Lifelong Learning Programme

ENGAGING PARENTS AS FACILITATORS OF CHILDREN'S LEARNING IN SCIENCE: MATERIALS FOR TRAINING AND DESIGN OF FAMILY WORKSHOPS

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FORWARD

The EU-funded FEAST consortium seeks to support adult engagement in science and technology. Specifically, FEAST aims to enhance the role that adults play when, as parents and carers, they support their children's engagement with science and technology in informal science institutions such as museums and science centres.

The consortium is coordinated by Ecsite, the European network of science centres and museums, and involves seven other partners from the Czech Republic, Italy, Sweden, Slovenia, the United Kingdom and the Netherlands. Five of the partners are internationally respected informal science institutions with considerable practical experience in developing inspiring exhibitions and innovative educational programmes for their visitors.

The following materials were developed to assist museum educators who wish to further develop their ability to support parents and carers in their role as educators of their children.

These materials stem from the work conducted by the consortium in two years of research and experimentation and incorporate the reflections emerging from the many discussions amongst the partners as part of the preparation for the FEAST international training course.

SUMMARY

Parents and carers are key in supporting their children's understanding of, and engagement in, science. By supporting parents we can help them to mediate their children's learning, but also to acquire new knowledge, skills and attitudes to enhance their own participation as scientifically literate citizens in a science and technology-rich society.

Research tells us that families come to informal learning institutions for a variety of reasons. Whilst there, families share personal stories, practice new vocabulary and build a common understanding of their shared experience. Many adults also actively support their children's learning with exhibits and programmes by offering encouragement, promoting hands-on engagement and providing explanations. But many adults appear to lack confidence in providing explicit support and instead are observed to stand back and leave any facilitation to the institution's educators. The reasons for this include fears about their own scientific knowledge, their lack of belief in their facilitation skills, and their limited understanding of the value of play and the nature of inquiry.

Science museums and science centres can facilitate parent involvement by providing explicit guidance and support. They can help parents to understand and reflect upon the key role that they play in supporting their children's learning. They can help parents to engage with their children in the inquiry process of asking questions, reflecting on prior knowledge, predicting outcomes and developing explanations for phenomena. Parents can also be taught simple facilitation techniques of asking open-ended questions and 'wh' questions (what?, why? where?). Parents and children can also be encouraged to engage in collaborative investigations and thereafter engage in their own personalised learning journeys which are in keeping with the family's particular needs and interests.
In addition to sharing their facilitation expertise, science museums and science centres can build on parent's prior learning and experiences to deepen their science content knowledge. With greater confidence in their understanding of science, parents are likely to feel more able to discuss scientific issues and scientific ways of working with their children. Institutions can also provide activities and materials for families to do back at home thus promoting the continuation of science-rich conversations.

Finally, science museums and science centres can foster adult engagement with children by reconsidering the design of their programmes and activities. They should ensure that the furniture and equipment is suitable for all ages; activities should comprise varying levels of complexity to meet the needs of varied ages and interests; and educators should use language that is appropriate for both adults and children.

The five FEAST workshops presented in this document utilise many of these approaches. Together, they may be considered to constitute the full repertoire of good practice for facilitating adult engagement with children in science. They comprise a valuable resource of tried and tested activities and are described here in ways which will allow other institutions to adopt and adapt them and also, we hope, develop their own activities which continue to promote the aims of FEAST.

STRUCTURE OF THE DOCUMENT

Chapter 1 introduces the theoretical basis underpinning our work in exploring how cultural institutions can further facilitate child learning by supporting parents and carers in taking on the role of educators. It reflects on the part played by parents in supporting child learning, and on the different type of mediation that parents may enact. It also offers insights on how institutions can foster the involvement of parents.

Chapter 2 consists of two practical checklists:

- A methodology checklist summarising the FEAST rationale. This list represents a useful reflection tool and is also pertinent to those who wish to disseminate and advocate the idea that science centres and museums can support parents to successfully adopt the role of science educators for their own children.
- An observation/reflection checklist that can be easily printed and used as a tool for self-evaluation for those who will develop and conduct new activities and workshops.

