendance, engagement, and student satisfaction (Michaelsen & Sweet 2011).

Project-based learning is a teaching strategy through which students learn by completing a project. The teacher (or student) selects a project that is of interest and involves topics that the teacher wants the student to learn (Furman & Sibthorp, 2013). For example, a student who wants to create a website will have to learn about numerous topics such as internet architecture, project management, and budgeting in addition to the more obvious subjects of server setup and web page creation. The advantages of project-based learning are that students will be more focused on mastering the content, will know how to apply what they learn, and will be more likely to retain the material (Thomas, 2000).

2.3 Educational assessment

When developing learning material, it is important to determine a set of learning outcomes. Learning outcomes are statements that say what educators expect learners (often students) to learn from a lesson, module, or even a whole curriculum. The outcome can be anything from simple knowledge and skills to attitudes and behaviours (Nygaard, Holtham, & Courtney, 2009; Hussey & Smith, 2008). Learning outcomes are usually as precise as possible, though they often use terms like "thorough understanding," which are subject to educator interpretation. Educators use learning outcomes for more than just assessment - they inform teachers and students what content teachers should cover in a lesson or school curriculum (Nygaard et al., 2009). Museums and other organisations can use learning outcomes for evaluating the educational value of their exhibitions, educational materials, and activities (Bonnell, 2013). The downside of learning outcomes is that they encourage a lesson to cover only the stated learning outcomes and can increase the bureaucracy of education, especially for curriculum or course outcomes (Hussey & Smith, 2008).

When creating educational material, it is important to evaluate the degree to which the material is successfully helping students learn. The evaluator can assess the material by focusing on the possible learning outcomes and using them as a guideline to gauge how much the student may have learned. A common framework to classify statements about what students learn is Bloom's Taxonomy. The taxonomy divides learning outcomes into categories of "Knowledge" and "Understanding" (Krathwohl, 2002), and educators should phrase the outcomes such that they fall into one of the above categories. When phrasing learning outcomes, Bloom's Taxonomy uses keywords: remember, understand, apply, analyse, evaluate, and create. Figure 1 organises the objectives into a pyramid formation to display the level of learning of a specific objective. For example, if a student is only able to remember direct information, she has achieved a base level learning outcome. If a learning outcome falls into the "create" section, the educator can be sure that the student has completely mastered the material. Also associated with each category of learning is a series of sample words that can assist in the phrasing of learning outcomes (Vanderbilt University, 2016).



Note: Vanderbilt University. (2016). *Bloom's Taxonomy Pyramid*. Retrieved from https://cft.vanderbilt.edu/guides-sub-pages/blooms-taxonomy/

Figure 1: Bloom's taxonomy in pyramid formation

There are many methods for evaluating an educational programme, such as interviews, surveys, observations, and evaluations of completed material. The most important part of the effectiveness of an educational programme is whether students achieve the desired outcomes (Weiman, 2015). To determine whether they have achieved the outcomes, students can complete self-evaluations on what learning outcomes they believe they have achieved. Teachers can also determine whether they think students have learned the material. Different organisations value certain types of feedback more than others. One method of evaluating programmes, created by the European Commission for vocational schools, is the Expero model (Cervai et al. 2013). This model takes into account the opinions of the school's stakeholders when evaluating educational material. The creators of this model developed two different categories, "SHOULD" and "IS," from which evaluators can base their analysis (Cervai et al., 2013). The category titled "SHOULD" is a basis for comparison and for relevant stakeholders to determine their expectations. Like its name, the "SHOULD" category is what the stakeholders believe to be the ideal educational material and model, which would be equivalent to learning outcomes. The "IS" category is an outline of the stakeholders' perception of the material's current state. The stakeholders create the "IS" outline by comparing the current materials to the expectations of the "SHOULD" category (Cervai et al., 2013). Once the stakeholders have defined information in both categories, they can make possible

recommendations to improve whatever they may be evaluating. Although this method is extremely effective at determining a set of learning outcomes that meet the stakeholders' expectations, it often leaves out student input.

Teachers often use common forms of assignments such as exams, homework, and projects for evaluation. When a teacher evaluates the students' work on an assignment, the evaluations not only describe student capabilities, but they also indicate the teacher's teaching ability and the educational material's ability to present information to the students. In addition to student work, teachers take direct feedback from students on their teaching. Despite the value of these evaluations in assessing teachers with student feedback, teachers often ignore the results of these evaluations because they believe that student feedback is not reliable or constructive (Golding & Adam, 2014). When educators are able to take the feedback they receive as constructive rather than critical, they often apply it to their lessons, thereby improving their teaching ability. However, students can only evaluate their teachers and lessons compared to lessons they have attended before. Students also have different priorities than educators. For instance, students may find certain activities more fun, and thus rate them higher than others regardless of the activity's educational value (Weiman 2015). For this reason, it is important that whenever collecting student evaluations, further analysis is always necessary and could lead to more accurate and representative results. In order for the teachers to avoid non-descriptive or unreliable evaluations, teachers should ask thought provoking and open-ended questions.

2.4 Education in the United Kingdom

The curriculum in the UK contains a set of subjects followed by all primary and secondary schools in England. Of particular relevance to this project's requirements are key stage two (KS2) and key stage three (KS3) educational programmes. Additionally, the UK curriculum implements STEM and STEAM programmes for the subjects of science, technology, engineering, and mathematics - as well as art, in the case of STEAM. For the science disciplines, the British Science Association has created credentials to encourage project work, called CREST awards. Many institutions, including the British Science Association, have created their own educational materials for students, ranging from teacher packs of short activities to long and involved projects.

2.4.1 National Curriculum of the United Kingdom

The national curriculum defines a specific set of subjects for each key stage that all primary and secondary schools in England follow. The UK Department for Education defines a key stage as a block of years where students study a similar set of subjects (Department for Education, 2013a). KS2 consists of students aged seven to eleven, in years three to six of their education. KS3 includes students ages eleven to fourteen, in years seven to nine of their education. The UK Department for Education aims for the national curriculum to provide essential introductory knowledge in order for students to become educated citizens. The UK Department for Education also pushes teachers to hold high expectations for their students and assess them regularly. Once a student reaches the end of her tenure in a key stage, the UK Department for Education requires the student to participate in evaluation exams. These exams evaluate the progress of each student and measure the amount of knowledge she has retained from the previous year (Department for Education, 2013a).

In 2013, the UK Department for Education outlined programmes of study for KS2 and KS3, which include science, design and technology, art and design, and mathematics. In KS2, teachers cover general topics of science including simple biology, physics, and chemistry. For the subject of design and technology, KS2 students learn how to research and develop design criteria for usable products targeted at a specific end user or group, as well as analyse simple existing mechanisms. The subject of art and design emphasises developing art and design techniques, though the government has continued to make changes, with the consequence of marginalising arts subjects (D&T Association, 2016). KS2 students cover mathematical materials such as arithmetic, fractions, geometry, and basic algebra (Department for Education, 2013b, 2013c, 2013d, 2013e).

During KS3, students cover STEM topics in further detail. In biology, physics, and chemistry, students expand their scientific knowledge on vocabulary, nomenclature, and units of measurement. In the technologies, KS3 students begin to solve their own technological problems, and communicate their solutions through sketches, models, and presentations. Students also expand their engineering knowledge by exploring more complex electrical and mechanical systems including systems with heat, light, movement, inputs, outputs, forces, and more. In the art subjects, KS3 students learn about art history and begin to analyse each other's work. Finally, KS3 students learn how to solve more complex mathematical problems in algebra, geometry, probability, and statistics (Department for Education, 2013b, 2013c, 2013d, 2013e).

2.4.2 STEM and STEAM education

The National Science Foundation (NSF) originally developed the acronym STEAM (Boy, 2013). STEAM education consists of the integration of the STEM subjects as well as art applied across and within each subject to stimulate student creativity. Since STEAM education is inherently interdisciplinary, STEAM programmes give each discipline's communities new opportunities to create inventive and diverse products (Peppler, 2013). By including creativity in the practise of STEM, teachers can not only effectively prepare their students for jobs, but also for their later education and adult lives. A study funded by the NSF monitored teacher and student performance to determine the effectiveness of STEAM education (Tillman, 2015). It found that while many teachers enjoyed STEAM education, they believed that creative learning opportunities for students were still limited in mathematics and science.

Additionally, when educational organisations assess STEAM programmes, only programmes with educators who simultaneously give the students the opportunity for a creative and hands-on component of their education, while also considering art and design throughout the assessment, are successful (J. Bequette & M. Bequette, 2012). Education in art bridges the gap between the facts of STEM and how these topics fit into our daily life (Vande Zande, 2007). The results of these studies imply that while STEAM is creating a productive environment for students to begin expressing their creativity in their work, students are still lacking a set of complete opportunities to learn and apply artistic design techniques in the STEM disciplines.

2.4.3 CREST Awards

CREST Awards are the only nationally recognised accreditation scheme for projects in the STEM subjects in the UK (British Science Association, 2015). By accrediting material, the British Science Association assures the quality of the material either meets or exceeds educational standards. Once the students complete a project that follows the guidelines for a particular CREST Award, the students, with help from their teachers, can apply for that CREST Award. The British Science Association created the awards more than 30 years ago (M. Rossini, personal communication, 21 March 2016). There are three main levels of CREST Awards: bronze, silver, and gold. The bronze award targets eleven to fourteen year old students (KS3) and requires a project that took roughly ten hours of work to complete. The silver and gold awards require 30 and 70 hours of work, and are for KS4 and A-level (KS5) students, respectively (British Science Association, 2015b).

In addition to these awards, the organisation offers a Discovery award (requiring a project that took at least five hours) and short primary school activities, which are currently under revision. The awards for projects at the primary school level (Star, Superstar, and Megastar) are usually hands-on activities that can be fit into one hour, which makes them easy to complete in a single lesson (M. Rossini, personal communication, 21 March 2016). Many schools, including Northwood School, a secondary school located in Hillingdon, run CREST Award programmes because they feel that awards motivate students, and teachers choose to spend time on activities that an educational agency has accredited. Several of Northwood School's after-school clubs do projects that qualify for CREST Awards (S. Marry, personal communication, 23 March 2016).

The CREST award project guidelines are flexible enough to include a wide variety of projects, from designing a game controller to doing forensics on automobile accidents. Several institutions have created more specific projects that meet the CREST award requirements (British Science Association, 2015b).

2.4.4 Examples of Educational Resources

Many institutions create teacher resources that teachers can use with their students. Such teacher resources include the British Science Association's *Crafty rafts* lesson, the Children's British Broadcasting Corporation's *Live 'n' Deadly* packet, and the London Science Museum's *Kitchen Science* packet (Appendix B). These educational models focus on presenting material that is auxiliary to the traditional curriculum to primary and secondary school students. Each packet organises its content in a straightforward format for teachers to follow.

The British Science Association has created multiple worksheets and lessons that align with the CREST Awards. For example, the *Crafty rafts* (Appendix B1) activity qualifies for the Superstar Award for KS2. This activity encourages students to work in groups to determine a functional design for a float. The *Crafty rafts* activity includes a competition where the students try to keep the most amount of weight afloat. The activity is completable on a low budget and teaches students about buoyancy, experimentation, and group collaboration.

The CBBC broadcasts a television programme *Live 'n' Deadly*, which aims to teach and engage children about wildlife. Associated with the programme the CBBC has developed a teacher's pack (Appendix B3) that provides a framework for teachers to connect their in-class lessons with those in the programme. The packet describes each lesson plan in depth, outlining curriculum links,

key vocabulary, preparation, and links to the television programme. The packet hosts a series of lessons which teachers can implement into any classroom or school club to further students' understanding of a variety of scientific facts and theories. Students and teachers can complete the activities contained in the *Live 'n' Deadly* packet anywhere, using common and easily accessible material, such as paper and cutout cards provided in the packet. For example, the *New Animal Discovery* lesson has students use their background knowledge of adaptation in animals to create descriptions of their own species. The CBBC has associated each lesson with a series of learning outcomes that the teacher can use to gauge student progress. By the end of the *New Animal Discovery* lesson, the student will be able to understand the relationships between animal adaptations, habitats, and diets (CBBC, 2014).

Similarly, the Science Museum's *Kitchen Science* packet (Appendix B2) includes a number of engaging activities students can complete outside of the museum, with everyday materials. Each activity in the packet has associated learning objectives for the teacher. For example, the *Milk Magic* activity has the students mix milk and food colouring to display the physical properties of both liquids (2016). The Science Museum includes a brief introduction explaining that the milk is composed of water, fats, minerals, vitamins, and proteins. When mixed with the food colouring, the compounds in each liquid react and cause the swirls. The packet also provides a series of discussion questions to wrap up the activity, such as, "What happens if you use different types of milk, for example semi-skimmed, low fat, or soya milk?" Included with each lesson are connections to everyday life and links to galleries in the Science Museum (2016).

2.5 The Design Museum

Museums have struggled to collaborate with school programmes in the past decade, as constraints with time and financial costs have caused teachers to question the value of educational programmes offered by museums (Boddington et al., 2013). Concurrently, museum educators must try to balance engaging students with meeting their own performance standards (Franco, 2010). Within the context of the UK, much of this divide in recent years stems from the global financial crisis and economic recession that began in 2007. This socio-economic downturn led to several sweeping policy changes and social reform (Boddington et al., 2013). One effect of these changes is the idea that in order for the Design Museum, as an organisation, to stay relevant, it must rely on the

public's opinions and expectations for all things museological (Tlili, 2014). In particular, the Design Museum works closely with the public to teach visitors about the concept of design.

The Design Museum, located directly south of the river Thames in London, has a vision for "everyone to understand the value of design," With over 200,000 visitors per year (The Design Museum, 2015), the Design Museum sees a need to expand the reach of the museum. Thus, the museum is using all methods possible to expand. These methods of outreach span from social media pages to educational materials accessible on the museum's Discover Design webpage. As seen in Table 1, the Design Museum has a higher ratio of online engagement per yearly number of visitors, demonstrated by a strong following on Twitter and Facebook, when compared to the British Museum, a widely known and successful museum. The Design Museum Twitter and Facebook accounts offer discounts to followers and include posts about design ideas, stories, and seminar information. Using the means of its already developed internet presence would be the best and most achievable method to accomplish its vision for everyone to understand the value of design (Design Museum, 1999a).

	Design Museum	British Museum
Yearly museum visitors	200,000	6.7 million
Twitter followers	2.54 million	700,000
Facebook likes	367,355	1.1 million

Table 1: Approximate numbers of museum visitors, Twitter followers, Facebook likes (About the Museum, 2015), (The British Museum, 2015)

The Discover Design framework is the museum's online resource for teachers and tutors to develop creative approaches to educate students about design (Design Museum, 1999b). Design Museum employees developed a series of educational material to encourage a nonformal learning environment for those visiting the museum. In many ways, these nonformal resources are more engaging than traditional classroom material as they guide the participants to interact with exhibitions and probe them to think more about design. The material featured on the Design Museum's website ranges from background materials for teachers, which show design in everyday life, to museum related material that spans pre-visit, during-visit, and post-visit activities (Appendix A). The museum staff created the current resources to educate students and teachers on design in

everyday life. While the museum has made these resources available online since 2014, it has not collected data on how teachers use the materials, nor on how effective they are.

As seen in the worksheet entitled *Exploring Your Journey* (Appendix A1) there are activities which the Design Museum would like students to take part in before attending the museum in order to begin thinking about design and be ready to discover design at the museum (Design Museum, 1999b). The worksheet prompts the participant to sketch a detail of Tower Bridge, or one of the towers, as an example. The same worksheet then asks the participant to specify why the participant chose that specific detail. By taking a seemingly simple activity and connecting it to the design of a larger system, the Design Museum facilitates its learning of design concepts.

Similarly, the *Exploring Exhibitions* worksheet (Appendix A2) encourages the student to pick an object that looks interesting, then asks a few questions about the student's reasoning for picking such an object. The worksheet then prompts the student to pick an object based on what it does, asking similar but different questions this time. This activity prompts the student to think critically about an object, bringing focus not to only its appearance, but also its function. When thinking about the object's function, the student can then hypothesise decisions the designer may have made during the design process.

Activities such as the *Exploring Your Journey* and the *Exploring Exhibitions* worksheets can be an effective method to provide information and insight on design that teachers may not normally consider. The students that will be using the resources are from both KS2 and KS3. Therefore, the resources should be appropriate for the learning styles of a broad range of students. The current worksheets have of a series of complicated questions. Seven-year-old students will not be able to understand the questions that a fourteen year old can, solely due to previous knowledge and thought processes.

3. Methodology

Our goal for this project was to improve students' understanding of design by developing resources that are accessible through the Design Museum for KS2 and KS3 teachers and students. We have tailored the materials to inform and engage the students about how to apply design thinking to STEAM subjects by learning about and analysing design concepts. In order to accomplish this goal, we have addressed the following objectives:

- Identify traits of teaching tools that teachers prefer
- Create museum visit materials and teacher packs based on the Design Museum's new exhibition
- Assess the newly created lesson plan via a pilot programme, analyse the results, and adjust the material accordingly

3.1 Identify traits of teaching tools that teachers prefer

We conducted a series of group interviews to identify teacher preferences using some example teacher resources provided by Mr Houston. For reference, our team recorded the interviews and took notes. To know what types of resources we needed to produce, we needed to determine what other kinds of educational resources teachers find useful. Educational tools include applications such as Microsoft PowerPoint, Microsoft Word, and ActivInspire. In particular, we used these interviews to determine the logistical components of our materials, including what types of resources that teachers use (teacher notes, presentations, worksheets, and readings), the length of individual activities, and what properties of the educational resources are appealing to teachers. Group interviews were the simplest method to acquire this information.

During the interviews, we brought resources created by other museums and educational institutions (*Crafty rafts*, *Live 'n' Deadly*, and *Kitchen Science* in Appendix B*)* for the teachers to indicate what characteristics of resources they prefer. Specifically, we showed the third-party resources to the teachers to figure out what format they preferred. We also gained knowledge about teaching styles and preferences among the selected teachers. Specifically, the research questions we investigated during our group interviews are in Appendix D1.

Our team conducted multiple interviews with teachers using the questions listed in Appendix C. The interviews took place on Tuesday 15 March during the first week of the project. David Houston, the Design Museum Learning Producer for schools, identified two schools for our team to visit and set up a meeting with teachers at both Colville Primary School and Northwood School, which is a secondary school. Since Mr Houston selected teachers he worked with in the past or that wanted to work with the Design Museum in the future to participate in our interviews, our sample of teachers was not random. Mr Houston wanted to meet with the teachers to discuss a partnership with the Design Museum, so we started the meetings with that discussion.

In the first group interview with Colville Primary School, we interviewed a KS1 and KS2 teacher in design and technology, the design and technology leader, and the science leader. There were several complications when we conducted the interview - for instance, the science leader and the technology leader did not teach KS2, and the school administration did not inform the teachers of the interview in advance.

The second group interview session took place at the Northwood School, where we interviewed the head of science, science club leader, and head of year seven. We gained knowledge about KS3 teachers and students. After the interviews, our team scheduled two follow-up appointments in order to observe a science class and for our team to pilot our resources with KS3 students on 12 April. We received an example lesson plan and Northwood's lesson plan guidelines.

Our team returned to the Northwood School on 23 March 2016 in order to observe a KS3 science class. We observed how Jenni Lister, a science teacher, presented the material to a year seven class and how the students reacted to the material. After observing the class, we had an informal discussion with a design and technology teacher about her subject and lesson structure. We have listed the dates and further information on each interview in Table 2 below.

Interaction	Date	Location	Teacher	Subject	Key stages taught
Interview 1	15 March 2016	Colville Primary School	Joyce Tackie	Art	KS1, KS2, and early years
			Ursula Parvex	Design and Technology	KS1
			Ellen Lydon	N/A	Early years
Interview 2	15 March 2016	Northwood School	Dev Thaker	Science	KS3, KS4
			Sinead Marry	Science and chemistry	KS2, KS3, KS4, KS5

			Jenni Lister	Science	KS3, KS4, KS5
Lesson Observation	23 March 2016	Northwood School	Jenni Lister	Science	KS3

Table 2: Interactions with teachers before pilot programme

Our team attended a meeting with Maria Rossini, who works for the British Science Association, the organisation responsible for creating the CREST Awards. We also attended various meetings with the Design Museum staff to determine traits and requirements for our materials. In particular, we discussed our plans with Mr Houston and Ellen Ferguson, Head of Programme - Learning.

To learn about what the Design Museum currently offers during museum visits aside from its printable worksheets, we attended a *Mystery Products* workshop for KS3 students at the Design Museum on 17 March. The *Mystery Products* workshop discussed and analysed a variety of mystery products, several of which had functionality that was difficult to determine. For example, there were cartoon characters magnetised to a metal plate and pole. What looked like a children's toy was actually a salt and pepper shaker. There were various mystery products similar to the shakers within the workshop. The instructor engaged the students throughout the hour-long session by asking questions frequently and challenging the students to think critically about design.

3.2 Create museum visit materials and teacher packs based on the Design Museum's new exhibition

Once we gathered enough information from teachers, we began the creation of the materials based on our previous research, teacher feedback, and collaboration with the museum's curators. The Design Museum asked us to develop the content for two types of resources corresponding to its permanent "Designer, Maker, User" exhibition: visit materials and teacher packs, both for KS2 and KS3. We have listed a complete list of the resources and their contents below for clarity:

- Visiting materials
    - one pre-visit lesson plan
    - one during-visit activity for each KS2 and KS3
    - one post-visit lesson plan

- Teacher packs for each KS2 and KS3 teachers
    - six lesson plans
    - six worksheets associated with the lesson plans
    - supplementary materials necessary for the context of the lesson or activities

The teacher packs focus on the "Designer, Maker, User" exhibition, but they are for classroom use and are not associated with any specific trip to the Design Museum. The teacher packs contain a series of lesson plans and their associated worksheets, and are separate from the visit materials. The visit materials consist of a pre-visit lesson plan, an activity that the students complete while visiting the exhibition, and a post-visit follow-up lesson plan. While our initial plans included a separate version of the pre-visit, during-visit, and post-visit materials, we only developed a separate version of the during-visit activity for KS2 and KS3 while the pre-visit and post-visit resources are the same between KS2 and KS3.

The first task in creating educational material for the "Designer, Maker, User" exhibition was to learn about the exhibition, the Design Museum's current educational programmes, and what physical materials the museum can actually produce. We could not visit the exhibition because it had not been built yet, and would not open until the museum opened at its new location in Kensington in November 2016. Instead, we met with Eleanor Suggett, one of the curators for the exhibition, about the "Designer, Maker, User" exhibition and what objects it will contain.

Excluding the introduction to the exhibit and the activity table, there are three sections corresponding to the "Designer, Maker, User" themes. Each section has its own title and topic. There are also subsections in each section to categorize specific objects or subtopics more clearly. A list of all the sections is below. We have taken the descriptions from the Design Museum's "Designer Maker User: Introduction + Exhibition Overview" document and edited for clarity:

- Designer: This section of the exhibition emphasises to viewers that design is a way to understand other people. It is a process that results from the interaction between the designer, user, and manufacturer. Designing is both a creative process and a professional method, and designers work between culture and commerce to impact our lives in many ways.
- Maker: This section of the exhibition illustrates to viewers that there are many approaches to design. Design reflects and changes the world we live in - sometimes it happens in ways we

do not anticipate or intend. Such effects are also seen in consumer goods and products, and individual taste is both a means of self-expression and a vehicle for the commercial manipulation of the consumer and the choices that they make.

- User: This section of the exhibition emphasises to viewers that design applies new technology and advances in manufacturing methods to products of all kinds, some aimed at the consumer, others applied for more specialised users such as medical equipment. This has ongoing economic, political, and social impact. Design can offer solutions to the problem of environmental sustainability and product life cycle, and offers a number of possible future directions for future manufacturing.

After we finished researching, we started to create lesson plans for the teacher packs. We expected to make two teacher packs, each with six lessons: one for KS2 and one for KS3. We expected the teacher packs to include similar lessons, but with each lesson altered to align with the appropriate key stage. After the completion of the project, the Design Museum shop intends to sell the packs for roughly ten pounds. Our role was to create the content for the lesson plans so a freelance graphic designer could create the final layout after the end of our project. Mr Houston encouraged us to create the lessons by starting with an object or story relating to the exhibition, creating an activity to go with it, and then finding links between the lesson and the curriculum. In order to create a set of clearly organised lesson plans, we decided to aim for two lesson plans per section: two for "Designer," two for "Maker," and two for "User."

To select objects and find stories for all our materials, we reviewed an excel table that listed approximately 600 objects that the Design Museum will display in the permanent exhibition at the Design Museum in Kensington. We looked for topics or connections that either interested us or that we believed would interest a student between the ages of seven and fourteen. We picked a series of objects that the students would recognise through their in-class curriculum. Our similar backgrounds and interests made for a biased item selection. After determining a list of twelve groups of objects, we then created a spreadsheet that listed each group, item call number, item description, designer of the object, and any material for which we believed we could develop an interesting story or activity. We met with Ms Suggett and Alex Newson, the other primary curator for the exhibition, in order to refine our understanding of the exhibition and determine which items held the strongest connections to the exhibit. We then began to develop corresponding activities with each connection. During this process we used educational models such as the *Live 'n' Deadly* teacher's pack (Appendix

B3), the *Kitchen Science* packet (Appendix B2), and a series of lesson plans provided to us by Ms Lister.

At this point, we used our list of groups of objects and recommendations from Mr Houston as our starting point for creating lessons. We were unable to think of activities to match all the objects in our list, so we had to revise the object list. Once we revised our list, we created or researched a hands-on activity to go along with each object in the list by brainstorming ideas. Once we decided on an activity, we constructed a story to introduce it. We created the stories by identifying a user that would potentially need the final product of the hands-on activity. After we created a detailed activity, we were able to develop learning outcomes, curriculum links, and a plenary session. We followed Mr Thaker's recommendation to create lesson plans which included group work and components of team-based learning because these lessons are often more exciting.

We originally intended for the development of learning outcomes to be an integral part of creating the lessons, but Mr Houston informed us that learning outcomes were easily created afterwards. He also said that learning outcomes are written in a specific way, and later helped us create and edit the learning outcomes for the lessons.

Our team decided to create one complete lesson plan first in order to receive feedback and to use as a model for all the other lesson plans. The first lesson plan we created was the *Wibble, Wobble, Wiggle Chair* lesson plan (Appendix G6). We targeted this lesson plan at KS3 students but it included suggestions for KS2 students. We made multiple iterations of this lesson plan and showed them to Mr Houston and Ms Ferguson. After receiving feedback, we modelled our new lesson plans on the exemplary prototype lesson plan. We then split the lesson plan into two versions, one for KS2 students and one for KS3 students. Once we split the lesson plan into KS2 and KS3, we performed the activity ourselves to ensure that the activity was manageable in terms of time and difficulty. After we completed the trial, Mr Houston and Ms Ferguson approved our lesson plan. With the lesson plan complete and approved, we were ready to complete a pilot programme with the *Wibble, Wobble, Wiggle Chair* (as described in section 3.3). After the pilot program, we based all of our other lesson plans on the structure of the *Wibble, Wobble, Wiggle Chair* activity.

We also created materials for students visiting the museum (Appendix I). We examined numerous materials created by museums for visiting students, and the Museum of Science and Industry, Chicago's *What is Science?* museum exploration guide (Appendix B4) inspired our team to create a booklet. The booklet inspired our team because along with the hands-on approach and

open layout, the booklet aligned with our sponsor's expectations. We then created a brief pre-visit lesson plan (Appendix I1) that introduced the Design Museum, the "Designer, Maker, User" exhibition, and the booklet that the students will use during their visit, for each KS2 and KS3. We created a short pre-visit lesson plan because, according to our interviews, teachers do not spend much time preparing for their museum visit, and rarely spend any time afterwards covering what the students did on the trip. For the during-visit material (Appendix I2), we created booklets that guide students through the exhibition. We created approximately two or three questions for each of the "Designer," "User," and "Maker" rooms. There will also be a design wall in the permanent exhibit which includes 300 objects nominated by the public. Additionally, we created two questions that focused on the object wall. Our team created the questions based on the pertinent information Ms Suggett and Mr Newson supplied. The post-visit material (Appendix I4) consists of follow-up questions from the museum that reiterates topics covered in the booklet. When developing the resources, we decided that we needed to create both KS2 and KS3 versions of the booklet. Although we created two versions of the booklet, we only created one version of the pre-visit lesson and one version of the post-visit discussion questions. We originally intended to have a separate KS2 and KS3 versions of the pre-visit lesson and post-visit discussion questions, but due to time constraints we made our pre-visit lesson plan and post-visit discussion questions generalized to be usable by both KS2 and KS3.

3.3 Assess the newly created lesson plans via a pilot programme, analyse the results, and adjust the material accordingly

Once we created our resources, we assessed one of our lesson plans to determine how it performed and determined if some teachers would use it. For the pilot programme, we chose to use the lesson plan called *Wibble, Wobble, Wiggle Chair*. We selected this lesson because it was our team's most complete lesson plan, and Mr Houston approved the idea. We were not able to test more of our lesson plans due to time constraints. We also did not assess the progress of students toward the learning outcomes we developed because Mr Houston asked us to leave the finalisation of the learning outcomes to him. He also requested that we not focus on completely developing the learning outcomes prior to the pilot programme due to time constraints.

We conducted pilot programmes on 12 and 14 April using our materials. We led a series of classes using our lesson plans and materials, followed by a student survey and a teacher interview. During the classes, we used an observation matrix (Appendix D4) and kept notes about student behaviour. We created the observation matrix to keep our observations organised and to obtain information about student behaviour without complicating the student surveys. We created the matrix by drafting research questions (Appendix D4) and associated observation questions. On 12 April we went to Northwood School and ran the KS3 version of the *Wibble, Wobble, Wiggle Chair* lesson plan with one of its science clubs, taught by Dev Thaker. Mr Thaker's science club consists of eight to twelve students in years seven to ten. It is an optional club, so the students in the club are not a representative sample since they are especially interested in science. On 14 April we conducted four pilot sessions (using the KS2 version of the *Wibble, Wobble, Wiggle Chair* lesson plan) at Colville Primary School. The sessions took place during art classes taught by Joyce Tackie. The Northwood School and Colville Primary School were the schools we visited for interviews, so our sample was equally biased as it was during the interviews. Compounding this issue, because we used the same students and teachers as before, we received the same biases as during the interviews, making it impossible to compare the two to determine what ways our sample was atypical.

During the pilots, we were always accompanied by a museum staff member or teacher who had previously undergone background checks by the government. In addition to providing us with information on the activities we used in the pilot programme, the pilot sessions provided us with further guidelines to modify our untested materials. A few days before we taught the lessons, we sent our lesson plans to Dev Thaker and Joyce Tackie for their own reference.

The *Wibble, Wobble, Wiggle Chair* activity has the students create a chair out of newspapers and a roll of tape in groups of four. In the KS3 pilot programme, we gave the students the KS3 version of the activity, which does not give a set of instructions and instead gives three hints on how to create a stable chair. Hints include the way to manipulate the newspapers to create a chair with structural integrity, possible shapes to conform the newspapers into, and what features the chair should have. In the KS2 pilot programme, we gave the students the KS2 version of the activity, which gives a set of nine steps to create a stool by rolling newspapers into tubes and taping them together. Additionally, there is an optional tenth step for advanced students, which instructs them to add additional features to the group's chair.

In each pilot programme, we investigated a set of research questions for KS2 (Appendix D2) and KS3 (Appendix D3) by distributing surveys to the students. We gave the surveys (Appendix E) on paper immediately after the completion of the pilot activity to reduce non-response bias and the chance of students forgetting about the activity (Schutt, 2015). We had separate versions of the surveys for KS2 students and KS3 students to compensate for the differences in reading ability and attention span between each group. The teacher interviews, which we conducted immediately after the student surveys, allowed us to gauge weak spots in our resources and possible avenues for improving them beyond what we could determine by observation. For the KS3 student survey, the penultimate question prompted the student to think critically about the important features of her design. In order to evaluate the student's success on this question, we developed an evaluation matrix, which graded the student from zero to two (Appendix E2). In addition to the surveys and interviews, we also used an observation matrix (Appendix E4) to make sure that we recorded our observations accurately and in a standardised manner.

In the teacher interviews (Appendix E3), we created our questions off of the following three research questions:

1. Which parts of a hands-on lesson plan do teachers believe are successful?
2. What topics outlined in the Design Museum's exhibition link to current UK curriculum?
3. What are teachers' recommendations for improving a lesson plan?

These questions helped us determine how we should modify to make our lesson plans to suit teacher needs better. Our KS2 student surveys (Appendix E1) told us how well students perform during a guided hands-on activity. Our KS3 student surveys (Appendix E2) answered three questions:

1. Do hands-on activities engage students in the design process?
2. What components can students identify as an important part of their designs?
3. What effects will viewing other designs have on the student's own design?

The observation matrix used in both the KS2 and KS3 classrooms covered five research questions:

1. Do hands-on engineering-based activities engage students in the design process?
2. What types of instructions do students struggle to understand?
3. How much time do students require to complete an activity?
4. What components can students identify as an important part of their designs?
5. Were the students able to improve upon their design?

The KS2 student survey questions are simpler than the KS3 questions to compensate for the students' lower reading level and shorter attention span (Elley, 1992; D. Houston, personal communication, 4 April 2016). We were initially worried that the students would give us the information we wanted to hear rather than their answers to the questions, but both the teachers we spoke to at Northwood School and Mr Houston assured us that the students were blunt and honest when giving feedback.

Once we collected all the student data, we put the data into a spreadsheet to conduct simple calculations. We analysed the results of each question individually, and for questions with a numeric answer, we calculated the mean. We also graphed the results from Colville Primary School. We could not quantify the teacher interviews' open-ended questions, but with only two teachers, we did not need to. Similarly, because our sample size at Northwood School was small, we did not graph those results. We separated the pilot sessions at Colville Primary School by year, combining the two year three classes together and combining the two the year four classes. We also asked whether the person taking the survey was male or female. After the analysis, we modified the *Wibble, Wobble, Wiggle Chair* based on the feedback obtained in the pilot programme. We also changed our other lesson plans based on the feedback that applied to more than just the lesson plan we piloted.

4. Results

During our project, we learned about what teachers prefer in educational material, created materials for the Design Museum's planned exhibition, and tested several of those lesson plans in a classroom setting. Teachers use a variety of teaching tools, from videos to written lesson plans. Teachers who teach KS2 and KS3 use similar types of teaching tools, but their requirements differ widely. We created twelve lesson plans with hands-on activities that link to the Design Museum's new exhibition, each of which went through at least two iterations. We then evaluated and modified those plans after our pilot programme.

4.1 Traits of teaching tools that teachers prefer

During our interview with teachers at Northwood School (Appendix F2) and our interview at Colville Primary School (Appendix F1), we learned about traits of teaching tools and general information about teaching in a classroom. Both the KS2 teachers and KS3 teachers were

unanimous in each interview: group work tends to make a lesson more exciting. During our observation of the Design Museum's *Mystery Products* workshop and the science class at Northwood School, we observed that when the teacher asked questions that prompted student interaction, it seemed to keep the students engaged. During our class observation at Northwood, many students did not complete their assignment because of low focus, among other reasons. The teacher gave the assignment as test preparation so that completing the assignment was less of a priority than learning or remembering the content. During the interviews, we learned that both Northwood School and Colville Primary School offer clubs whose supervisors have an interest in trips to the Design Museum, and potentially in lesson plans provided by the museum.

Our team learned that the primary school teachers we talked to value hands-on activities that relate to class trips. They expressed a preference for pre-visit and post-visit activities that were under 35 minutes, and a museum visit activity under two hours. The primary school teachers generally determine whether they will teach a lesson plan or activity by trying it out themselves. The students cannot keep still for more than 15 minutes during trips outside the classroom, according to the teachers. We also learned that the teachers we interviewed use resources that include lesson plans, PowerPoint presentations, short videos, tools for interactive whiteboards such as ActivInspire, online tools such as Discovery Education Espresso, and example assessments such as Testbase. Teachers generally do not follow lesson plans closely, especially experienced teachers. YouTube is a particularly common source of videos. The teachers said that videos are best kept short because of student attention spans and time constraints, especially for KS2. KS3 teachers use similar types of resources as KS2 teachers.

Based on the workshop we observed at the Design Museum, the lesson we observed at Northwood School, and the lesson plan the teachers at Northwood gave us, we learned that a typical lesson has three main parts. The first part is an introduction, which is typically a lecture and contains most of the new content learned in the lesson. The second part is the activity, which is often hands-on. The last part of most lessons is a brief activity that summarises what students learned in the lesson, or a plenary session (commonly referred to as a plenary).

We also learned about how the teachers prefer the teacher packs' structure. From our interview at Northwood School we learned that the teachers we talked to prefer when:

- Activities do not take too long and fit into the curriculum. Ms Marry said that teachers need to cover the entire curriculum for their subject and year, which leaves no time for activities

that do not fit into their pre-existing timetables. Resources for clubs can be more flexible, taking more time and only loosely tying into what the class is currently covering.

- The Oxford Cambridge and RSA (OCR) accredits the material, if it is impossible for the activity to tie into the curriculum directly. Teachers find it much easier to justify a trip or unit of work if the lessons link to the curriculum or other accredited organisations such as the British Science Association and its CREST Awards. According to Ms Marry, students also enjoy it if they receive a permanent mark of achievement, such as a badge or certificate. Tying into awards can also make the resources easier to find by teachers at other organisations.
- The lesson plans keep both high and low-achieving students in mind. Northwood's lesson plans always had expectations for high-achieving students (HAPS), moderately-achieving students (MAPS), and low-achieving students (LAPS), often having separate worksheets for the different groups.
- The lesson plans list links to the curriculum and learning outcomes to allow teachers to identify where lessons fit in their curriculum and what they teach.
- The worksheets and handouts for students photocopy well. To photocopy well, worksheets should be in black and white and any photos on the handouts should endure loss of quality without losing information. According to all three teachers, the *Live 'n' Deadly* packet was generally good, but was too busy and would not have enough contrast when photocopied in black and white.
- All resources have a clean design, especially those that teachers will photocopy. The materials we brought from the Thackray Medical Museum, which were at least 50 pages of text and a few printouts of drawings, were boring and too dense according to all three teachers.
- Teacher reading material is short. According to Mr Houston and the teachers we talked to, teachers have limited time and resources, and are unlikely to read background information if there is too much of it.
- Instructions are clear. All three of the teachers in the interview recommended the Science Museum's *Kitchen Science* packet as an example of clear, step-by-step instructions. Mr Thaker said it was perfect for his science club, and plans on using some of the activities.

