D2.5 A framework for identifying creative best practices in inquiry-based science education

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CREATIONS aims to demonstrate innovative approaches and activities that involve teachers and students in Scientific Research through creative ways that are based on the Arts and focus on the development of effective links and synergies between schools and research infrastructures in order to spark young people's interest in science and in following scientific careers. The foundation for this project is presented within Work Package 2 in five deliverables D2.1 (The features of inquiry learning: theory, research and practice), D2.2 (Essentials of creativity-enriched IBSE pedagogy), D2.3 (Effective learning environments for inquiry learning and teaching), D2.4 (Professional development of Educators: Considerations and Strategies) and D2.5 (A framework for identifying creative best practices in inquiry-based science education).

Deliverable D2.5 presents 'A framework for identifying creative best practices in inquiry-based science education'. This deliverable will present the process and the framework to identify best practices. By

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building on the best of current practice, the CREATIONS approach aims to take us beyond the constraints of present structures of schooling toward a shared vision of creativity and excellence.

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1. Introduction

The deliverable D2.5 presents 'A framework for identifying creative best practices in inquiry-based science education'. This deliverable will present the process and the framework to identify best practices. By building on the best examples of current practice, the CREATIONS approach aims to take us beyond the constraints of present structures of schooling toward a shared vision of creativity and excellence. The deliverable draws on the previous deliverables from Work Package 2 in order to synthesise everything learned there. While the elements of D2.5 can be used to 'identify' best practices, it also seems important to present them in such a way so as to be able to generate best practices. So while a consortium partner or Facilitator might use this deliverable to understand whether their science education activities are comparable to a CREATIONS notion of best practice, they may also use this deliverable to move their activities and practice in that direction or indeed to generate that practice per se.

This deliverable is deliberately written in a communicative 'us to you' style in order to make the ideas and activities as accessible as possible. Once the deliverable is complete, the University of Exeter team (UoE) will work with the CREATIONS web team to make its contents available on the CREATIONS website as a usable toolkit for thinking about the many angles on creativity in science education. For this reason, the reader may see content in [] which directly references instructions to users of the website. The website is considered to be a place where the consortium partners and Facilitators can map their demonstrating activity to ensure that the CREATIONS features are alive and present within their practice; as well as being a place for new practitioners to engage with CREATIONS through the web-based toolkit. The website will be structured something like the image below:

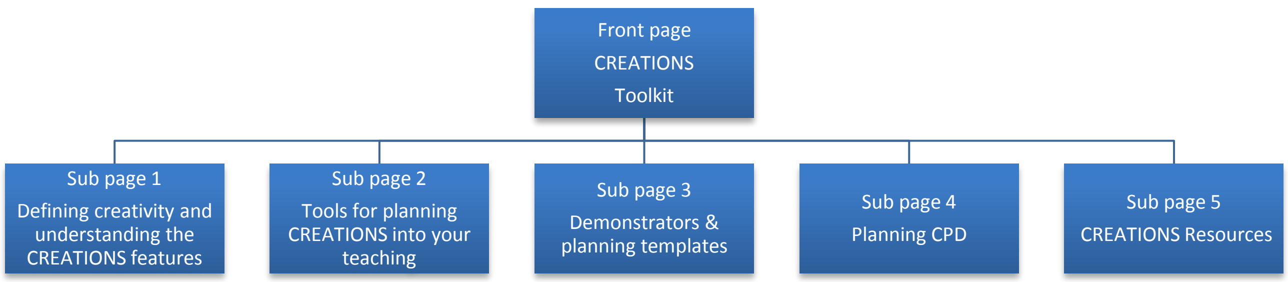

Figure 1: Proposed website structure

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The front page of this part of the CREATIONS website is likely to read as follows:

'Welcome to the CREATIONS Toolkit for teachers, lecturers, scientists, researchers, or artists, who from now on will be referred to as Facilitators. This website contains resources to help you define and plan creativity into science education and your teaching. It includes links to examples of existing good practice, downloadable planning, workshopping activities and teaching resources to support your teaching for creativity in science, including Inquiry Based Science Education (IBSE – more information here) and to share with your colleagues. There are also examples of videos and photographs explaining and demonstrating resources like the CREATIONS Wheel.'

1.1 Synthesis of definition, framework and features (Sub-page 1)

This section synthesises the creativity in science education definition, CREATIONS framework and features from D2.1 (Chappell, Hetherington, Slade, Ruck Keene and Cukurova, 2016), in order to allow consortium partners and Facilitators to consider their science education activities and practice in relation to them. The subsections below are likely to be sub-pages off the main defining creativity page above.

1.2 CREATIONS definition of creativity in science education

How do you define creativity in your science education planning and practice? We would argue that in order for individual or collaborating Facilitators to *own* or *live* the practice of developing creativity in science education, they need to have their own definition of what creativity is. Here we use the term definition loosely. It might not be laid out in words, an image or an object might represent it; it might not even be consciously stated in a specific media; Facilitators might just 'know it when they see it'. However, one way to work with creativity in practice is to find a way of articulating it that works for you. You can then cyclically develop it by reflecting on your articulation (words, image, object) over time, intertwined with practice.

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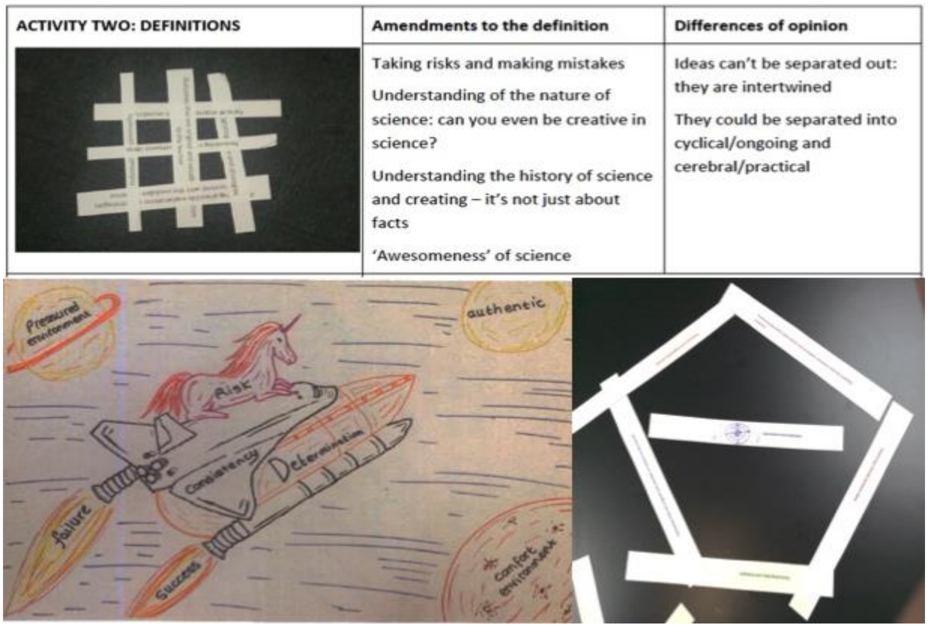
For the purposes of the CREATIONS project we were required to develop a word-based definition as follows:

> *“Purposive and imaginative activity generating outcomes that are original and valuable in relation to the learner. This occurs through critical reasoning using the available evidence to generate ideas, explanations and strategies as an individual or community, whilst acknowledging the role of risk and emotions in interdisciplinary contexts”*

We developed it in this way because we were working on a formal literature review and we wanted to be clear about how we were defining our terms. The definition above was slightly different before we began the literature reviewing and workshopping process that made up D2.1, and we then developed it in light of that review and workshopping events in order to come up with an overarching definition for the project.

We suggest that Facilitators use the workshopping process [link to webpage or in this document see Appendix 1 for workshop process] in order to see if their, perhaps subconscious, definition of creativity fits with the one we have proposed above. The workshopping process allows for the possibility of development of the definition in different contexts too.



ACTIVITY TWO: DEFINITIONS	Amendments to the definition	Differences of opinion
	Taking risks and making mistakes Understanding of the nature of science: can you even be creative in science? Understanding the history of science and creating – it's not just about facts 'Awesomeness' of science	Ideas can't be separated out: they are intertwined They could be separated into cyclical/ongoing and cerebral/practical

Figure 2: Different examples of how the definition was workshopped

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For some people representing creativity in words might be antithetical to the fact that creativity is a process and is alive in practice. For this reason, we also offer an image montage below. It is made up of images drawn or taken by people from various disciplines, which show how they would represent creativity, as well as images of the creative process in action from different CREATIONS science education demonstrators that already exist. You might decide to work with the images in the same kind of workshopping process as the words above. You could ask yourself questions such as: what image sums up creativity in science education for me? What can I see in the images here that make me think something creative is happening? What does this make me think about my own creativity in science education practice?