Chapter 3 presents the five workshops developed and tested by FEAST partner science centres and museums covering the following topic areas:
1. Floating and Sinking; 2. Mechanics and Vehicles; 3. Sound; 4. Astronomy; 5. Robotics.
Subchapters describe the rationale behind each workshop, highlighting some of the specific practical solutions developed to support parents in their educational role. These rationales will also help explainers and educators to reflect on how the methodological recommendations listed in chapter 2 may be practically implemented.
To help those who might wish to replicate the workshops, the document includes a brief description of the workshops together with practical tips and on-line links to detailed activity descriptions, materials and possible workshop re-adaptations for different institutional contexts.

Appendix A presents a commented literature review on methodologies for parent education.
In this document, key methodological aspects of a number of studies are discussed in detail in order to highlight how previous work has contributed in the development of a common methodology for FEAST workshops.
Key papers are individually commented, drawing attention to their methodological insights in terms of conceptualisations of engagement levels or advice on design of programmes. The methodological implications arising for FEAST workshops are then explicitly highlighted.

Appendix B provides a full set of references for all research reports and other publications cited.

1 PARENTS' ENGAGEMENT IN SCIENCE LEARNING: LITERATURE REVIEW

WHY FOCUS ON PARENTS?

Parents and carers are key in supporting their children's understanding of and engagement in science. By supporting parents we can help them to mediate their children's learning, but also acquire new knowledge, skills and attitudes to enhance their own participation as scientifically literate citizens in a science and technology-rich society.

THE ROLE OF FAMILIES IN CHILDREN'S LEARNING

Research shows that families actively work to build a common understanding of their experience in a museum or science centre: they share personal stories; they practice new vocabulary (Ash, 2003; McManus, 1989). Visits also affirm particular family values (Moussouri, 1997). A parent's involvement in his or her child's learning depends on how they view their own knowledge and mediation skills, and the extent to which they are encouraged to become involved (Hoover-Dempsey and Sandler, 1997).

Different parental roles are adopted at different times or in different settings. However, two broad types characterise the two ends of the spectrum: that of leaving the teaching of children to an educator, and thus standing back; and that of being integrally involved in their child's education.

In museum settings, parents have been found to adopt one of three positions: a neutral stance (standing back and observing); a neutral stance occasionally interrupted by bouts of modelling or easing an interaction; or a supervisory stance where they regulate or terminate play by comments such as 'we can't spend all our time here' (Wood and Wolf, 2010).

In a further study exploring parents' beliefs about learning, and in particular the value of play, researchers found that less than one sixth viewed play as a conduit for learning. Many parents were also found to lack confidence in knowing how best to play with their children (Downey, Krantz and Skidmore, 2010).

However, findings from the above studies notwithstanding, it is important that when reflecting on parental involvement in our own informal settings we do not judge behaviour too soon, or too adversely. As Wood and Wolf (2010: 48) conclude:

'When a parent stands back, or appears not to be interacting in the exhibition setting, it should not necessarily be interpreted as non-engagement, nor can the parent be seen as unprepared or unable to interact. It is indeed possible that family learning is still taking place, but understanding the motivation and choice of the parent can provide new directions for the design and development of exhibitions or individual elements.'

FORMS OF PARENT MEDIATION

Whilst many parents may be reticent in their support of learning, those that do take a more active role are cognizant of their actions. In other words, parents are accurate at describing the ways they support their children's learning. For example, Swartz and Crowley (2004) found that when asked about their behaviours parents noted that they observed their children (and did not interact with them); they encouraged them (but gave no specific support); they directed their children in the manipulation of exhibits, and gave instructions; they described key pieces of evidence within the exhibit; and finally, and offering the highest level of support, parents explained to their children by making connections including causal or analogical connections between the exhibit and other aspects of a child's experience.

Swartz and Crowley (2004) have characterised five different types of parent approaches to facilitation in a museum thus:

- A focus on fun – parents primarily allow their children to play.
- Individual discovery – parents emphasise the importance of letting their children take the lead.
- Back to basics – parents focus on helping their children learn the basic skills and vocabulary.
- Learning together – parents see themselves as guides of their children's learning.
- Explanations everywhere – parents use explanations to help their children reflect upon their experiences and make connections to the wider world.