- All the resources have a brand. According to Ms Marry, branding the resources not only helps organisation, but students will notice that the lessons are from a different organisation than usual, which interests students.

The entire transcripts of the two pre-pilot interviews are in Appendix F.

4.2 The teaching materials for the "Designer, Maker, User" exhibition

When we created our lesson plans, Mr Houston requested that our resources link to the permanent exhibition. Initially, we believed this request meant our lesson plans should focus on specific objects from the permanent exhibit, but after clarification from Mr Houston we realised we should focus on the themes of the exhibition as well. We decided to keep individual objects as the focus of each lesson to create a story within the lesson, but also combined our ideas with the themes of the permanent exhibition.

To begin, we created an initial lesson plan instructing students to make a car using a balloon and straws and presented it to Mr Houston and Ms Ferguson to receive feedback. They saw the lesson plan as too specific, and said it did not encourage the students' creativity, which they wished to cultivate in STEAM resources. Ms Ferguson requested that we include a story in each lesson plan, which would provide context for the lesson. Mr Houston added that he wished to see an object in the lesson plan that linked to the Design Museum's permanent exhibition, as well as more background information on the designer and object. Mr Houston also requested the following sections in each lesson plan: an introduction, the main activity, and a plenary session.

Additionally, we met with Assistant Curator Ms Suggett and Senior Curator Mr Newson to go over the sections of the exhibition, since Mr Houston requested that we link the resources to individual sections of the permanent exhibition. Excluding the introduction to the exhibit and the activity table, there are three sections corresponding to the "Designer, Maker, User" themes. Each section has its own title and topic. There are also subsections in each section to categorize specific objects or subtopics more clearly. With the feedback we obtained from Mr Houston, Ms Ferguson, Ms Suggett, and Mr Newson, we then developed drafts for four different lesson plans. We titled these drafts of the lesson plans *Advertise a Chair, Newspaper Chair, Balloon Vehicle*, and *Kitchen Design*. We then presented these drafts to Mr Houston for his comments.

The *Advertise a Chair* lesson plan had students create an advertisement for a chair based on the needs of a specific user profile. It featured a set of 60 cards, half of which listed different chair designs and their features, and half of which displayed different user profiles. The user profiles were text stories explaining the needs of each user, such as her career, hobbies, and preferences. The students needed to match a chair to another user and then create an advertisement based around their own design for a chair. The *Newspaper Chair* lesson plan discussed various types of chairs made out of different materials and then had students create a chair in groups using newspapers and tape. *Balloon Vehicle* was similar to the initial lesson plan, except instead of creating models based on race cars and ice cream trucks, the students would create vehicles based on double-decker buses. Finally, the *Kitchen Design* lesson plan made students discuss the designs of various kettles before creating their own kettles using aluminium foil.

Of these lesson plans, Mr Houston identified *Newspaper Chair* as closest to the Design Museum's ideal set of resources. He explained that the lesson plan had the potential for a story on a specific object and that we could base the activity on a theme using that object - in this case, chairs designed using different materials. He also pointed out that our lesson plans lacked links to specific sections in the permanent exhibition. Thus, in subsequent iterations, we based our lesson plans on the structure of the lesson plan for the *Newspaper Chair*, which included a list of links to the curriculum, links to the exhibition, and materials needed for the activity. We also took Mr Houston's suggestion to use the Wiggle Chair designed by Frank Gehry as the focus of the first half of the lesson plan. The Wiggle Chair, which will be in the "User" section of the exhibition, allowed us to create a story about the object and the designer.

Using the feedback we obtained from Mr Houston, we created another five lesson plans while also refining the initial *Newspaper Chair* lesson plan, which we retitled the *Wibble, Wobble, Wiggle Chair* lesson plan. We kept three of the drafts we initially created - *Newspaper Chair*, *Balloon Vehicle*, and *Kitchen Design* - to revise for later drafts. The *Balloon Vehicle* and *Kitchen Design* lesson plans resembled the *Newspaper Chair* lesson plan in structure and organisation. However, we removed *Advertise a Chair* from subsequent iterations because Mr Houston suggested we only have one lesson plan linked to chairs. We have listed the final set of lesson plans in the table below:

Lesson plan title	Brief description	Link to exhibition	Appendix
The Valiant Vespa	Teaches students about design and transportation and have the student construct a balloon vehicle	 Vespa clubman scooter	G1, H1
Brains and Braun: Less but Better	Teaches students about industrial design and user interaction	 Phonosuper SK5	G2, H2
Krazy Kettles and Trendy Teapots	Teaches students about user profiles and the differences between kettles and teapots.	 Various teapots	G3, H3
From the Streets to the Schools	Teaches about road sign standardisation and students create a sign for their school.	 Multiple prototype signs	G4, H4
Simply Sugru	Teaches students about fixing and improving objects based on aesthetic and functional design	 Sugru	G5, H5
Wibble, Wobble, Wiggle Chair	Teaches students about materials and students build a newspaper chair.	 Wiggle Side Chair	G6, H6

Table 3: Teacher pack lesson plan descriptions

The Valiant Vespa is the redrafted lesson plan for the original *Balloon Vehicle* lesson plan. Instead of a using a double-decker bus as the focus of the lesson, we used a Vespa since the Design

Museum would include a Vespa as part of the permanent exhibition. We revised the activity accordingly so that the lesson plan no longer included instructions on how to create a vehicle that contained two floors. The Vespa will be in the "Designer" section of the permanent exhibition.

The *Brains and Braun: Less but Better* lesson plan instructs students on how to design a control panel for an electronic object using paper and colouring pencils. The object used as the focus of the lesson was the Braun SK5, which was a dual-purpose radio and record player that was famous for its simplified design and popularity. In particular, we chose the Braun SK5 in order to teach students techniques about industrial design, and how designers use certain techniques to guide the user on how to use an object without any direct instructions from the designer. The SK5 will be in the "User" section of the exhibition.

We created the *Krazy Kettles and Trendy Teapots* lesson plan using the previous *Kitchen Design* activity, but we had to modify the lesson because the Design Museum curators removed some of the kettles from the list of objects shown in the permanent exhibit. To accommodate the changes in the exhibition plans, we added the option to design teapots. The object chosen for the lesson was the Hot Bertaa kettle, which Philippe Starck designed to fill and pour water through the handle. We chose this kettle to teach students about design choices related to functionality and external factors such as thermal conductivity. The lesson plan was originally a "Maker" section activity because the kettles were in the kitchen exhibit located in that section, but because the teapots will be in the "User" section, we reclassified the lesson.

From the Streets to the School gives students the task of identifying signs used in a school building as well as critically analysing the designs of those signs. Examples of signs included emergency exit signs, nameplates, and push or pull signs. The objects used as the focus of the lesson were the UK road signs designed by Margaret Calvert and Jock Kinneir, which were the first standardised road signs in Britain. The road signs will be in the "Designer" section of the exhibition.

We based *Simply Sugru* on the Sugru object, which is a type of material used to repair or improve objects. Jane ni Dhulchaointigh created Sugru to teach students about the material sciences and why specific materials are important in the design of an object. We based the activity on improving an object in the student's classroom, such as a book or piece of furniture, and adding or removing a feature of the object in some way. Sugru will be in the "Maker" section of the exhibition.

Due to the different attention spans and reading levels of the two key stages, we decided that the activities for the KS2 students should be hands-on, while the KS3 lesson should be a hybrid of

lecture, discussion, and hands-on activities. The activities should last between 20 - 40 minutes according to the feedback we received from both the KS2 and KS3 teacher interviews. In order to confirm that our lesson plans could meet these requirements, we created a chair based on the instructions listed in the *Wibble, Wobble, Wiggle Chair* activity and used the materials given in the lesson plan. We determined the activities should last between 20 - 40 minutes because the KS2 teacher we spoke with conducts lessons that are normally 35 minutes long, and the KS3 teachers we spoke with conduct lessons that are normally 60 minutes long. Thus, the portion of the lesson devoted to the activity would need to be long enough to give the students sufficient time to complete the activity, but still leave enough time for the teacher to cover the other parts of the lesson, such as the introduction and plenary session.

We discovered that while the activity fit our pre-established time requirements, which we based on our teacher interviews, the difficulty of the activity was too high for early KS2 students. Thus, we redrafted our lesson plan to create another lesson plan with a different version of the activity, separate from the KS3 activity, which we gave to the KS2 students during our pilot programme. In the test of the activity we created a simplified chair that lacked a back, but which students could still use to balance textbooks to measure how structurally sound it was. Additionally, this activity took less time than the previous activity, so it was better suited to KS2 lessons that had to run in a shorter time slot.

With the information obtained during our trial run of the *Wibble, Wobble, Wiggle Chair* activity, we separated each of the activities in our other lesson plans to create a KS2 version and a KS3 version of each lesson plan. For the KS2 version of each activity, we knew from Mr Houston's feedback that we could not let the students have open-ended activities, and as a result developed a set of instructions for students to create or design an object that still related to the context of the lesson plan. For the KS3 activities, we kept the instructions for the activity broad compared to the KS2 activity, which allowed the students to demonstrate their creativity and problem-solving skills. After creating an alternate version of each lesson plan for the KS2 teacher's pack, we had produced a total of twelve lesson plans for the teacher packs. The completed versions of each lesson plan are in Appendix G and H. We also created an introductory PowerPoint presentation to link to the lesson for *Wibble, Wobble, Wiggle Chair* (Appendix G6 and H6,) but we were unable to create additional presentations for the other lesson plans due to time constraints.

Separate from the teacher packs, we also created a set of visiting materials that students will use before, during, and after a visit to the Design Museum (Appendix I). The pre-visit resources (Appendix I1) instruct students on how to create a booklet to use during their visit to the museum. It also introduced the students to the "Designer, Maker, User" themes that the permanent exhibition will follow, as well as several objects that will be within the museum. We created an additional introductory PowerPoint presentation (Appendix I) for the pre-visit lesson plan, but we did not create presentations for the other visiting materials due to time constraints. The during-visit resources (Appendix I2) instructed students on how to fill in their booklet from the pre-visit resources by going through each section of the exhibit. In particular, we created the during-visit resources to make students think critically about the designer, the production process, and why designers design objects for users. After creating an initial draft of the booklet, we then developed a separate KS2 version of the booklet. Finally, the post-visit (Appendix I3) discussion questions ask students about their favourite objects and connections between the exhibition and their lives. We designed the post-visit resources with the intent for students to reflect on their visit and what they learned. The pre-visit and post-visit materials are the same between KS2 and KS3 because we were unable to create separate versions of the materials due to time constraints.

4.3 Assessment of the newly created lesson plans, analysis of the results, and adjustment of the material accordingly

After completing our teacher pack lesson plans and having them approved by the Design Museum staff, we conducted a series of pilots on varying groups to further the evaluation. We compiled the data into a graphical format and used the results to improve our lesson plans and make recommendations to the Design Museum.

4.3.1 Pilot programmes and observations

After we developed the lesson plans for the teacher's pack we ran a series of pilot tests. The first pilot test we conducted was on 12 April with an after-school science club at Northwood School. Participating in the pilot were a total of eight students, three girls and five boys, ranging from years seven to nine and ages twelve to fifteen. Mr Thaker, the science club's teacher, was also present. The lecture portion of the lesson engaged all the students and their responses were more

advanced than what we expected. When we asked about materials that designers made chairs out of, the students' answers were what we expected (metal, plastic, wood, glass), but the students also gave more complex materials, such as carbon fibre and specific plastic composites, as answers. At the beginning of the lesson, only a few students raised their hands, but as time went on, we were able to call on everyone.

After discussing chair materials and watching a short video about cardboard and the Wiggle Side Chair, we moved on to the activity of the lesson. The introduction to the lesson took 20 - 25 minutes, which was longer than the ten minutes we had previously allocated for it. Part of this length was because we were unable to start immediately - two students arrived late before we began the lesson, but we also misjudged the length of the questions in the introduction.

We received a large amount of participation in the activity section of the lesson, possibly because hands-on activities tend to be engaging (Prince, 2004). It is also possible that our lesson plan engaged students because we were running the pilot at a science club, which is heavily biased toward students interested in science and in furthering their learning of a science discipline. We put out the newspaper at the beginning of the lesson, but the students did not touch it or fiddle with it during the introduction, exceeding our expectations. Our sample was also likely biased because of a small sample population. It took less than 30 seconds for the students to form into groups because the students were already sitting in tables with four chairs.

During the activity phase of the lesson, we walked around separately and observed how the two groups approached building their newspaper chair. One group (henceforth referred to as group one) included all three girls. Both group one and the second group (henceforth referred to as group two) discussed the plans for the chair for about ten minutes before starting to fold their newspapers. We provided hints for the activity to both groups five minutes into the activity, but the students were mostly self-guided and we gave them no specific instructions on how to use the newspapers. Twelve minutes in, group two settled on a design using three legs of newspapers folded into small squares taped on top of each other. Group one rolled a few sheets of newspaper into tubes while continuing to discuss ideas.

The amount of time which the students in the first group needed to begin rolling the newspaper was longer than we expected, and creating tubes out of the newspapers never occurred to the students in group two. However, we correctly anticipated that different groups of students would have different approaches to the activity, as different people have different thought processes.

Additionally, changes to a problem's presentation to the student will greatly affect the way in which she approaches it (Laurillard, 1997). At this point, one of the students in group one sketched out her design idea. Different individuals assigned themselves different tasks in the groups especially group two. In group one, one of the students folded the newspaper into triangles while the others were creating tubes.

Roughly 20 minutes into the activity, group one had created what they described as a director's chair, where two tubes crossed in an "X" pattern to the left and right of a rectangular platform. Meanwhile, group two had finished making less than one leg of their chair. Group one determined that their chair was slightly unstable, so they added some rolls of paper on the bottom of the chair from left to right. In the last few minutes (around minute 29 of the activity), one of the students in group one started adding lots of tape to the chair to hold it up and group two added a base of newspaper, as well as another newspaper to act as a platform for the textbooks that the chair needed to hold. The two groups did not spend time looking at the other group's chair while working on their chair during this time.

Group one's chair was able to support five books before collapsing with the sixth. Each book was about ¾ of an inch thick, and about the size of an A4 sheet of paper. Group two's tower was able to support all ten of the books we had on hand, but only held them a few inches off the ground due to the chair's height. We show the students' final designs below, where we labelled group one's design chair A and group two's design chair B. Unfortunately we took the picture of group one's chair after the chair collapsed.

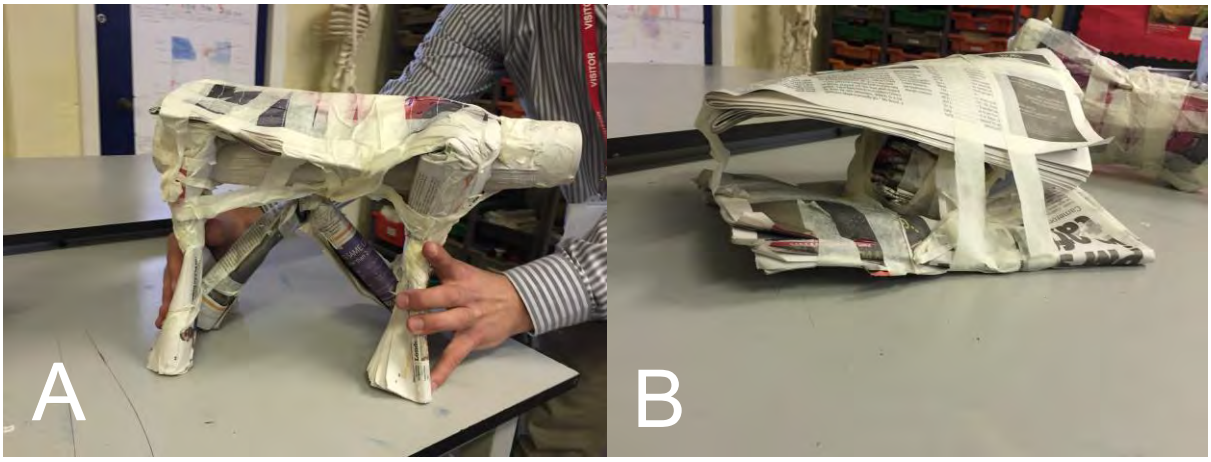


Figure 2: Final design of the two groups from KS3 pilot

Afterwards, we asked the students what they would do next time if they were to build a newspaper chair again. A student from group one said that she would make sure the tubes were able to support weight, and a student from group two said he would add supports to the sides. We were unable to have a longer plenary session since there was not enough time left in the lesson. We then passed out our surveys. After the students completed the surveys and left, we interviewed the teacher, Mr Thaker. The observation matrices for this lesson are in Appendix L.

We conducted our second pilot programme at Colville Primary School with a series of hour-long art classes for students in years three and four (ages seven to nine) on 14 April. We taught the lesson four times to four different classes - two year four classes before lunch and two year three classes in the afternoon. We taught the lesson using the KS2 version of the *Wibble, Wobble, Wiggle Chair*, which had a shorter lecture and detailed instructions for building a stool-like chair. There were eight adults in the classroom for the first class: our team, Mr Houston, Joyce Tackie (the art teacher), the regular teacher for the current class, and a teaching assistant. The teaching assistant left after the first lesson, leaving us with seven adults. Before the first lesson, Joyce Tackie suggested that we remove inappropriate pictures from the newspapers we had brought, which was not something that had occurred to us. Pictures of some of the students' final designs are below:

Figure 3: Pictures of the KS2 students' final designs

The first lesson had 22 students. Our introductory lecture took 20 minutes, and the students seemed engaged in answering questions. The students were also attentive to the lecture, questions,

and video, and discussion of different prices of chairs made of varying materials was especially interesting to students.

After the introduction, Ms Tackie split the students up into groups, which took less than one minute. We began our demonstration of how to roll four sheets of newspaper into a tube. Despite the demonstration, pictures in the presentation, and all eight of the adults assisting the students, many of the students had difficulty with figuring out how to roll their newspaper. The students had particular trouble determining how many sheets of newspaper to use for a tube and how to remove the sheets from the staples of the newspapers because we did not explicitly describe the process in the presentation. Fifteen minutes later, all the students finished making newspaper tubes. Students were able to bundle their tubes together quickly, though that also often required instructor help. A few students had trouble ripping the tape, so we brought out several scissors, which were not listed in our materials for our lesson plans. Having more than one roll of tape per group was also helpful for the students, with three rolls per table with eight chairs and two groups. Although we ran low on time, the students were still able to test their chairs with student art books, and were, for the most part, successful in creating a finished product. We also had time for the students to answer our survey.

The later lessons went similarly. The second class had 25 students, which meant we had five groups of four students and one group of five students. When we asked the students in the later classes if they thought they could build a chair out of paper, students told us that they could, presumably because they could see the previous classes' chairs that Ms Tackie displayed around the room. Rolling the paper also took less time for the same reason, which left enough time for the students to add backs or arms to their chairs after testing by stacking notebooks on the chairs. The introductory lecture took roughly 15 minutes for the three later classes. The year three students in the afternoon were less focused, and the classes were more disruptive as a result. Ms Tackie and the classes' regular teachers handled disciplining the students. The last class of the day was shorter than the previous classes because the students arrived late and needed to end early to prepare for the end of the school day, so we skipped showing them the video during the introduction. Despite the reduced amount of time for the lesson, all the groups in the last class were able to finish their chairs.

4.3.2 Pilot programme survey results

In the KS3 survey results, seven of the eight students reported that they enjoyed the activity, rating their enjoyment a five on a one to five scale (Appendix J1). Four out of eight students said they spent one to five minutes on planning the design of their chair, but our observations showed that the students spent longer on their designs - approximately 10 to 15 minutes per group. Presumably, this discrepancy was present because the activity engaged the students, and therefore the students lost track of time during the planning stage of the activity. Five out of eight students reported that their favourite part of the activity was testing their newspaper chair, while three out of eight students reported that their favourite part of the activity was building their newspaper chair, showing that the hands-on activity was well liked among the KS3 groups. Three out of eight students marked "Other" as their least favourite part of the lesson, where the students described "Other" as: "Being stopped from using too much tape," "non" *[sic, presumably none]*, or "nothing." All the students were able to improve their designs after observing other designs in the room. Finally, in question six, we asked an open-ended question concerning the design of the chair, and determined the success of answers based on a question rubric. By the end of the lesson, three out of eight students were able to identify both an important aspect of the chair and explain why that aspect made the chair efficient.

For the KS2 survey results, we received 93 responses to the first question, 91 responses to the second question, and 90 responses to the third question (Appendix J2). We did not include several responses that were illegible or unanswered in our analysis. For the first question, which asks how students felt while building the chair, 84 students reported that they felt happy while building their chair, indicating the majority of students enjoyed the activity. On question two, which asks how students felt working with their team, 62 students reported that they felt happy while working with their group, indicating that the majority of students enjoyed working with their classmates. Finally, on question three, which asks how well the student's chair would work for James, the user, 62 students reported that the user, James, would feel happy about their chair. This response indicates that the students were aware of the connection between the design and the user.

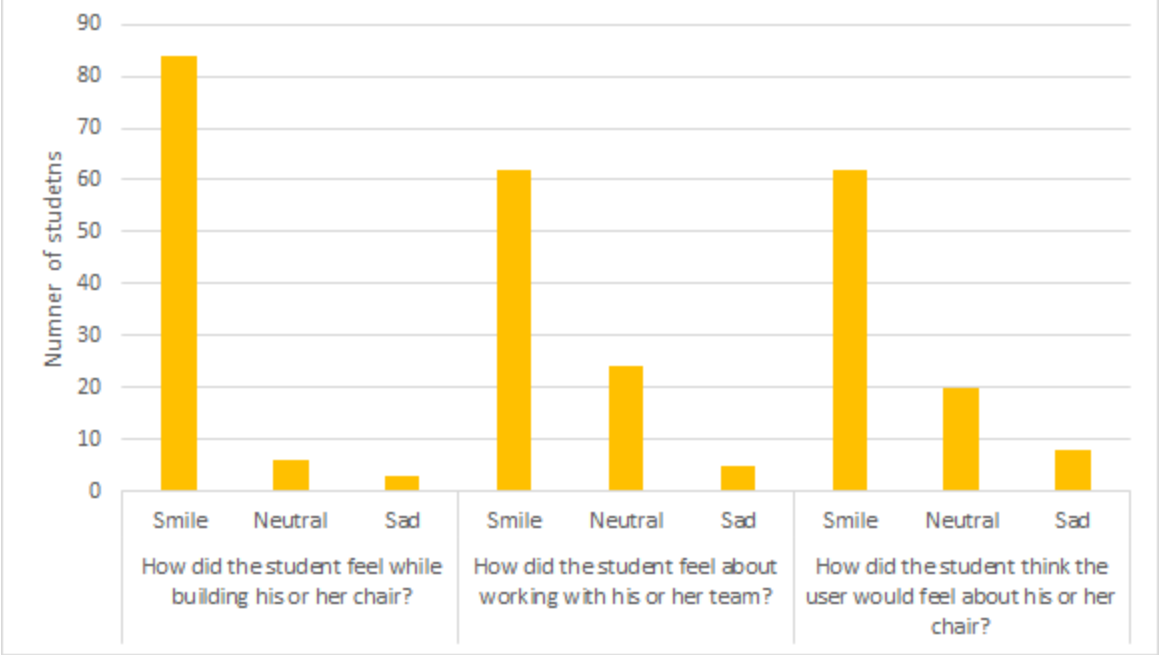


Figure 4: KS2 student evaluation for Wibble, Wobble, Wiggle Chair lesson (n=93)

In addition to the student survey following our pilot programme, we interviewed the two teachers involved in the pilot by asking them the questions we developed for our teacher surveys. The KS3 science club teacher, Mr Thaker, evaluated our lesson as complete in terms of content and length, and that the material was appropriate for the age range of his students (Appendix K1). He appreciated that the materials listed the links to the curriculum at the top of the page. He did, however, inform us that the material could go more in depth or cover more advanced topics, such as more advanced versions of the materials discussed in the lesson. He also recommended placing the learning outcomes at the top of the lesson plan, as well as the average time the lesson would take.

The KS2 design and technology teacher, Ms Tackie, was also satisfied with the lesson, but believed that the lesson lacked options for more advanced students (Appendix K2). Like the KS3 teacher, however, she approved the lesson and believed it was appropriate for the age range of her students, and that it matched her expectations on content, length, and organisation.

4.3.3 Assessments and improvements to educational material

As a result of our pilot programme and corresponding survey results, we determined various ways in which we could improve our lesson plans. Both teachers we talked to after the pilot programmes and most of the students in both KS2 and KS3 enjoyed the *Wibble, Wobble, Wiggle Chair*

lesson, so we did not need to make any drastic changes to the lesson. However, there were many suggestions for changes on a smaller scale. For example, we underestimated the length of time that the introduction requires, so we increased the time allocated for the introductory section. The other lessons we created have lectures of similar length, so we increased the allotted time for those lessons as well. From talking to Mr Thaker, we learned that we should highlight the length of the lesson as well as the learning outcomes at the top of the page. He also recommended that we add a keywords section. We have done so on one of our lessons. We learned that the *Wibble, Wobble, Wiggle Chair* lesson was age appropriate both in its KS2 and KS3 incarnations. We have since revised all our other lesson plans to match the *Wibble, Wobble, Wiggle Chair* lesson plan in complexity for KS2 and KS3. During our interview with Ms Tackie, she suggested that we have large printouts of the chairs to pass out to students at the beginning of the lesson, so we added them as supplementary materials to the lesson plan. We also added similar supplementary content to our other lesson plans. During the pilot at Colville Primary School, Mr Houston said that we should go more in depth when covering Frank Gehry and his creation of the Wiggle Side Chair. We have since added a paragraph to both the KS3 and KS2 version of the lesson plan about Frank Gehry and information on his creation of the Wiggle Side Chair. Our other lesson plans had a similar level of coverage on the designers in those lessons, so we added additional information about the designers in the other lesson plans as well.

5. Conclusions and recommendations

Our team has developed 16 educational resources for the Design Museum to use in order to educate both students and teachers on design concepts relating to the "Designer, Maker, User" exhibition. In this chapter, we discuss the results of our pilot programme and outline our team's recommendations for the Design Museum to continue the development of successful educational resources. We also discuss elements of our lesson plans that we determined made them successful.

5.1 Conclusions

The goal of this project was to create educational resources that introduce students to design through the STEAM subjects. The Design Museum requested that the materials created be a representation of their permanent exhibition, "Designer, Maker, User." To test that our lesson plans

were capable of engaging and teaching students about the themes related to "Designer, Maker, User," we planned to test all of our lesson plans in a pilot program, after which we planned to revise our lesson plans according to our results. Unfortunately, due to time constraints, we were only able to test one of our lesson plans. We were also unable to assess progress of learning outcomes due to logistical constraints.

During the pilot program, we defined three parameters to test over the course of the lesson: whether the lesson engaged students, whether students can identify an important part of their designs, and what effects observing other designs would have on the student's own design. Additionally, the observation matrix we created looked for behaviour based on the following five parameters: whether hands-on engineering-based activities engaged the students in design, what instructions most confused the students, how much time students require to complete an activity, what components the students identified to be important in their designs, and whether students were able to improve their designs in further iterations.

We observed that the lesson engaged both KS3 and KS2 students - according to exhibited behaviour and body language, such as eyes directed at the lecturer, raised hands when prompted with questions, and a lack of behaviour indicating a lack of engagement (for example, including broken eye contact, speaking with classmates during the lecture, and refusing to participate in the activity portion of the lesson). We also observed that students were able to use key components of their designs because every group in each lesson was able to build a chair, where we defined success as whether the students could place five books on the chair without it collapsing. However, while all the KS3 students who participated in the programme claimed to improve their designs after observation of other groups, we are sceptical of this claim because we did not give the students a significant amount of time to observe the design belonging the other group. Additionally, the KS3 students were only able to create one iteration of their chairs, so we were unable to observe whether they would be able to improve their designs. The KS2 students, however, were able to improve their chairs when given enough time, where we defined improvements as additional features or add-ons to their newspaper chairs. We observed that students in later classes of the series of four KS2 classes were able to complete the activity more quickly compared to earlier classes. According to the KS2 teacher who participated in the programme, the reason the KS2 students were able to complete the activity more quickly in later lessons was because they could see the projects previous classes completed upon entering the room and, for the classes after lunch, the students had talked about the

class during recess. As a result, we concluded that KS2 are able to improve their designs after observing the designs of other groups. We also believe that KS3 students would be able to complete the activity quickly, assuming students could observe the completed projects of other groups from previous classes.

The student surveys for both KS2 and KS3 were unable to obtain significant useful data from the students. The data we collected was not useful because many of the student responses seemed unreliable or not relevant, KS2 responses in particular. However, the lack of relevant responses was also partly because our surveys lacked complex questions that would encapsulate our research questions fully, especially in the KS2 surveys. As a result, much of the information we obtained over the course of the pilot programme was from our observation matrix and teacher interviews. Additionally, our pilot programme lacked significant information on the success of our lesson plans aside from *Wibble, Wobble, Wiggle Chair,* where we defined a lesson plan's success as whether we could observe all of the following points: whether the lesson engaged students, whether students can identify an important part of their designs, and what effects observing other designs would have on the student's own design. We did not define the success of a lesson plan by whether we met the learning outcomes of the lesson plan, as Mr Houston requested that we not spend excessive time developing the learning outcomes prior before the start of the pilot programme. As a result, we cannot accurately say whether our lesson plans are capable of conveying learning outcomes for our lesson plans. While we based most of our lesson plans on the *Wibble, Wobble, Wiggle Chair* lesson plan and thus shared similar structure and organisation, we were unable to obtain information related to whether the lesson plan engaged students or their understanding of design topics enhanced using different content, curriculum links, or objects from the Design Museum exhibition.

The classes that participated in the pilot programme were diverse in gender and ethnic groups in both KS2 and KS3. During the pilot programme, we did not investigate whether our lesson plans would have different effects on either of these groups because the Design Museum did not request this analysis and we did not expect significant results from such an analysis. Instead, we chose to focus on whether our lesson plans could engage students of different age groups, primarily those of KS2 (ages seven to ten) and KS3 (ages eleven to fourteen). In a discussion with Martin Webber, Curriculum Leader (Engineering) with OCR, we learned that there is a large gap in mental development between these key stages, both in terms of behaviour as well as understanding of

complex subjects (personal communication, 17 March 2016). Therefore, our primary goal of the pilot programme was to measure whether our lesson plans could sufficiently engage and teach students of both KS2 and KS3, where we used similar lesson plans in separate environments.

According to our observation matrices and feedback from the teachers who participating in the programme, we believe that the lesson plan we tested in the pilot programme was a success and met all of our expectations for the defined parameters. However, we must acknowledge that the scope and depth of our tests in the pilot programme were narrow due to logistical constraints, and therefore our other lesson plans should be thoroughly tested before selling them in the Design Museum. We have included this recommendation along with our other recommendations to the Design Museum.

5.2 Recommendations on approaches to pilot programmes

We recommend to the Design Museum the continued pilot testing and development of our lesson plans and visiting materials. In particular, we recommend further testing of the lesson plans that were not tested during the pilot programme, as well as all the visiting materials, for both KS2 and KS3. Additionally, our pilot tests lacked scope and depth, and we recommend that the Design Museum test the lesson plans with a wider variety of students, as we did not investigate whether our lesson plans had different effects on students of different genders or ethnicity.

During our pilot programme, we gained the most information from our observations and teacher interviews. Our observation matrix was not ideal, however - we did pencil in a timeline for each of the lessons since we did not include one in the printout. We did not make significant additional observations by repeating the lesson at Colville Primary School three times after the first. We recommend that when the Design Museum develops new educational resources, it runs the pilot programme once with each target age group, interview the teachers afterwards, and complete an observation matrix, containing a timeline, during the activity.

We also did not investigate whether students met the learning outcomes that we created for each lesson plan, as Mr Houston requested that we not focus on them during the pilot programme. For future pilot programmes, we recommend that the Design Museum assess whether students met the required learning outcomes by using a hybrid of an observation matrix and assessment after the programme. The assessment would contain questions pertaining to each learning outcome and we

would assess each of them using a matrix listing the parameters for each question. We used the observation matrix to assess student behaviour during the lesson, and would provide supplementary information about whether the students were able to meet the learning outcomes in case the answers to the assessment proved irrelevant or unreliable.

5.3 Recommendations on characteristics of lesson plans

While creating the set of our 16 educational resources, we learned details of how to develop content for the educational materials and details of logistics and formatting of our lesson plans. Our team recorded all of our discoveries throughout the development process and have compiled them into a compact set of recommendations to streamline the creation of future lesson plans at the Design Museum.

Teachers at both Northwood School and Colville Primary School indicated that they are unlikely to use lessons that take too much time, so we recommend that new lessons should fit within one class period (approximately one hour), though resources for clubs can be more flexible. We recommend that the length and learning outcomes of a lesson, or set of lessons, are clearly marked because they are important criteria that determine whether a teacher uses a particular lesson.

Our introductory lectures took about 15 - 20 minutes, which the teachers we interviewed after the pilot programme believed was a reasonable length. The questions in the lesson helped keep the students engaged. We recommend that the Design Museum continues to include similar questions from our resources in their workshops and teaching materials, and plan for the introductory lectures to take about 15 - 20 minutes. Since teachers at Colville Primary School and Northwood School spend no longer than one lesson preparing for a museum visit and rarely spend time afterwards on the visit, we recommend that, for future exhibitions, the Design Museum creates a brief introduction to the exhibition that includes what students should know before the visit and possibly some materials to excite students before their visit.

Because the teachers we interviewed praised the fact that we included links to the curriculum in our lesson plans, we recommend that the Design Museum considers school curriculum when developing its lessons. Teachers at Northwood School indicated that they are more able to use materials that have an accreditation or award, especially those that do not have strong links to their current curriculum, because they are more justifiable to the school than materials without outside

accreditation. While many accreditations in the UK educational system do not require additional awards to be accredited, all the accreditations we examined - except for the Discovery-level Award and the primary-school-level awards from the accredited CREST Award programme - require a greater investment of student and teacher time than the materials we produced. We recommend that the Design Museum consider obtaining accreditations for future teacher's packs or material associated with a visit to the museum.

We initially attempted to create several lessons by brainstorming an activity for the students and then trying to find an object or story that relates to the exhibition, but had difficulty finding appropriate links to the Design Museum's permanent exhibition. While a viable strategy, we recommend that the Design Museum primarily takes the opposite route when creating new material, and instead starts with the object or story and builds an activity around it, rather than attempting to create lessons around an initial activity.

At both Northwood School and Colville Primary School, the teachers we spoke with gave different material to high-achieving and low-achieving students. We recommend that in future lesson plans and workshops, the Design Museum should create material that either includes explicitly different material for high and low-achieving students or material for high-achieving students that the museum can easily simplify for low-achieving students.

During the interviews at Northwood School, we learned that teachers are unlikely to adhere to a lesson plan and are likely to ignore the introduction entirely if the museum does not provide them with a PowerPoint presentation of some kind. We recommend that the Design Museum include presentations or supplementary materials for any lesson that recommends a lecture component. Teachers said that they prefer materials that photocopy well, have clear instructions for activities, and are not too dense. We recommend that the Design Museum creates future worksheets with consideration to how readable they are as black and white copies. However, at Colville Primary School, we learned that teachers would like to have supplementary materials, especially for younger students or visual learners, such as photos of objects that the lesson focuses on. We recommend that the Design Museum includes such photos as supplementary materials in the teacher pack in colour. We also recommend that any instructions for KS2 students make extensive use of pictures. We recommend that the museum brands all of its materials with the Design Museum logo, because teachers at Northwood stated that branding the material will increase publicity as well as generate

student interest. Teachers explained that students prefer to use material from sources besides their school because it is different from other materials they are accustomed to.

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Appendices

Appendix A: Design Museum educational materials

A1. Exploring Your Journey - an example of the Design Museum's current worksheets.

DISCOVER DESIGN

Discover Design is supported by Brit Insurance

EXPLORING YOUR JOURNEY

The more you look the more you see.
The more you see the more you think.
The more you think the more ideas you have.

1 Sketch a detail of Tower Bridge below. Why did you choose this detail?

2 What can you see?

The way we look can affect what we see. Carefully roll this piece of paper into a tube and imagine it is a telescope. What can you see?

Everything you see can be reduced to a set of simple lines and shapes. This is very useful when you are drawing on the move.

3 Draw a pattern that catches your eye in your sketch book.

4 Name 3 things that help us look more closely:

1.

2.

3.

As you are walking along don't forget to look both up and down. Look up and see the tops of tall buildings, balconies and the sky. Look down and see snap-shots of details like floor tiles, drain covers and road-markings.