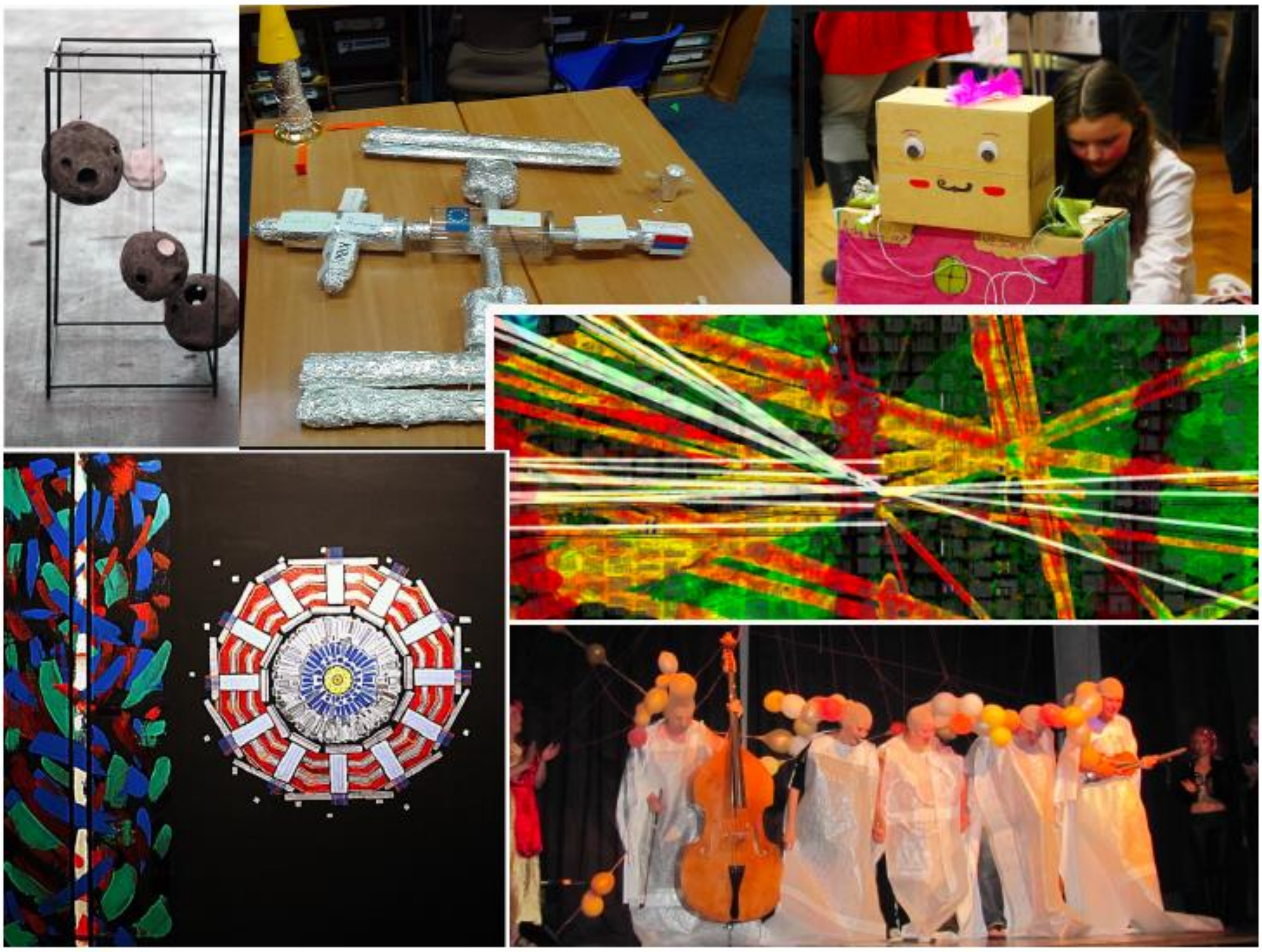

Figure 3: Montage of images from various demonstrator projects

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We would be very interested to hear the outcomes of any workshopping activities. (Please feel free to photograph your outcomes and post them in the blog below with your comments.)

1.3 CREATIONS framework and features

D2.1 [available here] demonstrated that there is a wealth of knowledge that has been generated in relation to the wider field of creativity in education, arts/science integration and partnership, and creativity in science education per se. Both the CREATIONS project and a pre-cursor project called CREAT-IT [http://www.creatit-project.eu] focused specifically on the research of a team of academics at the University of Exeter in the UK, who work in the Graduate School of Education's *Centre for Creativity, Sustainability and Educational Futures* [https://socialsciences.exeter.ac.uk/education/research/centres/cencse/]. Specifically, both CREATIONS (Chappell, Hetherington, Ruck Keene, Slade and Cukurova, 2016) and CREAT-IT (Craft, Chappell, and Slade, 2014) used a pedagogical framework grounded in wider literature but rooted in the theoretical and practical work of this team. The pedagogical framework for the CREATIONS project is show in Figure 4 below:

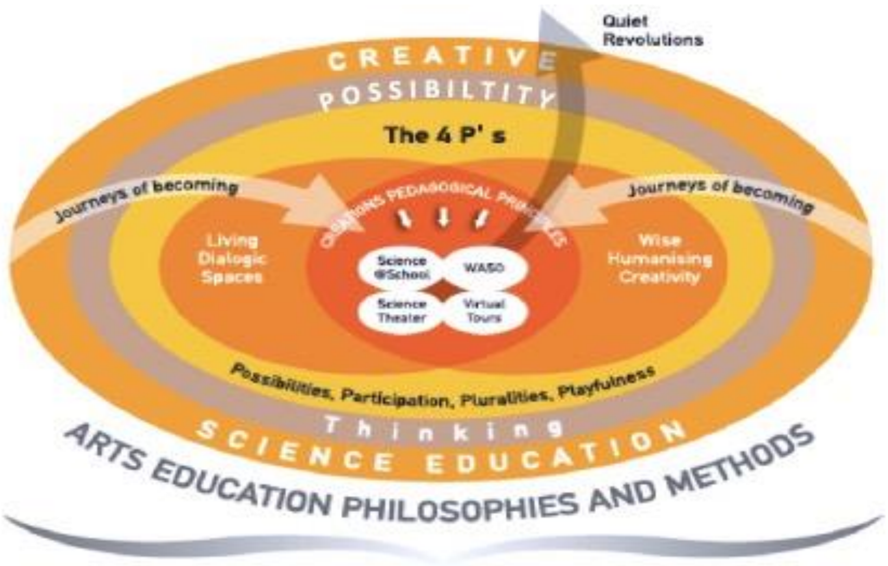

Figure 4: The configured CREATIONS theoretical framework

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The finer theoretical details underpinning this framework are available in D2.1 [available here] but for those interested in the bigger theoretical picture please follow the link here [goes to sub webpage or PDF] for a summary.

It is important to be clear that creative science education is the main context for the CREATIONS project; this therefore forms the main outer circle of the figure. At the bottom of the figure, arts education philosophy and methods is positioned as a 'holder' within which creative science education (as opposed to all science education) is being nurtured via arts and cultural practice. As we move in towards the centre of the figure we can see that one of the main drivers for CREATIONS creativity is possibility thinking for all involved. This concept was developed by Professor Anna Craft (2001). It means being able to ask 'what if' and 'as if' questions.

For example:

- What if the school takes a creative approach to curriculum development across the arts and sciences?
- What happens if I as the teacher collaborate with that artist as if I…?
- What if I/we choose to explore this scientific question rather than that one…?
- What if I/we use this arts approach to help me explore my question...?
- How can I/we imagine this as if I were…?

As we move in another layer towards the center of the figure, we can see four key defining features of CREATIONS classroom environments. These are the 4Ps of engagement in creative science education (Craft, 2011, Craft, 2015): pluralities (opportunities for students and teachers to experiment with many different places, activities, personal identities, and people); possibilities (opportunities for possibility thinking, transitioning from what is to what might be, in open possibility spaces); participation (opportunities for students and teachers to take action, make themselves visible on their own terms, and act as agents of change); playfulness (opportunities for students and teachers to learn, create and self-create in emotionally

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rich, learning environments).

We then come closer to the heart of the CREATIONS figure and find WHC (wise humanising creativity) and LDS (living dialogic space). WHC has at its heart the relationship between the creator's identity and their creativity, so as they make, they are also being made (Chappell, with Craft, Rolfe and Jobbins, 2012). WHC is not only an individual activity, but also happens in collaboration with fellow learners, teachers and other professionals (artists, researchers). These individual and collaborative creative activities form part of a wider web of ethically guided communal interaction geared towards both helping children and young people become more creative scientists and assisting teachers in becoming more creative in how they teach science. For this reason WHC is positioned very close to the heart of the CREATIONS figure as it is one of the core aims of the CREATIONS pedagogic principles.

Alongside and integrated with WHC, is LDS, always a partner to WHC in terms of developing practice. Living dialogic spaces are best created via creative learning conversations which at their simplest are about re-positioning power hierarchies, listening to the voices of all involved and then actioning the results of the conversations (Chappell and Craft, 2011). CREATIONS Demonstrators [http://creations-project.eu/partners/] will promote the idea of dialogue between people, disciplines, creativity and identity, and ideas.

As detailed above all of these layers have been synthesised together not only to develop this CREATIONS figure and accompanying narrative but also to generate the CREATIONS' own set of unique working pedagogical features. The features represent the unique way that the consortium ideas come together in order to underpin the CREATIONS Demonstrators pedagogies.