Of these types, research suggests that the use of explanatory conversations are most effective in supporting children's learning (Tare *et al.*, 2011).
A further study found that children of mothers who used open-ended 'wh' type questions (such as what, where and why?) would recall more information about their experience than children whose parents used limited questions (Benjamin, Haden and Wilkerson, 2010). These researchers also advise that parental reminiscing of a shared experience when back at home will help to fix the event securely in the child's mind.

Other researchers have found that parental support declines with increasing content knowledge on the part of the child. In other words, parents of 'novice' children support their children's engagement with new content, while parents of 'expert' children simply test existing knowledge and do not stretch their learning further (Palmquist and Crowley, 2007). Clearly this raises the question of how best to support parents and children who are already knowledgeable in a particular domain.

WHAT CAN INFORMAL SCIENCE INSTITUTIONS DO TO SUPPORT PARENT INVOLVEMENT?

Institutions can offer explicit support and guidance to parents. For example, children who were guided by parents who had watched an instructional video were found to engage more in high-level exploratory behaviour than those children whose parents had not watched the video (van Schijndel *et al.*, 2010). A workshop designed for family groups visiting the Exploratorium in which parents and children were helped to develop their own questions, experiments and explanations was also found to be effective in enabling families' subsequent engagement at the exhibits (Allen and Gutwill, 2009).

Institutions can also share their own expertise in supporting inquiry-based learning. In the context of museum and science centres, inquiry describes an approach to learning driven by a visitor's own curiosity, wonder or passion to understand an observation or solve a problem. To support inquiry experiences, educators encourage visitors to reflect on their observations, generate new questions, experiment, and to interpret their data.

To help parents in their efforts to facilitate inquiry, educators are advised to model and share the following inquiry-based facilitation techniques:

- Use open-ended questions that encourage detailed observation, practical investigation and reflective thinking.
- Suggest new aspects of the phenomenon to observe and try to encourage further experimentation and thinking.
- Listen carefully to a child's ideas, comments and questions and engage in dialogue to consider possible answers.
- Appreciate that dialogue and debate are useful tools for assessing the validity of ideas and for encouraging critical reflection.

- Consider any misconceptions (these are useful for pinpointing any difficulties in comprehension) and share alternative ideas and pieces of information that serve to contradict and challenge the learner's original premise.
- Encourage and promote learners to take more and more responsibility for their investigations so that they come to 'own' the inquiry experience.

In addition to supporting parents to adopt particular skills to foster inquiry, practical considerations need to be addressed. In the context of exhibit design, for example, Borun *et al.* (1997) call for exhibits to be:

- Multi-sided so that a family can cluster around an exhibit.
- Multi-user so that several sets of hands can comfortably access and engage at the same time.
- Multi-outcome so that the interaction can be complex or simple but still enable group discussion.
- Multi-modal to appeal to differing levels of knowledge and varying engagement styles.
- Easily readable with text arranged in easy to understand segments.
- Relevant, with explicit links to visitors' existing knowledge and experience.

A similar set of guidelines can be imagined to inform the design of educational programmes.
Activities should thus:

- Be located in enough space, and with appropriately sized furniture to allow all the family to participate.
- Have multiple outcomes so that the level of engagement can be complex or simple but still enable group discussion.
- Be facilitated by clear instructions for both adult and child participants.
- Make links to visitors' existing knowledge and experience.

FINAL WORDS

To support adult engagement with science, and in turn their facilitation of their children's learning, we need to acknowledge that adults come to an informal learning institution with a variety of motivations and perspectives.

Their motivation may be shaped in part by their family's specific interests, by a general desire to learn 'something', or simply by the desire for a day out. Their perspectives on how they may support their children's engagement with science and technology will depend on how they view their role as a parent, and on how they perceive their own self-efficacy in the subject matter and facilitation skills.