5 Look at the different types of street furniture. Try to find one of each of these...

1. Outdoor seating
2. Bollard
3. Lighting
4. Signpost

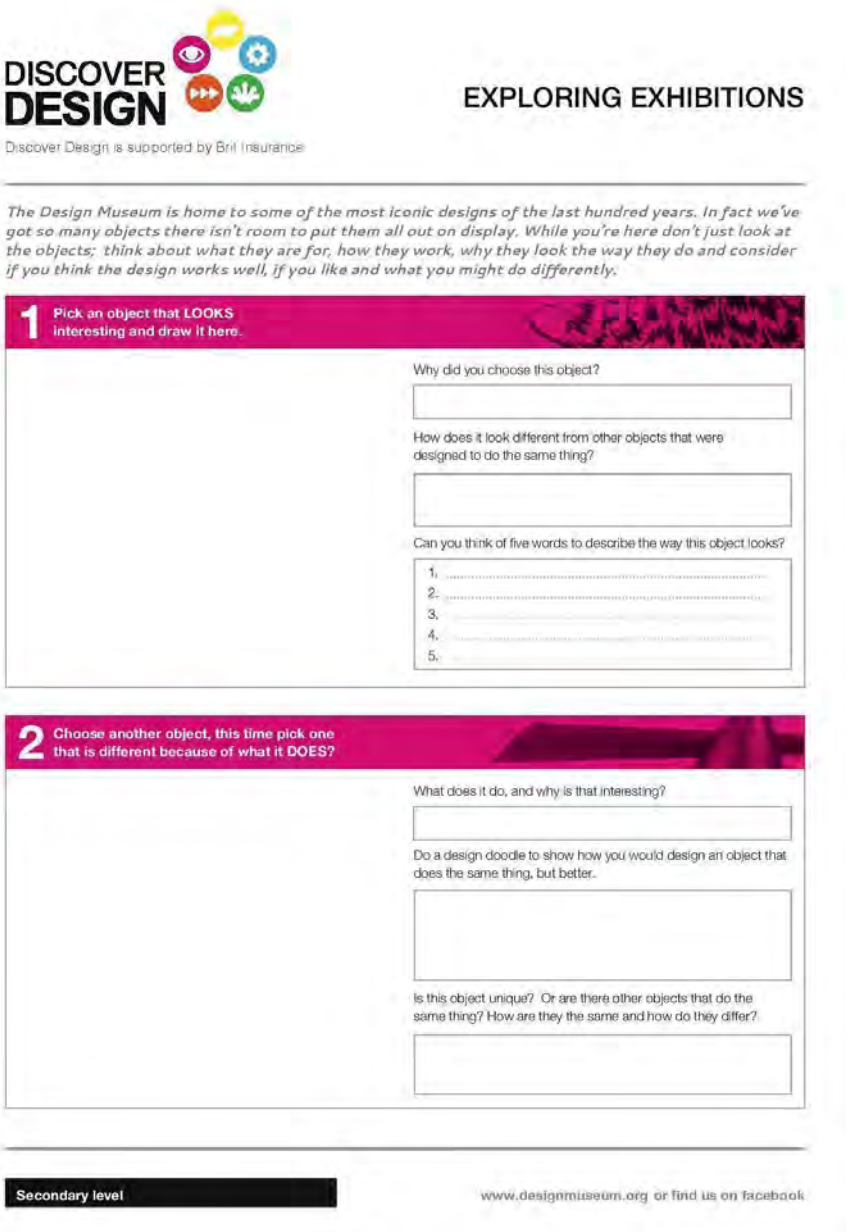
In your sketch book design your own piece of street furniture that would help other young people find their way to the Design Museum. What would it look like? Where would it go? What would it do?

Now you are looking closely at the world around you, you are ready to discover design at the Design Museum... enjoy!

Secondary level

www.designmuseum.org or find us on facebook

A2. Exploring Exhibitions - another example of the Design Museum's current educational resources.



DISCOVER DESIGN

Discover Design is supported by Brit Insurance

EXPLORING EXHIBITIONS

The Design Museum is home to some of the most iconic designs of the last hundred years. In fact we've got so many objects there isn't room to put them all out on display. While you're here don't just look at the objects; think about what they are for, how they work, why they look the way they do and consider if you think the design works well, if you like and what you might do differently.

1 **Pick an object that LOOKS interesting and draw it here.**

Why did you choose this object?

How does it look different from other objects that were designed to do the same thing?

Can you think of five words to describe the way this object looks?

1.
2.
3.
4.
5.

2 **Choose another object, this time pick one that is different because of what it DOES?**

What does it do, and why is that interesting?

Do a design doodle to show how you would design an object that does the same thing, but better.

Is this object unique? Or are there other objects that do the same thing? How are they the same and how do they differ?

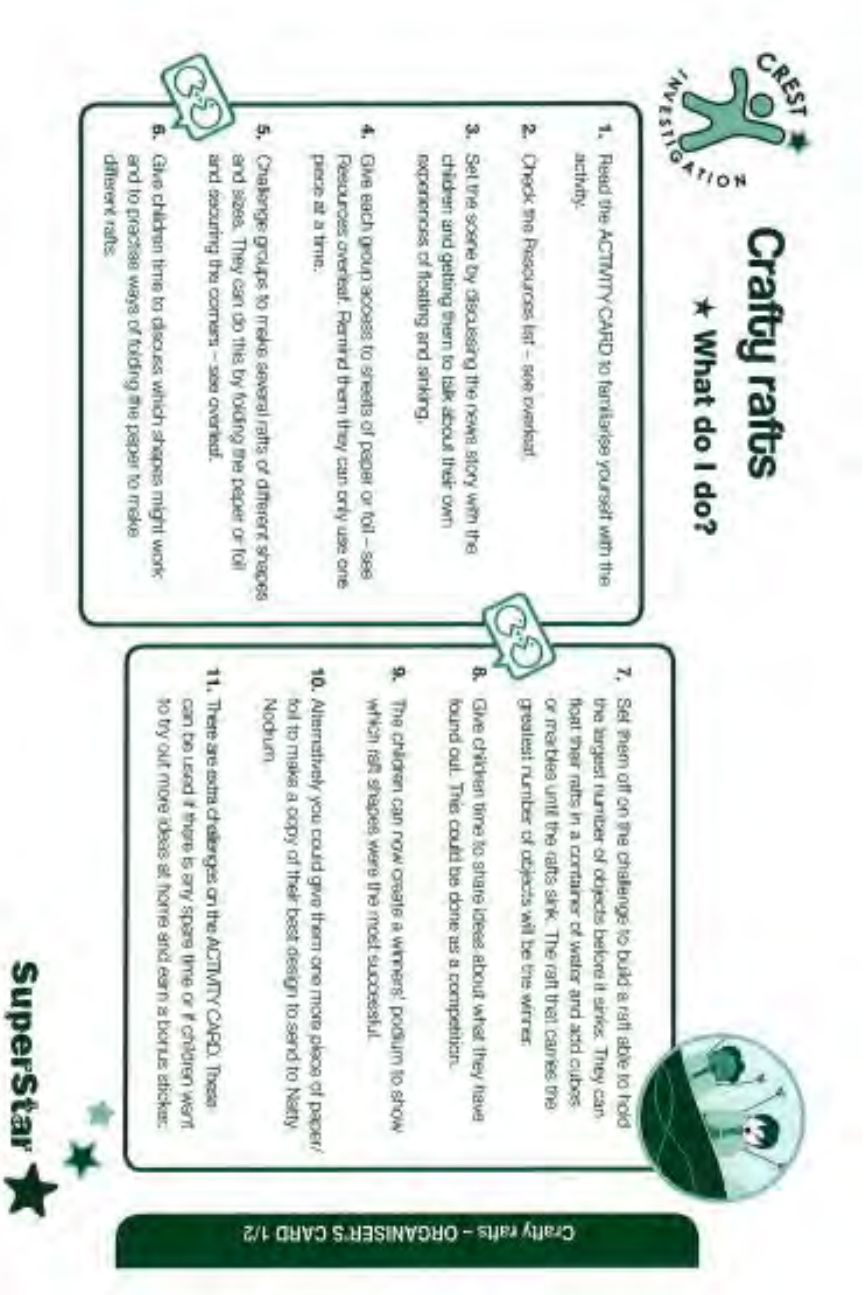
Secondary level

www.designmuseum.org or find us on facebook

(Design Museum, 199b)

Appendix B: Additional resources for comparison

B1. Crafty rafts from the British Science Association



Crafty rafts – ORGANISER'S CARD 1/2

CREST Investigation

Crafty rafts

★ What do I do?

1. Read the ACTIVITY CARD to familiarise yourself with the activity.
2. Check the Resources list – see overleaf.
3. Set the scene by discussing the news story with the children and getting them to talk about their own experiences of floating and sinking.
4. Give each group access to sheets of paper or foil – see Resources overleaf. Remind them they can only use one piece at a time.
5. Challenge groups to make several rafts of different shapes and sizes. They can do this by folding the paper or foil and adjusting the corners – see overleaf.
6. Give children time to discuss which shapes might work and to practise ways of folding the paper to make different rafts.
7. Set them off on the challenge to build a raft able to hold the largest number of objects before it sinks. They can float their rafts in a container of water and add cubes or marbles until the rafts sink. The raft that carries the greatest number of objects will be the winner.
8. Give children time to share ideas about what they have found out. This could be done as a competition.
9. The children can now create a winners' podium to show which raft shapes were the most successful.
10. Alternatively you could give them one more piece of paper/foil to make a copy of their best design to send to Natty Nodium.
11. There are extra challenges on the ACTIVITY CARD. These can be used if there is any spare time or if children want to try out more ideas at home and earn a bonus sticker.

SuperStar

★ Handy Hints

Resources

- ★ Plastic tanks or bowls of water – 1 per group
- ★ A square sheet of paper (20 cm x 20 cm) or A4 – 6 per group plus spare sheets
- ★ Foil (optional as an alternative to paper)
- ★ A set of marbles, or solid plastic or wooden cubes, all the same size – 30 per group plus lots of spares
- ★ Sellotape, masking tape, staplers, or other fasteners – provide the same for each group
- ★ Waterproof coverings if you are working on wooden desks
- ★ Other materials for raft making (e.g. different types of paper, lolly sticks, food trays, fasteners) if you want the children to do the extra challenges

Things to look out for

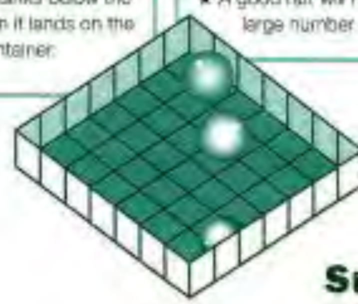
- ★ Make sure that the water is deep enough for the loaded rafts to float and not touch the bottom.
- ★ It's best if children use one sheet of paper at a time and are left to experiment with their own raft shapes.
- ★ Some children may add the objects to the raft too quickly or unevenly. Let them experiment on their own. They learn more when it goes wrong.
- ★ The children will need to agree on how they will know when a raft has officially sunk. This could be when it sinks below the water line or when it lands on the bottom of the container.

Safety

- ★ Mop up water spills quickly and collect escaped marbles to avoid accidents.

Background information

- ★ An object that is normally unable to float can be made to float by changing its shape. Different shapes will float in different ways. You will find a wide flat raft is very stable when it floats but can tip if it is loaded on one side. If the children are investigating carefully, the best raft is likely to be one with a large base and with sides approximately 1.5 cms deep.
- ★ A good raft will hold a surprisingly large number of objects.



CREST Star

SuperStar

Crafty rafts – ORGANISER'S CARD 2/2

(British Science Association, 2015a)

B2. *Milk Magic* activity from Science Museum kitchen science packet

Science Museum Learning | Kitchen Science

Milk Magic notes

Aims

- Predictions – think and pose questions such as, what happens when red and blue food colouring are mixed together?
- Observation skills – experiment and watch what happens.
- Scientific inquiry – exploring what happens when different materials are mixed together.
- Properties of materials – learn about surface tension.

Practicalities and preparation

- Test your food colouring beforehand. It should sit on top of the milk and not sink to the bottom.
- When repeating the experiment, ensure that all the food colouring and washing-up liquid have been completely removed, or the next experiment will be contaminated.
- Try putting cotton buds at different places in the milk.
- Don't stir the milk – just touch it with the tip of the cotton bud.

The science – an introduction

Milk is made up of water, vitamins, minerals, proteins and fats. When the washing-up liquid is added two things happen. First, the washing-up liquid lowers the surface tension of the milk so that the food colouring is free to flow throughout the milk. Second, the washing-up liquid makes the fats and proteins in the milk spread out. This happens very quickly, causing the liquid to swirl. The food colouring molecules bump together, letting us see the activity of the milk.

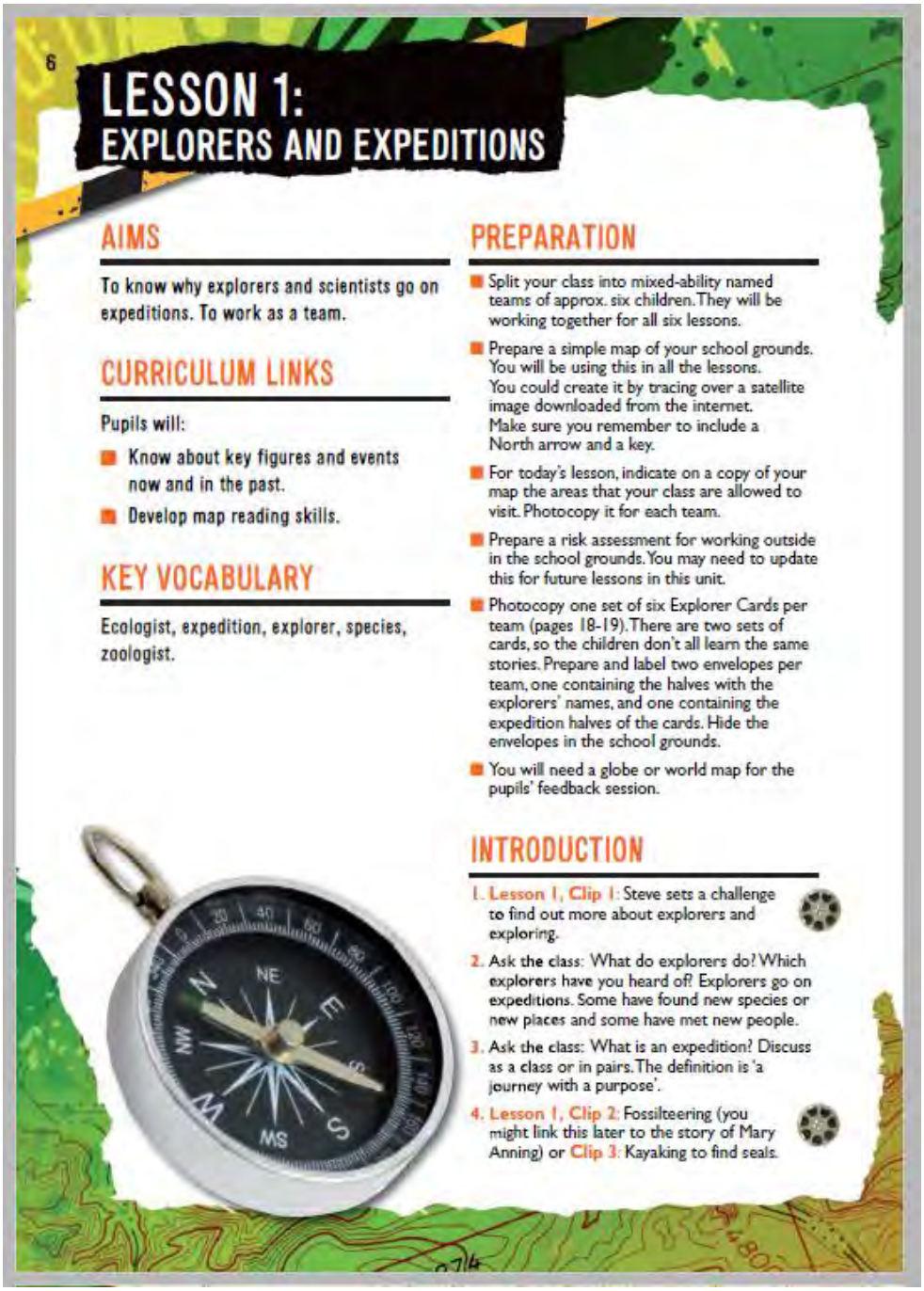
Discussion

- What colour do you think you will see when the red food colouring mixes with blue food colouring?
- Why do we see swirls in the food colouring? What is making the food colouring move?
- What happens if you use different types of milk, for example semi-skimmed, low fat or soya milk?
- What happens if you use water instead of milk? Will you get the same reaction?
- What would happen if you repeated the experiment but with washing-up liquid in place of the milk, and then dropped milk in afterwards? Would anything happen?

Page 22

(London Science Museum, 2016)

B3. *Live 'n' Deadly* teacher pack lesson plan



6

LESSON 1: EXPLORERS AND EXPEDITIONS

AIMS

To know why explorers and scientists go on expeditions. To work as a team.

CURRICULUM LINKS

Pupils will:

- Know about key figures and events now and in the past.
- Develop map reading skills.

KEY VOCABULARY

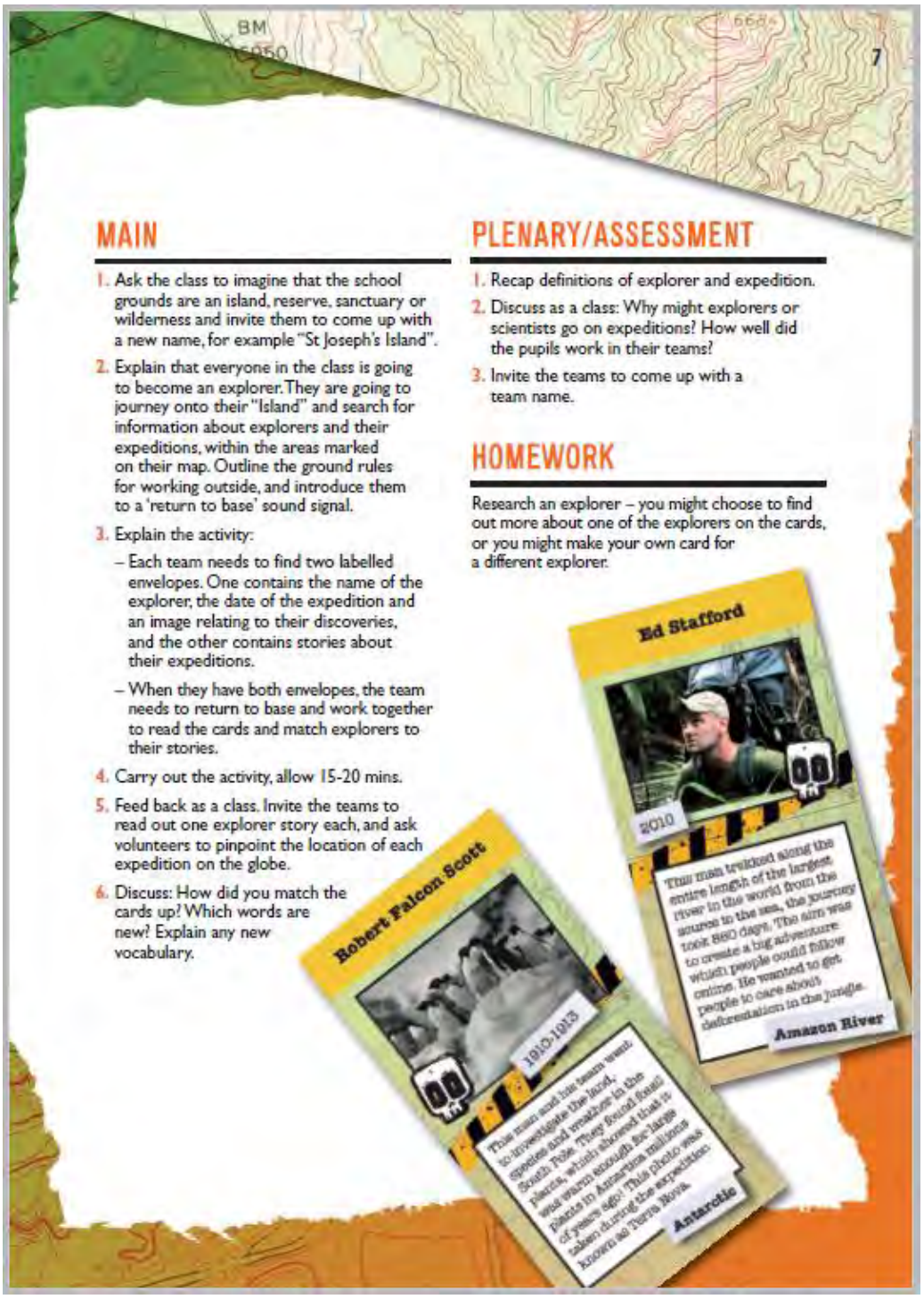
Ecologist, expedition, explorer, species, zoologist.

PREPARATION

- Split your class into mixed-ability named teams of approx. six children. They will be working together for all six lessons.
- Prepare a simple map of your school grounds. You will be using this in all the lessons. You could create it by tracing over a satellite image downloaded from the internet. Make sure you remember to include a North arrow and a key.
- For today's lesson, indicate on a copy of your map the areas that your class are allowed to visit. Photocopy it for each team.
- Prepare a risk assessment for working outside in the school grounds. You may need to update this for future lessons in this unit.
- Photocopy one set of six Explorer Cards per team (pages 18-19). There are two sets of cards, so the children don't all learn the same stories. Prepare and label two envelopes per team, one containing the halves with the explorers' names, and one containing the expedition halves of the cards. Hide the envelopes in the school grounds.
- You will need a globe or world map for the pupils' feedback session.

INTRODUCTION

1. **Lesson 1, Clip 1:** Steve sets a challenge to find out more about explorers and exploring.
2. Ask the class: What do explorers do? Which explorers have you heard of? Explorers go on expeditions. Some have found new species or new places and some have met new people.
3. Ask the class: What is an expedition? Discuss as a class or in pairs. The definition is 'a journey with a purpose'.
4. **Lesson 1, Clip 2:** Fossilteering (you might link this later to the story of Mary Anning) or **Clip 3:** Kayaking to find seals.



MAIN

1. Ask the class to imagine that the school grounds are an island, reserve, sanctuary or wilderness and invite them to come up with a new name, for example "St Joseph's Island".
2. Explain that everyone in the class is going to become an explorer. They are going to journey onto their "Island" and search for information about explorers and their expeditions, within the areas marked on their map. Outline the ground rules for working outside, and introduce them to a 'return to base' sound signal.
3. Explain the activity:
   - Each team needs to find two labelled envelopes. One contains the name of the explorer, the date of the expedition and an image relating to their discoveries, and the other contains stories about their expeditions.
   - When they have both envelopes, the team needs to return to base and work together to read the cards and match explorers to their stories.
4. Carry out the activity, allow 15-20 mins.
5. Feed back as a class. Invite the teams to read out one explorer story each, and ask volunteers to pinpoint the location of each expedition on the globe.
6. Discuss: How did you match the cards up? Which words are new? Explain any new vocabulary.

PLENARY/ASSESSMENT

1. Recap definitions of explorer and expedition.
2. Discuss as a class: Why might explorers or scientists go on expeditions? How well did the pupils work in their teams?
3. Invite the teams to come up with a team name.

HOMEWORK

Research an explorer – you might choose to find out more about one of the explorers on the cards, or you might make your own card for a different explorer.

(CBBC, 2014)

museum of science+industry chicago

1

NAME _____

WHAT IS SCIENCE?

MUSEUM EXPLORATION GUIDE

» INSTRUCTIONS

Cut pages, assemble in numerical order and staple to form a booklet. Then use your observations to complete the *What Is Science*? worksheet after your field trip.

2

OBSERVATIONS

When scientists make observations they **collect** data and **record** evidence.

DRAW SOMETHING YOU OBSERVE.

What do you see, touch or notice?

3

QUESTIONS

Science involves asking **questions** and developing experiments to answer them.

WRITE A QUESTION ABOUT SOMETHING INTERESTING IN THE MUSEUM.

4

HYPOTHESIS

A **hypothesis** is an explanation to a question that can be tested with an experiment.

FIND SOMETHING IN THE MUSEUM AND DRAW IT.

WRITE A HYPOTHESIS ABOUT IT.

Hypotheses are based on observations and things you already know.

EXPERIMENTS

5

Experiments involve **testing** and **retesting** ideas to answer questions and make discoveries.

DO AN EXPERIMENT AND DESCRIBE WHAT YOU DID.

WHAT DID YOU DISCOVER?

Don't worry if you make a mistake. It's part of science!

CREATIVITY

6

It takes creativity and imagination to create new ideas and to answer questions.

WRITE A NEW QUESTION, HYPOTHESIS OR EXPERIMENT.

INFERENCE

7

An inference is a **conclusion** or interpretation based on what you observe.

Example:
Observation: *I can see gray clouds in the sky.*
Inference: *I see gray clouds, so I think it might rain.*

MAKE AN INFERENCE BASED ON SOMETHING YOU OBSERVE.

OBSERVATIONS

8

DRAW SOMETHING YOU OBSERVE.

WHAT IS SCIENCE?

NAME _____

Use the information you gathered at the Museum to complete this worksheet.

HERE IS A PICTURE OF SOMETHING I OBSERVED...

AT THE MUSEUM I DISCOVERED...

SCIENCE INVOLVES MANY THINGS, INCLUDING...

AT THE MUSEUM I TESTED...

TO ME, SCIENCE IS...

QUICK TEACHER INSTRUCTIONS

BEFORE THE FIELD TRIP

1. Print an exploration guide for each student.
2. Have students assemble the guides before going on the field trip.
3. Tell students they will record their observations, experiences and thoughts while they explore the Museum.
4. Briefly review each page with students.

DURING THE FIELD TRIP

1. Make sure each chaperone understands what students will do. Emphasize the importance of having students complete the exploration guide.
2. Give each student their guide and a pencil. Make sure they complete it while exploring the Museum.

AFTER THE FIELD TRIP

1. Give each student their completed exploration guide and a worksheet if there is one. They will use their observations to complete the writing exercise.
2. Discuss all definitions and review everything they learned.

» REFER TO FULL LESSON PLAN FOR MORE DETAILS

museum of science+industry chicago

(Museum of Science and Industry, 2016)

Appendix C: Teacher interview questions about teaching tools

Initial teacher interview

1. What key stage(s) do you teach?
2. What types of teaching tools do you use on a regular basis? (PowerPoints, notes, worksheets, readings, etc.)
3. What resources would you like the Design Museum to provide?
4. Have you taken any class trips to museums? If so, have you used any teaching materials from those museums?
    a. What resources or activities did you use before the trip to prepare your students?
    b. What resources or activities did you use during the trip?
    c. What resources or activities did you use after the trip to follow up with your students?
5. How much classroom time do you devote to those activities?
6. What characteristics did you like or dislike in the resources you have used before?
7. Are there any particular topics or examples you think we should include in our teaching materials?
8. Would you prefer a more structured, pre-made lesson plan, or would you rather we create a series of suggested topics to cover?

Appendix D: Research questions for pilot programme:

D1. Research questions for pilot teacher interviews:

1. Which parts of a hands-on lesson plan do teachers believe are successful?
2. What topics outlined in the Design Museum's exhibition link to current UK curriculum?
3. What are teachers' recommendations for improving a lesson plan?

D2. Research question for KS2 student surveys

1. How well do students perform during the guided hands-on activity?

D3. Research questions for KS3 student surveys

1. Do hands-on activities engage students in the design process?
2. What components can students identify as an important part of their designs?
3. What effects will viewing other designs have on the student's own design?

D4. Research questions for observation matrix

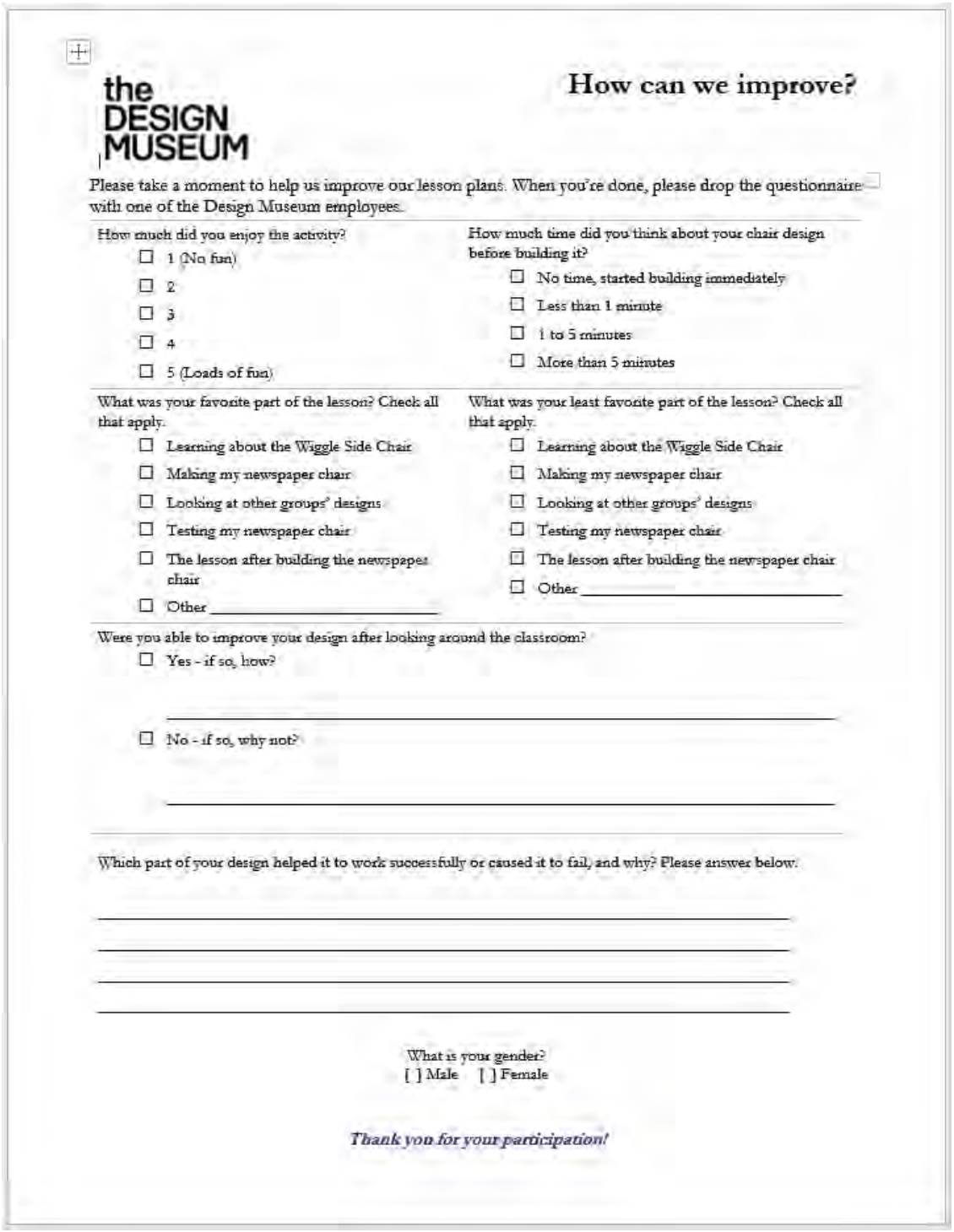
1. Do hands-on engineering-based activities engage students in the design process?
2. What types of instructions do students struggle to understand?
3. How much time do students require to complete an activity?
4. What components can students identify as an important part of their designs?
5. Were the students able to improve upon their design?

Appendix E: Pilot survey questions and observation matrix

E1. Student surveys: KS2

Draw the face that you think answers each question	
1. How did you feel while building your chair?	
2. How did you feel about working with your team?	
3. How well do you think your chair would work for James	

E2. Student surveys: KS3



the DESIGN MUSEUM

How can we improve?

Please take a moment to help us improve our lesson plans. When you're done, please drop the questionnaire with one of the Design Museum employees.

How much did you enjoy the activity?

- ☐ 1 (No fun)
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 (Loads of fun)

How much time did you think about your chair design before building it?

- ☐ No time, started building immediately
- ☐ Less than 1 minute
- ☐ 1 to 5 minutes
- ☐ More than 5 minutes

What was your favorite part of the lesson? Check all that apply.

- ☐ Learning about the Wiggle Side Chair
- ☐ Making my newspaper chair
- ☐ Looking at other groups' designs
- ☐ Testing my newspaper chair
- ☐ The lesson after building the newspaper chair
- ☐ Other _____

What was your least favorite part of the lesson? Check all that apply.

- ☐ Learning about the Wiggle Side Chair
- ☐ Making my newspaper chair
- ☐ Looking at other groups' designs
- ☐ Testing my newspaper chair
- ☐ The lesson after building the newspaper chair
- ☐ Other _____

Were you able to improve your design after looking around the classroom?

- ☐ Yes - if so, how?

_____

- ☐ No - if so, why not?

_____

Which part of your design helped it to work successfully or caused it to fail, and why? Please answer below.

_____

_____

_____

_____

What is your gender?
[ ] Male [ ] Female

Thank you for your participation!

Evaluation Rubric for penultimate question:

Which version of your designs worked best and why? - Rubric	Score
Student was able to both identify an important aspect of the chair and explain why that aspect made the chair efficient.	2
Student was able to either identify an important aspect of the chair or explain why the chair was efficient.	1
Student was unable to identify any aspect of their chair design and was unable to explain why it was efficient.	0

E3. Teacher survey - KS2 & KS3

the DESIGN MUSEUM

How can we improve?

Please take a moment to help us improve our lesson plans. When you're done, please drop the questionnaire with one of the Design Museum employees.

On a scale of 1 to 5, please rate your satisfaction with the lesson plan?

- ☐ 1 (Not satisfied)
- ☐ 2
- ☐ 3
- ☐ 4
- ☐ 5 (Very satisfied)

What part of the lesson plan did you like? Check all that apply.

- ☐ The length
- ☐ The variety of topics covered
- ☐ The lecture part
- ☐ The hands-on part
- ☐ The plenary part
- ☐ Other:

Was the lesson appropriate for the age range of your students?

- ☐ Yes
- ☐ No, please specify:

_____

_____

_____

Did the topics in the lesson correspond with the students' current curriculum?

- ☐ Yes
- ☐ Partially
- ☐ No

How might we improve the links between the lessons and your current curriculum?

_____

_____

_____

How can we improve our lesson plan?

_____

_____

_____

Thank you for your participation!

E4. Observation matrix - KS2 & KS3

RQ	Question:	No	Somewhat	Yes	Comments
1	Were the students concentrated on the activity throughout?				
1	Were the students discussing or sketching their designs at the beginning?				
1	Which part(s) of the lesson most excited the students? (asking questions, completing the work, and paying attention to the presenter)				
1	Which part(s) of the lesson did the students dislike? (looking around the room, talking to their friends, asking to use the toilet, etc.)				
2	Were the students confused with the instructions? (asking questions about the instructions or not progressing with the activity)				
2	Were the students responding to the PowerPoint presentation questions?				
3	Did the students have enough time to complete the activity?				
4	Were students discussing/concentrating on specific aspects of the chair to improve their design?				
5	Were the students observing their peers' designs during the time given?				
5	Were the students able to improve their design after observation?				
	Additional comments:				

	Too little time	Right amount of time	Too much time
Forming groups			
Introductory lecture			
Instructions			
Activity			
Post-activity share			
Wrap up discussion			

Appendix F: Teacher interview transcripts

F1. Colville Primary School

Key:

AC = Anthony Campagna

ED = Ezra Davis

PD = Paul Deplacido

MG = Miya Gaskell

DH = David Houston

J = Joyce Tackie

U = Ursula Parvex

EL = Ellen Ellen Lydon

MG: Right, well, we need to get that on recording, is the problem.

DH: Oh, right...one of the questions these guys have got is that as - as it is work for their, err, their module, their erm, their advisors want to - them to record all the interviews that take place with these teachers and all that, the question is would you be okay for that to be recorded?

EL: Yeah, it's fine.

DH: Okay, great.

PD: Okay, well we'll just introduce ourselves again, our school's WPI, we're working to develop resources for the Design Museum, current key stage two and three, erm, for the most part, and we did have a couple questions. Do you all teach key stage two, or -?

EL: No.

PD: No?

J: Err - no.

U: I'm just - I'm just Art key stage one and two and early years.

EL: Erm, I'm early years.

J: Erm, I'm - yes, I'm key stage one, erm, but I'm Design and Technology Coordinator.

PD: All right. Erm, so what teaching tools do you use on a regular basis like PowerPoints - like in terms of lesson plans?

EL: Erm - when teaching we would use ActivInspire, mostly, which is quite similar to PowerPoint but it's used in schools. Erm, we would also use, erm, probably websites as well, for example that's Espresso is a website we use that has a lot of games, and videos -

J: Base.

EL: Testbase, yeah, is another one. Erm, and...Yeah, that's what we would use in-class.

PD: All right. Then David's asked a couple times what the Design Museum...what could the Design Museum provide for you all and you said that the links between the Design Museum and the curriculum, so that's already covered, but...Have any of you taken class trips to museums? Not just the Design Museum in specific, but just in museums?

U: Yeah, yeah.

PD: You have?

EL: Lots and lots, yeah.

U: Yeah.

PD: All right, and if you have, what - have you used any teaching materials from the museum and either used it at the museum or here, in the school?

U: So, like I go to Tate Britain, and every September - as soon as we come back like the new academic year I go to Tate Britain so what I do is I go there to visit, and then I come back into school and I do like a lesson plan, so I do like ten different lesson plans for each class - I'll show you in a minute what I do - and then I'll put like a package together.

So we go on the visit and then we spend - we spend 2 hours just going around the museum and doing activities around and then we come back and sort of like expand on it, so if you see on the stairs, going up, most of the work there is from like Tate Britain. So we do that and then we go to the Orchard Galleries as well...and then, Light...Light - what was the one in northern Kensington? Lighthouse? No, that's Lighthouse down here.

EL: Oh, that, the Museum of Packaging?

U: Yeah, no, it was err -

EL: The Transport Museum?

DH: Was it - no, the British Museum?

U: No, yeah, there's another one in high Kensington but I can't remember what it's called as well, so we sort of sink work in there as well for them to put up in competitions, and…

EL: Oh, erm, Nox…

U: Li- li - Eh?

EL: The house, what's it called?

U: I can't remember.

J: Oh, the [inaudible] competition?

EL: Yeah, it's a really good one.

U: So the children do know that that Museum - they've gone on lots and lots of trips.