1.4 CREATIONS Features

The CREATIONS University of Exeter team want to make accessible what we have learned from our literature review, investigations into practice and information seeking workshops. We have condensed all of our investigations down into 8 suggested features of best practice in creative science education. We offer them below as a way of thinking about your science teaching practice and as a provocative way for you to frame the development of your science teaching planning and practice.

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Figure 5: CREATIONS features of creative education

Within CREATIONS the role of the teacher or Facilitator might best be described as a 'Meddler in the Middle'. This theory of 'Unlearning how to teach' by Erica McWilliams is an approach to creative education where teachers apply their professional wisdom and engage in the dynamic of learning with learners [see link via resources page]. We also identify with Gert Biesta's [see reading on resource page Biesta, 2004] idea of creative education as occurring in the relational interaction between teachers and students, not via a process of knowledge transmission. We imagine it is highly likely that science teachers/Facilitators working in this way will be engaging with Inquiry Based Science Education and suggest that there is a self-fuelling relationship between IBSE and the CREATIONS features as below:

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Figure 6: The interrelationship of IBSE and CREATIONS features

We are offering the CREATIONS features below for teachers/Facilitators who want to engage alongside and in relationship with their learners. During CREATIONS we have used a 'Cloudsheet' to track how we think the features come alive in different science education projects and Demonstrators. [Click here for an example – see Appendix 2 in this deliverable]. As you consider the features below, you might want to fill in your own Cloudsheet to see where you can find or develop CREATIONS pedagogic features in your own creative science education practice [Blank version downloadable here – Appendix 3 in this deliverable].

Please feel free to feedback any thoughts or upload your Cloudsheets via the forum below, so that the features can be developed together and used by the science education community [Link to blog]:

1. **Dialogue**: How can you ask a question in a way which leads to new ideas and then/also leads to more questions? How can you encourage your students to do this too, and to challenge and question some of the science they encounter in their everyday lives? When you have a dialogue with your students does it always need to be in words? Can you use a provocative image, a piece of physical theatre? There are some great examples of visual arts images that stimulate provocative questions in the CERN project [http://arts.cern], which pitch science and art directly 'in conversation' with each other. Other creative science projects focus directly on dialogue and debating difference to bring science alive for students [http://www.scicafe.eu/jrCafes and Student Parliaments - http://www.student-parliaments.eu/]. This can involve a great deal of

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conflict of ideas and attitudes. How can you be ready to take the risk of including difference and productive conflict into your science teaching?

2. **Interdisciplinarity** When the sciences and arts work best together they're really showing interdisciplinarity in action. No matter where we come from, as human beings we are interested in answering the same questions [http://arts.cern] to come up with new ideas. How can we find ways to use the different processes of the sciences and the arts to solve common problems? In your teaching how can you allow for problem-finding, exploring, reasoning, reflecting, questioning and experimenting? How can you mix learning facts with knowing how to experiment, how to make art, and help you and your students recognise feelings and emotions in all of this? And, importantly, how can you make sure the science and arts learning is of a high quality? Making sure you have access to the right equipment whether Bunsen burners or quality art materials is key here.
3. **Individual, collaborative and communal activities for change**: Creativity in science education is rarely a solo process. The arts are a really fruitful way of encouraging collaboration within a communally driven experimental science classroom so that everyone can have a go at being creative with scientific ideas and questions. Initiatives like SketchBetter: DrawLove [https://sketchbetter.org/2016/02/11/drawing-love-in-nottingham/#more-1972] run as part of Nottingham Festival of Science and Curiosity [http://www.stemcity.co.uk/festival.html] are great examples of arts activities which allow individuals to question and experiment with arts processes around science themes in a collaborative and communal way. Using combined science and arts skills can be another engaging way to collaborate creatively (see CERN's Webfest where young people created 3D games about particle physics and cheap cell-phone enabled cosmic ray detectorshttp://webfest.web.cern.ch/)
4. **Balance and navigation**: creative science teaching, which encourages creativity in science learning, is a constant balance in control and freedom, structure and openness. How can you develop the practice of stepping in with your expertise when students need it, but also stepping back and giving them the space to ask their own questions and follow them through scientifically themselves to generate their own new answers? Balance can also be about integrating existing

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scientific knowledge with engaging or enlightening arts processes so that children and young people's own everyday questions about the world are brought to life (the Imagineerium – http://www.imagineerproductions.co.uk/content/6604/home/home – is a good example of engineering and sculpture integrated and balanced together in education for children and their local community). Navigation is about acknowledging some of the common tensions and dilemmas we all face as educators - testing and assessment, the marketisation of education, and resource/time pressures.

5. **Empowerment and agency**: empowering students whilst covering everything in the curriculum can be extremely challenging – bearing in mind the constraints how can you give students more ownership of the science learning in small ways that might add together to help them be creative science learners? This might be about modeling your own passion for independently asking questions in science, to encourage them to do the same. Giving them agency is also about letting them see through the experimentation process even when it goes wrong so they own their mistakes as well as their successes. Engaging in larger scale creative science projects such as CERN@school (http://www.thelangtonstarcentre.org/cern-atschool/) can then build on students' day-to-day experiences of agency. CERN@school involves trusting students to use a pixel detector chip to detect ionising radiation. The IOP now supports local schools in using the CERN@school kit for curriculum learning and extension research projects which are owned by and relevant to teachers and students in their school.

6. **Risk, immersion and play**: taking risks is very connected to students and Facilitators being able to make mistakes and have agency within their learning. To do all of these things students and teachers need to be motivated and excited. This might mean grounding the IBSE process in real life burning questions or using the arts as a starting point for provoking questions [see how the Imagineers do this herehttp://www.imagineerproductions.co.uk/blog_entry/3109/news__events/latest_news/latest_news/go_ahead_for_the_festival_of_imagineers_2015___].

   The art@CMS touring exhibition also provides strong motivation for students to play with science. It presents an introduction to the exciting work carried out by physicists at CERN in

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Switzerland, and its two pods containing audiovisual displays, including The Large Hadron Collider, can be installed in any school. For students this is a great opportunity to immerse themselves in cutting edge physics and take risks with their ensuing ideas supported by their teacher.

7. **Possibilities**: really creative science teaching and learning can allow for multiple possibilities both in terms of thinking and spaces. In this kind of practice, it is important to know when it is appropriate to narrow or broaden thinking in the context of asking 'what if' questions, so that teachers and students can capture interesting new ideas. The performing arts especially are extremely good at creating spaces to generate new ideas – music can create dynamic listening spaces, dance works with bodily relationships in space, drama can change who we are, and give us new perspectives on the world through role taking. The UK Fun Palaces are a great example of this openness to possibilities [http://funpalaces.co.uk]. The organisation believes 'in the genius of everyone, that everyone is an artist and everyone is a scientists and that creativity in the community can change the world for the better'. Their project allows people to get immersed in connected science-arts experiences and playfully experiment with questions and processes. The outcomes show how vast the potential is for exploring ideas and constantly asking 'what if?'
8. **Ethics and trusteeship**: this final feature may be a little abstract but it is an extremely important part of the full creative process in both the sciences and the arts. It means that Facilitators and learners need to consider the implications and impacts on those around them of their creative science processes and products. From the question of what it means for a scientist to develop the science capable of making the nuclear bomb?, to how might a dance performance portray the family difficulties that ensue from diseases caused by particular genetic mutations?, thinking about ethics as part of any making process is complex. Here, the arts with their mastery of felt experience can be powerful ways of engaging in these questions in classroom settings. Trusteeship means thinking about who holds the values in question; and within education helping young people to understand that they are the young trustees of their own community values, now and in the future. Dependent on their focus and content, Write a Science Opera

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[http://www.reseo.org/project/write-science-opera], Junior Science Cafe's [http://juniorsciencecafe.de] and Student Parliaments [http://www.student-parliaments.eu/] are rich practices within which this kind of consideration of ethics and trusteeship can take place.

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2. Tools for planning CREATIONS into your teaching (Sub-page 2)

This section of the CREATIONS Toolkit will guide you through how to use the CREATIONS wheel and Honeycombs as a potential resource for planning the CREATIONS features and the Arts into your science enquiry. You will be guided through an example activity, to demonstrate this as a potential starting point for your own planning.