A variety of approaches may be adopted to promote and foster parental engagement. These include reviewing the design of the educational programme so that it is welcoming to all, ensuring that parents understand the purpose and value of their role as educators and actively promoting the skills of inquiry-based pedagogy.

In choosing to visit a museum or science centre as a family, parents clearly wish to have an experience that benefits their children in some way. In describing visitor behaviour, researchers agree that, in general, parents make conscious decisions about what their child is interested in and the level of content with which he or she can best cope. In short, parents for the most part mediate the experience as best as they can. It is YOUR role to support and enhance this mediation.

2 FEAST METHODOLOGY & PRACTICAL OBSERVATION CHECKLISTS

This chapter consists of two practical checklists that explainers and educators are free to print and use to support their everyday work and reflection:

Feast methodology checklist
This list summarises the FEAST methodology.
It represents a useful tool to support reflection on how to practically help parents to successfully adopt the role of science educators for their own children.
When developing workshops for adults with their children, FEAST results suggest that workshop designers and facilitators keep in mind these recommendations.
Moreover, Chapter 4 – comprising the description of tested FEAST workshops – refers to this list, presenting a number of workshop design choices that exemplify the practical adoption of these recommendations.

FEAST practical observation and self-reflection checklist
This table can be easily printed and used as a tool for self-evaluation for those who will develop and conduct new activities and workshops.
It can be used for planning and monitoring the effectiveness of family workshops.
The questions and reflections are based on the methodology checklist and on established good practice relating to teaching and learning in informal settings (Bell *et al.*, 2009; King *et al.*, 2007)

FEAST METHODOLOGY CHECKLIST

1 Help parents understand the key role that they play in supporting their children's learning.
Openly acknowledge that parents are uniquely knowledgeable about their children's interests and abilities, and that they already consciously or unconsciously act to support their children's learning.

2 Help parents reflect on their role as mediators.
Make sure that parents understand the purpose of their own engagement and are thus complicit in developing their facilitation skills.

3 Equip parents with skills to enhance their own and their children's engagement with the topic.
Help parents engage with their children in the inquiry process by encouraging them to: make observations; pose questions; assess sources of information; reflect on their own prior knowledge; plan investigations; gather, analyse, and interpret data; propose explanations and predictions. Provide them with explicit instructions about other key facilitation techniques, such as asking open questions and 'wh' questions (what?, where?, why?).

4 Enhance the interest of parents and their knowledge of the subject matter.
Provide parents with content information and/or new abilities to support their own personal learning: improving an adult's knowledge and skills will equip them with the confidence and competence to support their children's learning. Workshops should include varying levels of content information and complexity so as to satisfy the different learning requirements of adults and children.

5 Support collaboration between parent and child.
Design activities and spaces to enable and encourage active engagement of both children and adults. Be sensitive and keep in mind that every individual is different and that family dynamics can vary: react accordingly to different situations.

6 Encourage activities in which each member of the family finds his/her own role.
Help parents find a balance between active and supportive roles (observing, inspiring, discussing, explaining, etc) by encouraging parents either to join in with an activity and/or leave more space for their child.

7 Use parents' and children's already-existing knowledge as the starting point for investigations.
Value the insights that wrong answers and misconceptions can provide. Mistakes and confusions can be used as a resource to explore the reasons why some answers are better than others. Push thinking beyond existing limits. Imagination, emotions, and personal opinions are also useful tools to build common and personal understanding.

8 Support engagement in the processes of inquiry and research.
Encourage participants to take up the role of 'researcher' in their own right, pursuing a personalised learning journey that supports open-ended experiences with individual, non-standardised results. The priority of the workshop activities is not to 'teach' the subject knowledge related to the topic but rather to engage participants with the process of learning.

9 Encourage hands on experimentation and conversation.
Experimentation and conversation tend to support teamwork and make it easier for family members (including parents) to find a suitable collaborative role. Conversation can also serve to prompt exploration, enhance the skills of negotiation and support the consolidation of ideas and choices.

10 Strengthen learning by linking it to family life.
Think about how families might continue conversations and activities at home. Openly suggest ways to reinforce the (hopefully!) positive family dynamics built during workshops.