J: And within the classroom as well…

EL: Yeah, so I'd bring classes relating to like topics, it could be a science topic, or a history topic, or a geography topic...We could bring them on trips as well, and sometimes we'd make our trails to go through the museum, but a lot of the time we'd do our own workshops, actually.

PD: All right, and what sorts of activities are like, included in those workshops, for the most part?

EL: Usually the really hands-on ones where they get to explore the objects or different materials, they're usually the most popular and the best for the children, maybe, but, yeah.

PD: All right, awesome. And then, you touched on it a little bit but just like - time you spend on the activities in the classroom, if we were to make lesson plans how long would you actually use them - or how long would you want the activities to take?

U: The main activity would probably be like, 35 minutes at the most.

PD: That's what we were looking at, we just wanted to make sure we were on the same page, so.

U: Yeah.

PD: And then...what are some characteristics that make resources successful? Are there like certain -

U: So it's sort of like trial and error, so if I was to teach a lesson I want to try it out, before, to make sure that it works. And if it doesn't work, then it's not gonna work for the children, so I try it out, and they try it out, and sometimes it works and sometimes it doesn't. So, erm, resources, yeah.

J: I think it depends very much on the age range of the children you're thinking of. So erm, key stage one, that desire to touch is just huge. So things that are tactile, things that, you know, they can sort of actually really get their hands-on and explore...As, I think as you go up to key stage 2 perhaps they have a sort of wider concept of the world, and if you can pull things in that are relevant to their lives, then, you are able to engage them.

MG: So would you say more, for key stage 2...Perhaps having - still having hands-on activities in your lesson plans, but at the same time incorporating more -

EL: What they're interested in.

MG: Like, educational material that you're covering in-class, that sort of thing?

J: Erm, well, just in terms of the actual - erm, sorry, the question was about, erm, was it resources, or -?

PD: Yeah, what do you think makes a resource successful?

J: Right. Erm, okay, erm...Resources are sort of in general, for teachers, linking - linking to the curriculum...Yeah, they're often a good starting point for a unit of work, so if you are able to sort of raise questions, and sort of open up potential lines of investigation, through a visit, then I think teachers are able to run with that.

PD: Right.

U: And - and obviously it depends on what's been taught. So the resources work with every kind of lesson. Like, at the moment the year 5 we're looking at art….so the first week we started off with paint, and because it's just paint and it's got fine brush and all that movement, it was just slowing them down. So the following week it was like pastels, colouring pencils, charcoal, the whole lot. And then you just find that it actually helps them to speed up a bit, because the pastels are just like - whereas the paint brush it's kind [inaudible] like it's got to be perfect. So you just add more materials to it. So it's what it's been taught, you kinda look at the lesson and think...Like, this is what I've got to put out there. So, resources -

J: The possibility that growing...and not giving or adding anything away -

U: Yeah yeah. And you just keep giving -

J: - at the first opportunity, making or starting anything, you know.

PD: Right, and building on it, yeah. Okay. And that actually covered our next question, too, so that was good.

[Laughter]

PD: Yeah, that's essentially all we have for specific questions, so...Yeah, we just are really trying to get a couple things to pile up, and hopefully maybe come back and actually test them out after we test them ourselves, too, so.

MG: Right, and in the end we really want these to be things you would actually use in-class, so...as much as feedback as possible would be as helpful as you can.

U: I also know that when they go on a visit, like especially they do for art and design, like if they go on a visit - they can't - if they leave the building and go on a visit, they don't - they can't keep still for more than 15 minutes in one specific area, so if there was something like that when we came to visit

it might get a bit tricky, because they're so excited they just want to move on to find that. So if they split, then it makes it worthwhile. Like if it's all sitting down, like what we do in the classroom, we have a 10 minute intro and then they go off to do the lesson, and then we start to do plenary, it's fine because they know that it's their space, and they've got their books in front of them. But for some reason when we leave the building it just becomes - sort of - like 'I finished!' And they want to move on. And it's like [inaudible]. And so when we go to Tate Britain I make the lessons really like 10, 15 minutes the most? And then we move on to a room, and then we move on to another room, so by the end of the day they've done an hour and half, just from walking from room to room.

PD: Yeah, that's awesome.

ED: Would you use material that's - that you could use in a classroom before a visit to prepare you for the visit?

ALL: Yes.

EZ: Okay.

PD: And what types of materials do those entail?

EL: It could be like photographs...If they were going to explore a museum, you might look at the space first, and try and figure out what they might wanna visit and look at it as well.

J: Yeah, perhaps giving them that sense of ownership of their own visit is a good idea.

U: Like what can you see in here, yeah.

PD: So, what do you want to see of this museum or something like that?

J: Yeah, let's make a trail, let's, you know -

EL: Do you wanna look at different designs, do you wanna look at chairs, would you rather look at lamps...Yeah, specific to the museum, yeah.

MG: Would you use any material that you would you use to follow up after your visit? Or is it generally once you've left the museum, you're moving on to the next lesson?

U: Hmm...follow ups at all you could just still work on exactly what you would…

J: But a follow up could tie in to your next lesson.

U: I mean like these ants [on the wall], we saw them in the Sargia Gallery, and they started doing it there, on the 2nd, and then we came back into school and then the artists from the Sargia Gallery came down...so it took about two, three weeks to finish the whole project, but it started off there. So this wasn't done as part of our lesson in schools, it's a club thing. So we can always build on whatever you give us.

J: Yeah, that's really nice, as well, actually, because it doesn't even have to be within a set school day...because we run 40, I think, sort of after-school clubs, there's an escape to extend for the students who really enjoyed it or are really keen, they can do an optional club perhaps that ties in what they saw.

U: If you wanted to come in to a particular day for an hour, I could - cause actually I've got that club list now, I could actually tie that in with one of the days, and say look, you're gonna come in maybe on a Wednesday for the next 6 weeks from 3:30 to 4:30, and that could be a club with the children. Or, if you wanted the children to come down, we could sort of do like a three week slot, where we're trying to get the parents and say look, on such and such date the children will be travelling to such and such place and they're gonna be back by six o'clock. We're always willing to do things like that.

DH: Brilliant, okay. That's good for me, actually, that's a nice thing cause actually our schools offer - when we do have schools groups come in a lot them have a time slot is really till 1:30, so we know we have to get them out the door and get them back to school by a certain time. So actually sort of having that sort of club could make quite the difference.

U: So how far away are you? Tower Bridge you think?

DH: At the moment we're Tower Bridge, yeah, yeah.

U: And then you're gonna come to Kensington, here?

DH: Yeah, so that'd be the sort of thing we'd sort of look further down the line, really, for us that might be something we could get some sort of session after-school.

U: Cause the [inaudible] Gallery, they hadn't really got any - well, I guess Colville is really their only club there, so we do it on a Thursday. So we get there like five past four, and then leave like 5 o'clock on the dot to be back here by a quarter to six. So I suppose once you move to Kensington, that would -

J: It' a lot closer.

U: It would be a lot closer, yeah, 52 452…and that could be something. It wouldn't have to be just Colville, you could probably approach other schools as well, in Larkson, if they wanted to do something like that.

DH: Yeah, that would be something further down the line, of having sort of an offer, sort of a later workshop offer for on a regular basis where we're doing some sort of programmes or workshops.

U: Yeah.

DH: So have you guys got any more questions?

PD: No, that was all that we had.

DH: Is it possible then that we could talk about some potential day for the pilot, then?

J: We've got to pull up the, erm -

MG: Cut the recording here.

F2. Northwood School

Key:

AC = Anthony Campagna

ED = Ezra Davis

PD = Paul Deplacido

MG = Miya Gaskell

DH = David Houston

SM = Sinead Marry - Head of Science

DT = Dev Thaker - Science Club Lead Teacher

JL = Jenni Lister - Head Year 7

ED: Do you mind if we record you, and do you mind if we use your names in our report?

SM: No, of course.

JL: Yeah.

MG: Great.

SM: Do you want me to say if you record me, that's no problem?

MG: All right. [Laughter]

AC: All right. So. Starting off, which key stages do you both teach?

SM: I teach key stage two and key stage three and I usually teach up to key stage five as well, and Chemistry is my specialism.

AC: Ok.

JL: I teach key stage three and four and five.

AC: Ok. During your regular lesson plan, what do you usually use to present the material. Like PowerPoints, worksheets, notes.

SM: So I tend to use PowerPoint or the interactive whiteboard. I also use the normal whiteboard. Em. And I use Youtube, so videos, but I also use like reading comprehension, so worksheets and sometimes I dictate notes as well where they have to write whatever I say and obviously the textbook.

JL: Same.

ED: Ok.

AC: Alright, erm. So do you want to ask this one?

PD: No.

AC: So. What kinds of resources would you expect from the Design Museum. So like.. Moreso like, would you like something that pertains to something you are doing in-class or or would you want to… have like… So we're thinking about doing three kinds of materials. Kind of like pre-visit, during the visit, and post-visit. Would you like those to be connected to what you're doing in-class or would you like them to be separate?

SM: No. I think there should be a link to the curriculum because what happens sometimes is you run out of time. And so if it's something that is way off the curriculum then it makes it very hard to slot it in in terms (of) your year plan. Sometimes with key stage three there is time at the end of the year. So at the end of year 7 where you've actually finished all the year 7 stuff, but most of the time, teachers start teaching year 8 stuff. Em. And then so that time is extra time, but it always gets used up with something. So if it links to something else you can just build it into your normal chapter and just do it as a longer topic and that's what I would do.

And I've see- And yeah, I've been a key stage three coordinator and it involves in [inaudible] key stage four and a new curriculum.That would be my thoughts, but I dunno, Jenni might have something different.

JL: It would obviously be a good idea if it links in, but with key stage three there's normally time, like Sinead just said, there's normally time to be able to maybe go off topic if it a one off day or something like that, you know.

SM: Yeah, or if it was something totally separate you could do it as a science club thing so like where it's totally separate you could run a science club like other subjects have done that before where you. Where you… You know you could… I've done stuff like that before where you do it's a very specific project that they work on and it kinda links in with what they're doing, but actually it's something different. So that can be quite nice as well, if you have a teacher who's prepared to lead

that and give up their time and lead a group of students. You know through the three things and in one of the visits you come and lead them through the three things.

AC: Awesome. And so… Have either of you taken class trips to museums - either the Design Museum or other museums?

SM: Yeah, so that's where we met.

And I've done, em, and all the ones like where... what was it called? The Field Study Centre, well, I've done a few of those, and the London the zoo, em. And like an acting one, the PG owl [approximation]. Do you know that one?

DH: No, I don't

SM: The PG owl, it's not science really. It's more team building and stuff like that. It's like a [undecipherable] of thing, and they climb up the things them and… You know them?

DH: Yeah, yeah.

SM: Those ones.

[Door opens and student asks SM a question]

SM: Only the ones that are in the actual cupboard and she'll need a key to get them. … Alright, sorry, we're busy at the moment. Thank you.

[Door closes]

SM: Does that answer your question?

PD: Yes.

AC: And, when you visited these museums, did you use the museum's material or other material to either prep your class or use during the trip or use after the trip?

SM: Em. It was a combination of both for various trips, but I prefer when the centre actually provides some sort of a booklet or a piece of paper or something that they fill out, they give it to them at the start, and they, you know, work their way through that as they go through the day, and they carry it around. That's what I think is the most beneficial, because sometimes, you know, you might make a resource and you go on this trip and you realise that the questions you're asking to answer aren't covered at all and...or... it doesn't match up because my thinking is totally different to what you're going to pitch. I think it's always better if the resource totally matches, em, the actual thing and they, like they did with that one there and they went step by step, you lead them through this kind of booklet, and then it just makes it easy for them, because normally on a trip, you see, depending on what the trip is for, you might have it for with an SEN focus where you have to bring

students from different social groups, so there will normally be a range. Or one school might do it for high-achieving students and the next school you have in might do it for SEN, so the worksheet has to cater for everyone, and it's easier if you do it step by step. It allows the really weak students to go through to still go through and do something, whereas the higher ones will add more detail and, you know, they'll be much sharper.

[Paper shuffling]

DH: And so that would be the CREST award - Discovery. Yeah.

SM: That's the standard one isn't it.

DH: Yeah, it's the lowest entry for the CREST. So you guys have the meeting with the British Science Association next week. But basically that's sort of the CREST award, erm, or CREST passport you do in the discovery and it's broken down into sections and they fill them out as they go along. And that's what- [Paper shuffling in background]

SM: And that's really nice, and that's probably one of the best ones. That's good, especially if a trip matches up and if you could come up with something that matches up with this, because it means that they get the award at the end, you know, ticks a lot of boxes and they really love doing it when it's recognised.

DH: Would you consider doing a CREST award which wasn't linked, so, in the sense of having… so our problem is, most of the schools we'll see, we'll see for an hour. When it comes to it, we can maybe tick off the research side of things.

SM: Yeah, yeah, so, yeah, like, in terms of this school, we've already started doing the CREST Awards and they've started doing the... and they've started working their way through the, so it would really be … you could already link it in, maybe you just talk about skills… things that you do, or things that you do in university. Often it's the stuff we've said, but when an outsider says it it's just much more exciting. It's like they don't believe us that people have meetings and share ideas, and, you know, we write lab reports, or… they just don't, so when someone else says it they go wow, they said that. And you're like yeah, haa. And sometimes, even if it's just one part of it, yeah, if we had everything filtered before that would make total sense. It depends on the school, and what the needs are, and what you're offering.

DH: Yeah, yeah, so I mean at the Transport Museum, the trip was kind of based-

SM: It was the whole day, wasn't it.

DH: Yeah, and y- we actually structured around CREST itself, which is nice in some ways, but in others it did restricted us, because we had to get through that in the time.
SM: Yeah it did, but that was how we came across it, because I was looking to do CREST and I wasn't running science club and that's because somebody else was and they weren't willing to do that. And I found a letter and something came in and it landed on my desk - someone said 'oh this looks like something you might be interested in.' And I said, 'yeah I would,' and then I rang up, and then I went to get the funding, and I had to haggle to get the funding. I pitched for way more than we needed, and I got lots more. So that was how we got to be going.And they loved it, it was really successful. Students loved it and teachers loved it, and the head teacher loved it which was brilliant. So, yeah, I think it is, I think it was… The CREST Award was why it was flagged up in my mind. So. I dunno, I think it's nice if it links to an award, it's not just another school trip, it serves a purpose. And often people want to do the CREST Award but don't know how to get started. Err… You know they want to get some accreditation, so maybe if you didn't have accreditation, but if it was some sort of certificate at the end. Something like that, I think students like that.
MG: So then, this would be like during the visit to the museum.
SM: Yeah, like, or if you gave, you know, at the end, if they all completed instead of everyone on completion of this you will have and then you gave the one certificate to the teacher and the teacher handed them all out. It's just so -- I always think they get some sort of like they've achieved something in science, or they've learned, they now know how to, you know, be in a lab or whatever it is, or whatever, kind of, whatever you're doing, or they're an expert in electricity or something. I just think it would be nice. If you couldn't use CREST, you could still do something like this. And the idea if they completed this they'd still get a certificate, I think that would be really good.
MG: And, so then those places that you visited, did they offer any materials to prep before the visit, or after to follow up?
SM: Yeah, one of them did, they offered materials before, and it was a certain amount we have to go through, and there were certain like kind of blanks almost and where then an external lecturer came in and went around to different places and the students had different things to do in different places. And then another one was where I actually sent in... this, they were really flexible, this was the Field Study Centre, and they covered various things, through ecosystems, woodlands, and everything, and they had a really big site. And they said 'you tell us what you want to do and we'll accommodate them,' so I sent them, kind of like a pack really, big booklet of things that the students have to fill in,

and together we built the day around that. And we planned when they'd do walks, and when, but they tailored the day to suit what I needed to get filled in. But that was for an exam, it was different because that was for key stage four, so it was specific design criteria, and it was specific experiments that they needed for their coursework, so it was kind of different, it wasn't just a trip to go, it was a trip that had a purpose. And I normally find that those are the easiest ones to get funding for, you see. If you say a trip for fun, it's harder to negotiate.

DH: What level of, erm, CREST are you doing at the moment? Is it Discovery? Or-

DT: Bronze.

DH: Oh you're doing Bronze? Fantastic.

DT: We're doing like rockets and, they're going to building lots of, and they're going to try out lots of different shapes of rockets and look at kind of the aerodynamics. And. We're deciding whether to do just pure distance and, hopefully they're going to figure out, kind of like, 45 degree angle, and whichever shape works best for them. Or, we're going to have targets. I've got some targets, well, they're really just giant frisbees but they've got holes in them holes in them. So, we're not sure yet -- Or,what I might do, because they're doing it in groups, because when I phoned the call, they said that's find, that we might just let them choose which one. We gave the option for [undecipherable] experiment as well, but none of them wanted to do it, they wanted to do the rockets.

DH: Right, right. Fair enough, it's the sexier one, isn't it; it's the easier sell. So you're doing Bronze, hat was the appeal of Bronze? Why that one?

DT: Just because, it's an extended project, but it's not, for me as well, cause I've never done a CREST award, it was easier for me to manage. And also Silver seems really long. But engineering club are doing the -

SM: Damn them.

DT: -doing it on the same day as us.

DH: Really?

SM: Yeah, they took loads. We had loads, and then engineering club opened, and they got projects from Heathrow or somewhere.

DH: Really?

DT: [inaudible] we can't compete with them.

SM: So I introduced you to the head of technology as well, because, obviously, they do Design and Technology here. Yasmin have loads of… What was it they've gotten?

DT: Next year there will be a Silver, but that'll be next year. So, what they're working on now, erm, [inaudible] ends up being a Silver if they're successful. So they're building like F1 cars [inaudible] with a battery. It's really good, they've got like tracks and --

DH: Yeah.

SM: It's not that good, like erm…

[Laughter]

PD: We're engineers too, so we[inaudible].

[Laughter]

DH: That's awesome, okay, that's very good. Sorry guys, you can carry on.

PD: That's fine.

AC: Do you want to ask?

PD: Have either of you got pre- or post- visit materials from museums or anything?

JL: When I've been on… I've only done a couple, we've made our own to go. But like Sinead said, it's a bit of a nightmare because you don't know exactly what-- you're told exac- you're told what what you're going to do on the day- you don't know what's going to happen, so it's definitely better to have them provided.

DT: We went to the Natural History Museum with my PGC. I helped organise that, and we got this pre-pack thing. It wasn't much, it just told us that we're going to do evolution and kinda just what the day was, but it didn't tell us anything to kinda teach at all. And so, it told us we were going to do evolution and we were going to have a kind of university style lecture. It wasn't university lecture, but it was in an lecture theatre, so they felt nice and grown up.

[Laughter]

DH: Right, right. Yeah.

DT: And then erm, and afterwards, they kind of just got a booklet thing that they could go around the museum, fill in, and be able to keep that. So there was no kind of post information, but that booklet, I guess, was meant to contain it all.

DH: What would be… What would be more relevant though, would it be more thematic stuff, or more literal objects?

DT: Ermm, I think, thematic stuff, personally, but I don't know how you would like [inaudible].

JL: I agree.

ED: So would you want a lesson plan for before and after the exhibit? That talks about something that's mentioned on the trip?
DT: That would be really good. I would quite like… I don't know if we need necessarily a lesson plan before and after, but kind of, knowing something specific…
SM: Yeah, like cover these three things, as this will be discussed in detail and they'll see this. So then you can kind of get them ready for it like, and pitch it, and sell it, build up. 'And that's why this is so brilliant, and we're going to see one of them.' So then they're like, 'So this was what you were saying the other day,' which I think makes it really relevant. Whereas if they just arrive, it kind of loses the impact, because you just see it, you haven't made them wait, you know. Told them, and built a bit of anticipation, you know. It doesn't have to be a lesson plan, because so many teacher won't get, lose it, won't follow it, won't like it, won't follow it, whatever. So, it just has to be what will be covered, and what would be advised to cover beforehand. And you could always give one or two resources, might be suggested, but kind of go with whatever.
DT: Yeah, that's what I was going to say.I wouldn't mind some kind of suggested--
SM: Yeah, or some kind of worksheet or something.
DT: Or even like a video.
SM: A video is always good.
PD: Our original plan was, we just kind of thought, but having a short activity at the beginning that links to something in the museum that they would see there. Then do something kind of a little more general, but still include that topic, and then at the end, erm, like after the visit, kind of do like a wrap up, of like everything.
SM: Yeah, that makes sense. Have you been into see teachers teaching?
DH: We've got a session, erm, on Thursday, which is actually one of our sessions we run in the museum. We haven't got anything planned, if that was an offer. Shoot me an email.
SM: No, that's what I would just say to you - go and see what happens in lessons and-
[Interruption by student]
DT: If you want, you can leave it in my room.
SM: That's what I would do, because you're going to planning four teachers, four students. Like then... I don't know when you were last in school, but my advice would be there's no point in planning, like me planning a Formula 1 car having not seeing Formula 1 happen. It just makes sense

to me to go into a school and sit in on some science lessons. Yeah, so that will be something that I can arrange. That's no problem, you could come in and see... How long are you here for?
MG: Seven weeks, so until the end of April. Preferably we would be able to set something up before then.
SM: Yeah, you could certainly come in and see some science lessons, you can always come in and see me whenever. So yeah, I can speak to you, I'll just give you my email and…
DH: It may be a good idea to get some dates in the diary today, if that's okay with you, not to push it too far.
SM: No, no, that's fine. So you live in central London now, do you?
PD: Yes.
AC: So, for the pre- and post-visit stuff, like before you visit the museum and maybe after you visit the museum, how much classroom time would you dedicating, do you think?
SM: Like a lesson. Like again, it's just this idea of time, and you can't just go and rehash it over and over again. Like, they've been on the trip. The trip has happened. If you spend any time around students, like what happened yesterday it's like pfffft. Or someone will say, "I don't remember that." "Yesterday, do you remember?" "Ooh, was that when they gave us, like, the pink pen?" Give them something and they'll remember it. But you've got to just do it short and snappy and just move on because they'll have forgotten anyway. The post thing would be small and short.
PD: We were thinking that it would be about a half an hour or something like that.
SM: Yeah, I would say, the max you will get will be a lesson.

MG: Okay. And the actual stay at the museum would be an hour or so.
SM: You've just got to factor in how worthwhile it will be, so if it's an hour, that's an expensive hour. The coach might cost a couple of hundred. And then they're there for an hour on the way back with the coach.
DH: So I think… I think I should elaborate on that. I think you're talking about gallery time in that one particular gallery. The main gallery for the museum is opening… The free gallery that we're opening this year is the gallery these resources will be based around. So that's going to be the one gallery we have around for the next eight years or so. We'll have temporary exhibitions in there as well, which will have their own resources to them, but the actual time in that particular gallery will be about an hour. So that might be combined with a workshop, it might be combined with…

SM: Something else.

DH: Yeah, there will be two or three things going on.

SM: So they could be there for two or three hours, the whole thing.

DH: Yeah. It would be like a whole day visit with an hour in the middle.

SM: Just because the price of a coach for an hour, is, so it has to be… That's all I was going to say. It's just a practical thing. But you're not thinking, probably, about the money.

MG: We were more thinking in terms of that one particular-

PD: Gallery.

MG: Yeah. That whole trip would probably take through that one particular gallery would take about an hour. So that's how we would structure it.

SM: That makes sense.

AC: Are there any particular topics or examples that you'd like us to use on… while making the materials, are there topics in-class that you believe are related to design that would, like, properly flow into your visit?

DT: We do like polymers and composites and stuff.

[Activate 1 and Activate 2 textbooks are dropped on the desk (by Philippa Gardom Hulme]

SM: So you might like to have a look at this, this is year 7 book. And the green one is the year 8 one. So…

JL: I think there's more in the year 8 [inaudible]

SM: If you just look at… I just look at the table of contents, and that kind of gives you a brief overview of what's covered. So the green one is the year 8 one and the blue one is the year 7 one, so have a look and see. This is a brand new specification. It only came out last year. And this textbook is very snazzy and very new, so it is quite modern, so I don't know if there's anything. Feel free to have a flick through it. With this, we've got all the lesson plans, all the resources, exams and etcetera. So it did come with a lot of great resources, so if you were thinking about linking anything to this, I would probably speak to a teacher or speak to me and find out - there might already be a worksheet, you know and you could just… but I don't know if it would be copyright infringement to you're their stuff.

DH: Yeah, well, if we do anything, it would be inspired by, it wouldn't be direct-

SM: It would be inspiring.

DH: Yeah, of course. We would never use a direct sort of…

SM: But if the school had bought the rights to it.
DH: Yeah, yeah, it depends. What we're really looking to create at the end of this is a pack that would go with the exhibition itself. So, something which you could take away, you could potentially take some lesson plans out of there. And, they link into the themes of the exhibition and cover other things as well. So, it would be something which looks at, we could have lessons around materials but using examples from the exhibition. It's completely ermmm, as far as the content of any of the lessons it would be completely around what the museum has on offer. So yeah, it would me more along the lines of something you'd see if you've ever seen the Curiosity Project that Siemens are doing, they've got a lot of worksheets that are based on that sort of thing. But it would be more sort of the [indecipherable] that comes out of that.
DT: That sounds good. That's like we knew we were going to see, like if they were going to show them, barnacles or stuff, so we kind of looked at Darwin and stuff.
DH: Brilliant.
DT: We didn't get anything from the museum. Just we're going to look at barnacles. So it would be good to know what actually barnacles are.
MG: One of the things that stands out to me, flipping through this is the materials sciences. What types of materials are used and alloys and certain objects and how that relates to their design and function. And maybe…[inaudible discussion in background] re-usable energy and recycling. I know we've sort of talked about that in the exhibition - more efficient designs, sort of what designs are a good and bad designs.
ED: So to use the example of Darwin and barnacles, would you want us to provide… What would you want us to provide about Darwin or would you want us to provide anything about Darwin before the trip?
SM: So it's kind of up to you and what the activity is. What you don't want to do, is you don't want to tell them too much so that you spoil it on them. And you don't want the teacher going along and pre-teaching everything, and then you come along and they're like "we did this yesterday" and then they'll know all the answers because that will be rubbish for you. You'll probably get teachers doing this anyway, that just happens sometimes, but you will have to… be able to set the parameters, if you want them to know absolutely nothing, and for it to be discovery all along the way, then you put a note to the teacher, please don't teach anything about Darwin, please cover someone similar or… It's really up to you. Teachers would be happy to teach something about them or not. I don't know

if you want me to say anything about content wise, that would depend about what year. So what year are you aiming for, or what age, or?

MG: We're working with key stage two and key stage three.

SM: For key stage three, I don't think they know anything about Darwin-

ED: Oh, no. That was just an example… Uh, things that you learned about before going on the trip.

SM: What you could just do, you could go on, and ask, find out, just have a look at the key stage three curriculum and then that would be a very good indicator or you could give a little survey to the teacher before they come, and just say what topics have you covered, and they'll be able to tick off what topics they've done, so then you'd know what this class has done a lot, and this school hasn't done. You could have two or three different versions of the same thing.

MG: For future trips, because I'm sure trips will become year round we want it to sort of fit where the current class is in the curriculum, sort of more of a dynamic, if you come, you should come before or after. You know?

SM: Yeah, so you want them to come when they have not done this or haven't covered this. Yeah, well that's what you'd give in your notes to your teacher, like where you were planning lesson plans, you would say this must have been covered and this shouldn't be covered. And you would say that from the very beginning and you'd give these to teachers at the start of the year and teachers would just plan around that, because like, we do it here in a standard order and work our way through, but in bigger schools, that's not the case. They do it in a different order. So once you let them know, the'd plan… you'd have a key stage 3 coordinator who would work around that and who would just coordinate that. Like it's not… One chapter doesn't follow on from another; it does and it doesn't. You know, you can do one on biology and one on chemistry and physics. You could leave out one chapter until they see you.

ED: So what kinds of materials would you like us to provide, like, would you like us to just give the teacher some notes, or put together a PowerPoint, or video?

SM: I always… I like videos, so you could maybe have someone outside the Design Museum or something saying, "This is where you're going to come, but before you come you need to know" and then you say, you know, "We've given your teacher a worksheet and you need to fill this out", and then notes for the teacher. And I think that this would be easiest for you to ensure that they've covered X, Y, and Z, because they must have completed this worksheet and then it's a guidance for the teacher as well. And some sort of a video and you could say things, but you don't want to show

anything because then they would say, "We saw that in the video weeks ago" and they will just say, "This is not interesting" or they'll say exactly what they think.

DH: We're in that position anyway, because we couldn't show anything at the moment, because we don't have the building.

[Laughter]

SM: Well, there you go. Then you could just stand in a car park and be like, "This is where you will be here."

[Laughter]

DT: I just thought something nice would be group activity, maybe where they design something.

SM: Oh, that's nice.

MG: We actually did bring a couple of example resources, from other museums, not the Design Museum specifically. But erm-

SM: The Science Museum are a great… They have loads of stuff online as well. They're your competition.

DH: I actually work there too. I work for both museums.

MG: Can you sort of get an idea based on what is present in these packs, what you'd prefer, or what you don't really think-

SM: I love the Science Museum, cause there's quite a lot of stuff online. Like, my last school I went online, they had all questions, like kids sent in, like "Do elephants jump?" Was one, and all these really random questions, and I printed them all off, the answers, and put them all on big A3 and had them everywhere, and the amount of kids that said "Ms, how did you find the answer for that?" And I was like, "That's research." And then I said... I did tell one class cause I had last year, "Hey you looked up all these questions" "Well, I just got one of those minds." And then I said "Just go on to the Science Museum." Because they were really good questions, like I would never have thought of them.

DH: They-they- it used to be written on all the walls of all the galleries, they've actually closed it from being an active gallery, so it's going to be reopened at the end of the year. They used to be on the walls there, so people would come up to you and say "Why's glue not…"

[Multiple people talking at once]

MG: This was an example of the content we be prepared, but not the layout or anything.

DT: The only thing I have to say about that one [indecipherable] is that for the film crew one, it's quite resource heavy, the trip might have some problems with finances. It would be okay for some schools, but not [indecipherable]

MG: Is there anything that stands out as sort of like, not usable, or?

DT: I wouldn't say that any them stood out as not usable, because there are [indecipherable] and they literally tell you exactly what you need to do. I've actually… [indecipherable]

DT: For trips, personally, I've would say, if you wanted them to be excited about it, then group work tends to be more exciting, as opposed to individual work. Yeah, this does look very good.

MG: Right now we're leaning towards the pre-visit activities as being more hands-on and group oriented, just so we want to get them excited about things that are to come.

[Indecipherable discussion about the example resources]

DT: I do think videos… but I wouldn't say a lot of videos, a short clip.

MG: Maybe a few minutes.

DT: Yeah.

[More indecipherable discussion]

DT: Could we see the science one?

SM: Yeah, that one's really good. I'd say if you asked really nicely, you could keep that one for science club.

DH: Yeah.

SM: That was a yes? Put it in your bag.

DH: Yeah, you can take that one.

SM: Yeah, that's a good one for science club, yeah.

PD: Yeah, there's a couple really good ones in there.

DT: This is perfect for science club.

DH: There's some great experiments in there.

DT: We were trying to get this, and, we couldn't find any film canisters.

DH: I'm pretty sure, we, the Science Museum, buys them from GLS or something like that.

DT: Really?

DH: Yeah, one of the supplies we go to… Or Tim star or something like that.

[Victoria and Albert Museum brochures pulled out]

SM: I don't like this one as much.

DH: That's more of the salesy kind of things, and they don't seem to have much in the way of resources like that one.

SM: Yeah, I don't know actually what information…

DH: [Indecipherable] You're getting out of that. [Indecipherable]

SM: Yeah. I know I'm just flicking through it, but that's what most teachers do. You get so much of this literature… In the first two minutes it goes in a pile – the I'll read when I'm not busy pile, and it ends up somewhere and no one finds it again. And obviously this cost a lot of money.

[Indecipherable conversation about example resources]

MG: This is part of a layout and content issue.

SM: Yeah, it's like the layout, I can see where they were going, but there's no real information.

MG: Nothing stands out and or is easy to find.

SM: Yeah.

SM: It's kind of more of a brochure.

[Indecipherable conversation about other example resources]

ED: If you look at this, it doesn't really have a clean design either...

ED: I don't think that one's [the Science Museum's Kitchen Science packet] coming back with us.

MG: I think this one [one of the Thackray Museum packets] is more of an initial draft of what… something we might make, but without the Comic Sans, because that's not really… a thing.

[Quiet conversation]

ED: It [The Thackray Museum packet] has some really good information if you dig into it, but…

MG: The way that the lessons are actually structured, I think, is pretty good. Because it goes over, an explanation and a summary for the initial content, and then it sort of gets into everything else, but it's very specific.

DH: Feel free to take the Science museum one because because I can get another one.

DT: Yeah, thank you.

DH: It's a really good one. The Kitchen Science one, it's brilliant.

DT: It's literally like science club planned for the next…

DH: Really.

DT: Yeah, until the end of…

DH: So actually that one's a nice simple… It's a nice simple. It's nice to build into. There's not really much in there, just practical things you can do.

DT: I would say… I don't know if this would ever go with a trip. And they say literally, do this stuff on a trip. But it's good to get you into it, the museum, as a whole. Kind of introduce it early, especially if you are using the book, so right here it's got society, museum, easy to use instructions.
DH: Really the appeal is that actually there are things that are not really a lesson there or anything like that, but there's a basis of things that you can go "that is good, I can build this out of it." So it's more of building blocks you have than anything that's complete.
SM: It's branded, which is quite nice. This [Live 'n' Deadly teacher's pack] is really nice, and was clearly designed by a teacher. This is a standard like lesson plan, or a standard layout. So I handed around one of the books, which was the teacher reference, so yeah, you can see the style of layout, where we're always like, how… what we're doing, how it links to the curriculum, and like starter, main, plenary and that is kind of standard teacher language. And teachers might write that on their actual PowerPoint presentations, so if you were going to write lesson plans, this is the best one I've seen so far, cause it's clear. Emm. you know, this would be the style, so I don't know if you were [indecipherable] cover something like this in some sort of booklet like that.
DH: At a key stage 3 level, would that be… If the lesson plans were in there would that be something you would use?
SM: Yeah. I think you would get teachers who would use this.Yeah. You see that they have clips. They have clips that match up to certain parts, that would make sense, I mean. This is CBBC's but actually… BBC did something similar for [indecipherable], where they published materials. I have one of their books that I found in a cupboard in a previous school that no one was using, and I said, "Why are you not using this. This is worksheets?" And they said, "I got it in the post and never opened it." So they kind of gave it to me and I bought all the series myself on DVD, so I had all the clips that matched up and they made it worksheets, and it was really nice because it was in a binder like this, and it was really useful. Not necessarily a lesson plan, but it's a resource, it's technically on something with very specific questions, so you can build it around it. And it was, you know, came in a nice paint, use things from it, and I quite liked it. I didn't use the lesson plans, purely because, it's a very personal thing, lesson plans, and [indecipherable] And the way I might teach something, Dev might teach it in totally the opposite way. You often see in a lesson plan, "Oh I would never have done that, I wouldn't have thought of that." But you run into that with anything you do. Teachers have millions of resources, so it might be nice to give some hints, and then you know give a lesson

plan if you want to… I don't know what you need for your project. If it's a lesson plan or if you're going take…

DH: Well that's kind of guided by what you want to… What you guys really want to do. And that's what we want at the end of it. A pack that we can have as sort of really similar to these things here. Actually this one was brought out - it's CBBC, but actually it was brought out because the layout was really nice and actually sort of - it's quite straightforward, if look at something like this it seems more of something like what you're doing as opposed to what the V & A's got -

SM: The V & A are way off. I mean that's like just a brochure, that's not something - I don't know who would read that. Like I can't even see a key stage 5 teacher even picking that up. This is something that an AQT would use, so somebody who's a nearly qualified teacher, I could see them finding this really really useful, they're often the ones that get the key stage 3 world or build and try to do trips and stuff, so I think that would suit them. Something like this paired up with the practical side of the museum, because that's just a lovely resource - whereas this isn't so much a resource more just the lessons, but I haven't seen any lovely practicals to go alongside -

DH: So there's meant to be resources at the very back, but they are kinda more, cut-out and keep type things, you're meant to sort of put them together yourself, so when you get to these type things you have to sort of have the worksheets to link into some of the lessons, but -

SM: Yeah, so some of these are quite nice. The only thing I would say, and this is being really pedantic, is when you photocopy this, you're photocopying it black and white and it looks crap.

ED: Yeah. [inaudible]

SM: You know you bring this out, and it looks lovely, and then you photocopy 50 copies and it's black and white and it loses it's appeal, so when you're making things it's gotta photocopy in black and white and sees what it looks like. Because all the colours are brilliant, but sometimes some of the stuff like - y'know it really this toner isn't great, or really these dots don't come out well - so, you've got to kind of watch that. Which sounds really miserable, but - nobody photocopies in colour.

DH: No, no, no.

SM: Unless you were to give them, you know - here's 200 copies. But you'd have to be so confident they're gonna use them because they'd probably get shoved in a box somewhere.

DH: That's good because our design budget might not be as a - as high as we'd like. [Laughs]

SM: No, it's - budgets are tight everywhere, aren't they.

DH: Yeah, yeah yeah completely, yeah. Yeah. So good, because actually the style side of things we love the Kitchen Science one as a -

SM: Mmm, it's really keen.

DH: You know, we were saying from our point of view, Design Museum wise, that's - the sort of things in there are really great. What we like, what fits in with our brand is more sort of our - more something like that.

SM: Yeah. The science museum is really clean, really pure, and it's easy to see - it's on a white background so it copies well. So you know, teachers could easily photocopy - they wouldn't, but they could photocopy that booklet you know, and give it to you if they wanted. [Laughs] Whereas this one wouldn't photocopy well at all. And it's on shoddy paper.

DH: Is that the [inaudible] paper? It's not because it's -

SM: It should be like cards, no?

DH: Yeah, yeah.

SM: Or wait a binder, or something more -

DH: That on was just printed out from these ones so that's just a pdf -

SM: But coloured printer.