2.1 What is the CREATIONS Wheel and how to use it?

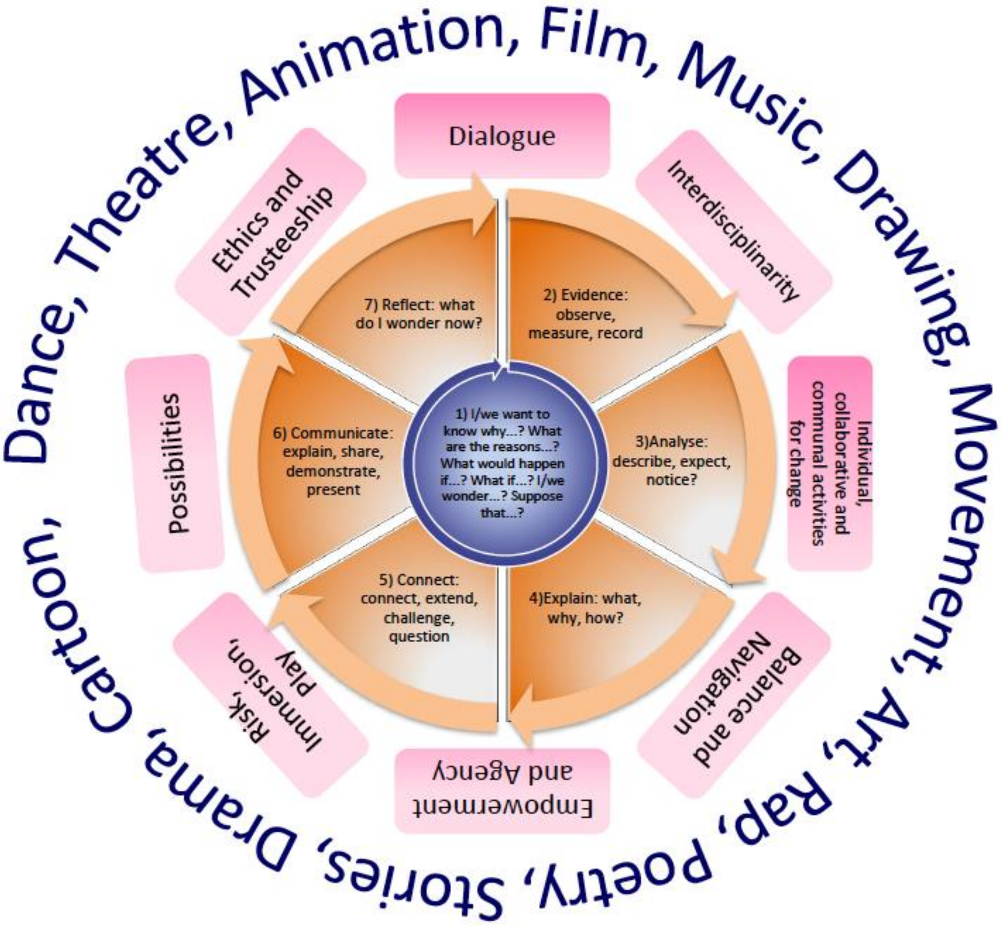

Figure 7: CREATIONS Wheel developed by University of Exeter

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The CREATIONS wheel is a physical tool to use with your students or young people. It is a way for them to generate questions about a theme or topic. Using the central wheel there are prompts for the students to begin their discussions. They then follow the second layer, which is structured around the IBSE Cycle [link to more IBSE info], each stage of the cycle has further prompts to probe thinking. The gaps between the different segments allow for the third and forth layers to show through (the CREATIONS Features and Arts disciplines). It is envisaged that at each stage the person using the wheel has an opportunity to consider how they might integrate the Arts and features at this stage [sub-page here to show examples of arts in science education – Appendix 4 in this deliverable].

Figure 8: Embedded video of example conversation using the CREATIONS Wheel

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2.2 Lesson idea / explanation using the IBSE cycle and CREATIONS wheel

Topic: forces, balance, gravity

Stimulus: watch Human Table Video

Figure 8: Embedded video example of Human Table activity

Question stage: Using the central wheel the young people begin to generate as many questions as they have about the topic and the video they have just watched, for example they might suggest:

- *We want to know why / how that worked, do you just have to be strong or is there something else going on here?*
- *I wonder if you can make the table using only one leg.*
- *What would happen if you made the table with 3 people instead of 4?*

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After the young people have generated as many questions as they can about the topic, they then select one they wish to explore further.

As the young people move through each stage of the IBSE cycle around the wheel, they constantly consider how the Arts can be integrated or enhanced at each phase of the process (i.e. the gap in between the segments) where the young people can muse if they can integrate the arts at this point.

2.3 The CREATIONS Honeycombs

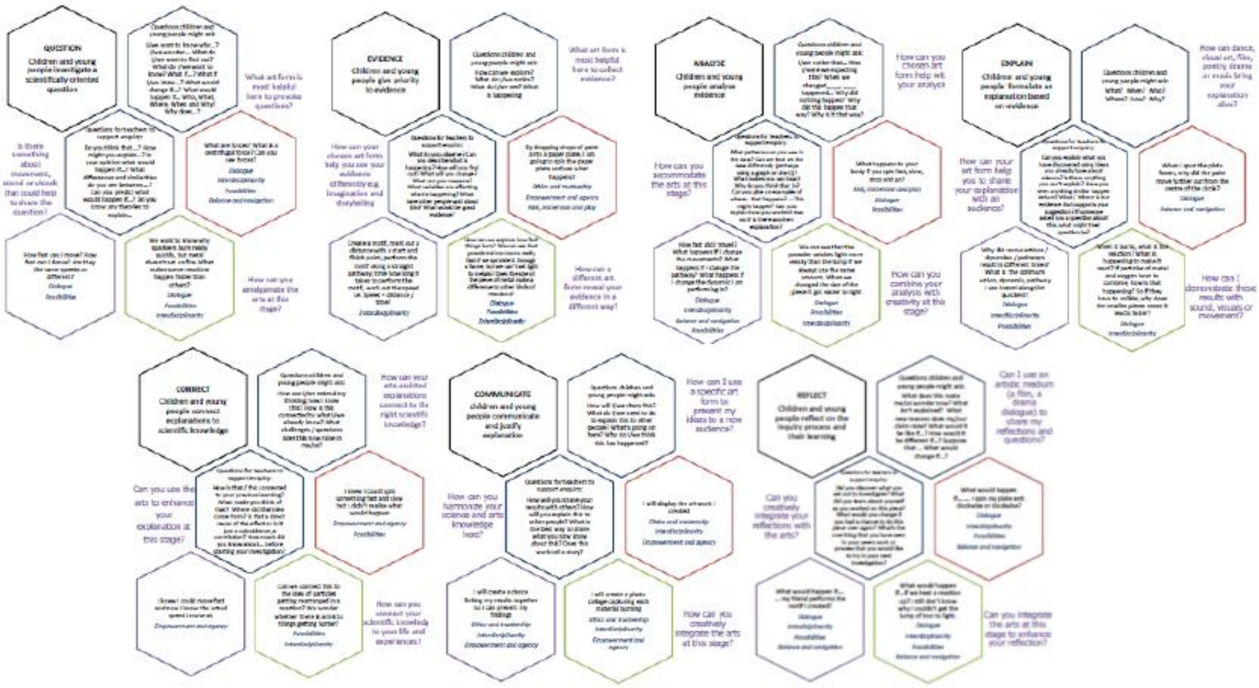

Figure 9: CREATIONS Honeycombs mapped together developed by University of Exeter

Using the honeycomb as a prompt / support to show you questions you might ask the young people during this process the Facilitator role is to further support the young people in questioning how can the Arts can be employed, used, integrated, enhanced during this stage of the process?

Some suggestions about how this might look:

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- The young people can explore further shapes through movement i.e. counterbalance and counter tensions - they can create a dance about forces and gravity.
- They can engage with film and media by making a video of themselves conducting their experiment.
- They can engage with music by applying different forces to a stringed instrument to compose a piece of music.
- They can engage with art and make a photo collage documenting their experiment

[Links to Download a PDF of each honeycomb – see Appendix 7]

[Question]

[Evidence]

[Analyse]

[Explain]

[Connect]

[Communicate]

[Reflect]

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3. CREATIONS Demonstrators (Sub-page 3)

3.1 What are the CREATIONS demonstrators?

The CREATIONS Demonstrators are principally a set of guidelines for Facilitators to follow and implement in their own educational scenario. By engaging with the CREATIONS features we hope to demonstrate how any potential Facilitator can take advantage of existing initiatives and research infrastructures. Table 1 below breaks down for you how the CREATIONS features are connected with the Responsible Research and Innovation (RRI) process and the IBSE Cycle resulting in what we consider to become an effective learning environment the Facilitator would strive for to ensure high quality learning occurs.

CREATIONS Pedagogical Framework		IBSE	
CREATIONS features	**RRI aspects**	**Essential features of IBSE**	**Effective learning environments**
• Dialogue • Interdisciplinarity • Individual, collaborative and communal activities for change • Balance and navigation • Empowerment and agency • Risk, immersion and play • Possibilities • Ethics and Trusteeship	• Governance • Public engagement • Gender equality • Science education • Open access/open science • Ethics • Sustainability • Social justice/inclusion	• QUESTION • EVIDENCE • ANALYSE • EXPLAIN • CONNECT • COMMUNICATE • REFLECT	• Communities of practice • Simulations • Arts-based • Dialogic Space / argumentation • Experimentation (Science laboratories and eScience applications) • Visits to research centres (virtual/physical) • Communication of scientific ideas to audience

Table 1: How to create an effective learning environment as developed by NKUA

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The Demonstrators Framework was created from various existing good practice IBSE initiatives. This is a suggested planning framework and a further planning resource can be found here (link please also see Appendix 6)

Demonstrator's structure	
1. Introduction or Demonstrator Identity	• Author • Subject domain • Type of activity • Duration • Setting (formal/informal learning) • Effective learning Environment
2. Rationale of the Activity/ Educational Approach	• Challenge (Description of the problem) • Added Value (Elaboration on the applied creative approaches and their purpose)
3. Learning Objectives	• Domain specific objectives • General skills objectives
4. Demonstrator characteristics and Needs of Students	• Aim of the demonstrator (which issues it explores) • Student needs addressed (e.g. acquire more in-depth knowledge, interaction with researchers, get first hand info, develop social, collaboration skills, experience scientific inquiry, etc.)
5. Learning Activities and Effective Learning Environments (ELE)	Explained based on the CREATIONS features, RRI, IBSE principles and Effective Learning Environments (ELE)
6. Additional Information	Class organisation and Management (e.g. assignment of roles/responsibilities, etc.)
7. Assessment	The Methodology that should be used in order to evaluate and assess the activities (e.g. questionnaires, videos, interviews, focus groups)
8. Possible Extension	After the implementation and the assessment of the activity a report should be conducted to recommend possible modifications as well as possible extensions of the activity (e.g. to integrate other activities or combine with other demonstrators).