FEAST PRACTICAL OBSERVATION AND SELF-REFLECTION CHECKLIST

ASK YOURSELF/THINK ABOUT:	YOUR NOTES:
How does the activity start: • what input/introduction is provided (if any)? • how are participants accommodated in the workshop space?	
How does the 'scaffolding' provided by the workshop leader develop during the activity?	
What type(s) of role does the workshop expect of parents?	
Which types of facilitation skills are explicitly shared with parents?	
Are the principles of inquiry-based learning shared or modelled by the workshop leader?	
What strategies are used to invite and encourage parent engagement and support active collaboration and dialogue between parents and children?	
Understanding of broader contextual issues: • how do parents respond to boys and to girls? • how do parents respond to children who are subject experts?	
What questions does the facilitator ask?	
What is the role of the facilitator? • in managing error or frustration • in encouraging further experimentation/ exploration of alternatives/new solutions etc. • in providing subject knowledge • in reflecting on what happened	

What is at the centre of the group's attention? (and when? how much?)

- the experiment/task/process
- the child
- the parent
- the facilitator
- the final goal

Does the workshop enable/encourage

- play and experimentation?
- active collaborative engagement? (of both children and adults)

Are parents observed using their new facilitation and inquiry skills? In what ways?

Do parents and children demonstrate new understanding of science content?

Are other aspects of learning (non-content, non-skill focussed) supported by the workshop ie:

- development of imagination
- emotional development
- appreciation of aesthetics
- sensory stimulation

Is there space for change of plans during the activity?
For deviation?
For improvisation?

If yes, what do these depend on?

How does the activity end?

- what is the focus of the wrap-up? (subject-knowledge, outcome, emotions, fun, participation, etc.)
- what aspects of the activity are discussed?
- is there any part devoted to 'what we take home'?

What are the strongest aspects of the workshop?
What are the weakest aspects?

3 FEAST WORKSHOPS: DESCRIPTIONS AND RATIONALE

The FEAST workshops aspire to empower parents as facilitators of their children's learning in science, equipping them with skills that go beyond the museum visit. At the same time, they are developed with the objective to build specific tools and methodologies that can help museum explainers enrich and strengthen their work with family audiences.

Acknowledging the role played by families is key to understanding how young people engage (or not) with science. For example, a parent's own feeling about science and their level of involvement with science-oriented issues can affect their child's attitude to science.
Creating the conditions so that parents feel competent, confident and aware both of the value of science and of the importance of their own role in shaping young people's view has been the challenge for the FEAST project. The workshops below were all developed with this scenery in mind.

The five workshops differ in their approach and format, but they are all built upon an understanding of learning, facilitation and the nature of interaction within families.

This chapter gives an overview of each workshop's rationale and practical approach. It presents the activities in such a way that they may be adopted and adapted for use by other informal science institutions. Most importantly, it highlights the key methodological recommendations identified by FEAST (see FEAST methodology checklist in chapter 2).

For each workshop you will find:
- A brief overview of the activities in the workshop.
- Key methodological principles guiding workshop rationale and practice.
- Things to consider when choosing to run this workshop.
- Links on where to find full detailed descriptions and associated workshop materials.

WS.1

TALKING ABOUT SCIENCE: FLOATING AND SINKING

Developed by Science Center NEMO, Amsterdam, the Netherlands

BRIEF OVERVIEW OF THE ACTIVITIES IN THE WORKSHOP

In this workshop parent and child explore the phenomena of 'floating and sinking', working together as a team. The activities are based on common misconceptions about floating and sinking.
First parents attend a theoretical introduction about science learning while the children participate in an entertaining demonstration in a separate space.
Parents and children then join together to participate in a science quiz to predict whether objects will sink or float in ten different situations. What at first glance may seem simple soon turns out to be intriguing and challenging not only for children, but for parents too.
Each family chooses three out of the ten situations and is able to test and refine their initial answers through direct experimentation. The activity is structured around a four-step approach: predict, explain, experiment and reflect. Adults and children specifically refer to this model by using a template notebook.
The workshop is concluded with reflections on the most surprising things learnt and with an explainer-led demonstration on Archimedes' Principle. Knowledge of this natural law and the experiments will help parents and children to continue their investigations at home.