[Multiple people talking and laughing]

DH: Always got it - it defaults to black and white, so it's - yeah.

[Laughter]

DH: Well I think the last one is worth seeing the Thackray stuff actually, on the bottom there.

ED: Oh. Going and digging in it?

DH: Yeah. This is actually a teacher pack that we bought as part of our research.

ED: This one?

DH: Yeah. And this is what you get sort of, as a -

[Multiple people talking over each other]

SM: I've seen that one.

DH: We can pass it around, so -

SM: This looks very comprehensive.

ED: It is.

DH: It does.

SM: Okay. This font is the same as the - isn't it the same as the mark scheme, the AQA mark schemes, the font and the layout? So the similar style to like the specifications on the exam. So I don't like it because I'm like, oh my god, markings.
[Laughter]
ED: Yeah.
SM: This will photocopy really well. I know, it's so - it's so boring, but you know, photocopy. It's very clear. Again, these will photocopy nice. Not very challenging, though. Mm. Yeah. Nothing like, amazing. No better than the worksheets I - we already have on file, from a programme that we would have bought, or that every school would have. I don't know why you would sign up to this when you already have something for your specification. I don't see what extra this brings, like, you know there'd be worksheets - I have folders of worksheets over there that are exactly the same, that are purchased from a whole programme for a whole year, a whole spec, so - why buy this?
DH: Yeah. That was ten pounds, that one.
SM: [Gasp] But your ten pound for what? You can get all this free online!
DH: [Laughs] Yeah, exactly, yeah.
SM: Go on to TDS! Have you been on TDS?
[DH shakes head]
SM: Make sure in it - just google TDS, put a full stop at the end or else you'll go to Tesco. And that's not what I'm saying. [inaudible] for a Saint Patrick's thing, then go to Tesco. But err, yeah, you can get all this online. It looks very old, and the date -
DH: Err, yeah, I was actually quite when we received that.
SM: It's really old, yeah, when was this published?
DH: Oh I dunno to be honest, [low mumbling]
SM: This is something they've had knocking around for the last ten years. And they just keep selling them around for a ten, or - but you will get teachers who will buy it, but they'll be few and far between. And when they get it they'll be disappointed.
DH: Oh well, yeah, we will.
[Laughter]
DH: We've uh, we've talked - research wise, we end up buying them, but actually, some of those -
SM: [Reading off the lesson plan] "Write on the drawing any dangers to health you can find."
DH: Mmm.

SM: Sure. Why would you pay them for that drawing? Why wouldn't you just find your own drawing? Yeah there's nothing there, that's horrible. Where is it for?
DH: That's Thackray Museum, it's in Bristol, I think.
SM: Haven't even heard of 'em, so…
DH: No, no, to be honest I hadn't either, until -
SM: And I don't think I'm going to any time soon. [Laughs] Yeah, I wouldn't bother with that one, that's...really bad. You did get that plastic wallet though, did they send you that as well?
DH: That's - yeah, it's all included in the price.
SM: That's good, that was good value. There was a very - there was a ten that's worth photocopying in there, it has value. They spent that money on printing.
DH: Yeah, yeah, there's some - free package and postage as well.
SM: Was it? So I think they sent you that for free, cause they had it twenty years ago and then -
DH: There's a - there's a couple somewhere with [inaudible]
SM: I bet there is, they probably had house and said keep flogging 'em! Keep flogging 'em!
DH: Yeah, yeah. So did you guys have any more questions?
AC: I guess I have one more thing. So, would you like the materials to be - so you mentioned that you'd like it to be connected to your curriculum, would you like to be a very structured lesson, or more like this is what you should cover, just to clarify?
SM: I think you could do both, you could probably say you should cover these things, here's a - within our pack we've included a lesson plan and resources you may like to use, however feel free to just cover this and use your own. Because some teachers might even teach a long time and might have always done it the same way, and sometimes they can kind be of a bit, you know - it can be hard to make teachers teach something they know in a different way, but then you'll get other teachers, where you'll get the younger teachers who'll be really keen to do it the way you've asked them to do it, or you'll get some people who just think oh, I've done that, but actually this is totally different, I want to have a go. And then you'll get those teachers that'll be like, I'm not going to make something like that, I don't have time, they've sent me this pack and I want a lesson, I want it ready, and I'm not going to put the time in. So I think I would do both, say what you want to have to cover, to what point, what they should know before, what they should know after the trip, etcetera. And then here's an example of a lesson plan, here's some sample resources, feel free to use them. I'd also brand everything - I would also brand all the resources, because it's a bit different to

what they're used to seeing. So everything that we do, with these, is really heavily branded like we're Activate everywhere, so the kids know the logo, and it's on every single worksheet. Whereas if they something on a different worksheet, it can make a slight difference. And, you know, it's nice for the teachers to be like oh, that's the Science Museum and I use that for that. Just be a way of kind of differentiating from everything else. Which is what you're trying to do. Because you're not trying to sell a new specification because you'd have the competition of heavy weights up against, you're trying to sell something extra special, like really exciting, really innovating stuff. Should be a bit - you know, should be a oxy snazzy for what you've got to photocopy them. But not like that, that's rubbish. That's what - that one would never photocopy, whereas that one would photocopy lovely, but both of them are rubbish, for various reasons though. They should have had a child together and met somewhere in the middle. One is like crazy colours, and one is no colours.

DH: Yeah, yeah. This one would end up sort of like a black sheet and this one would like a little -

SM: Yeah, that's the thing. Yeah, it wouldn't, you wouldn't see anything.

MG: Oh, erm, really quick, what key stage do you teach? Since we didn't catch it at the beginning.

DT: Uhh… Three and four.

DH: So ermm... I think maybe the last thing to cover is, would it be possible to then get these guys to witness a lesson?

SM: Yeah, I like how you use the word witness though. [indecipherable laughter] period five on Friday. I'm actually leaving to another school at the end of the term so, I'm going to another school and I'll take you with me again. You'll be everywhere then. I'm thinking I should be doing this. So I'll give you my new email and I'll [indecipherable] just use my personal one until then. That's the one I always use. You can come to my school after, or I can put you in touch with someone here, and you can arrange to see some lessons here. It's totally up to you. Like…

DH: It might be good because these guys are on a really tight time scale if there's any sort of - even before Easter.

SM: So if you want to come in next week, like, you could come in. Say it's Tuesday… So, do you want to come in on Monday?

ED: I think we have meetings on Monday. We have…

JL: We're off timetable on Monday, anyway.

DT: We have our GCSE [indecipherable]

[pages flipping]

PD: Monday is… fine…

ED: Here's our schedule.

[quiet discussion]

JL: We're only in school until Thursday, so it's either Tuesday, Wednesday, or Thursday. Thursday may not be ideal.

SM: Wednesday?

DH: Mmm-hmm.

SM: Yeah? Wednesday?

DT: Yeah.

PD: What time works for you?

SM: We start from half eight, so half eight is forum time. So, what you might like to do… I'm not teaching period one on Wednesday. Dev, are you teaching period one on Wednesday?

DT: Yeah, I'm teaching seven, year seven.

SM: I'm teaching year eight after that, year eight after that. So you could come in from… say you arrive at half eight… It's fine if you don't. Arrive by ten to nine, so between half eight and ten to nine, or you can come to forum if you want and just talk to students. Are you, I don't know, doing any student interviews? I dunno if that might part of your project. You could always take some students out and interview them and say, find out what they look forward to on trips. You know, what do they like about trips. And they will be very honest with you about what they like and what they don't like. So if you come between half and ten to nine, and you can stay until… well, you can stay until lunch if you like. But it might be a good idea to stay until… period three or period four, or until lunch? So until twelve or one. That way you get a nice half day.

ED: Yeah.

PD: Great.

DH: That would be awesome, okay.

SM: I'll give some [inaudible]

DH: The other thing is, once they put something together, would it be possible, is there any time in like Science club to come along and try it out?

DT: Yeah, definitely.

DH: And maybe sort of take over from you, you know. And give you an afternoon off. And actually try a session out.

DT: You don't have to convince me.

DH: With it… I have to say again, on a tight time frame, it would be right after Easter work would be suitable?

DT: Every Tuesday after-school, we do science club, but we can try and put on another session. But I don't know when children are free, that's the only thing.

DH: Yeah, because also the Tuesday would be the last Tuesday back. It would be the post - Actually no, that would be fine, that would work out.

ED: The twelfth?

DH: No, not the twelfth, ermmm, sorry, I need to look at my diary again. Yeah, it would be the twelfth, wouldn't it then. Yeah, yeah. Tuesday the twelfth, would that be a possibility?

DT: Yeah, we'd be back at school.

JL: Yeah.

SM: Yeah.

MG: Okay…

DH: Ermm… [recording ends]

Appendix G: Educational resources - KS3 teacher packs

Table of contents

Learning outcomes:

- Students will be able to create their own balloon vehicle.
- Students will be able to improve upon an existing design.
- Students will develop discussion and communication skills.
- Students will be able to create a design when given a pizza delivery driver's needs.

the DESIGN MUSEUM

Links to the curriculum:

- Physics: friction, momentum, speed, acceleration, pressure, weight
- Engineering: structural integrity
- Design and Technology: the design process
- Mathematics: dimensions, scales, and ratios

Materials:

- 1 balloon (9-inch or smaller) per group of 3 students
- 3 straws (non-bendy, roughly 1 cm diameter types are recommended) per group
- 4 plastic bottle caps per group (water bottles usable as additional material)
- 2 wood skewers
- Scissors
- Tape/Glue
- Cardboard (less than 1 square foot per group)
- Weights: One pound coins (10 g per coin), dominoes (20 g), marbles (4 g) or other small weights
    - Total weight per group should equal at least 100 grams (10 grams = 1 pizza)
- Optional materials: Rubber band, paper, miscellaneous item bin for add-ons - give your students the chance to use any spare materials that you may have around the classroom

Lesson plan:

Introduction (15 minutes)

Script:

Corradino D'Ascanio designed the Vespa in 1946 after the Second World War. D'Ascanio was an aeronautical engineer who was an Italian helicopter pioneer. He did not enjoy traditional designs of motorcycles. Therefore he designed the Vespa motor scooter to be more comfortable and to have a much less bulky design.

The Vespa's design differs from other types of two-wheelers, such as motorbikes or bicycles, in that Vespas allow the rider to sit as though on a chair. Such a design allows for more comfortable seating and was embraced by the 'Mods' of the 1960s, as the positioning of the seat allowed the rider to drive around without getting dirt or grime on his clothes.

The term 'Mod' was created in the late 1950s when Londoners called small groups of young men who focussed on music, specifically modern jazz, and fashion 'modernists'. The 'Mod' movement expanded in the 1960s and eventually the name adopted a new meaning: everything new and

exciting. The 'Mods' loved the scooter because of Italian style and because unlike the motorcycle, the driver's clothes did not end up covered in muck.

- Discussion questions
    - Do you know what a Vespa is?
    - Can you describe one and its purpose?
- **(1 minute)** Show the Javier Mariscal Vespa video (https://vimeo.com/94349597)
- Different users have different needs, which means that different products are better for different people (accompany with an image of a Vespa scooter).
    - Who might use a Vespa? Would any of you want a Vespa?
    - What decisions or features did the designer use when making the Vespa to please the user?
    - How might you design/change a Vespa? (1-2 volunteers)

Activity: Build and test initial balloon vehicle (25 minutes)

Break students into groups of 3-4 if applicable, break the students into high achieving and low achieving groups. When applicable, the different performance levels will receive different worksheets. Read aloud the story of Mr. Archie. Show examples of balloon vehicle. Set a distance for the vehicle to travel (recommended distance: 1 m)

User Profile: Mr Archie is a Mod who owns a Vespa and loves the design. He is also a pizza delivery man whose business is expanding. Since his business is expanding, Mr Archie's Vespa can no longer carry the number of pizzas he needs to deliver. But Mr Archie likes his Vespa - especially how comfortable and fashionable it is! He wants you to design a vehicle that can fit as many pizzas as possible while still reaching its final destination, but also has design features to make it resemble a Vespa.

Pass out the user profiles to the students and have them design and build their balloon vehicle. If applicable, give respective sheets to both high achieving and low achieving students.

High achieving students: Create a completely new format and design for the vehicle. Achieve over the expected amount of weight.

Low achieving students: Follow the pre-defined format and design of the vehicle. Make slight adjustments to the vehicle to improve the initial design.

Have students build the vehicle out of the materials listed.

- It must travel at least 1 m on one full tank (blown up balloon)
- It must hold and carry at least 100g in weights
    - If it fails, redesign the vehicle until it succeeds
    - If the student's vehicle can carry the 100g, try to put on even more

(Optional) Improve the balloon vehicle (5 minutes)

Ask students to look around the class and try to make improvements to your vehicle based on the designs of others in the class. Once the students are done, have the students re-test their new vehicles with the weights.

Testing the balloon cars (5 minutes)
When finished building, test the vehicle by loading it with weights, blowing up the balloon and letting it go. Mark the distance the vehicle travels, or test the vehicle alongside a meter stick.

Plenary (5 minutes)

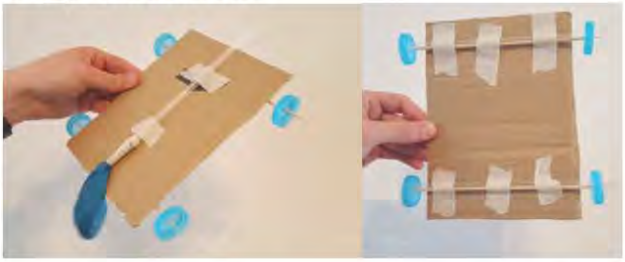
- Why did the group make certain design choices?
- What worked? What did not?
- What improvements or changes could you make to your design if you had more materials?
- Did looking at any other designs inspire you to make any changes to your own design? What changes did you make?
- What was a change/component that made the biggest difference with your balloon vehicle?

(Optional) Homework
Design an automated vehicle for delivering pizzas.
Things to think about:

- Without the need for a space for the driver, what would the vehicle look like?
- Could you have one the size of a pizza box?
- Would it need to be bigger?
- What problems would be created and what problems would be overcome by having a smaller sized vehicle?

You should sketch the design of your automated vehicle on a piece of graph paper. Your design should be drawn to scale, and the scale should be listed in a key on your paper.
Note: You may need to research pizzas and delivery vehicles to create a good design.

Example balloon vehicle:



<u>Links to Design Museum Designer/Maker/User exhibition:</u>

- From the city to the spoon - Exhibition objects - Vespa
    - Reference: https://vimeo.com/9434959

High achieving students: Mr Archie is a Mod who owns a Vespa and loves the design. He is also a pizza delivery man whose business is expanding. Since his business is expanding, Mr Archie's Vespa can no longer carry the number of pizzas he needs to deliver. But Mr Archie likes his Vespa - especially how comfortable and fashionable it is! He wants you to design a vehicle that can fit as many pizzas as possible while still reaching its final destination, but also has design features to make it resemble a Vespa.

Create a vehicle using the given material. Customise your vehicle for Mr Archie. Continue improving your vehicle to maximize the amount of weight it can hold.

Low achieving students: Mr Archie is a Mod who owns a Vespa and loves the design. He is also a pizza delivery man whose business is expanding. Since his business is expanding, Mr Archie's Vespa can no longer carry the number of pizzas he needs to deliver. But Mr Archie likes his Vespa - especially how comfortable and fashionable it is! He wants you to design a vehicle that can fit as many pizzas as possible while still reaching its final destination, but also has design features to make it resemble a Vespa.

Base your balloon vehicle off the image shown. Make slight adjustments to the vehicle to improve the design to fit Mr. Archie's desire.

Learning outcomes:

- Students will be able to create a control scheme for a chosen object.
- Students will develop collaboration and teamwork skills.
- Students will be able to guide a user using graphics and colour theory.
- Students will develop observational skills.

Links to the curriculum:

- Design and technology - industrial design, user interfaces, human technology interaction, radios, electronics
- Maths - probability, geometry
- Art - colour theory

Materials:

- 2 sheets of A3 paper per pair of 2 students
- Pencils
- coloured pencils/markers
- Scissors
- Glue

Lesson Plan:

Introduction (15 minutes)

Script:

Prior to the 1950s, consumer electronics were almost entirely made of wood - wooden radios and gramophones were quite common in this era. However, the 1950s marked the beginning of more familiar models of consumer electronics made out of metal with simple designs. One model in particular, the SK4, is known for being a hallmark of modern design techniques. Also known as the Phonosuper, it was created by industrial designer Dieter Rams. Both a radio and a record player, it was designed to be non-intrusive in the home and guide the user with its layout and simple colour scheme, which was a departure from other models at the time.

- Designer corner: Dieter Rams was a designer who worked at Braun during the 1950s. Originally a cabinet maker, it was his previous work experience that inspired the design of the Phonosuper. Rams is also known for creating the ten principles of good design, which are still used by designers today.
- Phonosuper facts:
    - Also called SK5 or SK4 (the SK4 was the initial version, the SK5 was the improved version)
    - Simple, modern (for its time) design
    - White, square, metallic
    - Both a radio and a record player

    - Controls were designed to guide the user
    - Designed by Dieter Rams
- How did we get to the metal, streamlined electronics we have today?
- **(1:05 minutes)** Paul Smith discussing the SK5 ("Phonosuper") video: https://vimeo.com/87671242
- Discussion Questions
    - What particular feature did Paul Smith mention in the video that he liked about the Phonosuper?
    - Why do you think this feature was important?
    - What sorts of things do you notice about the Phonosuper?
- Show pictures of the SK5

Instructor's Note: *The buttons are treble at the top, bass in the middle, and volume at the bottom - point out that treble and bass are in the order of their frequencies with the higher frequencies controlled above the lower frequencies.*

- Discussion questions
    - What do you notice about these controls? Do you think there is any significance to the colours? How so? What about the shape and placement of the buttons?
        - The grey buttons match the colour of the record player
        - The buttons match the indentation for a finger
        - There are five buttons - the same as the number of fingers on each hand
        - The depressed button stands out and signifies which button is selected; pressing a new button releases the button currently depressed
        - The buttons are inline with one another; the dials are separate from the rest of the buttons
    - Why do you think Rams designed the Phonosuper this way?
        - Make it discreet at home when not in use
        - Make it easier for anyone to use
        - Make it easier for the user to see the controls
        - Make the purpose of each button clearer to the user - each button has a specific purpose and the buttons/dials are placed in a specific order

Introduction: Industrial Design and the 10 principles of good design (15 minutes)

Script:

Although he studied architecture and interior design Rams went on to be an important industrial designer. But what is an industrial designer? Industrial design is concerned with items that have to be mass produced on an industrial level, like TVs, phones, chairs and cars. If it has to be mass produced and takes advantage of a machine to make it then the chances are that it's a piece of industrial design. Rams went from a study that is concerned with making unique structures like buildings that can be tailored to its users, to making objects that would be used by lots of people with diverse needs and requirements.

- Some people think industrial design is only around the phone, workplace, and school but it goes much further.
- Industrial design should consider the needs of its intended user.
- Good industrial design provides insight into the use and functionality of the object without obvious direction.

Dieter Rams' ten principles of good design:

Good design:

1. Is innovative
2. Makes a product useful
3. Is aesthetic
4. Makes a product understandable
5. Is unobtrusive
6. Is honest
7. Is long lasting
8. Is thorough down to the last detail
9. Is environmentally friendly
10. Is as little design as possible

Explanations of the ten principles:

1. Is innovative – The possibilities for progression are not, by any means, exhausted. Technological development is always offering new opportunities for original designs. But imaginative design always develops in tandem with improving technology, and can never be an end in itself.
2. Makes a product useful – A product is bought to be used. It has to satisfy not only functional, but also psychological and aesthetic criteria. Good design emphasizes the usefulness of a product whilst disregarding anything that could detract from it.
3. Is aesthetic – The aesthetic quality of a product is integral to its usefulness because products are used every day and have an effect on people and their well-being. Only well-executed objects can be beautiful.

4. Makes a product understandable – It clarifies the product's structure. Better still, it can make the product clearly express its function by making use of the user's intuition. At best, it is self-explanatory.
5. Is unobtrusive – Products fulfilling a purpose are like tools. They are neither decorative objects nor works of art. Their design should therefore be both neutral and restrained, to leave room for the user's self-expression.
6. Is honest – It does not make a product appear more innovative, powerful or valuable than it really is. It does not attempt to manipulate the consumer with promises that cannot be kept.
7. Is long lasting – It avoids being fashionable and therefore never appears antiquated. Unlike fashionable design, it lasts many years – even in today's throwaway society.
8. Is thorough down to the last detail – Nothing must be arbitrary or left to chance. Care and accuracy in the design process show respect towards the consumer.
9. Is environmentally friendly – Design makes an important contribution to the preservation of the environment. It conserves resources and minimizes physical and visual pollution throughout the lifecycle of the product.
10. Is as little design as possible – Less, but better – because it concentrates on the essential aspects, and the products are not burdened with non-essentials. Back to purity, back to simplicity.

Discussion questions:

- Do any of the features you observed in the SK5 fit into any of the ten principles? Why?
- What sorts of objects do you use without thinking about how to use them?
- Are there any objects that you think follow these ten principles?
- Do you think you can design an object so that someone can use it without being told how?

Activity:

Design a control scheme (15 minutes)

Break students into groups of 2. The students will create a control scheme for an object of their choice without using words or numbers. The students should use multiple types of cues to indicate how parts of the control scheme are used.

List of a few types of user cues:

- Colour
- Indentation
- Graphics/Symbols

Instructor's Note: *It must be an object that people interact with, not just observe or collect - if a student pair chooses an object without any interactive functionality, they will not be able to complete the lesson properly. Example: A clock is not allowed because its purpose is to show time and it does not use the time in any way. However, a timer might be allowed because a user can interact with it and set limitations with it.*

Make sure the students consider the following when designing their control schemes:

- Don't assign colours at random - consider how you can use them to note differences in functionality between types of buttons or dials. Would contrasting colours stand out more than similar colours?
- Try to keep your graphics simple - if you make them too complex, it might be hard to distinguish them.
- Consider using shapes to your advantage - what sorts of objects have recognizable silhouettes? Can you use those as a reference to the purpose of a button or switch?
- Don't forget about the ten principles of good design! Keep them in mind as you design your controls, and try to make your features match with the principles.

The students may use their paper in whatever way you choose to create their interface, but they must be glued on to their second sheet of paper before they switch with another pair.

(Optional) High achieving student activity: Simplification

Choose an object (it can be the same object as the original activity) that has a control scheme and simplify the controls. Requirements:

- You must remove at two buttons, levers, or other physically interactive component.
- You must remove at least two colours, patterns, or other aesthetic component.
- The object must retain its original function.
  Example: A timer that is simplified must still alert the user in some way that the set amount of time has passed.
- You may create buttons that use dual functionality, e.g. a play/pause button on iPods.

Test control scheme with another group (5 minutes)

Once two pairs of students finish their control scheme, they should swap their interfaces with the other pair, and attempt to figure out how to use the object correctly without any instructions. The pair that receives the new control scheme should work together to identify the purposes of buttons based on the layout, colours, and graphics.

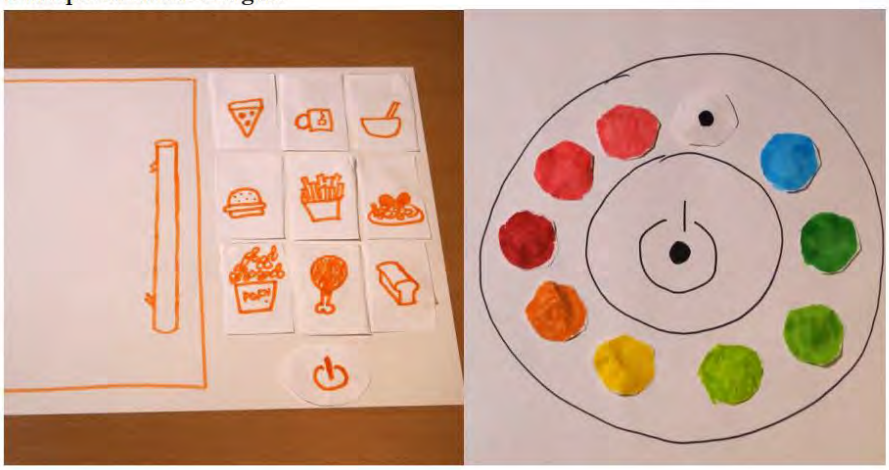
Optional: The pair that gave away their control scheme should hold up a Rams card if the other pair is right, and a not-Rams card if the other pair is wrong. Note that this will take more time because they will work on only one object together at a time.

Plenary (5 minutes)

- Ask students about their pair's design
  - Why did you design the control scheme the way you did?
  - How did you attempt to give the user hints on the functionality of the object through the control design?
  - What sorts of colours did you use? How did you order your switches and buttons? Do you think it made a difference?
  - Was your partner pair able to figure out what your object was? Why or why not?
  - What would you do differently if you were to redesign your control scheme?

- Did your initial plans for your design change significantly by the end of the lesson?

Example interface designs:



Links to Design Museum Designer/Maker/User exhibition:

- The Designer/Maker/User exhibition includes the Braun SK5
- Examples of other Braun objects in the exhibition:
  - Citrus Press
  - Coffee maker KM 321
  - Desk fan HL1
  - Nizo Braun Super 8 camera
  - PK-G3 Stereo
  - Clock signal radio ABR 21
  - DW30 digital watch

Further information:

- The Braun SK5
- Comparison of Apple and Braun
- Dieter Rams - Reference: http://designmuseum.org/designers/dieter-rams
- Graphic of Dieter Rams' ten principles of good design

Learning outcomes:

- Students will be able to create their own kettle/teapot
- Students will be able to collaborate with partners to create a final design
- Students will be able to associate designs with a given user's needs

Links to the curriculum:

- Earth science - phase changes, water boiling, density changes from becoming steam, vaporisation, condensation
- Materials - heat conduction of materials, materials' melting point
- Design and technology - material sciences (tin, copper, titanium, etc.)
- Arts - crafting

Materials

- User profile and kettle drawing worksheets
- Drawing materials
- 1 m of tin foil per group, for up to 5 groups
- 1 plastic water bottle per group, for up to 5 groups
- 1 straw per group, for up to 5 groups

Lesson plan:

Introduction (15 minutes)

Script/designer corner:

The MG33 kettle was originally sold in 1980 and is now one of Alessi's trademark items. It mimics one of Alessi's earlier kettles by the same designer, which had a bird shaped whistle. The bird on the kettle whistle was playful, but the body of the kettle was a standard design that could be easily mass produced, making it ideal for a corporation. It was designed by Michael Graves. Designer corner: Michael Graves was a designer who was known for his playful designs, including animals on his teapots and kettles. His designs also attracted him to the world of cartoons, and he designed several buildings for Walt Disney.

The Hot Bertaa kettle was designed by Philippe Starck and was one of his less successful creations. Based on the concept of 'immobile aerodynamics', it was meant to take an unmoving object - the kettle - and provide motion to it. It is normally filled by pouring water into the handle, and the steam produced by the heating water is also released through the handle. Unfortunately, the complex mechanism to redirect the steam was unreliable and the kettle failed to convey its use to consumers, so it was consequently pulled from production in 1997 - only a year after it was introduced.

- Show image of the Hot Bertaa kettle
    - Ask students to guess what the object might be.
    - Hands up vote: what people think it is.
    - Have the students identify aspects of the kettle they recognize. Possibly list the aspects they choose.
    - Ask the student why they are choosing that aspect, or what makes them think it is a specific object.
- **(3:17 minutes)** The Hot Bertaa kettle video: https://vimeo.com/79779682
- Discussion questions
    - How is a teapot different from a kettle? A kettle is meant to heat up the water, whereas a teapot is meant to store hot water and/or tea, coffee or other hot drinks.

- Show image of Michael Graves MG33
    - Do you notice any similarities between the objects?
    - Do you notice any differences?
    - How do you think the MG33 did as a product compared to the Hot Bertaa kettle? Why?

Purpose & appearance of kettles and teapots

- Hands up: who has used a kettle before, or has a kettle in their kitchen?
- How do you use a kettle?
    - Heating water for: tea, coffee, cooking, etc.
    - Decoration
- Ask students about features of kettles, draft a list on the board. Examples: Whistle, water viewport, size, cost, materials (metal, plastic), self-heating (electric), handles that prevent steam burns. Ask about features of teapots.

- Optional material focus:
    - What different materials would a designer want to use when making a kettle?
        - Plastic handle- does not heat up and burn the user
        - Conductive metal - easily heats up the water inside through heat transfer
        - High melting point metal - will not melt or burn before the water boils
    - What different materials would a designer want to use when making a teapot?
        - Insulating material - hold in the heat of the tea
        - Plastic handle - does not heat up and burn the user
    - Why would you need a designer to make a kettle or a teapot? What might the designer do?
        - To make the kettle/teapot look good.
        - To make the kettle/teapot work correctly.
        - To fit the consumer's needs.

Activity:

Design a kettle or teapot (10 minutes)

- Pass out the user profile worksheet to everyone in the class. Each of the user profiles worksheets are labelled with a number at the top. Have the students group together using their numbers on their worksheet (aim for 5 or less groups). Once the students are in groups, have the groups discuss a kettle/teapot design for their user. **(5 minutes)**
    - Ask if they want to design a kettle or a teapot.
    - Ask what materials they might use for their kettle/teapot.
    - Ask them what features they may add to the kettle/teapot.
    - Ask them what features they may avoid using for their kettle/teapot.
    - Ask if the user would want to buy their kettle/teapot and why.
- Have each student draw his or her group's kettle/teapot design on their own worksheet. Have the students determine which components of their design to keep and which to get rid of. Encourage the students to have creative freedom when designing their kettle/teapot. **(5 minutes)**

Create a miniature kettle or teapot prototype (15 minutes)

<u>Instructions:</u>

Preparation for the instructor before the lesson (about 5 minute for bottle):

1. Gather water bottles (1 bottle for each group).
2. Cut all bottles in half using scissors or other cutting tool.
3. Take the original top half of the bottles and cut off any additional plastic at the bottom to form a makeshift lid. Do not remove the cap during or after this step.
4. Measure out about one meter of tin foil for each group.

- Have the students start to create their kettle/teapot. The kettle/teapot should be based off of the students' drawing from the previous "Design a kettle/teapot" step.

- Make it clear that some of their features will not be possible with the tin foil and this is how the designer - maker relationship goes. When a designer makes a design, he or she needs to consider the available material.
- Encourage students to work around these issues and figure out solutions and compromises.

For the students during the activity (25 minutes):

1. Using a pen or other sharp object, poke a hole towards the bottom of the bottle. Be sure not to make the hole too large, it should be exactly the diameter of your straw.
2. Cut one end of the straw at a slight angle, and insert into the hole. Tape the straw on the outside of the bottle so that the straw is flush against the inside of the bottle.
3. Cut the other end of the straw so it is an appropriate length for your teapot or kettle. Distribute 1 m of tin foil to each group. Tell the students they will have 15 minutes to create their kettle/teapot design using the tin foil and plastic bottle given to them.

Swap user profiles (5 minutes)

- After completing their designs, have each group swap their user profile worksheet with another group. Make sure each group has a new profile (Ex. 1→2, 2→3, 3→4, 5→1). Have the students discuss the new user profile and their kettle/teapot design in their groups.
    - Does your kettle/teapot design satisfy this new user profile?
    - What works? What does not work?
    - Have the students draft a list of things that work in the design and a list of things that do not work.

Advanced KS3 activity - Thirty minute teapot (for classes capable of using and firing clay):
Have the students create a teapot, based on the user profiles, using clay. Limit the creating process to either 30 minutes or 1 hour. Allow the students to make any changes or improvements they would like to the teapot. Alternatively, allow the students to make one of the teapots provided in supplementary material.

Plenary (10 minutes)

- Take one to two volunteers and ask them about their kettle/teapot design.
    - Describe their user profile.
    - Discuss group's kettle/teapot and how it matches the user profile.
        - What features did the group add to their kettle/teapot?

        - What features did the group avoid when designing their kettle/teapot?
    - Ask the other students in other groups about any improvements or changes which could be made.
    - What happened when you received the different user profile?
- Discussion questions
    - What parts of the user profile's requirements were difficult to incorporate into the kettle/teapot? Which parts were easier? Why?
    - How did you create your kettle/teapot to accommodate your user's needs?
    - Did you need to change your design when you started to build it with the foil? What did you need to change?
    - Did your kettle/teapot meet the requirements of the second user profile as well as the first? If not, why?

Example kettle/teapot construction:

Links to Design Museum Designer/Maker/User exhibition:

- The Designer/Maker/User exhibition contains many different types of kettles and teapots.
- Examples of kettles and teapots and their designers:
    - Michael Graves - MG 33 teapot
    - Luigi Colani - Drop teapot

    - Jessie Tait - Flowermist teapot
    - Wilhelm Wagenfeld - Jenaer Glas tea service
    - Masatoshi Sakaegi - Teapot
    - Arne Jacobsen - Cylinda Line teapot
    - David Mellor - Pride teapot
    - Walter Gropius and Louis McMillen - TAC1
- Previously shown in the Design Museum:
    - Philippe Starck - Hot Bertaa kettle - 1989 - Reference: http://discover.designmuseum.org/object-page/hot-bertaa
    - Nils Chudy and Jasmina Grase - MIITO Precise

User profiles:

1

Ella has a small flat without a stove, but still wants to make hot tea for herself. Ella also has Alzheimer's disease and has difficulty remembering to switch things off. Can you design a kettle/teapot to boil enough water for just one cup of tea which will also keep Ella and her flat safe?

1. Get into your groups by number.
2. Discuss the user profile you have been given with your group.
3. Determine if you will design a kettle or a teapot.
4. Everyone draw their group's kettle/teapot on another sheet of paper.
5. Decide which features of the kettles/teapots are best and combine to make the best kettle/teapot.

2

Lily is an elderly lady that has trouble lifting heavy objects and wants a nice kettle/teapot that she can put on the table. She also does not want to burn her lips, she likes her tea to be below 85°C. Can you design a kettle/teapot that Lily would like?

1. Get into your groups by number.
2. Discuss the user profile you have been given with your group.
3. Determine if you will design a kettle or a teapot.
4. Everyone draw their group's kettle/teapot on another sheet of paper.
5. Decide which features of the kettles/teapots are best and combine to make the best kettle/teapot.

3

Theo has a very large family and wants to save time when making tea for everyone's breakfast in the morning. Everyone in his family wakes up at a different time, so he wants to also keep the tea warm. Theo does not have a large kitchen, so he wants his kettle/teapot to be easily stored away. Design a kettle/teapot which will help Theo and his family.

1. Get into your groups by number.
2. Discuss the user profile you have been given with your group.
3. Determine if you will design a kettle or a teapot.
4. Everyone draw their group's kettle/teapot on another sheet of paper.
5. Decide which features of the kettles/teapots are best and combine to make the best kettle/teapot.

4

Jonathan goes camping every weekend, but needs a kettle/teapot to boil water while he is in the woods. He only brings his backpack on these trips so he can go hiking. Please design a kettle/teapot for him.

1. Get into your groups by number.
2. Discuss the user profile you have been given with your group.
3. Determine if you will design a kettle or a teapot.
4. Everyone draw their group's kettle/teapot on another sheet of paper.
5. Decide which features of the kettles/teapots are best and combine to make the best kettle/teapot.

5

Jessica loves iced tea, but hates making new tea every day. Design a tea kettle/teapot where Jessica can boil water for her tea and keep it at a colder temperature so she can make cold tea for herself later in the week.

1. Get into your groups by number.
2. Discuss the user profile you have been given with your group.
3. Determine if you will design a kettle or a teapot.
4. Everyone draw their group's kettle/teapot on another sheet of paper.
5. Decide which features of the kettles/teapots are best and combine to make the best kettle/teapot.

Learning outcomes:

- Students will create signage for the school
- Students will develop their ability to analyse road signs
- Students will identify important design features of road signs

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Links to the curriculum:

- Design and Technology - analysis of key events and individuals in design and technology have helped shape the world, design criteria and specification, create ideas through discussion
- Engineering - civil engineering
- Art - graphic design, typography

Materials:

- 1 piece of A3 paper per student
- Drawing materials - pencils, coloured pencils, markers, crayons
- Scissors
- 1 roll of tape (for hanging up signs)
- Optional: construction paper

Lesson plan:

Introduction (15 minutes)

Script/designer corner:

Imagine you're driving across the country to see some relatives who live a few hundred miles away. Every town you drive past, every stretch of road has a different sign system with different font used for the words and a different way of displaying them. Some signs are complicated, some are written vertically and you have no navigational system to help you. Just when you think that you are used to reading one style of sign that goes flying past, you have to get used to a completely new layout of sign. This is what driving in Britain over 50 years ago was like.

Now we have clear road signs that are the same whether you are in a big city or the countryside. In 1957, the task of making this huge change to roads up and down the country was given by the government to just two designers: Graphic designer Jock Kinneir and his assistant Margaret Calvert. During their work, they visited other countries to research their road signs and performed visibility tests using prototypes. Before creating the road signs, Margaret Calvert and Jock Kinneir made signs for passengers to navigate around Gatwick Airport. They developed a system of easily read road signs using the principles they discovered, and created a lot of standards:

- Size of the road signs were much larger than they were before
- Used more pictures instead of words
- Made signs that look like the maps of junctions
- Used both uppercase and lowercase letters in signs because word shape makes signs much more readable *(Most road signs at the time only used capital letters)*

- Changed colour and shape of their signs to match the international convention *(The UN's Geneva Protocol on Road Signs and Signals of 1949)*
- Created simple pictographs, some of which are based on Calvert's life *(The cow on the farm animals warning sign is based Calvert's relative's cow named Patience, the girl in the school children crossing is Calvert)*

- Discussion questions
    - Why are all road signs formatted similarly?
    - Would it be difficult to identify road signs if they were all different shapes, colours, and sizes?
    - What are some other places that can use signs? *(If the students don't bring it up, mention schools)*

Activity:
Discussion (15 minutes)
Students will create signs to hang around the school based on standards the class develops. Lead the class in a discussion to determine what standards the students want to make.
Ask the class:

- What signs should we make? Think about what signs would be most useful.
    - Around the school: Bathrooms this way, directions to classes, exits, cafeteria, gymnasium, library, principal's office, caution signs, room numbers, watering fountains, staircases, room numbers, lifts, intersections…
    - In the classroom: Location of various supplies, exit and entrance, nameplates, coat rack, light switch…
- Should the signs we make instruct the reader? (E.g. a 'Quiet, people are studying' sign) Or are they telling the reader about the school? (E.g. 'Bathrooms this way') What does that tell us about how the signs should be designed?
- What situations are these signs used for? Is it an emergency or other urgent situation? Or is it a casual and relaxed situation?
    - Urgent situations warrant capital letters and bolded font
    - Relaxed situations use fewer capital letters, more symbols
- How many colours should we use? Which ones? Why?
- What shape should each type of sign be?
- What common symbols should be on the signs?
  (e.g. white arrows indicating directions)

(Optional) Lead the class around the school (5-10 minutes)
Lead the class around the school, and have students volunteer for certain locations.