Table 2: Demonstrators generic framework as developed by NKUA

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4. Professional Development for Creative Science Education (Sub-page 4)

How do you think about excellence in creative science teaching?

Here at CREATIONS we carried out a survey to find out what science education professionals and scientists thought about creativity in science, and what professional development would help them teach for creativity. Along with the literature review and workshop activities, the survey has helped us to develop a shared vision of excellence in creative science teaching, with key features identified – see section 2 for more information [link to D2.1 subpage]. For those interested in the detailed data analysis and findings please look at the deliverable report D2.4 [available here].

What professional development do Facilitators need?

Many survey participants valued the creative nature of science in science education, but also recognised the restraints. This was often about knowing how to teach it, fit it into the curriculum, and find time and resources. To help develop the CREATIONS vision and put it in to practice, our results show that we need high-impact professional development in teaching for creativity in science and in dialogic pedagogy.

We found that teachers had often been involved in learning about inquiry-based science education (IBSE) and using technology, but that learning about teaching for creativity in science and/or in dialogic pedagogies was much less common. Both Primary and Secondary teachers felt this; although Primary teachers said they had fewer training opportunities. We think that additional science teacher education in teaching for creativity and dialogic pedagogy would help teachers put their ideas about creativity in science into practice. Please have a look at the CREATIONS Demonstrators [Framework available here][examples available here], as they are also useful resources to help teacher educators achieve this.

Another challenge we identified for teacher educators is making sure that professional development does have high impact – our survey showed that professional development for teaching for creativity did not always have a strong impact on practice.

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What does good professional development look like?

Teachers told us that a high quality learning environment is crucial. They are looking for:

- Opportunities to participate in courses (either face to face or through online study)
- Evidence-based teaching suggestions
- A non-judgemental and supportive learning environment so that they feel able to take risks and try out new ideas
- Autonomy over their learning, with individualised learning that allows for self-direction
- The chances to network with peers, collaborate, reflect on and share good practice.

At CREATIONS, we aim to engage with teachers by providing a suite of resource materials [demonstrators and our workshop activities/toolkit links]. These materials will enable you to explore teaching for creativity in your lessons with support and independence. Good professional development also includes opportunities for educators to network with peers, collaborate, reflect on and share good practice. In this way, teacher *agency and empowerment*, and *individual, collaborative and communal activity for change* [key CREATIONS features – link] are embedded in the professional development process as well as in the CREATIONS pedagogy itself. To support professional development, we welcome Facilitators and teacher educators to join the CREATIONS discussion forum [link here]. Previous projects and the wider literature have all identified that participating in Action Research, Lesson Study or Study Groups can all be highly effective ways of engaging teachers in developing professional practice. Some resources to support these approaches with examples of how they have been used in previous EU projects into IBSE and Creativity are shown in link - Appendix 5 of this deliverable [link here].

Suggestions for Teacher Educators

How can you help teachers engage students with creativity in science? The CREATIONS Features [link], Demonstrators [link] and Framework [link], are all useful resources to support teacher educators in doing this. We also identified [Deliverables link] some suggestions for planning training provision that might use and share the CREATIONS vision for creativity in science education. These include:

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- Include explicit teaching for creativity in science in their courses
- Openly address different conceptions of creativity inside and outside science
- Consider how teaching knowledge and teaching for creativity can be mutually supportive– some ideas from cognitive science are helpful here [links to further reading and resources].
- Modelling good practice in generating scientific questions
- Enable new teachers to access creative pedagogies through experience and modelling
- Help make links between disciplines (see the *interdisciplinarity* feature) by exploring and using different vocabularies and terminologies
- Make links with other University and School departments for interdisciplinary projects
- Offer support with assessment of student outcomes of creative pedagogies [Link also see appendix 5] for some suggestions from previous projects that might be useful.
- Facilitating new teacher networking and reflection (e.g. In the UK, #ASEChat and #UKEdChat on Twitter).

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5. CREATIONS Resources (Sub-page 5)

This section contains links and resources for further information to support you in your understanding of the CREATIONS toolkit. We have also sourced additional reading for those that are interested in challenging their understanding further.

Practical resources available to download to assist you in your planning

- Workshop plan for creativity definition
- CREATIONS Wheel
- CREATIONS Honeycombs

Links to other projects for stimulus and inspiration

- Imagineerium productions http://www.imagineerproductions.co.uk/content/6604/home/home
- Lab 13 http://www.ignitefutures.org.uk
- Fun Palaces http://funpalaces.co.uk
- Junior Science Café http://portal.opendiscoveryspace.eu/community/junior-science-cafes-780508
- Write a Science Opera (WASO) http://www.reseo.org/project/write-science-opera
- art@CMS http://artcms.web.cern.ch
- Science Theatre http://www.opendiscoveryspace.eu/community/science-theater-774520
- Student Parliaments http://www.student-parliaments.eu/

Social media

- Twitter [link]
- Facebook [link]

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Further reading

- Biesta, G. (2004) "Mind the Gap!" Communication and the Educational Relation. Counterpoints, 259, 11–22. Available here:http://www.jstor.org/stable/42978490?seq=1#page_scan_tab_contents
- Biesta, G. (2016) The Rediscovery of Teaching: On robot vacuum cleaners, non-egological education and the limits of the hermeneutical world view, Educational Philosophy and Theory, 48:4, 374-392. Availablehere: http://www.tandfonline.com/doi/pdf/10.1080/00131857.2015.1041442
- Craft, A. (2012) Childhood in a digital age: creative challenges for educational futures. London Review of Education, 10(2) pp. 173–190. Available here: http://oro.open.ac.uk/37518/
- Craft, A. (2012) Possibility thinking. Available here: http://www.open.ac.uk/creet/main/sites/www.open.ac.uk.creet.main/files/06%20Possibility%20Thinking.pdf
- Craft, A. (2013) Childhood, possibility thinking and wise, humanising educational futures. International Journal of Educational Research, 61 pp. 126–134. Available here: http://oro.open.ac.uk/37519/3/8908FA06.pdf
- Cremin, T; Glauert, E; Craft, A; Compton, A and Styliandou , F (2015) Creative little scientists: exploring pedagogical synergies between inquiry-based and creative approaches in Early Years science.Education 3-13, 43(4) pp. 404–419. Availablehere: http://oro.open.ac.uk/42510/
- McWilliam, E. (2012) 'Unlearning how to teach': https://www.youtube.com/watch?v=7b9e8Pvo46A.
- NRC (2000) Inquiry and the National Science Education Standards A Guide for Teaching and Learning Available here: http://www.nap.edu/read/9596/chapter/2#7
- Rocard, M. (2007) Science Education Now: A renewed pedagogy for the future of Europe. Available here: http://ec.europa.eu/research/science-society/document_library/pdf_06/report-rocard-on-science-education_en.pdf
- Salna, L. (2012) Creativity as a 21st Century Skill: Training Teachers to take it beyond the Arts. Creative Studies Graduate Student Master's Projects. Paper 158. Available here: http://digitalcommons.buffalostate.edu/cgi/viewcontent.cgi?article=1167&context=creativeprojects

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6. References

Chappell, K. & Craft, A. (2011) Creative learning conversations: producing living dialogic spaces, Educational Research, 53:3, 363-385

Chappell, K., Craft, A., Rolfe, L., Jobbins, V. (2012). Humanising Creativity: valuing our journeys of becoming. International Journal of Education and the Arts, 13:8, 1-35. Available from: http://www.ijea.org/v13n8/

Chappell, K., Hetherington, L., Slade, C., Ruck Keene, H. and Cukurova, M. (2016) D2.1 The features of inquiry learning: theory, research and practice

Craft, A. (2015) Possibility thinking: from what is to what might be, Chapter 13 Wegerif, R., Li, L. and Kaufman, J. C. (2015) The Routledge International Handbook of Research on teaching and thinking

Craft, A. (2001) 'Little c Creativity' in Craft, A., Jeffrey, B., Leibling, M., Creativity in Education, London: Continuum (45 – 61)

Craft, A. (2011), Creativity and Educational Futures. Stoke on Trent: Trentham Books

Craft, A., Chappell, K. and Slade, C. (2014) D2.1 CREAT-IT Pedagogical Framework

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7. Appendices

List of appendices

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Appendix 1 Creativity definition workshop process

CREATIONS: Creativity definition workshop

This activity draws on the idea of the workshop creating a living dialogic space via creative learning conversations in which all participants are listened to and have a voice.[1] *This approach has been used in order to model the kind of facilitation and pedagogy that the CREATIONS project itself is aiming to encourage.*

Aim: to facilitate thinking about and documenting:

How does the CREATIONS definition (below) apply to your science education practice and/or the CREATIONS demonstrator you are using?