KEY METHODOLOGICAL PRINCIPLES GUIDING WORKSHOP RATIONALE AND PRACTICE

Enhance the interest of parents and their knowledge of the subject matter.

- The topic chosen aims to be attractive for children and at the same time sufficiently challenging for parents. The workshop is based on misconceptions (which adults also possess) on phenomena associated with floating and sinking. What at first glance may seem simple, turns out to be interesting to investigate and to think about for parents too.
- During the science quiz parents are 'forced' to predict if a block sinks or floats in a certain situation. This activity stimulates them to think about the phenomenon themselves. For a short moment they step out of their role of facilitator of the child's learning and concentrate on their own knowledge and learning. The quiz is not about identifying who knows the most, but more a way to make misconceptions explicit.

Help parents understand the key role that they play in supporting their children's learning.

- Prior to the workshop, parents receive a theoretical introduction about science learning. It is highlighted that nearly everyone thinks or knows something about scientific and technical subjects. We gain this knowledge by experience and via theoretical information. To really understand how something works, one must integrate new information with the knowledge already held. Combining new information and existing knowledge is a difficult process that does not happen all by itself, - it requires effort. Children need help with this from a teacher or parent.

Equip parents with skills to enhance their own and their children's engagement with the topic.

- The workshop focuses on the inquiry learning skills of predict, explain, experiment and reflect. Within the context of the theoretical presentation about science learning, these four skills are introduced to the parents prior to the workshop.
- During the workshop itself the explainer reminds the parents about these four skills and about what they, as a parent, can do to support their child's learning in each of the steps.
- The workshop is designed so as to help parents and their children to express their knowledge from previous experiences (non-verbal knowledge) in words. Parents and children who are not used to talking about science together can experience and practice the ways in which developing an explanation serves to integrate new information and existing knowledge.

Support collaboration between parent and child.

- Parent and child work together as a team. This ensures that the parent can give his/her full attention to the child.
- For each step (part of the workshop), the role of the parent is made clear. In this way parental engagement is explicitly encouraged during the workshop.
- The 'explain' part of the workshop stimulates parents to be aware of the child's perspective while conducting the experiments together later on.
- Allowing children and parents to choose their three favourite experiments provides them with the space to follow their own particular interests and questions.

THINGS TO CONSIDER WHEN CHOOSING TO RUN THIS WORKSHOP

- Notify parents in advance (by email, in the museum or website) on the purpose of this workshop in order to ensure that the expectation of the parent matches the offer of the workshop.
- This workshop is more focussed on developed thinking and talking skills than it is on addressing the science underlying floating and sinking.
- Make sure that parents and children feel safe enough to make mistakes. The quiz is not about right and wrong. Rather it is a way to find out what they already know about floating and sinking. Be sure to take in the quiz forms of the parent to avoid parents and children comparing their answers, which may upset the children.
- Through predicting, explaining and experimenting parent and child begin a thought process. We do not expect them, at the end of the workshop, to understand everything about the phenomenon. Instead we hope that both adults and children will have the interest and the thinking skills to continue exploring science phenomena together at home.
- The demonstration at the end of the workshop ensures that all the thinking and experimenting of children and parents is summarized in a conclusion at the end of the workshop in a satisfactory way. The demonstration should be light, fun and entertaining.