Instructor's note: *If you haven't lead the class around the school, have a list of possible areas in the school and have students volunteer to complete each.*

Students create their signs (20 minutes)

Each of the students are going to make a sign for the school, but all the signs need to match the standards you just created. Pass out the paper and drawing material and have students create their school signs. When the activity is over, hang the signs in their appropriate locations.

Alternate activity: Individualised signs (20 - 40 minutes)

Margaret Calvert based a lot of her signs off of personal experience. The animal warning sign she developed was based on one of her neighbour's cows, and she based the school crossing sign on a picture of herself as a young girl.

The students make a sign based on one of his or her personal experiences. Here are some ideas for signs that they might want to make:

- A school crossing sign with the student's picture instead of the girl on Calvert's sign
- An animal warning sign that uses a picture of a pet or animal the student has seen
- A cycle route ahead sign based on his or her bicycle
- A pedestrian crossing light using the student's outline
- A bus stop sign based on a bus you often take
- A Quiet Lane or Home Zone sign based on his or her life
- A Motorway service area sign with symbols based on their cutlery, bed, or other symbols

Things to keep in mind while the students create their signs:

- Contrast - Signs with high contrast are easier to read
- Readability - Signs with simpler diagrams and less text are easier to read
- Simplicity and clarity - Anyone who sees the sign should understand the markings on it before they drive past. Don't add too many colours or a drawing that is too complex.
- Shapes and colours - Warnings usually are red-outlined triangles, instructions are usually blue circles, etc.

Plenary (5 minutes)

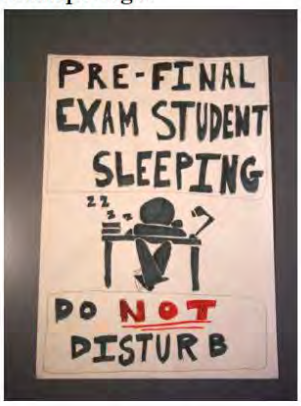
Discussion question:

- Why did you design your road sign the way you did? What made you choose the colours, lettering, or size?
- Would your road sign work on the side of an actual highway? What might you change to allow it to effective?
- Are there any places around your house that could use better signage? Why?
- If you could use a sign to show people that this is your room what would you put on it?

(Optional) Homework for high achieving students

Kinneir and Calvert worked on the signs at Gatwick Airport - international airports must address speakers from multiple languages, so symbols and clear illustration are important. Your assignment is to use signs, photos, or your own illustrations to guide a person who does not speak your language. Create step-by-step instructions to guide someone from the school to your house using only symbols - no letters or words.

Example sign:



Links to Design Museum Designer/Maker/User exhibition:

- The Designer/Maker/User exhibition contains multiple prototype signs that Jock Kinnier and Margaret Calvert designs.
- 50 Years of British Road signs, a past exhibition at the Design Museum focussed on Kinneir and Calvert's work

Further Information:

- 50 Years of British Road signs, a past exhibition at the Design Museum http://www.britishroadsignproject.co.uk/
- *Know Your Traffic Signs, Official Edition* booklet published by the Department For Transport - has a history of signs in the beginning, as well as an exhaustive list of signs
- *Design of modern road signage*, a BBC Bitesize video about this effort

Supplementary materials:

The school crossing sign with the girl loosely based on Calvert

The Transport typeface developed for road signs.

Legibility test carried out by the Road Research Laboratory at Benton Airport in 1959.

A few prototypes of the new signs made in 1963.

Learning outcomes:

- Students will be able to create improvements and personalise objects within the room
- Students will develop collaboration and teamwork skills
- Students will be able to identify the proper tools to fix objects
- Students will develop observational skills

Links to the curriculum:

- Science - materials, chemistry, and biology
- Design and technology
- Engineering

Materials:

- Paper/construction paper (3 sheets per pair)
- Tape/Glue (1 roll/stick per pair)
- Cardboard (1 - 2 boxes per pair)
- Scissors (1 per pair)
- Coloured pens/pencils/markers

Lesson plan:

Introduction (20 minutes)

Script/designer corner:

Originally from Ireland, designer Jane Ní Dhulchaointigh (pronounced nih-goo-oh-hin-tic) came up with the idea for Sugru while she was studying for her masters degree at the Royal College of Arts in London. She was tired of buying and replacing her things and wanted to improve and repair what she already owned. Using her experience as a previous chemistry major, she created the original Sugru prototype in 2003. After assembling a team of specialists and being awarded a grant for her project, she worked through the recession of the early 2000s to officially launch Sugru in 2009. Today, Sugru is sold at retailers all around the world. The name Sugru comes from the Irish word for 'play'.

Created using silicone technology, Sugru has the texture of play-doh and sticks to almost any material, including glass, plastics, fabrics, and wood. After it is exposed to air for thirty minutes, it begins to harden. After twenty-four hours it turns into rubbery, durable silicone. When it hardens, it is flexible and can withstand most types of weather and extreme temperatures as well as electricity. Once its use is finished, Sugru can be removed using sharp objects, such as knives.

- Sugru Facts:
  - Created using silicone technology
  - Texture of play-doh
  - Sticks to glass, plastics, fabrics, and wood
  - Hardens after exposure to air, turns rubbery after 24 hours

        - Flexible
        - Withstands most weather conditions
    - Removable using sharp objects
- Discussion questions
    - What was the last object you remember breaking (accidentally or otherwise)?
    - How many objects do you replace in a year? What kinds of objects do you replace the most?
    - Do certain objects get replaced entirely or do you only replace a few parts at a time?
    - Do you think the replacement of objects is wasteful or efficient? Why?
- **(3:26 minutes)** Sugru: How is it made? https://vimeo.com/80459596
- Discussion questions
    - Have you ever wanted to fix an object you use so that it works better for you?
    - What object would you improve or personalise in your own style?

Improve and personalise an object (20 - 30 mins)

Together with your partner, pick an object in your classroom and create a new version of that object out of cardboard and construction paper.

Requirements:

1. You must either add or remove at least one feature that you think your chosen object should have or does not need.
    - Examples of additional features: extra drawers, an extra cover, secret compartments
    - Examples of removable features: extra padding, nails that stick out, surface area that is not often used
2. You must personalise your object so that it contains features unique to both you and your partner.
    - Examples of such features: your favourite colours, patterns, fictional characters

Key words:

- Personalisation is an aesthetic choice (decoration, colour, general appearance).
- Improvement is a functional choice (additional features, compartments, or purposes)

Instructor's Note: *These two terms are not mutually exclusive, but for the purposes of the lesson, treat them as though they are.*

Plenary (5 min)

- Ask students what features they added, removed, or replaced
    - Why did you add/remove/replace those features? Did you consider other purposes that feature might have/have had (e.g. a bar lining the bottom of the desk might be obstructive, but it supports the structure of the desk)
    - Why did you choose to remove certain features but not others?
    - What would happen if you removed certain features but not others?

Example completed activity:

Links to Design Museum Designer/Maker/User exhibition:

- The Designer/Maker/User exhibition, "Ways of Making" section, contains Sugru
- Sugru: How is it made? - https://vimeo.com/80459596
- Timeline of Sugru - the "Sugru Story"

G6. Wiggle, Wobble, Wiggle Chair

G6.1 Lesson plan

Learning outcomes:

- Students will be able to create a newspaper chair
- Students will develop collaboration and teamwork skills.
- Students will be able to create a design for a given user's needs.
- Students will develop observational skills.

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Links to the curriculum:

- Physics/Engineering - forces, trusses, stress
- Design and technology - design process
- Earth science - sustainability

Materials:

- 1 newspaper chair instructions per group of 4
- 5 newspapers per group of 4
- 1 roll of tape per group of 4; masking tape recommended
- 5 textbooks or similar weights per group of 4

Lesson plan:

Introduction (15 minutes)

Script:

In the 1960s, designers began creating cardboard furniture as an alternative to traditional mediums. The furniture offered for a light, attractive design which also featured noise-reducing qualities in any room. Frank Gehry, an architect, created and designed one of the most notable pieces of cardboard furniture known as the Wiggle Side chair. Gehry saw a pile of corrugated cardboard, his preferred method of producing architectural models, outside of his office one day and decided to experiment with a pocket knife and hand saw. Using only cardboard and glue, Gehry created the "Easy Edges" series of cardboard furniture. The alternating corrugated cardboard patterns made for a very strong build. Gehry wished to make all of his furniture to suit anyone's budget, but the raising prices of the Easy Edges caused him to halt production of his furniture. "I started to feel threatened. I closed myself off for weeks at a time in a room to rethink my life. I decided that I was an architect, not a furniture designer … and I simply stopped doing it."

- Designer corner: Frank Gehry is an architect who uses cardboard to create architecture models. He started cutting and gluing cardboard shapes together and ended up with a very sturdy structure he called "Easy Edges." In 1972, Gehry experimented creating furniture out of the "Easy Edges" and he eventually created the Wiggle Chair.
- Discussion questions
    - What do you use a chair for?
    - Do you have a favorite chair?
        - What does it look like?
        - What is it made out of?
        - Why do you like it?

    - Why are chairs designed differently?
        - Why do some classes have stools?
        - Why do teachers have different chairs from students?
    - What sorts of materials are chairs typically made of?
    - Do you think you can design a chair made out of sustainable material like cardboard?
    - Does cardboard limit the design of the chair or can we make beautiful desirable objects with unexpected materials?
- **(3 minutes)** Wiggle chair video: https://vimeo.com/79779682
- Hands up: who has made something from cardboard before? Do you think that cardboard is a strong material? Why?

Activity: Design a newspaper chair (30 minutes)

Break students into groups of 4. Read aloud the story of James and his friend. Have students build a newspaper chair. The chair should be able to hold up the weight of up to 5 textbooks and freely stand roughly one foot above the surface they are building on.

James broke one of his chairs and is having a guest over in an hour. James is a postman who has some spare newspapers at his house. Can you help James prepare a chair for his friend using only newspapers and tape?

- Have the students think carefully about their design for the chair:
    - Rolling newspapers create strong shapes.
    - Level structures are usually more stable than non-level ones.
    - Crossing cylinders can provide structural support.
- Have the students discuss with your group members and test your ideas!
- Have the students create the chair in groups following instructions.

Instructor's Note: *Remind the students they only have a short amount of time to build the chair, so they don't spend too much time on planning the design.*

(Optional) Improve the newspaper chair (1-5 min)

- Look around the class at other designs and possibly incorporate features of their chairs.
- Encourage students to experiment to make their designs unique.
- HAPS: Have the students propose a change to their chair given a specific user situation (e.g. a school chair, a gaming chair, or an office chair).

Test your chair (5 minutes)

- Have the students test their chairs by putting a textbook on top of it.
- Continue adding textbooks, testing the structure of the chair.

Plenary (5 minutes)

Ask students about their group's design

- Why did you design the chair the way you did?

- What techniques did you use to keep their chair from collapsing?
- How stable is the chair? Did it collapse? Did it wobble when you put weight on it?
- How long would the chair last? How would you make it last longer?
- What would you do differently if you were to make another newspaper chair?
- What sorts of materials do you think you could make a chair out of? What kinds of designs would such materials require?
- How could you design other objects to be sustainable?

Example chair construction:

<u>Links to Design Museum Designer/Maker/User exhibition:</u>

- The Designer/Maker/User exhibition contains many different types of chairs.
- Examples of chairs and their designers:
    - Frank O. Gehry - 1972 - Wiggle Side Chair - Reference: https://designmuseum.org/design/chairs-1970s
    - Charles Eames - 1956 - Lounge - Reference: https://designmuseum.org/design/chairs-1950s
    - Verner Panton - 1968 - Panton - Reference: https://designmuseum.org/design/chairs-1960s
    - Gaetano Pesce - 1969 - Donna Up5 - Reference: https://designmuseum.org/design/chairs-1960s

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Wibble, Wobble, Wiggle Chair

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Reduce, Reuse, Recycle

- What are examples of reusable material within your school or your home?
- What can you make using re-usable resources?

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What materials are chairs made from?

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Chairs from different materials

Plastic	Metal	Wood	Synthetic mesh	Paper
Panton Chair (1968) Verner Panton	Crown Chair (1988) Tom Dixon	Plywood Chair (1988) Jasper Morrison	Aaron Chair (1992) Donald Chadwick and William Stumpf	Cabbage chair (2006) Nendo Inc. Tokyo
£200	£450	£1,000	£5,500	£13,000

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What do you use a chair for?

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Why are chairs designed differently?

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Do you think you can design a chair made out of reusable material?

Wiggle Chair Video

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https://vimeo.com/79779684

Making a newspaper chair

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James broke one of his chairs and is having a guest over in an hour. James is a postman who has some spare newspapers at his house. Can you help James prepare a chair for his friend using only newspapers and tape?

Instructions

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Materials:

- 5 newspapers
- 1 roll of tape

Assignment:

- Groups of 4
- Build a chair that can support the weight of five textbooks.
- Your chair needs to hold the books at least one foot off the ground.

Hints

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Think carefully about your design for the chair:

- Rolling newspapers create strong shapes
- Level structures are usually more stable than non-level ones
- Crossing cylinders can provide structural support
- Have you considered a platform to sit on?

Discuss with your group members and test your ideas!

The Valiant Vespa

Design Museum. (2014, May 7). DM25 | Javier Mariscal on Vimeo. Retrieved from https://vimeo.com/94349597

Goldstone, K. (2015, May 8). The Mod movement – A super-cool British sub-culture. Retrieved from https://www.greatnorthernfestivals.com/modska/News/ArtMID/503/ArticleID/1010/The-Mod-movement-%E2%80%93-A-super-cool-British-sub-culture

Brains and Braun: Less but Better

Design Museum. (2015, November 3). Dieter Rams. Retrieved from http://designmuseum.org/designers/dieter-rams

Minimally Minimal. (2014, April 8). Braun SK55. Retrieved from http://www.minimallyminimal.com/blog/braun-sk55

Krazy Kettle and Trendy Teapots

Alessi. (n.d.). Kettle, 9093. Retrieved from http://www.alessi.com/en/products/detail/9093-kettle

Design Museum. (n.d.). Hot Bertaa | Discover Design. Retrieved from http://discover.designmuseum.org/object-page/hot-bertaa

From the Streets to the School

Design Museum. (2015). British Road Sign Project. Retrieved from http://www.britishroadsignproject.co.uk/jock-kinneir-margaret-calvert/

Simply Sugru

Design Museum. (2013, November 27). *Discover Design: How is it made? Sugru on Vimeo* [Video file] Retrieved from https://vimeo.com/80459596

Our story | Sugru. (2015, April). Retrieved from https://sugru.com/story

Wibble, Wobble, Wiggle Chair

Vitra Design Museum: Wiggle Side Chair - Frank O. Gehry. (n.d.). Retrieved from http://www.design-museum.de/en/collection/100-masterpieces/detailseiten/wiggle-side-chair-frank-o-gehry.html

Appendix H: Educational resources - KS2 teacher pack

Table of contents

Learning outcomes:

- Students will be able to create their own balloon vehicle.
- Students will be able to improve upon an existing design.
- Students will develop discussion and communication skills.
- Students will be able to create a design when given a pizza delivery driver's needs.

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Links to the curriculum:

- Physics: friction, momentum, speed, acceleration, pressure, weight
- Engineering: structural integrity
- Design and Technology: the design process

Materials:

- 1 balloon (9-inch or smaller) per group of 3 students
- 3 straws (non-bendy, roughly 1 cm diameter types are recommended) per group
- 4 plastic bottle caps per group
- 2 wood skewers
- Scissors
- Tape/Glue
- Cardboard (less than 1 square foot per group)
- Optional materials: Rubber band, paper, miscellaneous item bin for add-ons - give your students the chance to use any spare materials that you may have around the classroom

Lesson plan:

Introduction (15 minutes)

Script:

There once was an engineer named Corradino D'Ascania, who designed helicopters in Italy. Besides helicopters, Corradino was quite interested in motorcycles, but he did not like the traditional design of the average motorcycle. Because of this, he designed a stylish and more comfortable vehicle. He called it the Vespa motor scooter, which is Italian for wasp.

The difference between the Vespa and other two-wheeled vehicles (i.e. motorbike, bicycle, scooter) is that Vespas allow the rider to sit as though on a chair. This design allows for more comfortable seating and was embraced by the 'Mods' of the 1960s, as the positioning of the seat allowed the rider to drive around without getting dirt or grime on his clothes.

The term 'Mod' was created in the late 1950s when Londoners called small groups of young men who focussed on modern jazz music and fashion 'modernists'. The 'Mod' movement expanded in the 1960s and eventually the name adopted a new meaning: everything new and exciting. The 'Mods' loved the scooter because of its Italian style and because unlike the motorcycle, the driver's clothes did not end up covered in muck.

- Discussion questions
  - Do you know what a Vespa is?

    - Can you describe one and its purpose?
    - The name comes from the Italian word for wasp. Does the Vespa sound like a wasp?
- **(1 minute)** Show the Javier Mariscal Vespa video (https://vimeo.com/94349597)
- Different users have different needs, which means that different products are better for different people (accompany with an image of a Vespa scooter).
    - Who might use a Vespa? Would any of you want a Vespa?
    - What decisions or features did the designer use when making the Vespa to please the user?
    - How might you design/change a Vespa?

Activity: Build and test initial balloon vehicle (25 minutes)

Break students into groups of 3-4. Read aloud the story of Mr Archie. Show examples of balloon vehicles. Set a distance for the vehicle to travel (recommended distance: 1 m)

User Profile: Mr Archie is a Mod who owns a Vespa and loves the design. He is also a pizza delivery man whose business is expanding. Since his business is expanding, Mr Archie's Vespa can no longer carry the number of pizzas he needs to deliver. But Mr Archie likes his Vespa - especially how comfortable and fashionable it is! He wants you to design a vehicle that can fit as many pizzas as possible while still reaching its final destination, but also has design features to make it resemble a Vespa.

Have students build the vehicle out of the materials listed. It must travel at least 1 m on one full tank (blown up balloon).

Note (lower KS2 classes only): Prior to the lesson, poke holes in all the bottle caps you will use for the class.

<u>Instructions:</u>

1. Cut a square piece of cardboard for the base of your vehicle. The width should be slightly less than the length of your straw.
2. Attach the 2 axles (straws) to the bottom of the cardboard using tape.
    a. Do not push the tape down too hard, causing the straw to be flattened.
3. Push the skewer through the hole in one of the bottle caps.
4. Insert the skewer into one of the straws attached to the cardboard chassis.
5. Attach the other wheel to the skewer.
6. Repeat steps 3-5 for the remaining axle.
7. Making the engine
    a. Take a balloon, a flexible straw, and some tape. Insert the end of the straw into the balloon, and tape around the balloon opening. Be sure the seal is tight enough that air does not leak out.
    b. Tape the engine to the top of the vehicle by the straw.
8. Blow up the balloon using the straw, put a finger over the end once the balloon is filled.

9. When ready, let it go! See if your vehicle can travel at least 1 m.

(Optional) Improve the balloon vehicle (5 minutes)

Ask students to look around the class and try to make improvements to your vehicle based on the designs of others in the class. Once the students are done, have them re-test their new vehicles with the weights. Add design features (seat, colour, etc.) - encourage them to add features that are common in Vespas.

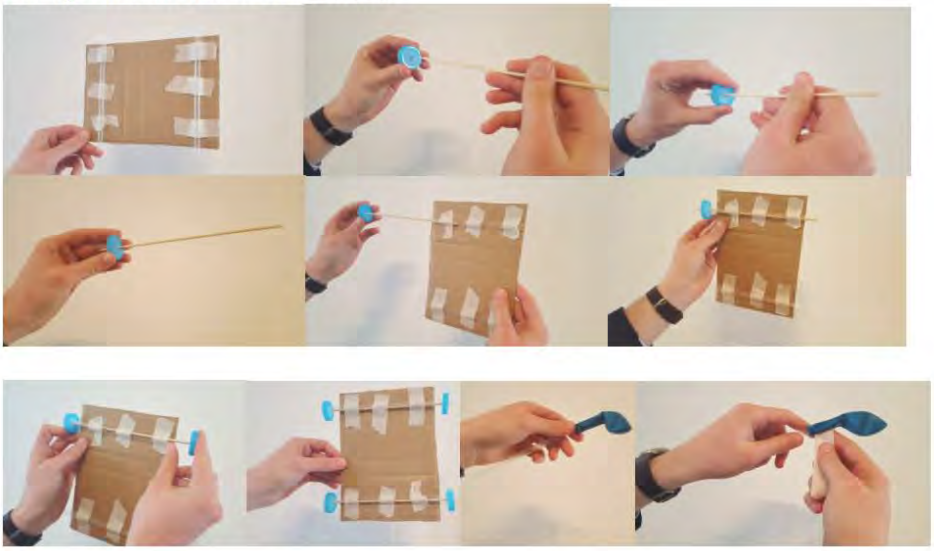
Testing the balloon vehicles (5 minutes)

When finished building, test the vehicle by loading it with weights, blowing up the balloon and letting it go. Mark the distance the vehicle travels, or test the vehicle alongside a meter stick.

Plenary (5 minutes):

- What worked? What did not?
- What improvements or changes could you make to your design if you had more materials?
- Did looking at any other designs inspire you to make any changes to your own design? What changes did you make?
- What made your balloon vehicle work?

Example balloon vehicle instructions:



Links to Design Museum Designer/Maker/User exhibition:

- From the city to the spoon - Exhibition objects - Vespa
    - Reference: https://vimeo.com/94349597

Learning outcomes:

- Students will be able to create a control scheme for a chosen object.
- Students will develop collaboration and teamwork skills.
- Students will be able to guide a user using graphics and colour theory.
- Students will develop observational skills.

Links to the curriculum:

- Design and technology - industrial design, user interfaces, human technology interaction, radios, electronics
- Maths - probability, geometry
- Art - colour theory

Materials:

- 2 sheets of A3 paper per pair of 2 students
- Pencils
- Coloured pencils/markers
- Scissors
- Glue

Lesson Plan:

Introduction: SK5 (15 minutes)

Script:

Prior to the 1950s, consumer electronics were almost entirely made of wood - wooden radios and gramophones were quite common in this era. However, the 1950s marked the beginning of more familiar models of consumer electronics made out of metal with simple designs. One model in particular, the SK4, is known for being a hallmark of modern design techniques. Also known as the Phonosuper, it was created by industrial designer Dieter Rams. Both a radio and a record player, it was designed to be non-intrusive in the home and guide the user with its layout and simple colour scheme, which was a departure from other models at the time.

- Designer corner: Dieter Rams was a designer who worked at Braun during the 1950s. Originally a cabinet maker, it was his previous work experience that inspired the design of the Phonosuper. Rams is also known for creating the ten principles of good design, which are still used by designers today.
- Phonosuper facts:
    - Also called SK5 or SK4 (the SK4 was the initial version, the SK5 was the improved version)
    - Simple, modern (for its time) design
        - White, square, metallic
    - Both a radio and a record player

    - Controls were designed to guide the user
    - Designed by Dieter Rams
- How did we get to the metal, streamlined electronics we have today?
- **(1:05 minutes)** Paul Smith discussing the SK5 ("Phonosuper") video: https://vimeo.com/87671242
- Discussion Questions
    - What particular feature did Paul Smith mention in the video that he liked about the Phonosuper?
    - Why do you think this feature was important?
    - What sorts of things do you notice about the Phonosuper?
- Show pictures of the SK5

Instructor's Note: *The buttons are treble at the top, bass in the middle, and volume at the bottom - point out that treble and bass are in the order of their frequencies with the higher frequencies controlled above the lower frequencies.*

- Discussion questions
    - What do you notice about these controls? Do you think there is any significance to the colours? How so? What about the shape and placement of the buttons?
        - The grey buttons match the colour of the record player
        - The buttons match the indentation for a finger
        - There are five buttons - the same as the number of fingers on each hand
        - The depressed button stands out and signifies which button is selected; pressing a new button releases the button currently depressed
        - The buttons are inline with one another; the dials are separate from the rest of the buttons
    - Why do you think Rams designed the Phonosuper this way?
        - Make it discreet at home when not in use
        - Make it easier for anyone to use
        - Make it easier for the user to see the controls
        - Make the purpose of each button clearer to the user - each button has a specific purpose and the buttons/dials are placed in a specific order

Introduction: Industrial Design and the 10 principles of good design (15 minutes)

Script:

Although he studied architecture and interior design Rams went on to be an important industrial designer. But what is an industrial designer? Industrial design is concerned with items that have to be mass produced on an industrial level, like TVs, phones, chairs and cars. If it has to be mass produced and takes advantage of a machine to make it then the chances are that it's a piece of industrial design. Rams went from a study that is concerned with making unique structures like buildings that can be tailored to its users, to making objects that would be used by lots of people with diverse needs and requirements.

- Some people think industrial design is only around the phone, workplace, and school but it goes much further.
- Industrial design should consider the needs of its intended user.
- Good industrial design provides insight into the use and functionality of the object without obvious direction.

Dieter Rams' ten principles of good design:

Good design:

1. Is innovative
2. Makes a product useful
3. Is aesthetic
4. Makes a product understandable
5. Is unobtrusive
6. Is honest
7. Is long-lasting
8. Is thorough down to the last detail
9. Is environmentally friendly
10. Is as little design as possible

Explanations of the ten principles:

1. Is innovative – The possibilities for progression are not, by any means, exhausted. Technological development is always offering new opportunities for original designs. But imaginative design always develops in tandem with improving technology, and can never be an end in itself.
2. Makes a product useful – A product is bought to be used. It has to satisfy not only functional, but also psychological and aesthetic criteria. Good design emphasizes the usefulness of a product while disregarding anything that could detract from it.
3. Is aesthetic – The aesthetic quality of a product is integral to its usefulness because products are used every day and have an effect on people and their well-being. Only well-executed objects can be beautiful.

4. Makes a product understandable – It clarifies the product's structure. Better still, it can make the product clearly express its function by making use of the user's intuition. At best, it is self-explanatory.
5. Is unobtrusive – Products fulfilling a purpose are like tools. They are neither decorative objects nor works of art. Their design should therefore be both neutral and restrained, to leave room for the user's self-expression.
6. Is honest – It does not make a product appear more innovative, powerful or valuable than it really is. It does not attempt to manipulate the consumer with promises that cannot be kept.
7. Is long-lasting – It avoids being fashionable and therefore never appears antiquated. Unlike fashionable design, it lasts many years – even in today's throwaway society.
8. Is thorough down to the last detail – Nothing must be arbitrary or left to chance. Care and accuracy in the design process show respect towards the consumer.
9. Is environmentally friendly – Design makes an important contribution to the preservation of the environment. It conserves resources and minimizes physical and visual pollution throughout the lifecycle of the product.
10. Is as little design as possible – Less, but better – because it concentrates on the essential aspects, and the products are not burdened with non-essentials. Back to purity, back to simplicity.

Discussion questions:

- Do any of the features you observed in the SK5 fit into any of the ten principles? Why?
- What sorts of objects do you use without thinking about how to use them?
- Are there any objects that you think follow these ten principles?
- Do you think you can design an object so that someone can use it without being told how?

Activity: Design a control scheme (20 minutes)

Break students into groups of 2. The students will create a control scheme for a microwave without using words or numbers. The students should use multiple types of cues to indicate how parts of the control scheme are used.

List of a few types of user cues:

- Colour
- Indentation
- Graphics/Symbols

Instructions: Together with a partner, design a control scheme for a microwave.

1. Fold your paper in half once.
2. Repeat four times. You should now have a thick, folded rectangle.
3. Unfold your rectangle completely and cut the paper along the folded lines. You should now have 16 smaller rectangles.

Instructor's Note: *Rectangles should be ~ 1x2 inches.*

4. Take one rectangle and fold it in half, then cut a semicircle while it is still folded.
5. Unfold your half circle. You should now have a paper circle.

Instructor's Note: *The circle should be ~ 1 inch in diameter.*

6. Arrange nine rectangles so that there are three rectangles on three rows on the right side of your second sheet of paper.
7. Place the circle below the bottom row of rectangles. Glue in place.
8. Glue the rest of your rectangles into place.
9. Draw a large rectangle in the space next to your rectangles and circle.
10. Colour in your rectangles using coloured pencils or markers. Think of things you can microwave and try to draw them!

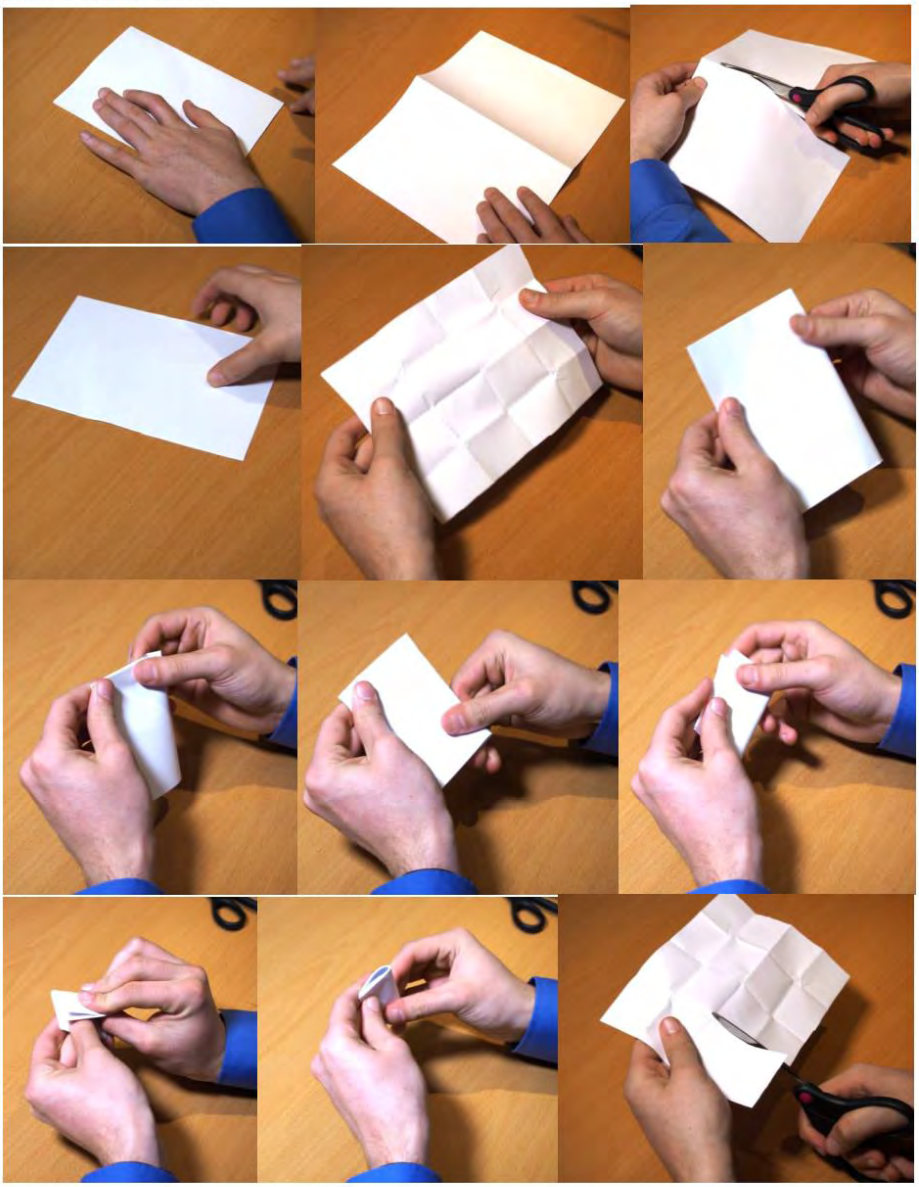
Optional high achieving student instructions:

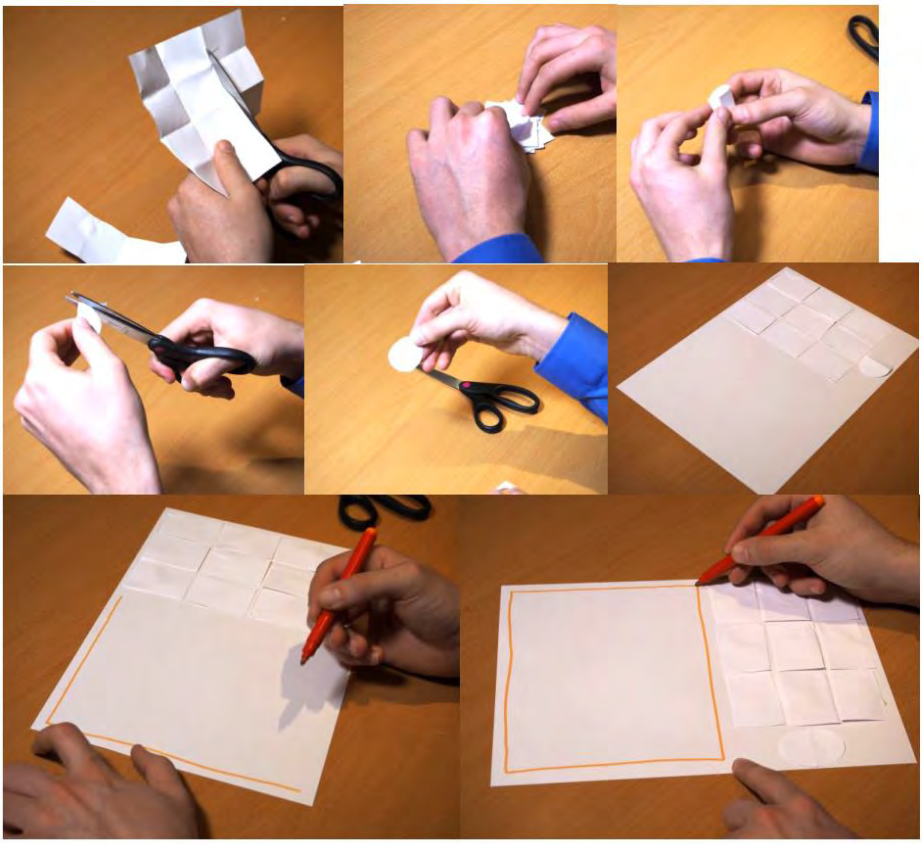
Rearrange your paper rectangles in any order, but in a way that makes it easy to tell which button is which. You must use all the rectangles, the circle (start button), and draw one window for the microwave door.

Plenary (5 minutes)

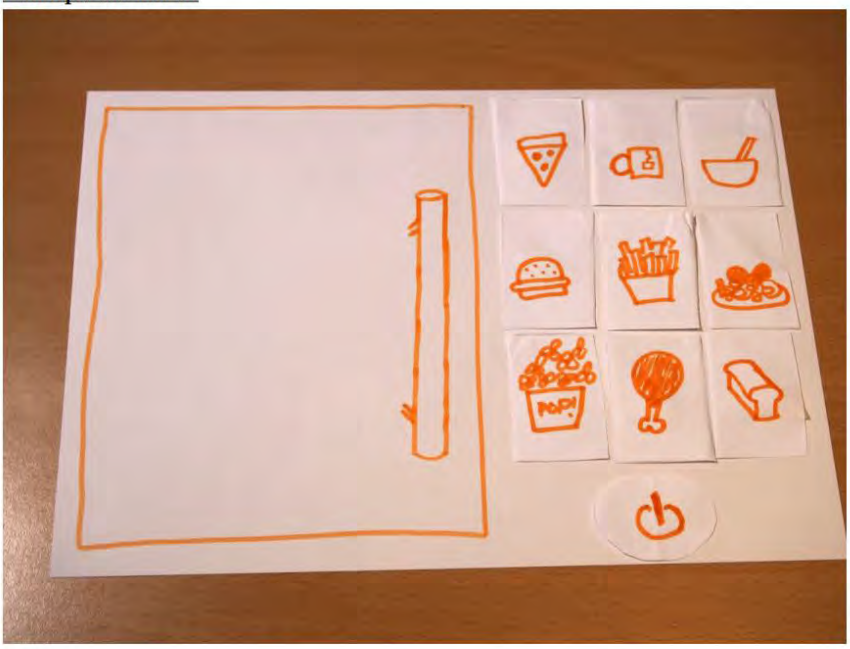
- Ask students about their pair's design
    - Why did you design the control scheme the way you did?
    - How did you attempt to give the user hints on the functionality of the object through the control design?
    - What sorts of colours did you use? How did you order your switches and buttons? Do you think it made a difference?
    - Was your partner pair able to figure out what your object was? Why or why not?
    - What would you do differently if you were to redesign your control scheme?
    - Did your initial plans for your design change significantly by the end of the lesson?