"Purposive and imaginative activity generating outcomes that are original and valuable in relation to the learner. This occurs through critical reasoning using the available evidence to generate ideas, explanations and strategies as an individual or community, whilst acknowledging the role of risk and emotions in interdisciplinary contexts".

What is creativity in science education?

Firstly print off and cut out the following list of definition elements onto separate slips of paper (approx. 2 cm's wide). You might also want to have some blank slips available to add your own elements:

Elements separated out on slips of paper are:

[1] Chappell, K., & Craft, A. (2011) Creative learning conversations: producing living dialogic spaces. *Educational Research.* 53(3) pp. 363–385.

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Purposive and imaginative activity

Outcomes that are original and valuable in relation to the learner

Critical reasoning

Using evidence to generate ideas, explanations and strategies

Individual and community

Acknowledging the role of risk and emotion

Interdisciplinary contexts

Producing plausible explanations and strategies consistent with the available evidence

Either on your own or with a group of colleagues interested in creativity in science education, rank or arrange the key elements that make up the CREATIONS definition of creativity in science education *in a formation in relation to your practice and/or Demonstrator*. Which elements of the definition can you recognise? Which can't you find? What examples of different parts of the definition can you think of? How might you or might you not develop your practice to respond to this?

Here are some examples of ways in which Facilitators have responded to this task previously.

Some preferred to work from 'scratch' and create their own definitions with words and mind maps

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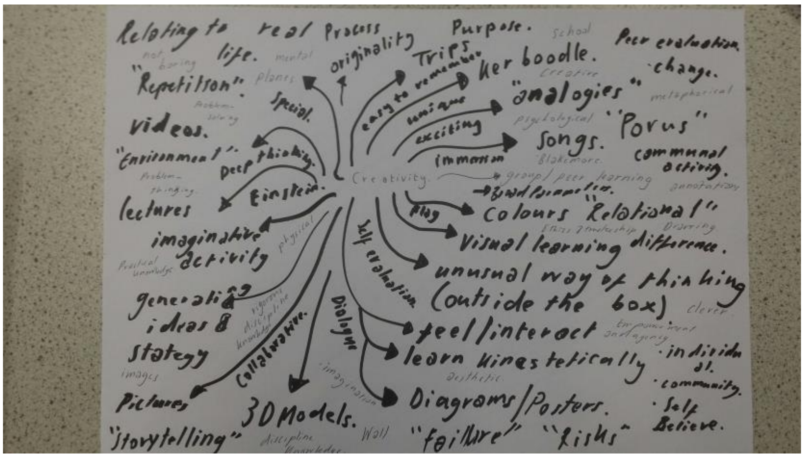
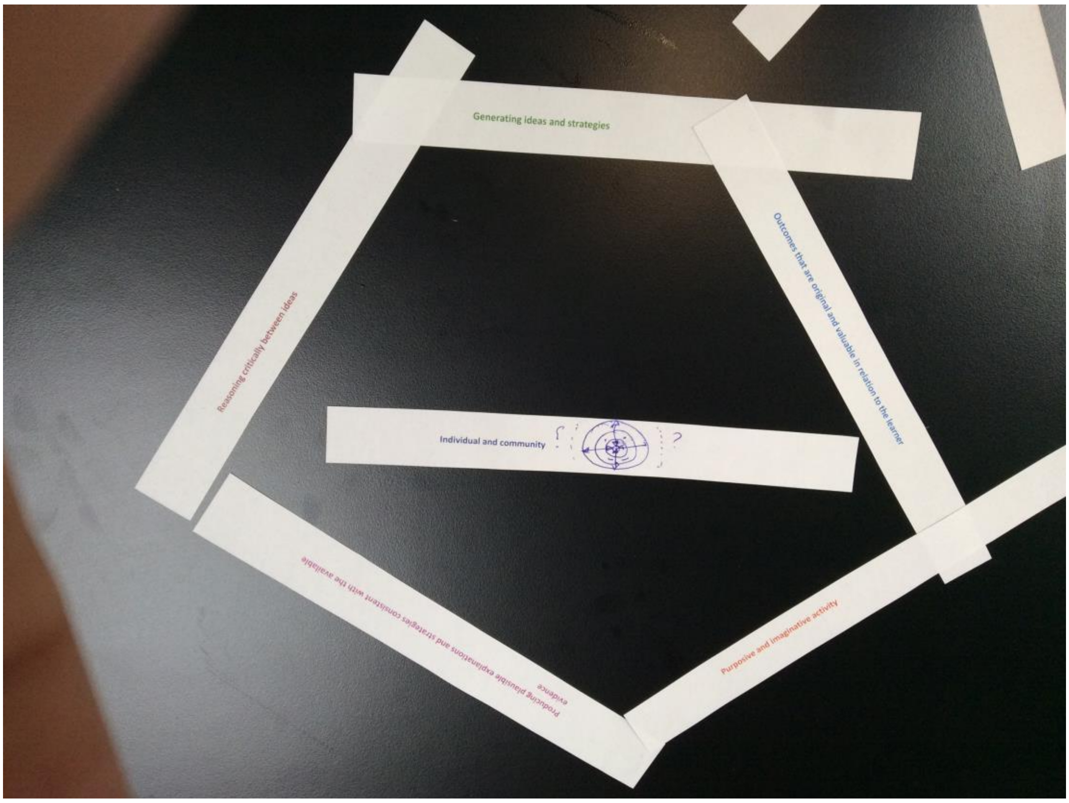
ACTIVITY TWO: DEFINITIONS	Amendments to the definition	Differences of opinion
	Participators did not like the idea that a lot of jargon was used in the definition. They preferred to start from an empty page than a ready-made definition. Participators commented that the definition we were given is driven by curriculum and this itself is restrictive, i.e. the opposite of creativity.	Creative work must be: 1. relational (to cater for the individual person) 2. porous (the in/out school boundaries need to be blurred, cross thinking must be allowed) 3. realistic and connect to the real world of teaching 4. engaging and open 5. valuable (allow freedom of choice and expression) 6. inspirational (make contact with students on an emotional level) 7. To allow for mistakes and be given time to flourish 8. To not be expected to reach a final destination and not be judged/measured for its impact The above list is not a ranking order. All 8 points are equally important. Creativity in science education: Finding new ways of developing both understanding and the spirit of enquiry.



Other participants did not want to rank the statements and created shapes that reflected their belief that it is part of a whole rather than a hierarchy.



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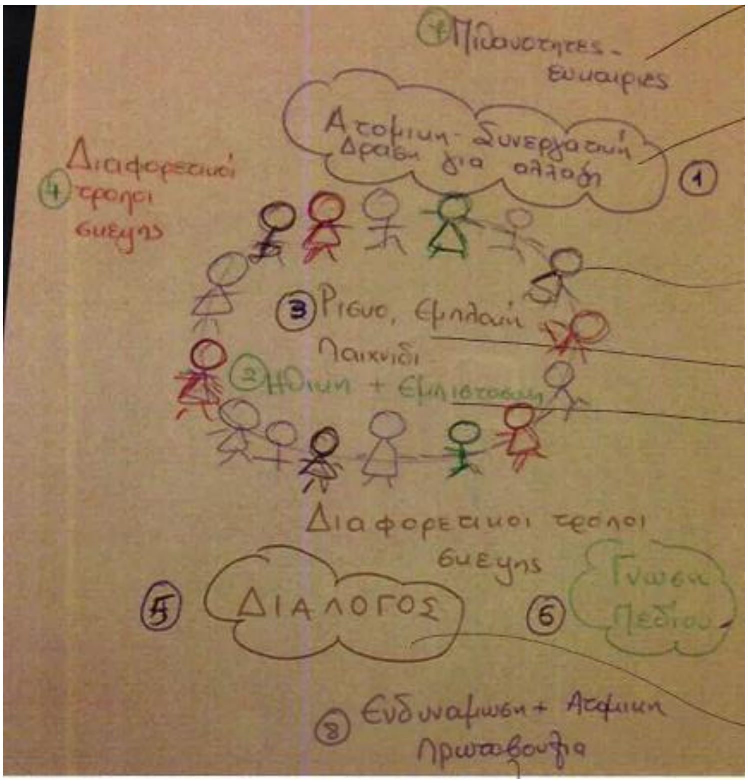
And some participants preferred to create their definitions with images.