DETAILED DESCRIPTIONS AND ASSOCIATED WORKSHOP MATERIALS:

http://feastportal.wordpress.com/results/

WS.2

VEHICLES THAT ROLL: MECHANICS

Developed by Teknikens Hus, Luleå, Sweden

BRIEF OVERVIEW OF THE ACTIVITIES IN THE WORKSHOP

In this workshop children and parents try to solve a challenge together: 'build a gravity car and test it on an inclined plane'.
First parents are introduced to the workshop, and are given an explicit focus on the problem solving method and on how to work together with their children in this process: Challenge → Construct → Test → Rebuild → Test again → Reflect and Share. At the same time, in a separate room, children are given an introduction to the materials available and begin to experiment with building.
Then families come together using different materials to invent and build a vehicle. In so doing they will inevitably grapple with Newton´s laws of motion, even if they do not know they are! They test their vehicle on the inclined plane and they reflect and share their findings. If they want they can move on and try to improve their vehicle by, for example, adding an engine.
Next, the parents and children work again in different rooms: children finish their vehicle and decorate it if they want while parents are introduced to some of the science concepts behind this workshop including Newton's laws of motion.
The last phase involves the whole group in a discussion to share results and findings.

KEY METHODOLOGICAL PRINCIPLES GUIDING WORKSHOP RATIONALE AND PRACTICE

Support engagement in the processes of inquiry and research.

- The workshop activities are based on a challenge, but they are open ended so there is no predetermined way to solve the task. As the child and parent are asked to work on their project they engage in collaborative learning: they have fun and discover things together by practically solving problems, building, testing and improving.

Enhance the interest of parents and their knowledge of the subject matter.

- The separate sessions in which parents are introduced to both the problem solving method and specific science concepts gives them the opportunity to deepen their personal knowledge and facilitation techniques.

Equip parents with skills to enhance their own and their children's engagement with the topic.

- Explainers guide the discussion and create motivation and conversation by asking reflective and constructive questions. They model good conversation practice and research by asking questions such as "What if…", "Can you…", "How…".

Encourage hands on experimentation and conversation.

- The reflection moment at the end of the workshop gives children and parents the opportunity to see different kinds of solutions and to talk about the related science as well as to become more aware of their process of learning collaboratively.

Strengthen learning by linking it to family life.

- The scientific content provided to parents helps them to continue thinking about and explore the topic at home.
- Families are provided with kits and materials to take away. This encourages further learning and exploration in the more familiar home context.

THINGS TO CONSIDER WHEN CHOOSING TO RUN THIS WORKSHOP

- The workshop requires quite a lot of material. It is important that the explainers are familiar with this material.
- To be able to use reflective and constructive questioning, the explainers should be familiar with building the vehicles themselves.
- There are some safety rules that the explainers must explain to the participants:
  - Always use goggles when working with propellers and motors.
  - Be cautious when using hot melt adhesive.

DETAILED DESCRIPTIONS AND ASSOCIATED WORKSHOP MATERIALS:
http://feastportal.wordpress.com/results/

WS.3

AERONAUTIC SPACE AREA PRACTICE: SPACE

Developed by Techmania Science Center, Plzen, Czech Republic

BRIEF OVERVIEW OF THE ACTIVITIES IN THE WORKSHOP

The basis of this astronomy workshop for parents and children is to accomplish the mission of a flight from Earth to the moon of another planet.
At the beginning of the workshop parents and children work separately. While parents complete a half-hour theoretical introduction and familiarization with the programme of the workshop itself, the children are engaged in 'astronaut training', engaging in physical and reaction-time exercises. This training starts their imagination and prepares them for what will happen next.
In the subsequent phases parents and children work together as an astronomy team working on task of the mission. They use a telescope to find their planet; they build a spacesuit; they build a rocket and launch it; they land on the planet´s moon; and finally, they take pictures of the moon´s surface with view of the planet in the background.

KEY METHODOLOGICAL PRINCIPLES GUIDING WORKSHOP RATIONALE AND PRACTICE

Strengthen learning by linking it to family life.

- The narrative context of the mission stimulates the imagination of both parents and children. The topic of space is appealing for both age groups and may already be part of family experience from books, films, school exercises etc. This familiarity and appeal of the subject has the potential of stimulating further conversation and research activity at home.
- The narrative and the reference to imagination helps to motivate children and keep their attention. Using stories might be a suggestion for parents on how to introduce other science activities at home.
- All the products developed by the adult-child pair during the workshop may be taken home. Thus families may improve their creations or build new and better ones.

Equip parents with skills to enhance their own and their children's engagement with the topic.