Picture instructions:





Example interface:



Links to Design Museum Designer/Maker/User exhibition:

- The Designer/Maker/User exhibition includes the Braun SK5
- Examples of other Braun objects in the exhibition:
    - Citrus Press
    - Coffee maker KM 321
    - Desk fan HL1
    - Nizo Braun Super 8 camera
    - PK-G3 Stereo
    - Clock signal radio ABR 21
    - DW30 digital watch

Further information:

- The Braun SK5
- Comparison of Apple and Braun
- Dieter Rams - Reference:
  http://designmuseum.org/designers/dieter-rams
- Graphic of Dieter Rams' ten principles of good design

Learning outcomes:

- Students will be able to create their own kettle/teapot
- Students will be able to collaborate with partners to create a final design
- Students will be able to associate designs with a given user's needs

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Links to the curriculum:

- Earth science - phase changes, water boiling, density changes from becoming steam, vaporisation, condensation
- Materials - heat conduction of materials, materials' melting point
- Design and technology - material sciences (tin, copper, titanium, etc.)
- Arts - crafting

Materials

- User profile and kettle drawing worksheets
- Drawing materials
- 100 cm of tin foil per group, for up to 5 groups
- 1 plastic water bottle per group, for up to 5 groups
- Tape, preferably waterproof tape
- Scissors or knife for teacher preparation

Lesson plan:

Introduction (15 minutes)

Script/designer corner:

The MG33 kettle was originally sold in 1980 and is now one of Alessi's trademark items. It mimics one of Alessi's earlier kettles by the same designer, which had a bird shaped whistle. The bird on the kettle whistle was playful, but the body of the kettle was a standard design that could be easily mass produced, making it ideal for a corporation. It was designed by Michael Graves. Designer corner: Michael Graves was a designer who was known for his playful designs, including animals on his teapots and kettles. His designs also attracted him to the world of cartoons, and he designed several buildings for Walt Disney.

Another famous designer like Michael Graves was Philippe Starck. When Philippe Starck started working as a designer, there were many other famous designers working at the time, like Michael Graves and Richard Sapper. So when Philippe got an offer for a job with large company like Alessi, he was quite nervous - he wanted to be famous like Michael and Richard! He decided to design a kettle, much like Michael did, but he wanted his design to be special, something that would be different from every other kettle. An idea occurred to Philippe - what if the kettle could be filled and emptied through the handle?

Philippe called his idea 'immobile aerodynamics' and the result of his design was the Hot Bertaa kettle. Unfortunately, the Hot Bertaa kettle is hard to use, as the design is confusing and can hurt someone if they use it incorrectly. When Alessi pulled the kettle from production, the company was quoted saying, 'You should not need an instruction manual to operate a kettle'.

Later, Philippe claimed the kettle was one of his 'big regrets'. Creating a design just to become famous was not a good or pure reason, and as a result the design of the kettle suffered. 'After 5 years, we could not recall why this object existed. So if a thing starts out badly, it ends badly, too,' Philippe said. Luckily, there are some people who do like the Hot Bertaa kettle; it is now the favourite design fiasco of Alessi CEO Alberto Alessi.

- Show image of the Hot Bertaa kettle
- Discussion questions
    - What might this object be? Hands up vote: what people think it is.
    - What aspects of the kettle do you recognize (possibly list the aspects they choose).
- **(3:17 minutes)** The Hot Bertaa kettle video: https://vimeo.com/79779682
- How is a teapot different from a kettle?
    - A kettle is meant to heat up the water, whereas a teapot is meant to store hot water and/or tea, coffee or other hot drinks.

- Show image of Michael Graves MG33
- Discussion questions
    - Do you notice any similarities between the objects?
    - Do you notice any differences?
    - How do you think the MG33 did as a product compared to the Hot Bertaa kettle? Why?

Purpose & appearance of kettles and teapots

- Hands up: who has used a kettle before, or has a kettle in their kitchen?
- How do you use a kettle?

    - Heating water for: Tea, coffee, cooking, etc.
    - Decoration
- Ask students about features of kettles, draft a list on the board. Examples: Whistle, water viewport, size, cost, materials (metal, plastic), self-heating (electric), handles that prevent steam burns. Ask about features of teapots.
- Optional material focus:
    - What different materials would a designer want to use when making a kettle?
        - Plastic handle- does not heat up and burn the user
        - Conductive metal - easily heats up the water inside through heat transfer
        - High melting point metal - will not melt or burn before the water boils
    - What different materials would a designer want to use when making a teapot?
        - Insulating material - hold in the heat of the tea
        - Plastic handle - does not heat up and burn the user
    - Why would you need a designer to make a kettle or a teapot? What might the designer do?
        - To make the kettle/teapot look good.
        - To make the kettle/teapot work correctly.
        - To fit the consumer's needs.

Activity:
Design a kettle or teapot (10 minutes)

- Pass out the user profile worksheet to everyone in the class. Each of the user profiles worksheets are labelled with a number at the top. Have the students group together using their numbers on their worksheet (aim for 5 or less groups). Once the students are in groups, have the groups discuss a kettle/teapot design for their user. **(5 minutes)**
    - Ask if they want to design a kettle or a teapot.
    - Ask what materials they might use for their kettle/teapot.
    - Ask them what features they may add to the kettle/teapot.
    - Ask them what features they may avoid using for their kettle/teapot.
    - Ask if the user would want to buy their kettle/teapot and why.
- Have each student draw his or her group's kettle/teapot design on their own worksheet. Have the students determine which components of their design to keep and which to get rid of. Encourage the students to have creative freedom when designing their kettle/teapot. **(5 minutes)**

Create a miniature kettle or teapot prototype (requires preparation prior to lesson)
Instructions:
Preparation for instructor before lesson (~5 minutes per bottle):

1. Gather water bottles (1 bottle for each group).
2. Cut all bottles in half using scissors or other cutting tool.

3. Take the original top half of the bottles and cut off any additional plastic at the bottom to form a makeshift lid. Do not remove the cap during or after this step.
4. Measure out about one meter of tin foil for each group.

For the students during the activity (20 minutes):

1. Wrap section of tin foil around the water bottle.
2. Roll a small section of tin foil into a tube-like shape.
3. Tape the roll of foil to the side of the bottle.
4. Wrap another section of tin foil around the bottom of the bottle to cover up the tape.
5. Wrap tin foil around the top section of the bottle (including the bottle cap).
6. Optional: Allow the students to customise their kettle or teapots however they like.

Swap user profiles (5 minutes)

- After completing their designs, have each group swap their user profile worksheet with another group. Make sure each group has a new profile (Ex. 1→2, 2→3, 3→4, 5→1). Have the students discuss the new user profile and their kettle/teapot design in their groups.
    - Does your kettle/teapot design satisfy this new user profile?
    - What works? What does not work?
    - Have the students draft a list of things that work in the design and a list of things that do not work.

Plenary (10 minutes)

- Take one to two volunteers and ask them about their kettle/teapot design.
    - Describe their user profile.
    - Discuss group's kettle/teapot and how it matches the user profile.
        - What features did the group add to their kettle/teapot?
        - What features did the group avoid when designing their kettle/teapot?
    - Ask the other students in other groups about any improvements or changes which could be made.
    - What happened when you received the different user profile?
- Discussion questions
    - What parts of the user profile's requirements were difficult to incorporate into the kettle/teapot? Which parts were easier? Why?
    - How did you create your kettle/teapot to accommodate your user's needs?
    - Did you need to change your design when you started to build it with the foil? What did you need to change?
    - Did your kettle/teapot meet the requirements of the second user profile as well as the first? If not, why?

Example kettle/teapot construction:

User profiles:
1

Ella has a small flat without a stove, but still wants to make hot tea for herself. Ella also has Alzheimer's disease and has difficulty remembering to switch things off. Can you design a kettle/teapot to boil enough water for just one cup of tea which will also keep Ella and her flat safe?

1. Get into your groups by number.
2. Discuss the user profile you have been given with your group.
3. Determine if you will design a kettle or a teapot.
4. Everyone draw their group's kettle/teapot on another sheet of paper.
5. Decide which features of the kettles/teapots are best and combine to make the best kettle/teapot.

2

Lily is an elderly lady that has trouble lifting heavy objects and wants a nice kettle/teapot that she can put on the table. She also does not want to burn her lips, she likes her tea to be below 85°C. Can you design a kettle/teapot that Lily would like?

1. Get into your groups by number.
2. Discuss the user profile you have been given with your group.
3. Determine if you will design a kettle or a teapot.
4. Everyone draw their group's kettle/teapot on another sheet of paper.
5. Decide which features of the kettles/teapots are best and combine to make the best kettle/teapot.

3

Theo has a very large family and wants to save time when making tea for everyone's breakfast in the morning. Everyone in his family wakes up at a different time, so he wants to also keep the tea warm. Theo does not have a large kitchen, so he wants his kettle/teapot to be easily stored away. Design a kettle/teapot which will help Theo and his family.

1. Get into your groups by number.
2. Discuss the user profile you have been given with your group.
3. Determine if you will design a kettle or a teapot.
4. Everyone draw their group's kettle/teapot on another sheet of paper.
5. Decide which features of the kettles/teapots are best and combine to make the best kettle/teapot.

4

Jonathan goes camping every weekend, but needs a kettle/teapot to boil water while he is in the woods. He only brings his backpack on these trips so he can go hiking. Please design a kettle/teapot for him.

1. Get into your groups by number.
2. Discuss the user profile you have been given with your group.
3. Determine if you will design a kettle or a teapot.
4. Everyone draw their group's kettle/teapot on another sheet of paper.
5. Decide which features of the kettles/teapots are best and combine to make the best kettle/teapot.

5

Jessica loves iced tea, but hates making new tea every day. Design a tea kettle/teapot where Jessica can boil water for her tea and keep it at a colder temperature so she can make cold tea for herself later in the week.

1. Get into your groups by number.
2. Discuss the user profile you have been given with your group.
3. Determine if you will design a kettle or a teapot.
4. Everyone draw their group's kettle/teapot on another sheet of paper.
5. Decide which features of the kettles/teapots are best and combine to make the best kettle/teapot.

Learning outcomes:

- Students will create signage for the school
- Students will develop their ability to analyse road signs
- Students will identify important design features of road signs

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Links to the curriculum:

- Design and Technology - analysis of key events and individuals in design and technology have helped shape the world, design criteria and specification, create ideas through discussion
- Engineering - civil engineering
- Art - graphic design, typography

Materials:

- 1 piece of A3 paper per student
- Drawing materials - pencils, coloured pencils, markers, crayons
- Scissors
- 1 roll of tape (for hanging up signs)
- Optional: construction paper

Lesson plan:

Introduction (15 minutes)

Script/designer corner:

Imagine you're driving across the country to see some relatives who live a few hundred miles away. Every town you drive past, every stretch of road has a different sign system with different font used for the words and a different way of displaying them. Some signs are complicated, some are written vertically and you have no navigational system to help you. Just when you think that you are used to reading one style of sign that goes flying past, you have to get used to a completely new layout of sign. This is what driving in Britain over 50 years ago was like.

Now we have clear road signs that are the same whether you are in a big city or the countryside. In 1957, the task of making this huge change to roads up and down the country was given by the government to just two designers: graphic designer Jock Kinneir and his assistant Margaret Calvert. During their work, they visited other countries to research their road signs and performed visibility tests using prototypes. Before creating the road signs, Margaret Calvert and Jock Kinneir made signs for passengers to navigate around Gatwick Airport. They developed a system of easy to read road signs using the principles they discovered, and created various standards:

- Size of the road signs were much larger than they were before
- Used more pictures instead of words
- Made signs that look like the maps of junctions
- Used both uppercase and lowercase letters in signs because word shape makes signs much more readable *(Most road signs at the time only used capital letters)*

- Changed colour and shape of their signs to match the international convention *(The UN's Geneva Protocol on Road Signs and Signals of 1949)*
- Created simple pictographs, some of which are based on Calvert's life *(The cow on the farm animals warning sign is based Calvert's relative's cow named Patience, the girl in the school children crossing is Calvert)*

- Discussion questions
    - Why are all road signs formatted similarly?
    - Would it be difficult to identify road signs if they were all different shapes, colours, and sizes?
    - What are some other places that can use signs? *(If the students don't bring it up, mention schools)*

Activity:
Individual signs around the classroom (20 minutes)
Imagine that someone who doesn't speak English will be visiting your school and spending time in your classroom. Create a sign that describes the location or purpose of something around the classroom without using any letters or words. It could be a light switch or a coat rack or even where to find the pencils.

Instructions:

1. Decide what sign you are going to make.
    - Possible ideas are: Location for pencils, exit and entrance, coat rack, light switch, book storage, and location to line up.
2. Sketch the drawings and symbols you want on your sign.
    - Perhaps suggest they keep their designs simple. The signs should be able to be understood from across the room.
3. Colour in your sign.
4. Hang your sign up.

For high achieving students:

- Have them try to indicate an action clearly. Try something like, 'Line up here', 'Quiet zone', or 'This light switch controls these lights' instead of simply listing the location of something.
- Have the students use only a few colours and mostly simple shapes. What colours should they use on a warning sign? What about an instructional sign?

Alternate activity: Individualised signs (20 minutes)
Margaret Calvert based a lot of her signs off of personal experience. The animal warning sign she developed was based on one of her neighbour's cows, and she based the school crossing sign on a picture of herself as a young girl.

The students make a sign based on one of his or her personal experiences. Here are some ideas for signs that they might want to make:

- A school crossing sign with the student's picture instead of the girl on Calvert's sign
- An animal warning sign that uses a picture of a pet or animal the student has seen
- A cycle route ahead sign based on his or her bicycle
- A pedestrian crossing light using the student's outline
- A bus stop sign based on a bus you often take
- A Quiet Lane or Home Zone sign based on his or her life
- A Motorway service area sign with symbols based on their cutlery, bed, or other symbols

Plenary (5 minutes)

Discussion questions

- Why did you design your road sign the way you did? What made you choose the colours, lettering, or size?
- Would your road sign work on the side of an actual highway? What might you change to allow it to effective?
- Are there any places around your house that could use better signage? Why?
- If you could use a sign to show people that this is your room what would you put on it?

Example sign:

Links to Design Museum Designer/Maker/User exhibition:

- The Designer/Maker/User exhibition contains multiple prototype signs that Jock Kinnier and Margaret Calvert designs.
- 50 Years of British Road signs, a past exhibition at the Design Museum focussed on Kinneir and Calvert's work

Further Information:

- 50 Years of British Road signs, a past exhibition at the Design Museum http://www.britishroadsignproject.co.uk/
- *Know Your Traffic Signs, Official Edition* booklet published by the Department For Transport - has a history of signs in the beginning, as well as an exhaustive list of signs

Design of modern road signage, a BBC Bitesize video about this effort

Supplementary materials:

The school crossing sign with the girl loosely based on Calvert

The Transport typeface developed for road signs.

Legibility test carried out by the Road Research Laboratory at Benton Airport in 1959.

A few prototypes of the new signs made in 1963.

Learning outcomes:

- Students will be able to create improvements and personalise objects within the room
- Students will develop collaboration and teamwork skills
- Students will be able to identify the proper tools to fix objects
- Students will develop observational skills

Links to the curriculum:

- Science - materials, chemistry, and biology
- Design and technology
- Engineering

Materials:

- Paper/construction paper (1 A3 sheet/2 A4 sheets per pair)
- Tape/Glue (1 roll/stick per pair)
- Scissors (1 per pair)
- coloured pens/pencils/markers

Lesson plan:

Introduction (20 minutes)

Script/designer corner:

Jane Ní Dhulchaointigh (pronounced nih-goo-oh-hin-tic), a designer from Ireland, was tired of buying and replacing her things and wanted to improve and repair what she already owned instead. One day, she was using a knife to cut up an apple when she realized that the grip of the knife was quite uncomfortable. She thought it would be easier to use if she made a grip that would mould in the shape of her hand, like play-doh. Jane thought this was a great idea - and wouldn't it be neat if the mould had other features like being waterproof so she could wash the knife in the sink, or being flexible so she could always change the shape of the grip how she wanted? Thus, Sugru was born. Jane invented Sugru to help other people who wanted to fix things instead of replacing them, or who wanted to improve things instead ignoring their ideas. The name Sugru comes from the Irish word for 'play'.

- Sugru Facts:
  - Created using silicone technology
  - Texture of play-doh
  - Sticks to glass, plastics, fabrics, and wood
  - Hardens after exposure to air, turns rubbery after 24 hours
    - Flexible
    - Withstands most weather conditions
  - Removable using sharp objects
- Discussion questions
  - What was the last object you remember breaking (accidentally or otherwise)?

    - How many objects do you replace in a year? What kinds of objects do you replace the most?
    - Do certain objects get replaced entirely or do you only replace a few parts at a time?
    - Do you think the replacement of objects is wasteful or efficient? Why?
- **(3:26 minutes)** Sugru: How is it made? https://vimeo.com/80459596
- Discussion questions
    - Have you ever wanted to fix an object you use so that it works better for you?
    - What object would you improve or personalise in your own style?

Improve and personalise an object (20 - 30 mins)

Together with a partner, create a pencil box using cardboard, then personalise your pencil box with your favourite colours and patterns.

Instructions:

1. Take one empty coloured pencil box (cardboard, e.g. Crayola) place it in the middle of the construction paper so that it is 2 inches away from the edge (about the length of your index finger).
2. Fold the construction paper against the bottom of every edge of the box.
3. Fold the construction paper against the top of every edge of the box. The sides of your paper should now overlap with each other.
4. Use tape or glue to stick the overlapping long edges of the construction paper together.
5. Tape or glue one (and ONLY one) short side of the construction paper. You should now have a box that is open on one end.
6. Tape or glue the remaining side of the construction paper to the flap of the pencil box.
7. Decorate your box using coloured pencils and paper. Customize it with things that are special to you and your partner!

Key words:

- Personalisation is an aesthetic choice (decoration, colour, general appearance).
- Improvement is a functional choice (additional features, compartments, or purposes)

Instructor's Note: *These two terms are not mutually exclusive, but for the purposes of the lesson, treat them as though they are.*

Plenary (5 min)

- Ask students what features they added, removed, or replaced
    - Why did you add/remove/replace those features? Did you consider other purposes that feature might have/have had (e.g. a bar lining the bottom of the desk might be obstructive, but it supports the structure of the desk)
    - Why did you choose to remove certain features but not others?
    - What would happen if you removed certain features but not others?

Example personalised pencil box construction:

Links to Design Museum Designer/Maker/User exhibition:

- The Designer/Maker/User exhibition, "Ways of Making" section, contains Sugru
- Sugru: How is it made? - https://vimeo.com/80459596
- Timeline of Sugru - the "Sugru Story"

H6. Wibble, Wobble, Wiggle Chair

H6.1 Lesson plan

Learning outcomes:

- Students will be able to create a newspaper chair.
- Students will develop collaboration and teamwork skills.
- Students will be able to create a design for a given user's needs.
- Students will develop observational skills.

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Links to the curriculum:

- Physics/Engineering - forces, trusses, stress
- Design and technology - product design
- Earth Science - recycling, sustainability

Materials:

- 5 newspapers per group of 4
- 1 roll of tape per group of 4; masking tape recommended
- 5 textbooks or similar weights per group of 4

Lesson plan:

Introduction (15 minutes)

Script:

Architect Frank Gehry loved using cardboard to make models of the buildings that he designed. One day he saw a pile of cardboard outside his office and decided to experiment. With the help of his pocket knife and some glue, Frank made a chair out of the pile of cardboard and glue. Soon he experimented, making different pieces of furniture such as tables, stools and sofas. He called his cardboard furniture 'Easy Edges'.

- Designer corner: Frank Gehry is an architect who uses cardboard to create architecture models. He started cutting and gluing cardboard shapes together and ended up with a very sturdy structure he called "Easy Edges." In 1972, Gehry experimented creating furniture out of the "Easy Edges" and he eventually created the Wiggle Chair.
- Discussion questions
    - What are examples of reusable material within your school or your home?
    - What can you make using reusable resources?
    - What do you use a chair for?
    - What materials are chairs made of?
- **(3 minutes)** Wiggle chair video: https://vimeo.com/79779682
- Do you think that we can make a chair from just newspaper?

Activity: Build a newspaper chair (30 minutes)

Break students into groups of 4. Read aloud the story of James and his friend. Walk the students through building their chair. Make sure to clearly demonstrate how to make one of the cylinder tubes. The chair should be able to hold up the weight of up to 5 textbooks.

James broke one of his chairs and is having a guest over in an hour. James is a postman who has some spare newspapers at his house. Can you help James prepare a chair for his friend using only newspapers and tape?

Instructions:

1. Take 4 full sheets of newspaper out of the stack (remove staples if necessary).
2. Stack the sheets of newspapers and fold them in half.
3. Roll your newspapers into a cylinder.
   Hint: Make sure you roll the newspaper short ways, not long ways. Make sure every cylinder is the same way because you want the tubes the same length.
4. Using your roll of tape, tape the newly rolled cylinder to keep it from unrolling.
5. Repeat until your group has sixteen tubes.
   Hint: Make sure all the tubes are the same length.
6. Take 4 cylinders and tape them together so that they form a circular shape, then tape them on the top and on the bottom to keep them from unrolling. Each team member should do this step so that your group is left with 4 bunches of cylinders.
7. Place the cylinder bunches upright together so that they form a rough circle
   Hint: Have teammates hold the cylinders together while one person tapes them all together at the top, then again for the bottom.
8. You should now have a stool. Try placing a textbook on top of your stool. If your chair collapses, don't worry! Try collecting your tubes and start again.
   Hint: If the top of your stool is uneven, use the scissors to cut the tops off.
9. If your stool can hold one textbook securely, keep adding more books for a maximum of 5.
10. Optional: Try adding features to your chair - maybe a seat, back, extra legs, or armrests. See if you can make it distinct from everyone else's chair!

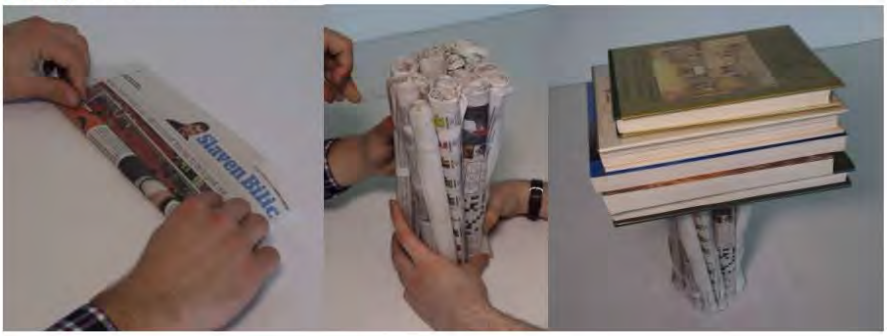
Instructor's Note: *The number of cylinders students can make depends on how many newspapers you have in total and the time you have- please use your own discretion. Make sure to allocate time for students to test their chairs. Step 10 should only be done if there is enough time and newspaper remaining for everyone in the class.*

Plenary (5 minutes)

Ask students about their group's design

- How stable is the chair?
  - Did it collapse?
  - Did it wobble when you put weight on it?
  - What techniques did you use to keep their chair from collapsing?
- What would you do differently if you were to make another newspaper chair?
- If you were to make this chair for yourself, what features would you add?

Example chair construction:



Links to Design Museum Designer/Maker/User exhibition:

- The Designer/Maker/User exhibition contains many different types of chairs.
- Examples of chairs and their designers:
    - Charles Eames - 1956 - Lounge - Reference: https://designmuseum.org/design/chairs-1950s
    - Verner Panton - 1968 - Panton - Reference: https://designmuseum.org/design/chairs-1960s
    - Gaetano Pesce - 1969 - Donna Up5 - Reference: https://designmuseum.org/design/chairs-1960s
    - Frank O. Gehry - 1972 - Wiggle Side Chair - Reference: https://designmuseum.org/design/chairs-1970s

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Wibble, Wobble, Wiggle Chair

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Reduce, Reuse, Recycle

- What are examples of reusable material within your school or your home?
- What can you make using re-usable resources?

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What do you use a chair for?

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What are chairs made from?

Plastic	Metal	Wood	Synthetic woven fabric	Paper
Panton Chair (1968) Verner Panton	Crown Chair (1988) Tom Dixon	Plywood Chair (1988) Jasper Morrison	Aeron Chair (1992) Donald Chadwick and William Stumpf	Cabbage chair (2008) Nendo Inc. Tokyo
£200	£13,000	£450	£1,000	£5,500

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Wiggle Chair Video

https://vimeo.com/79779684

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the DESIGN MUSEUM

Making a newspaper chair

James broke one of his chairs and is having a guest over in an hour. James is postman who has a some spare newspapers at his house. Can you help James prepare a chair for his friend using only newspapers and tape?

Instructions

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Materials:

- 5 newspapers
- 1 roll of tape

Assignment:

- Groups of 4
- Build a chair to support 5 textbooks
- Needs to hold the books 1 foot off the ground

Step 1

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Separate 4 sheets of the newspaper

Fold your sheets in half

Step 2

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Step 3

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Make 16 tubes total

(4 per person)

Step 4

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Step 5

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Step 6

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Create a seat for your stool

The Valiant Vespa

Design Museum. (2014, May 7). DM25 | Javier Mariscal on Vimeo. Retrieved from https://vimeo.com/94349597

Goldstone, K. (2015, May 8). The Mod movement – A super-cool British sub-culture. Retrieved from https://www.greatnorthernfestivals.com/modska/News/ArtMID/503/ArticleID/1010/The-Mod-movement-%E2%80%93-A-super-cool-British-sub-culture

Brains and Braun: Less but Better

Design Museum. (2015, November 3). Dieter Rams. Retrieved from http://designmuseum.org/designers/dieter-rams

Minimally Minimal. (2014, April 8). Braun SK55. Retrieved from http://www.minimallyminimal.com/blog/braun-sk55

Krazy Kettle and Trendy Teapots

Alessi. (n.d.). Kettle, 9093. Retrieved from http://www.alessi.com/en/products/detail/9093-kettle

Design Museum. (n.d.). Hot Bertaa | Discover Design. Retrieved from http://discover.designmuseum.org/object-page/hot-bertaa

From the Streets to the School

Design Museum. (2015). British Road Sign Project. Retrieved from http://www.britishroadsignproject.co.uk/jock-kinneir-margaret-calvert/

Simply Sugru

Design Museum. (2013, November 27). *Discover Design: How is it made? Sugru on Vimeo* [Video file] Retrieved from https://vimeo.com/80459596

Our story | Sugru. (2015, April). Retrieved from https://sugru.com/story

Wibble, Wobble, Wiggle Chair

Vitra Design Museum: Wiggle Side Chair - Frank O. Gehry. (n.d.). Retrieved from http://www.design-museum.de/en/collection/100-masterpieces/detailseiten/wiggle-side-chair-frank-o-gehry.html

Appendix I: Educational resources - Visit material

Table of Contents

I1 Pre-visit materials

I1.1 Lesson plan

Pre-visit:

Put together the "during visit" booklet. Print the two pages on one sheet of paper, double-sided if possible. Follow the instructions on the front of the booklet. Each student will need scissors and staples for their booklet.

Learning outcomes:

- Students will learn about the relationships between the designer, user, and manufacturer.
- Students will critically analyse the designs and functions of objects.

Materials:

- Pencils
- Scissors
- Staplers
- 1 unassembled 'During your visit' worksheet per student

Lesson plan:

Introduction (15 minutes)

Script:

The Design Museum is a museum of contemporary design and architecture, which opened at its Kensington location in late 2016. The museum has a permanent 'Designer, Maker, User' exhibition in addition to its traveling exhibitions.

The 'Designer, Maker, User' exhibition introduces the visitors to the world of design. The gallery shows that design is a result of a relationship between the designer, the user, and the manufacturer. The exhibition has three major areas, each focusing on the designer, user, or manufacturer. On display are a variety of objects, from construction materials to fashion.

Object Spotlights:

- Designer: There are many types of design and designers
- Designers are sometimes thought to work within a set of established disciplines such as graphic design, architecture, fashion or product design. While these disciplines are a perfectly valid way of describing design they do not do justice to its scope and diversity. Design is not just about a set of professional and creative disciplines. Nor is it restricted by size, physicality, cost or location. Design is a process and it is a way of thinking. From kitchenware to software, and from healthcare to high-street fashion, design thinking leads to creative solutions that impact every area of our lives. As suggested by the Italian architect Ernesto Rogers in 1952, the role of the designer stretches from the city to the spoon.
- New Tube
    - The new Tube will be rolled out in 2020. The new carriages have the capacity to run fully automated without a driver. The new Tube will also be much larger, air cooled, faster and more frequent, handicap accessible, and more reliable.
    - In what way do you think the designer designed this section of the tube to be different from other, older sections?

    - Why did the designer pick these design choices?

- Maker: Design, technology and manufacturing
- This section explores the way in which designed objects are made. There are key principles to mass production and these make it possible to make the things we want at a price we can afford. Mass manufacture made our modern, comfortable way of life possible. The future of manufacturing is full of possibilities and the way things will be made is changing. Manufacturing is continually evolving. The evolution of manufacturing in the last 100 years has radically changed the way we live. What will the future look like?
- Fairphone
    - KS2: Some objects are made using conflict minerals, which are resources that are obtained in conditions of armed conflicts or while abusing human rights. The Fairphone was designed to function without using any conflict materials so that the workers who make it are not put at risk by working in a warzone.
    - KS3: The Fairphone is designed and produced with minimal harm to people and the planet. It does not contain conflict minerals (gold, tantalum, tungsten), and has fair labour conditions for the workers along the supply chain that produces it.
    - Do you know what materials your electronics are made of?
    - Check the tags on your clothes you're wearing right now - where were they made?
    - Why might most of your clothes be from China or India?
        - Inexpensive for companies
        - Often underpaid workers
        - Poor working conditions

- User: What is the impact of design on the user and the user on design?
- We are all users of design. The user section demonstrates the many ways in which design touches every aspect of our lives. Design gives us the freedom to live the way we choose and to express ourselves in the way that we want. It equally changes the world around us and influences us in ways we do not always appreciate. Design is both a creative act and a commercial profession that is tied to business.
- Apple products
    - The first products Apple developed looked quite different from the products we use now. The Apple computers are smaller and have more functions than they used to, and are specifically designed for beginners.
    - Why do you think Apple products have changed in appearance over time?
    - Do you think the changes Apple made were to please a user? Who might they have made the changes for?
    - What features do you think a Mac has that make it easy to use for a beginner?

Assembling the 'During your visit' booklets (15 minutes)

Assemble your booklet. Then, pick two objects, one that must cost less than £20 and one with any price. Write them in your booklet, and when you go to the museum you get to see if anyone had the same idea as you did.

Further Information

- Videos about a few of the objects in the 'Designer, Maker, User' exhibition
    - One Laptop Per Child - https://vimeo.com/79779685
    - Wiggle Chair - https://vimeo.com/79779684
    - Vespa - https://vimeo.com/94349597
    - Sugru - https://vimeo.com/80459596
- Notable designers:
    - Philippe Starck
    - Dieter Rams
    - Frank Gehry
    - Michael Graves

Design Museum Visit

Designer, Maker, User Exhibition

Design Museum Introduction

[ADD PICTURE OF NEW DESIGN MUSEUM]

Object Spotlight - Designer Section

New Tube

- In what way do you think the designer designed this section of the tube to be different from older sections?
- Why did the designer pick these design choices?

[ADD PHOTO OF NEW TUBE DESIGN]

Object Spotlight - Maker Section

Fairphone

- Do you know what materials your electronics are made of?
- Check the tags on your clothes you're wearing right now - where were they made? Why might most of your clothes be from China or India?

Object Spotlight - User Section

Apple Products

Why do you think Apple products have changed in appearance over time?

Do you think the changes Apple made were to please a user? Who might they have made the changes for?

What features do you think a Mac has that make it easy to use for a beginner?

[ADD PHOTO OF MOST RECENT APPLE LAPTOP ON DISPLAY]

Booklet Instructions

Cut along dotted lines

Stack papers in numerical order

Staple the pages together to make your booklet

I2. During-visit materials

I2.1 KS3 During-visit worksheet

'During Your Visit' booklet KS3:
***We have based our activities on the format from the following link:
http://www.msichicago.org/fileadmin/assets/educators/field_trips/What_is_Science_student_guide.pdf

Notes to designer: Each "page" will be ¼ of an A4 piece of printer paper, with dotted "cut-here" lines separating the pages. The title page will be completed by the designer. Each subsection name, ex. From the City to the Spoon, should be somewhere on the page. Each page, including the title page, should be numbered. Pages with open ended questions should be left mostly blank, or supply lines to write the answer on. There are two different worksheet, labelled "booklet #1" and "booklet #2". The only thing that changes is the order of the pages, in order to prevent congestion in the exhibition.

Landscape A4 piece of paper. Using edges of the A4 page for the outer dotted lines. When printing double sided, choose setting to "flip along long edge

Page 1	Page 3
Page 5	Page 7

Page 2	Page 4
Page 6	Page 8

Booklet #1 (start with object wall)
Title page: (page1)

- "Designer, Maker, User"
- "Museum visit guide"
- The Design Museum Logo
- Name _____
- Instructions: Cut pages, assemble in numerical order and staple the booklet together. Use during your museum visit to the Design Museum.

Object wall (page 2-3):

- **Page 2:** Pick two objects from your life that you think are designed well, one of which should cost less than £20, one any price. Explain why you chose the item you did. Are the objects you nominate on the object wall?
- **Page 3:** Pick two items from the object wall and find an object later in the exhibition that is similar in form or function. Fill out table below.

Object wall	Matching object	Why they match
Bicycle wheel	Morph wheel	They look similar and are both wheels

Designer:

- **Page 4:** From the City to the Spoon - Count how many objects do you see on a daily basis. ___(space for #)___ Draw your favourite object below:
- **Page 5:** From the City to the Spoon - Find the hanging logos. Pick a logo you recognise and observe it carefully. Draw it. Why do you think you recognise it? What features (colours, letters, or symbol) are most noticeable about this logo? List those features in the space below:

User:

What is the impact of design on the user and the user on design?

- **Page 6:** Agents of Change - What product do you think has made (or will make) the biggest change to similar product design? Why?
- **Page 7:** Choice and taste - Which object in the Choice and taste area do you prefer the most? Why do you like that object? Is there anything about the appearance of function of the object that appeals to you?
- Additional option: Design and business - For each of the companies, list design features that make their products desirable, e.g. a Walkman fits into your pocket so it can be portable.
  Apple:
  Braun:
  Sony:

Maker:

- **Page 8:** The Evolution of Technology - How has the appearance of phones changed in the last century? Do you notice any similarities between the designs of the models? Why do you think the design changed (user, material, design, etc.)?

Booklet #2 (end with object wall)

Title page: (page1)

- "Designer, Maker, User"
- "Museum visit guide"
- The Design Museum Logo
- Name _____
- Instructions: Cut pages, assemble in numerical order and staple the booklet together. Use during your museum visit to the Design Museum.

Designer:

- **Page 2:** From the City to the Spoon - Count how many objects do you see on a daily basis. ___(space for #)___ Draw your favourite object below:
- **Page 3:** From the City to the Spoon - Find the hanging logos. Pick a logo you recognise and observe it carefully. Draw it. Why do you think you recognise it? What features (colours, letters, or symbol) are most noticeable about this logo? List those features in the space below:

User:

What is the impact of design on the user and the user on design?

- **Page 4:** Agents of Change - What product do you think has made (or will make) the biggest change to similar product design? Why?
- **Page 5:** Choice and taste - Which object in the Choice and taste area do you prefer the most? Why do you like that object? Is there anything about the appearance of function of the object that appeals to you?
- Additional option: Design and business - For each of the companies, list design features that make their products desirable, e.g. a Walkman fits into your pocket so it can be portable.
  Apple:
  Braun:
  Sony:

Maker:

- **Page 6:** The Evolution of Technology - How has the appearance of phones changed in the last century? Do you notice any similarities between the designs of the models? Why do you think the design changed (user, material, design, etc.)?

Object wall:

- **Page 7:** Pick two objects from your life that you think are designed well, one of which should cost less than £20, one any price. Explain why you chose the item you did. Is the item you picked on the last page on the wall?
- **Page 8:** Pick two items from the object wall and find an object later in the exhibition that is similar in form or function. Fill out table below.

Object wall	Matching object	Why they match
Bicycle wheel	Morph wheel	They look similar and are both wheels

'During Your Visit' booklet content KS2:

***We have based our activities on the format from the following link:
http://www.msichicago.org/fileadmin/assets/educators/field_trips/What_is_Science_student_guide.pdf

Notes to designer: Each "page" will be ¼ of an A4 piece of printer paper, with dotted "cut-here" lines separating the pages. The title page will be completed by the designer. Each subsection name, ex. From the City to the Spoon, should be somewhere on the page. Each page, including the title page, should be numbered. Pages with open ended questions should be left mostly blank, or supply lines to write the answer on. There are two different worksheet, labelled "booklet #1" and "booklet #2". The only thing that changes is the order of the pages, in order to prevent congestion in the exhibition.

Landscape A4 piece of paper. Using edges of the A4 page for the outer dotted lines. When printing double sided, choose setting to "flip along long edge

Sheet 1:

Page 1	Page 3
Page 5	Page 7

Sheet 2:

Page 2	Page 4
Page 6	Page 8

Booklet #1 (start with object wall)

Title page: (page1)

- "Designer, Maker, User"
- "Museum visit guide"
- The Design Museum Logo
- Name _____
- Instructions: Cut pages, assemble in numerical order and staple the booklet together. Use during your museum visit to the Design Museum.

Object wall:

- **Page 2:** Pick two items from the object wall and find an object later in the exhibition that is similar in form or function. Fill out table below.

Object wall	**Matching object**	**Why they match**
Bicycle wheel	Morph wheel	They look similar and are both

		wheels

- **Page 3:** Pick two items from the object wall and think of a way to combine them. Draw this new object you have created.

Designer:

- **Page 4:** From the City to the Spoon - Count how many objects do you see on a daily basis. ___(space for #)___ Draw your favourite object below:
- **Page 5:** From the City to the Spoon - Look at the spoons that are on display. Are there any spoons you wouldn't use at home? Why? Now pick one you would use and draw it below.

User:

What is the impact of design on the user and the user on design?