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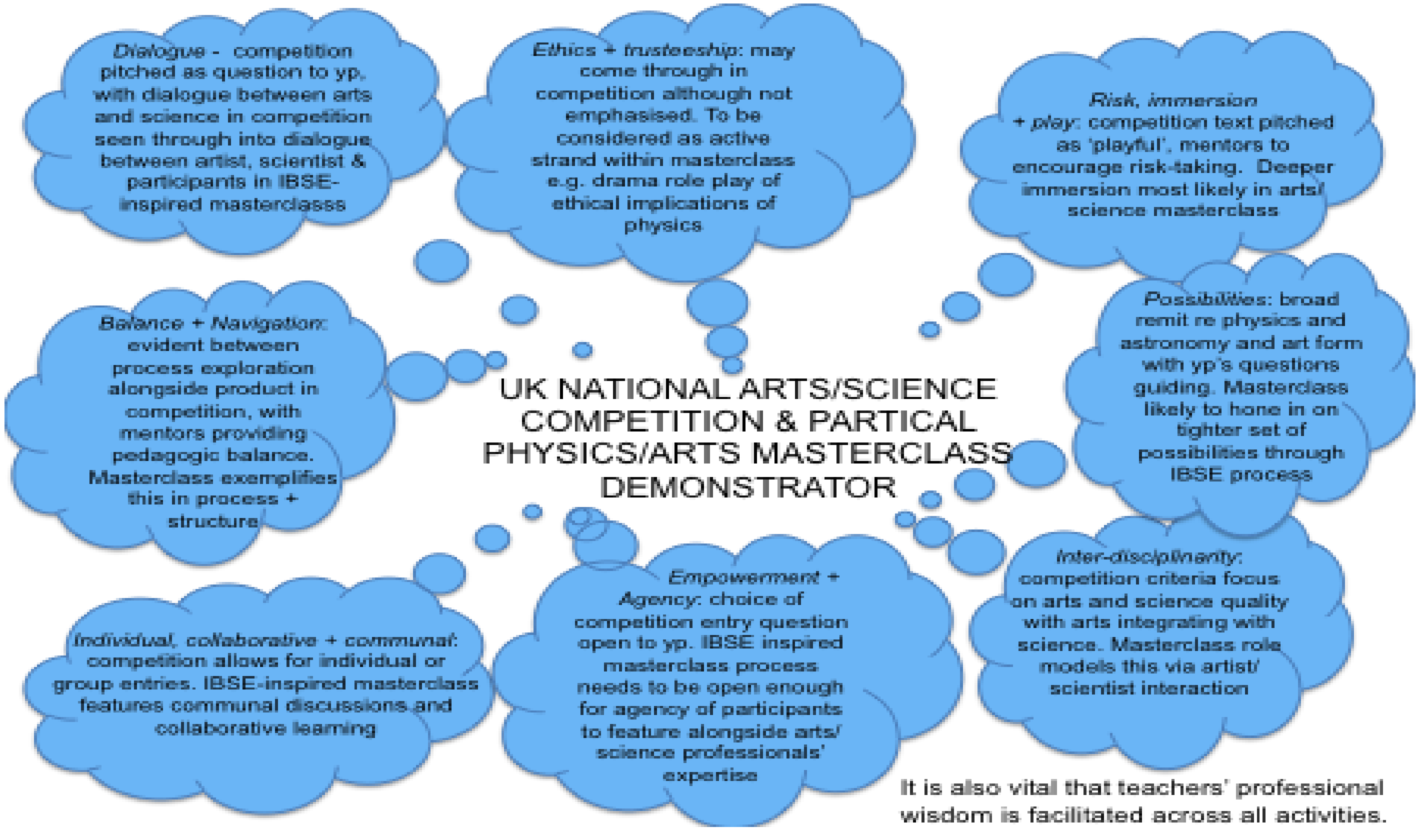
Appendix 2 Example Cloudsheet



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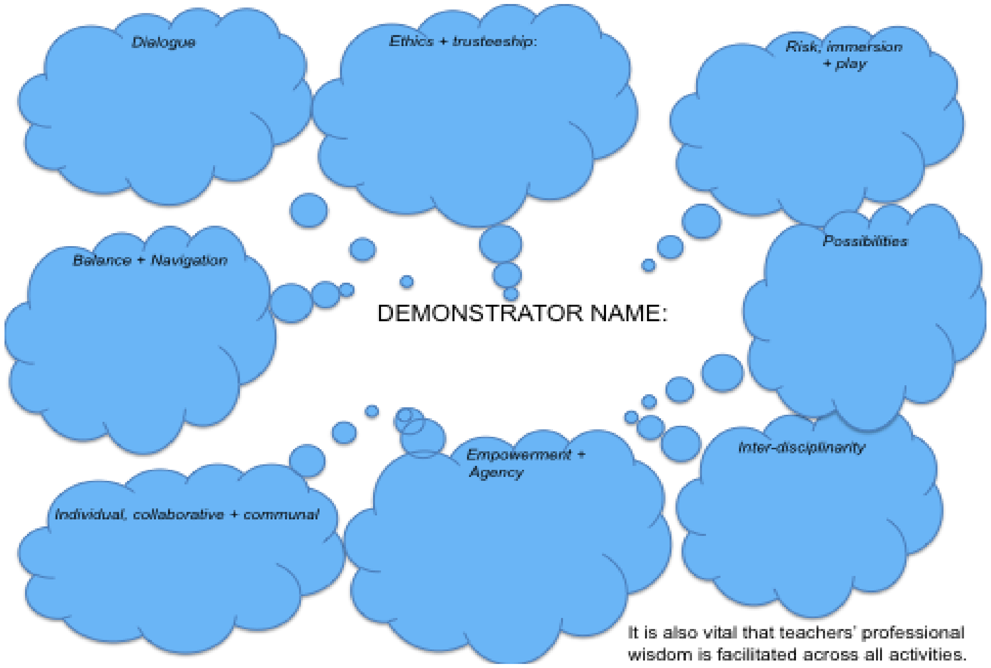
Appendix 3 Blank Cloudsheet



CREATIONs features cloud. For further information please contact UoE CREATIONs team: k.a.chappell@exeter.ac.uk

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Appendix 4 Examples of arts/science projects

How can we incorporate the Arts into our science teaching?

We believe that the integration of the Arts and Sciences can be generative and engaging for both children and young people as well as their teachers and community. There are many projects that already use this approach of involving the local community.

The Imagineer project is a creative company that specialise in creative and celebrating work that combines imagination, creativity, and engineering.

http://www.imagineerproductions.co.uk/content/6604/home/home

Figure 10: The Imagineer project

The Fun Palaces believe in the genius of everyone, that everyone is an artist and everyone is a scientists and that creativity in the community can change the world for the better

http://funpalaces.co.uk

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Figure 11: Fun Palaces

Write a Science Opera (WASO) is a specific methodology for creating science-informed original performances in schools. This creative professional development approach to inquiry-based music and science education allows children of different ages, to create an educational performance as they are supported by their teachers, opera artists and scientists.

http://prosjektsider.hsh.no/waso/

Figure 12: Write a Science Opera (WASO)

(ART@CMS) is an education and outreach initiative of the CMS experiment at CERN that seeks to act as an inspiring springboard for engaging the public in general, and youth in particular, in the excitement of scientific research in High Energy Physics (HEP). It thus aims to promote a long-lasting dialogue between the

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LHC scientific community, the art world and educational communities for a greater appreciation and understanding of particle physics research and its contribution to education and society.

http://artcms.web.cern.ch/artcms/

Figure 13: Art@CMS

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Appendix 5 Resources for Teacher Professional Development

CREAT-IT Project Website link http://www.creatit-project.eu

Open Discovery Space Portal link http://www.opendiscoveryspace.eu/

PRIMAS Project Website link – guide for professional development providers. http://www.primas-project.eu/artikel/en/1300/professional-development/view.do

PATHWAY Website link – Resources for IBSE. http://pathway.ea.gr/pathway-resources

SAILS Website link - Resources to support assessment of inquiry learning. http://www.sails-project.eu/portal

Guidance for Teachers doing Lesson Study. http://lessonstudy.co.uk

Guidance for Teachers doing Action Research. http://www.jeanmcniff.com/ar-booklet.asp

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Appendix 6 Suggested planning tables developed by NKUA

<table>
<tr>
<td>Science topic:

(Relevance to national curriculum)

Class information

Year Group:

Age range:

Sex: both

Pupil Ability: e.g. (The scenario allows space for pupils of various abilities to participate)</td>
<td colspan="2">Materials and Resources

What do you need? (e.g. printed questionnaires, téléconférence, etc.)

Where will the learning take place? On site or off site? In several spaces? (e.g. science laboratory, drama space etc.), or one?

Health and Safety implications?

Technology?

Teacher support?</td>
</tr>
<tr>
<td colspan="3">Prior pupil knowledge</td>
</tr>
<tr>
<td colspan="3">Individual session project objectives (What do you want pupils to know and understand by the end of the lesson?)

During this scenario, students will</td>
</tr>
<tr>
<td>Assessment</td>
<td>Differentiation

How can the activities be adapted to the needs of individual pupils?</td>
<td>Key Concepts and Terminology

Science terminology:</td>
</tr>
</table>

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		Artsterminology:

Session Objectives:

During this scenario, students will

Learning activities in terms of CREATIONS Approach

IBSE Activity	**Interaction with CREATIONS Features**	**Student**	**Teacher**	**Potential arts activity**
Phase 1: **QUESTION:** students investigate a scientifically oriented question	Students pose, select, or are given a scientifically oriented question to investigate. *Balance and navigation* through *dialogue* aids teachers and students in creatively navigating educational tensions, including between open and structured approaches to IBSE. Questions may arise through *dialogue* between students' scientific knowledge and the scientific knowledge of professional scientists and science educators, or through *dialogue* with different ways of knowledge inspired by *interdisciplinarity* and personal, embodied learning. *Ethics and trusteeship* is an important consideration in experimental	E.g. Engage with teacher's questions. Watch videos and use the web to explore evolution.	E.g. Will use challenging questions and the web (images, videos) to attract the students' interest in ….	