- **Page 6:** Agents of Change - Find the 3D printed hands. How do you think these hands could help people?
- **Page 7:** Choice and taste - Which object in the Choice and taste area do you prefer the most? Why do you like that object? What do you like about the way the object looks or what it does?
- Additional option: Design and business - For each of the companies, list design features that make their products desirable, e.g. a Walkman fits into your pocket so it can be portable.
  Apple:
  Braun:
  Sony:

Maker:

- **Page 8:** The Evolution of Technology - Look at the radios. Why do you think older radios are made out of wood, but newer radios are made out of metal or plastic?

Booklet #2 (end with object wall)

Title page: (page1)

- "Designer, Maker, User"
- "Museum visit guide"
- The Design Museum Logo
- Name _____
- Instructions: Cut pages, assemble in numerical order and staple the booklet together. Use during your museum visit to the Design Museum.

Designer:

- **Page 2:** From the City to the Spoon - Count how many objects do you see on a daily basis. ___(space for #)___ Draw your favourite object below:
- **Page 3:** From the City to the Spoon - Look at the spoons that are on display. Are there any spoons you wouldn't use at home? Why? Now pick one you would use and draw it below.

User:

What is the impact of design on the user and the user on design?

- **Page 4:** Agents of Change - Find the 3D printed hands. How do you think these hands could help people?
- **Page 5:** Choice and taste - Which object in the Choice and taste area do you prefer the most? Why do you like that object? What do you like about the way the object looks or what it does?
- Additional option: Design and business - For each of the companies, list design features that make their products desirable, e.g. a Walkman fits into your pocket so it can be portable.
  Apple:
  Braun:
  Sony:

Maker:

- **Page 6:** The Evolution of Technology - Look at the radios. Why do you think older radios are made out of wood, but newer radios are made out of metal or plastic?

Object wall:

- **Page 7:** Pick two items from the object wall and find an object in the exhibition that is similar in form or function. Fill out table below.

Object wall	**Matching object**	**Why they match**
Bicycle wheel	Morph wheel	They look similar and are both wheels

- **Page 8:** Pick two items from the object wall and think of a way to combine them. Draw this new object you have created.

I3. Post-visit worksheet

Post-visit Worksheet:

1. Pick your favourite object from the visit and:
    a. explain how it may have been designed
    b. explain how it may have been manufactured
    c. explain who could/would use it
2. List three objects you saw that you did not know about before the trip.
3. Out of all the objects you saw at the Design Museum, list some objects you have at home.
4. What object might you add to the Design Museum exhibition if you had the opportunity?

Appendix J: Pilot programme student survey results

J1. KS3 survey results

Q1: How much did you enjoy the activity? (scale of 1 to 5)

Q2: How much time did you think about your chair design before building it?

A. No time, started building immediately
B. Less than 1 minute
C. 1 to 5 minutes
D. More than 5 minutes

Q3: What was your favourite part of the lesson? Check all that apply.

A. Learning about the Wiggle Side Chair
B. Making my newspaper chair
C. Looking at other groups' designs
D. Testing my newspaper chair
E. The lesson after building the newspaper chair
F. Other

Q4: What was your least favourite part of the lesson? Check all that apply.

A. Learning about the Wiggle Side Chair
B. Making my newspaper chair
C. Looking at other groups' designs
D. Testing my newspaper chair
E. The lesson after building the newspaper chair
F. Other

Q5: Were you able to improve your design after looking around the classroom?

A. Yes
B. No

Q6: Which part of your design helped it to work successfully or caused it to fail, and why?

Q7: What is your gender?

Rubric associated with Q7:

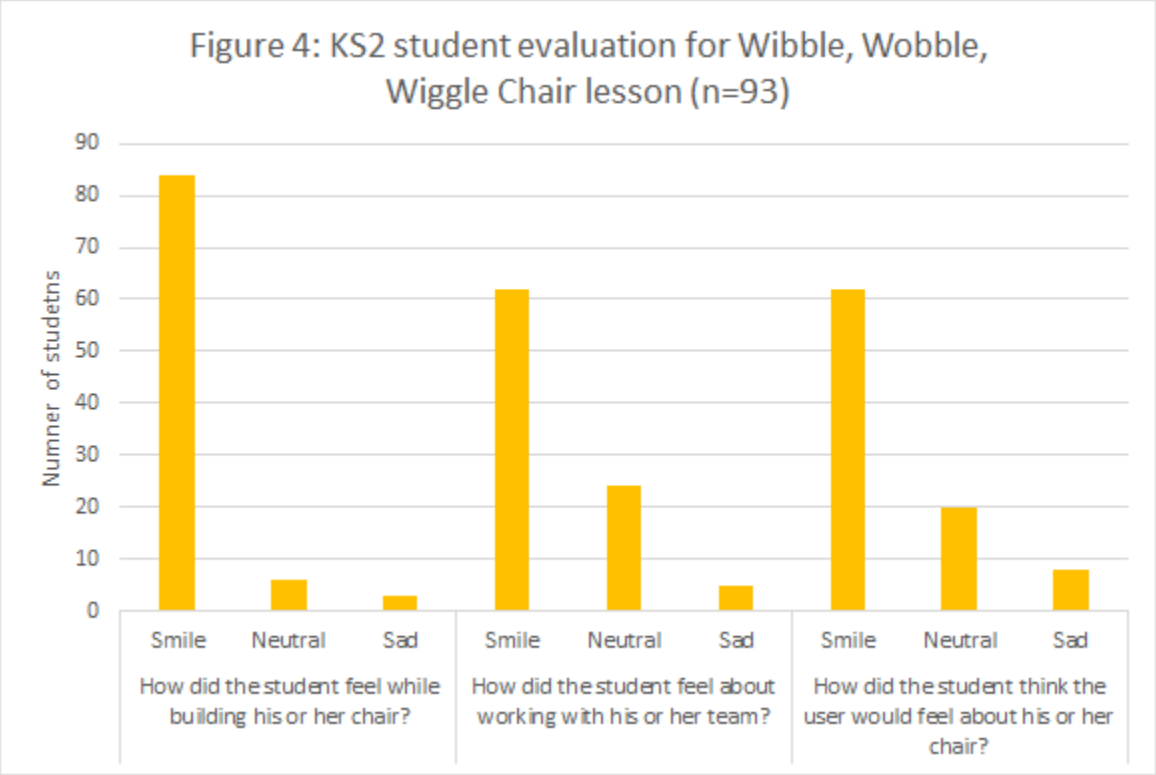
Which version of your designs worked best and why? - Rubric	Score
Student was able to both identify an important aspect of the chair and explain why that aspect made the chair efficient.	2
Student was able to either identify an important aspect of the chair or explain why the chair was efficient.	1
Student was unable to identify any aspect of their chair design and was unable to explain why it was efficient.	0

	Q1	Q2	Q3	Q4	Q5	Q6	Q7
Student 1	5	C	A, D, E	C	A	2	F
Student 2	3	B	F	A	A	2	M
Student 3	5	C	D	A	A	2	M
Student 4	5	C	B	C	A	1	M
Student 5	5	B	A, B, D	N/A	A	1	F
Student 6	5	C	B, D, F	F	A	1	F
Student 7	5	D	C, D	F	A	0	M
Student 8	5	D	A	F	A	0	M
Mode:	4.75 (AVG)	C (4/8)	D (5/8)	F (3/8)	A (8/8)	1.125 (AVG)	M (5/8)
STD:	0.7071067812					0.8345229604	

J2. KS2 survey results

		Boy	Girl	Total
How did you feel while building your chair?	Smile	51	33	84
	Neutral	2	4	6
	Sad	2	1	3
How did you feel about working with your team?	Smile	38	24	62
	Neutral	15	9	24
	Sad	2	3	5
How do you think James would feel about your chair?	Smile	38	24	62
	Neutral	13	7	20
	Sad	3	5	8

*Some students left questions blank or illegible on their surveys.



Appendix K: Pilot programme teacher interviews

K1. Northwood School secondary pilot interview with Dev Thaker (11:52 minutes)

Key:

AC = Anthony Campagna

ED = Ezra Davis

PD = Paul Deplacido

MG = Miya Gaskell

DT = Dev Thaker

PD: -so we're gonna take a survey on the questions that we created about the pilot programme that we just ran, do you mind if we record you?

DT: Yeah, that's fine.

MG: Could you - do you mind if you introduce yourself really quickly?

DT: Yeah, sure. Hi, I'm Dev Thaker, I'm a science teacher at Northwood school, and I run the science club.

MG: Okay, great, thank you.

[Laughter]

MG: So, this is just a set of survey questions that we have for you. And, for, the, erm -

AC: We'll just talk you through it, I'll fill it out.

MG: Okay.

AC: So for the first question, on a scale from one to five, please rate your satisfaction -

DT: With the lesson plan?

AC: Yeah.

DT: I thought it was great, it was really easy to follow.

AC: Okay.

DT: Basically it let me know exactly what you were going to do, so...It helped me be prepared.

PD: Awesome.

MG: Was that - would you say that your satisfaction with the activity was different?

DT: No, I thought the activity was fantastic. I would have told you -

MG: [Laughs] Okay.

DT: When you emailed on the holiday, you know, I could tell, they would - they would like it. Y'know. Designing things lends itself to being creative, and children like to see what they've made straight away.

PD: Okay. Do you think we spent a little too much time on the intro and didn't give them enough time on the activity itself?

DT: I think -

PD: That's what we thought.

DT: I think, looking back - so when I first looked at your lesson plan, was it 25 minutes that you had set aside to make the chair?

ALL: Yeah.

DT: I thought that would be fine. I didn't anticipate that they would have that much trouble coming up with a plan - or I didn't think they would get so hindered in not making like the columns, and things like that. So I would say yeah, in future it would probably be 30 - an extra ten minutes wouldn't have gone amiss.

MG: Mm-hmm.

DT: But at the same time, we had all the faff about the video and things, so -

PD: Yeah, true.

DT: Y'know, that's something that maybe, you couldn't have foreseen.

PD: Okay.

MG: Okay. And then, erm - do you think that the lesson was appropriate for the age range of your students?

DT: Yeah, I thought it was perfect. That was - it was kind of - the concept was there for them to get, and it was easy for them to grasp, but at the same time it was challenging enough that they felt like they were really achieving, and accomplishing something.

ED: Hmm.

PD: What part of the lesson plan did you like, particularly like? And there's a couple listed - length, variety of topics, the lecture part, hands-on part, or plenary.

DT: I mean, the hands-on part was perfect. I thought that was the best bit. The lecture bit was really good too, because I thought, one, your style of presenting was really good, both of you *[PD and MG]*. Quite - quite natural, with the children.

PD: Yeah, with the - [inaudible] - a couple times.

[Laughter]

DT: Yeah, but they seemed to like you, all of you guys. It makes a difference - you can tell when people come and maybe they're not so - not keen is the wrong word, but like, not so comfortable, in front of the children, and sometimes they *[the children]* get that vibe. Whereas with you guys it was perfect and you had a good variety of kind of, talking about things - you had the pictures, I loved the five chairs, that was really good - and then getting them to guess the price, that was really engaging.

PD: Yeah, just something to get them a little bit more engaged.

DT: Yeah.

PD: And we actually - in our lesson plan we have the links, like, optional -

DT: Oh yeah, so - yeah.

PD: Yeah, so if you wanted to put them in a presentation or something, or even pull up the pictures, that's fine, we included them, so.

DT: Oh, fantastic.

ED: And there's a little more about each chair.

PD: Yeah, a little bit more information about designers and [inaudible].

DT: That's good.

MG: And then did the topics in the lesson correspond with the students' current curriculum? Is this stuff that they've covered or haven't gotten to yet, or…

DT: I would say they cover it more in Design and Technology, so in, kind of like…like woodwork. I don't think they call it woodwork anymore -

PD & MG: Yeah.

DT: But that kind of - those kinds of topics that they do, they call it product design, so they design things in the tech room. So that's why when they were talking about the plastic chair, and they said they could make it because they have the tech - when they have the - that bit where you put the sheet of plastic over the - something like that. Can you tell that I'm not a tech teacher?

[Laughter]

DT: But yeah, so, I think it lends really well to that. In terms of physics, it - it lends well, in terms of, they won't really know what they've done. A lot of physics done. They've really - when they think about how to balance it, and, even something like - centre of gravity, whatever, y'know, these are things that can be inferred from it, and that will definitely help them. It's whether your aim is that

they explicitly know that they've done it. I don't personally think it matters, but I know some schools would.

PD: Yeah, so we were planning on making the lesson plans a little general, because we know that different types of teachers would use them, and maybe something we that we can add to our lesson plan is suggestions to link to physics, or link to earth sciences, or link to Design and Technology.

DT: In fact the one thing it did link to really well was recycling, cause we've done recycling with those three girls. I've just done it in-class.

ED: Mm-hmm.

MG: And things like sustainability, and that's -

DT: Yeah.

MG: Okay.

DT: Yeah, cause we just did a test on the earth, so we did like all climate change, and recycling, and - so that's why - that's why they kept going on about metals, because at first they didn't think metals could be, but I was like do you put cans into the recycling? And they were like yeah. So.

[Laughter]

PD: That's good.

MG: So then - just to sort of go off of that, how can we improve the links between the lessons and the current curriculum, do you think?

DT: For this particular one? There's more - there's more materials, in modern-day. So like, we've done meshes, and composite materials and things like that. So that would be...year eight, 13 upwards - 13 year-olds, upwards. So you could have gone more in depth on that and they wouldn't have been out of their depth. Or maybe talk about the proxies themselves, of the materials, and why - why they were chosen. So you know when you have the five chairs?

PD: Mm-hmm.

DT: And you kind of touched upon it with the plastic - the plastic bent chair? And how it took them so long to...to make that, because it was too brittle, and they couldn't find the plastic that was bending or strong enough. So maybe talking more about the properties would make it slightly more scientific, but it's whether you want it to be scientific or product design. But, to be honest, I don't think anyone would have any complaints about that. It was really, really good.

PD: Awesome. And just for more general improvements - we've been talking about it the whole time, but just general improvements to the lesson plan, not exactly the lesson that we taught, but the printout that we - *[PD and ED leave the table to get the printout]*

ED: -somewhere.

MG: Yeah, any general suggestions you might have going forward.

DT: Yeah I was gonna tell you about the layout, but -

MG: Of the lesson plan?

DT: Yeah.

ED: Yeah.

[PD and ED return to the table with the lesson plan printout]

DT: So...it was done -

PD: They're both backside, actually.

MG: Right.

DT: It was done really well. I know this is gonna sound really particular - it's not really like a big deal in any way, shape, or form, but I would just do - I would put the lesson outcomes, or the learning outcomes *[DT circles the learning outcomes]* probably the highest.

ALL: Yeah. Okay. Mm-hmm.

DT: Just because - that's pretty much how lesson plans are done.

PD: You gauge which ones you want to use.

DT: Yeah.

PD: Okay.

DT: And I would probably put the links to the actual Design Museum at the end in some sort of like-

PD: Further information, or something like that. Okay.

MG: Okay.

DT: But to be honest, that was just, if I was like flicking through -

PD: Yeah, you wouldn't wanna see the links and everything -

DT: You would want to see like the lesson outcomes and the links to the curriculum. I really like this bit *[DT points to the 'Links to the curriculum' section]*, I didn't really think about having that bit so explicit, that was really good. I didn't think I would get that.

PD: And I think we have to fix like the grammar and how it's done -

DT: Yeah, so like, lesson titles and stuff.

PD: Exactly -

DT: I would say, if I was doing it, I would have - do you mind if I -?

PD: Yeah, absolutely.

DT: *[Sketching on the lesson plan printout]* So you'd have like the title there *[top-centre of the page]*, and then I would have something here *[right-hand corner]* that tells you, you know, the time, and things like that. Maybe - maybe, like, year groups, or - so this would have been key stage three, like that. *[DT writes 'KS3' and 'time' in the corner of the page]* Just so that the information's right there, at the top, and then obviously this *[the 'Learning outcomes' section]* like, up there. *[DT draws an arrow from the learning outcomes to the top of the page]*

MG: Right.

PD: And then the Design Museum logo too, and everything - [inaudible]

DT: Yeah yeah, I would definitely -

PD: - would actually be on it, yeah, absolutely.

MG: All right.

DT: But those would be the changes I would make. But the actual lesson plan itself is really good. It's better - better than my lesson plans.

[Laughter]

ED: Do you think we should be more detailed or less detailed?

DT: Probably shouldn't have said that on the recording.

[Laughter]

ED: I mean you're making them for yourself, so you don't need to make them good enough to hand to someone else [inaudible]

DT: That's true, that's true.

MG: Yeah.

DT: What I can do, is - I'll do it later, after we've done this, but I'll print you out some of our, kind of, our lesson plan templates that we have to use for our observations. So those are meant to be proper lesson plans.

MG: Okay.

ED: All right.

DT: But sorry, what was your question about?

DT: You sure?

AC: What were you gonna say? I think it was - I thought it was pretty good -

MG: Whether it was too specific or -

ED: Oh yeah!

AC: Oh yeah.

ED: It was whether it was specific enough or too specific on the instructions about the presentation.

DT: So is this lesson plan for - for me to know - for you - if you guys are coming in and for me to know what's happening, or for me to teach from?

PD: It would be for you to teach. So this *[the lesson plan]* would be included in the teacher's pack - just like the *Kitchen Science* one.

DT: I think this is - this is enough. Like -

PD: Okay.

DT: I can't imagine - cause if you gave the PowerPoint with it, it was pretty self-explanatory, where it was going. Yeah, so I wouldn't actually have a problem - I don't think I would need any extra information.

MG: But, if we weren't going to have the PowerPoint -

PD: Yeah, cause we're basically pulling things off this *[the lesson plan]* for the PowerPoint, and that's basically how we created it, but -

DT: I would say you should give the PowerPoint to them. That would be my personal opinion.

ED: Yeah.

MG: Okay, awesome.

DT: Yeah, cause I don't think people - teachers, particularly, want to make a power - if you didn't give the PowerPoint with it, chances are - they might do the newspaper chair activity, but chances are they wouldn't do the lesson.

PD: Okay.

AC: Yeah, that makes sense.

MG: Right, okay.

ED: That's it.

PD: All right, thank you very much, that's where I'll stop that.

DT: Yeah, I'll look for the, uh - the template.

PD: All right, awesome.

K2. Colville Primary School pilot interview with Joyce Tackie (11:52 minutes)

Key:

AC = Anthony Campagna

ED = Ezra Davis

PD = Paul Deplacido

MG = Miya Gaskell

DH = David Houston

J = Joyce Tackie

MG: Okay. So this is the Colville pilot. Colville Primary School pilot and we're here with Joyce Tackie. Is it alright if we record you?

J: Yeah.

MG: Great, thank you. I just wanted to…

J: Am I going through it again?

MG: You don't have to, we took notes, I just wanted to not…

J: And then I also think that even though they're in year three and four, usually it's alright to go backwards, so we could look at like traditional stories, like Goldilocks and the Three Little Bears. So there's Baby Bear, Mummy Bear, and Daddy Bear chairs, and they could actually do it in sizes, and you could get some really, kind of like… you could end up with and see what they've done... when each group has done the same thing, emmm, it's good, but we could make it even more exciting and challenging for them. So if you imagine one group could do a baby chair. Either they're happy or they're not. And then another group does the Daddy Bear's chair. So if… Thinking about sizes, or looking at or thinking about my chair needs to be smaller than yours and your chair needs to be bigger than mine. And maybe relating it to a story. Cause like, when you talked about… emm...

PD: The designer.

J: Yeah, the scenario, the designer wanting another chair. That was great, but maybe you three could do something different. There's no [indecipherable] you four.

PD: Okay.

J: Because before you came in, they knew we were making chairs because they because they've obviously talked about it in the playground. So they knew they were making chairs and so it's nice if

when they come in and there's a different picture, there's a challenging picture on the table. And they look at it and design a similar one, or the same, so maybe next time there's a three, or six chairs on the table for making something different.

DH: Okay.

J: And I thought the questions and the evaluation sheets were really good, but they do evaluations every single every single thing that we do, is determined. Even the evaluation sheet you could make really challenging for them. So, they could have a sheet and put in like… They could circle it and you could have more questions to ask them, related to what you actually think about the lessons as well. Because they do it every, every time they're doing it they returning an evaluation sheet. So don't feel that you have to limit the questions you can put...

AC: Yeah…

J: And yeah that was it.

PD: And so we do have a few questions too, and he's going to ask you a couple.

ED: On a scale of one to five, how satisfied were you with the lesson?

J: Five.

ED: Great. Was this appropriate for the age range?

J: Yeah.

ED: Should we have done something slightly different?

J: No.

ED: Erm… What parts of the lesson plan did you like? Err… Was the length good?

J: Yeah. So, I think the whole class teaching was between five and seven minutes, so it wasn't long. It didn't drag on. It gave them enough time to actually do the lesson, and they finished it within time. So all four classes were able to finish the activity, so the timing was good.

ED: Does it match up at all with your current curriculum?

J: Yeah, yeah.

ED: Let's see… You already answered the next question, how can we improve the lesson plan. You had some great ideas.

J: I think the lesson plan is great. I think it's great, I just think that, because the two classes are two different classes and they are two different kind of emm.. They both work in different ways. So I thought that maybe year three being the youngest, cause they're more like key stage one, upper key stage one, so it would be nice if it was related to a story. And maybe year four, they… the scenario

that you had up. So we're doing it with James. James is the mailman and went somewhere and he broke a chair and I think that's a nice scenario. But maybe year three could have something related to like, Goldilocks story. We all know Goldilocks and the three little bears. The three little bears… Goldilocks sat on all the chairs, and broke all three chairs this time, so this time, we need one group to make Baby's chair… Because they're still shifting away from key stage 1. And it would be nice to still have that memory of traditional stories and fairy tales.

MG: So with regards to the lesson plan, do we want to show the actual one....

D: She has one.

J: I've got one.

MG: I wasn't sure…

J: It's great, exactly how I do mine.

[Paper shuffling]

J: It's actually how I do my lesson plans. This isn't year three, it's actually year two. So you've got the learning objective, I've got skills, the whole class teacher resources, got the same thing. And then there's skills, and the plenary there. So, it's exactly the same thing.

AC: That's awesome.

PD: That's good to hear.

ED: Hmm… So we've got one other question, I don't know how relevant it is any more, but how could we improve the link between the lessons and your current curriculum.

J: So, at the moment, year three are going to be doing printing, so it's not what they're doing at the moment, but they have done work like this… even when we've done… this was done in a club, but we've got children from different classes coming in the club. And then in year four, we're doing money containers, so again, it's designing and making. So, money containers can be done with newspaper, it can be done with fabric, it can be done with boxes, so again, it's all part of designing and making. So, even if it's not part of a unit that we're doing this time, it is something that they do. Emm… We always use recycling materials, so even if it's not chairs, it could be something else, cutting out letters and using it to write their names, using it for a piece of display work. So it does fit in with the unit of work, but it might not be in the Summer term, it might be in the Spring term, they do recycling materials quite a lot in there.

ED: I think that was it out of our pre-written questions.

DH: So yeah, the Wiggle Chair, kind of supposably the focus of that, but what they kind of picked up on more was the paper chair. That seemed to be more exciting to them.
If things changed over, so I thought, watching it, my feeling about it was actually that the wiggle chair could have been a nice intro to the whole thing, with the video, and then talked about different kinds of materials, and then the paper chair could have been the segue to the activity. Because I think when they, when they were doing the activity a lot of them were thinking, 'I've got the Wiggle Chair in my mind, why's my chair not looking like that?' So do you think that would work around that way? If the Wiggle Chair was taken out and put in the beginning, and the story of Frank Gehry was told in the sense of-
J: So you mean the whole six chairs you showed.
DH: Yeah, so rather than having the whole six chair at the beginning, showing the video, and then talking about other materials, so, something about crazy materials that chairs are made out of and then, and saying, and going back to the more traditional stuff and then coming to the paper one last. And using that as a start to the practical.
J: So in that case, it would have been nice to maybe have... we've got plastic chairs in the class, it would be nice if we had a wooden chair. It's quite difficult to get all those resources, so again pictures would have been ideal on the table. Because we've got a lot of EAL (English as an Additional Language) children, and as you saw [Student 1] with SEM, it would be nice to have a picture in front of him.
DH: So if we were to, sort of, as part of a teacher resource, provide a copy, like a large copy, of some of those pictures.
J: So all those pictures you had on the board were great, but if they were A4 size, blown up, one each on the table. So they come in, they pick it up, they discuss it amongst themselves on the table, what these materials… rather than us doing in front of the class, then we get their attention back a few minutes afterward, and then as a group they put their hands up and say, 'right, this is made out of plastic, this is made out of wood.'
MG: So you'd prefer if pictures were supplementary material, like on their own, just the pictures, separate.
J: I wouldn't say I'd prefer it, but just- Seeing how they learn, it's the best way for them to actually see it in front of them. So I usually would have a picture and the actual material, so if I was doing something like… I don't know… ermm… So say if I was cooking, sorry it's not part of it, but if I

was cooking, I'd have a plastic cabbage and a real cabbage and a picture. Because children learn in different ways and some of them prefer the actual texture of the actual thing, some of them… so everybody…. Like [Student 2], he'd just look at the picture and he's got it and he's just find, whereas someone like [Student 1] would want to look at it, fiddle with it, pull it apart, and then, so… They all have different ways of learning, so I think yeah. Probably have more resources, like a resources pack, together. So those pictures you showed of chairs; the chairs were amazing, so you could have those same chairs on the table, but they make them out of paper. So the metal chair, which came out as sort of like a pumpkin kind of shape, they could think of kind of bending it, bending it then bending it there. So that could be one chair made. And there was that other chair that kind of went back a bit. So it was looking at all those pictures and making chairs out of it. I don't know what you think.

PD: It's definitely good, good ideas-

J: The materials you showed on the board were amazing, just blowing them up to A4 size and and that's it.

DH: And if they were in sort of a teacher pack, a resource pack, would you just, would you be tearing the pages out, or would you photocopy them more.

J: It depends, most class sizes are 24 to 30 or 22 to 30, so if I was going to teach that lesson, I would have one group have one A4, so the six chairs you had on the board I would have four children have six pages, and another four six, and another four six. And then get them to talk about it amongst themselves, and then, afterwards, let them all back, and then give one group one picture, and another group another picture, another group another picture. So all the six pictures that they talked about, now spread out into four groups, which makes it 24. And then if they could make a similar chair. Because the chairs were pretty cool, they were lovely chairs. If it was blown up more, it gets them to talk about the shapes, talk about the form. It gets them to talk about so many things, and the language around it is amazing, because there's so much to get out of it.

DH: Yeah, yeah. Do you think the level of the lesson could been pitched higher, do you think the content could have been-

J: I think it was just right. I think it was just on the right. Like I said, it's key stage two, they both learn differently. But… Because year three came in and they saw and remembered, they had an idea of what they were doing already. But if they came in and... we're not doing the same chair, we're doing a picture, then it becomes more challenging for them.

DH: So as far as you can tell, if you were doing a whole day's worth, that would be an option to put in your afternoon classes.

J: Yeah

DH: Awesome. Have you guys have anymore questions?

AC: We're all set.

DH: Thank you so much.

J: It was lovely.

MG: Thanks so much.

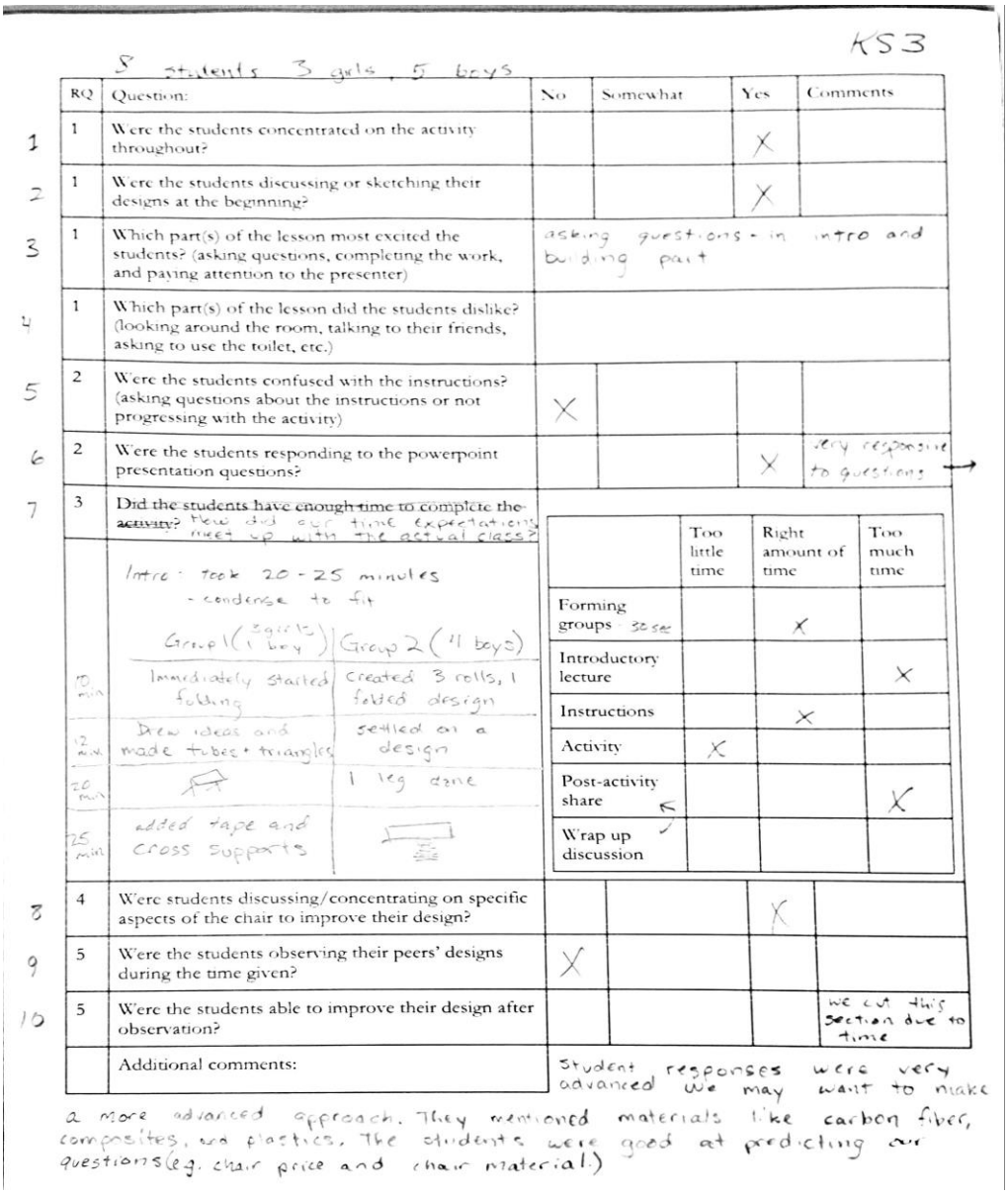
DH: Thanks so much. You were amazing at the discipline, which was brilliant.

[Laughter]

J: Year three, remember when they came in, I told you. It was amazing-

MG: End the recording.

Appendix L: Pilot programme observational matrix results



KS3

8 students 3 girls, 5 boys

	RQ	Question:	No	Somewhat	Yes	Comments
1	1	Were the students concentrated on the activity throughout?			X	
2	1	Were the students discussing or sketching their designs at the beginning?			X	
3	1	Which part(s) of the lesson most excited the students? (asking questions, completing the work, and paying attention to the presenter)	asking questions - in intro and building part			
4	1	Which part(s) of the lesson did the students dislike? (looking around the room, talking to their friends, asking to use the toilet, etc.)				
5	2	Were the students confused with the instructions? (asking questions about the instructions or not progressing with the activity)	X			
6	2	Were the students responding to the powerpoint presentation questions?			X	very responsive to questions →
7	3	Did the students have enough time to complete the activity? How did our time expectations meet up with the actual class?				
8	4	Were students discussing/concentrating on specific aspects of the chair to improve their design?			X	
9	5	Were the students observing their peers' designs during the time given?	X			
10	5	Were the students able to improve their design after observation?				we cut this section due to time
		Additional comments:	Student responses were very advanced We may want to make a more advanced approach. They mentioned materials like carbon fiber, composites, and plastics. The students were good at predicting our questions (e.g. chair price and chair material.)			

Intro: took 20-25 minutes
- condense to fit

	Group 1 (3 girls, 1 boy)	Group 2 (4 boys)
10 min	Immediately started folding	created 3 rolls, 1 folded design
12 min	Drew ideas and made tubes + triangles	settled on a design
20 min		1 leg done
25 min	added tape and cross supports	

	Too little time	Right amount of time	Too much time
Forming groups - 30 sec		X	
Introductory lecture			X
Instructions		X	
Activity	X		
Post-activity share			X
Wrap up discussion			

2. One group drew their prototype. Another group considered multiple designs before completing the building.

3. The students were responsive to showing two types of chairs and comparing them. Also talking about the teachers chairs versus the students' chairs.

6. All students were answering the questions. Only 1 student remained silent. Two girls were very excited and answering all of the questions.

Group 1: collapsed under 6 books, make sure tubes are able to support weight

Group 2: supported 10 books, but only a few inches off the ground. Would have added supports if more time.

KS2

22 Students 9:30 lesson

RQ	Question:	No	Somewhat	Yes	Comments
1	Were the students concentrated on the activity throughout?			X	
1	Were the students discussing or sketching their designs at the beginning?				
1	Which part(s) of the lesson most excited the students? (asking questions, completing the work, and paying attention to the presenter)				
1	Which part(s) of the lesson did the students dislike? (looking around the room, talking to their friends, asking to use the toilet, etc.)				
2	Were the students confused with the instructions? (asking questions about the instructions or not progressing with the activity)		X		initial rolling of tubes
2	Were the students responding to the powerpoint presentation questions?			X	
3	Did the students have enough time to complete the activity?				
	Even with 7 adults, kids were struggling with rolling - 1 min - 9:50 finished rolling - 10:05 well into building - 10.15 end at 10.30 Demonstration of tube rolling was tricky				
4	Were students discussing/concentrating on specific aspects of the chair to improve their design?		X		some added seats and back rests
5	Were the students observing their peers' designs during the time given?			X	
5	Were the students able to improve their design after observation?		X		
	Additional comments:				Scissors may be good to include (to cut tape and even out height of tubes). Having 1.5 rolls of tape per group was good Put out newspaper at beginning

	Too little time	Right amount of time	Too much time
Forming groups		X Joyce did	
Introductory lecture	X	Still 20 mins	
Instructions		X	
Activity		X	
Post-activity share	X		
Wrap up discussion	X		

10.45 class 25 students KS2

RQ	Question:	No	Somewhat	Yes	Comments
1	Were the students concentrated on the activity throughout?				
1	Were the students discussing or sketching their designs at the beginning?				
1	Which part(s) of the lesson most excited the students? (asking questions, completing the work, and paying attention to the presenter)				
1	Which part(s) of the lesson did the students dislike? (looking around the room, talking to their friends, asking to use the toilet, etc.)				
2	Were the students confused with the instructions? (asking questions about the instructions or not progressing with the activity)		X		
2	Were the students responding to the powerpoint presentation questions?		X		
3	Did the students have enough time to complete the activity?				
	People thought they could make a chair out of paper 11:30 — 11:32 —				

	Too little time	Right amount of time	Too much time
Forming groups			
Introductory lecture		X 15 min (11:00)	
Instructions			
Activity			
Post-activity share			
Wrap up discussion			

4	Were students discussing/concentrating on specific aspects of the chair to improve their design?		X		
5	Were the students observing their peers' designs during the time given?			X	
5	Were the students able to improve their design after observation?		N/A		
	Additional comments:	May take longer with only 2 teacher			

2nd class was faster because they saw the other class's desig
Do not use inappropriate newspaper.

1:15 class KS2

RQ	Question:	No	Somewhat	Yes	Comments
1	Were the students concentrated on the activity throughout?		X		Tough keeping their focus
1	Were the students discussing or sketching their designs at the beginning?		X		
1	Which part(s) of the lesson most excited the students? (asking questions, completing the work, and paying attention to the presenter)	activity			
1	Which part(s) of the lesson did the students dislike? (looking around the room, talking to their friends, asking to use the toilet, etc.)				
2	Were the students confused with the instructions? (asking questions about the instructions or not progressing with the activity)		X		needed more clarity
2	Were the students responding to the powerpoint presentation questions?			X	
3	Did the students have enough time to complete the activity?				

	Too little time	Right amount of time	Too much time
Forming groups		X	
Introductory lecture		X	
Instructions		X	
Activity		X	
Post-activity share	X		
Wrap up discussion		X	

4	Were students discussing/concentrating on specific aspects of the chair to improve their design?			X	
5	Were the students observing their peers' designs during the time given?			X	
5	Were the students able to improve their design after observation?	X			
	Additional comments:				

little crazy keeping focus. Need to clarify instructions

2:25 class KS2

RQ	Question:	No	Somewhat	Yes	Comments
1	Were the students concentrated on the activity throughout?		X		
1	Were the students discussing or sketching their designs at the beginning?	X			
1	Which part(s) of the lesson most excited the students? (asking questions, completing the work, and paying attention to the presenter)	asking questions			
1	Which part(s) of the lesson did the students dislike? (looking around the room, talking to their friends, asking to use the toilet, etc.)				
2	Were the students confused with the instructions? (asking questions about the instructions or not progressing with the activity)			X	didn't ask questions but didn't pay attention
2	Were the students responding to the powerpoint presentation questions?			X	
3	Did the students have enough time to complete the activity?				

~50min (shorter)	Too little time	Right amount of time	Too much time
Forming groups			X
Introductory lecture			X
Instructions	X		
Activity		X	
Post-activity share	X		
Wrap up discussion	X		

4	Were students discussing/concentrating on specific aspects of the chair to improve their design?		X		
5	Were the students observing their peers' designs during the time given?	X			
5	Were the students able to improve their design after observation?		X		
	Additional comments:				

Chaotic, lack of focus, hard to bring attention to the activity