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	design and collaborative work, as well as in the initial choice of question.			
Phase 2: **EVIDENCE:** students give priority to evidence	Students determine or are guided to evidence/data, which may come from *individual, collaborative and communal activity* such as practical work, or from sources such as data from professional scientific activity or from other contexts. *Risk, immersion and play* is crucial in *empowering* pupils to generate, question and discuss evidence.			
Phase 3: **ANALYSE:** students analyse evidence	Students analyse evidence, using *dialogue* with each other and the teacher to support their developing understanding.			
Phase 4: **EXPLAIN:** students formulate an explanation based on evidence	Students use evidence they have generated and analysed to consider *possibilities* for explanations that are original to them. They use argumentation and *dialogue* to decide on the relative merits of the explanations they formulate, *playing* with ideas.	.		
Phase 5: **CONNECT:** students connect explanations to	Students connect their explanations with scientific knowledge, using *different ways of thinking and knowing* ('knowing that', 'knowing how', and 'knowing this') to relate their ideas to both disciplinary knowledge		.	

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scientific knowledge	and to *interdisciplinary* knowledge to understand the origin of their ideas and reflect on the strength of their evidence and explanations in relation to the original question.			
Phase 6: **COMMUNICATE:** students communicate and justify explanation	Communication of *possibilities*, ideas and justifications through *dialogue* with other students, with science educators, and with professional scientists offer students the chance to test their new thinking and experience and be *immersed* in a key part of the scientific process. Such communication is crucial to an *ethical* approach to working scientifically.			
Phase 7: **REFLECT:** students reflect on the inquiry process and their learning	*Individual, collaborative and community-based* reflective *activity for change* both consolidates learning and enables students and teachers to balance educational tensions such as that between open-ended inquiry learning and the curriculum and assessment requirements of education.			

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Appendix 7 CREATIONS Honeycombs developed by University of Exeter

QUESTION

Children and young people investigate a scientifically oriented question

Questions children and young people might ask:

I/we want to know why...? I/we wonder…. What do I/we want to find out? What do I/we want to know? What if...? What if I/we knew...? What would change if...? What would happen if… Who, What, Where, When and Why? Why does...?

What art form is most helpful here to provoke questions?

Is there something about movement, sound or visuals that could help to share the question?

Questions for teachers to support enquiry:

Do you think that….? How might you explain…? In your opinion what would happen if…? What differences and similarities do you see between….? Can you predict what would happen if…? Do you know any theories to explain…

What are forces? What is a centrifugal force? Can you see forces?

Dialogue

Interdisciplinarity

Possibilities

Balance and navigation

How fast can I move? How fast can I dance? Are they the same speeds or different?

Dialogue

Possibilities

We want to know why sparklers burn really quickly, but metal doesn't set on fire. What makes some reactions happen faster than others?

Dialogue

Possibilities

Interdisciplinarity

How can you amalgamate the arts at this stage?

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EVIDENCE

Children and young people give priority to evidence

Questions children and young people might ask:

How can we explore? What do I/we notice? What do I/we see? What is happening

What art form is most helpful here to collect evidence?

How can your chosen art form help you see your evidence differently e.g. imagination and storytelling

Questions for teachers to support enquiry:

What do you observe? Can you describe what is happening? How will you find out? What will you change? What can you measure? What variables are affecting what is happening? What have other people said about this? What would be good evidence?

By dropping drops of paint onto a paper plate, I am going to spin the paper plate and see what happens?

Ethics and trusteeship

Empowerment and agency

Risk, immersion and play

Create a motif, mark out a distance with a start and finish point, perform the motif along a straight pathway, time how long it takes to perform the motif, work out the speed i.e. Speed = distance / time?

Interdisciplinarity

How can we explore how fast things burn? We can see that powdered iron burns really fast if we sprinkle it through a flame, but we can't set light to metals? Does the size of the piece of metal make a difference to other kinds of reactions?

Dialogue

Possibilities

Interdisciplinarity

How can a different art form reveal your evidence in a different way?

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ANALYSE

Children and young people analyse evidence

Questions children and young people might ask:

I/we notice that… Was I/were we expecting this? When we changed____, _____ happened... Why did nothing happen? Why did this happen that way? Why is it that way?

How can your chosen art form help with your analysis

Questions for teachers to support enquiry:

What patterns can you see in the data? Can we look at the data differently (perhaps using a graph or chart)? What makes you say that? Why do you think that is? Can you give an example of where… that happens? …This might happen? Can you explain how you worked that out? Is there another explanation?

How can you accommodate the arts at this stage?

What happens to your body if you spin fast, slow, stop and go?

Risk, immersion and play

Dialogue

Possibilities

How fast did I travel? What happens if I change the movements? What happens if I change the pathway? What happens if I change the dynamic I am performing in?

Dialogue

Interdisciplinarity

Balance and navigation

Possibilities

We can see that the powder catches light more easily than the lump if we always use the same amount. When we changed the size of the piece it got easier to light

Dialogue

Possibilities

Interdisciplinarity

How can you combine your analysis with creativity at this stage?

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EXPLAIN

Children and young people formulate an explanation based on evidence

Questions children and young people might ask:

What? When? Who? Where? How? Why?

How can dance, visual art, film, poetry, drama or music bring your explanation alive?

How can your art form help you to share your explanation with an audience?

Questions for teachers to support enquiry:

Can you explain what you have discovered using ideas you already have about science? Is there anything you can't explain? Have you seen anything similar happen before? What / Where is the evidence that supports your suggestion? If someone asked you a question about this, what might their question be?

When I spun the plate faster, why did the paint move further out from the centre of the circle?

Dialogue

Balance and navigation

Why did some actions / dynamics / pathways result in different times? What is the optimum action, dynamic, pathway I can travel along the quickest?

Dialogue

Interdisciplinarity

Possibilities

When it burns, what is the reaction? What is happening to make it react? If particles of metal and oxygen have to combine, how is that happening? So if they have to collide, why does the smaller pieces mean it reacts faster?

Dialogue

Interdisciplinarity

How can I demonstrate these results with sound, visuals or movement?

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CONNECT

Children and young people connect explanations to scientific knowledge

Questions children and young people might ask:

How can I/we extend my thinking now I know this? How is this connected to what I/we already know? What challenges / questions does this now raise in me/us?

How can your arts-assisted explanations connect to the right scientific knowledge?

Can you use the arts to enhance your explanation at this stage?

Questions for teachers to support enquiry:

How is that / this connected to your previous learning? What made you think of that? Where did that idea come from? Is that a direct cause of the effect or is it just a coincidence, a correlation? How much did you know about... before starting your investigation?

I knew I could spin something fast and slow but I didn't realise what would happen

Empowerment and agency

Possibilities

I knew I could move fast and now I know the actual speed I move at.

Empowerment and agency

Can we connect this to the idea of particles getting rearranged in a reaction? We wonder whether there is a link to things getting hotter?

Possibilities

Interdisciplinarity

How can you connect your scientific knowledge to your life and experiences?

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COMMUNICATE

children and young people communicate and justify explanation

Questions children and young people might ask:

How will I/we share this? What do I/we need to do to explain this to other people? What's going on here? Why do I/we think this has happened?

How can I use a specific art form to present my ideas to a new audience?

How can you harmonize your science and arts knowledge here?

Questions for teachers to support enquiry:

How will you share your results with others? How will you explain this to other people? What is the best way to share what you now know about this? Does this work tell a story?

I will display the art work I created

Ethics and trusteeship

Interdisciplinarity

Empowerment and agency

I will create a dance linking my results together so I can present my findings

Ethics and trusteeship

Interdisciplinarity

Empowerment and agency

I will create a photo collage capturing each material burning

Ethics and trusteeship

Interdisciplinarity

Empowerment and agency

How can you creatively integrate the arts at this stage?

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REFLECT

Children and young people reflect on the inquiry process and their learning

Questions children and young people might ask:

What does this make me/us wonder now? What isn't explained? What new reasons does my/our claim raise? What would it be like if…? How would it be different if…? Suppose that ... What would change if...?

Can I use an artistic medium (a film, a drama dialogue) to share my reflections and questions?

Can you creatively integrate your reflections with the arts?

Questions for teachers to support enquiry:

Did you discover what you set out to investigate? What did you learn about yourself as you worked on this piece? What would you change if you had a chance to do this piece over again? What's the one thing that you have seen in your peers work or process that you would like to try in your next investigation?

What would happen if…….. I spin my plate anti clockwise or clockwise?

Dialogue

Interdisiplinarity

Possibilities

Balance and navigation

What would happen if…. ... my friend performs the motif I created?

Dialogue

Interdisiplinarity

Possibilities

Balance and navigation

What would happen if…if we heat a reaction up? I still don't know why I couldn't get the lump of iron to light.

Dialogue

Interdisiplinarity

Possibilities

Balance and navigation

Can you integrate the arts at this stage to enhance your reflection?

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