- The initial half-hour theoretical introduction to parents ensures that they are aware of the active role they are asked to play and helps them to feel empowered to lead the activities with confidence.
- Parents are given informative material (to take home) about the science behind the tasks contained in the workshop. This empowers them to engage in further explanation and exploration with their children.
- At all times the explainer describes procedures via PowerPoint presentations with additional information, and provides materials and stays close to help or advise, thus modelling good facilitation and acting as a reassuring figure for parents.

Support collaboration between parent and child.

- Parents and children are asked to carry out the hands-on tasks together. The workshop is designed so that parent and child are treated similarly and act as equal partners.

Encourage work in which each member of the family finds his/her own role.

- The narrative context sets some specific roles: the explainer is the narrator, the parent is the head of the mission and child is the astronaut. This also helps define teaching/learning roles within this imaginative frame.
- One of the activities sees parents decorating space suits for their children and children decorating hats for their parents. This activity allows parents and children to work on a similar task but on different objects, without interfering with each other. Moreover, the exchange of the results creates a collaborative atmosphere.

THINGS TO CONSIDER WHEN CHOOSING TO RUN THIS WORKSHOP

- The workshop requires time and preparation. It is important that the explainers are familiar with the story and practicalities of the 'mission' before workshop.
- The telescopes indicated in the recommended websites are quite cheap and provide the possibility of showing how lenses work. Other types of telescopes can be used.
- It is important to note that using the telescope to look directly at the Sun is potentially dangerous.
- Consider time to familiarise with the Stellarium program, which is needed for printing pictures of the planets.

DETAILED DESCRIPTIONS AND ASSOCIATED WORKSHOP MATERIALS:

http://feastportal.wordpress.com/results/

WS.4

MOBILE PARENTS MEETING: SOUND

Developed by Hiša eksperimentov, Ljubljana, Slovenia

BRIEF OVERVIEW OF THE ACTIVITIES IN THE WORKSHOP

This workshop consists of 2 separate sessions, taking place one week apart.
The chosen topic is sound and its properties, but the same structure could be applied to a different topic.
During the first session, parents meet at the Science Centre and interact with a number of sound exhibits. Experts and exhibit designers are available to offer insights on the topic of sound. Parents then participate in a workshop to build some simple sound exhibits around the same subject.
During the second session, parents visit the Science Centre with their children. First they enjoy the science show "Soundology". Parents are then encouraged to take up the role of explainers and lead their children in interacting with the exhibits.

KEY METHODOLOGICAL PRINCIPLES GUIDING WORKSHOP RATIONALE AND PRACTICE

Help parents understand the key role that they play in supporting their children's learning.

- In the second session, parents take up the role of facilitators. Being familiar with the exhibits, the topic and the experiments they can truly and confidently guide their children through the workshop. Parents learn how important it is to take an active part in their children's education by actively doing so at the science centre.

Enhance the interest of parents and their knowledge of the subject matter.

- In the first session, parents explore the exhibits without their children, gaining deeper understanding of the topic. By dedicating time to their own learning and by taking the opportunity to develop adult conversations with their peers, with exhibit designers and with explainers the adults gain greater knowledge and understanding.
- Parents also receive a practical guide including instructions on how to build simple experiments at home, which stimulates them to explore the subject further.

Equip parents with skills to enhance their own and their children's engagement with the topic.

- Parents consolidate the acquired knowledge thanks to the science show called Soundology.
- Parents also gain additional communication skills by presenting exhibits to their children.

Strengthen learning by linking it to family life.

- After the exhibit exploration, parents are invited to build simple experiments and they are provided with more information on the topic of sound, comparing science centre situations with everyday life through the experiments and knowledge they gained.
- Parents can be recruited through school-based activities. Thus they take part in what could be a structured formal meeting (for example, a parents' evening with teachers) in an informal environment. This model creates connections between formal and informal learning institutions, reinforcing through collaboration the educational network that supports parents in the intellectual upbringing of their children.

THINGS TO CONSIDER WHEN CHOOSING TO RUN THIS WORKSHOP

- Having sound-based exhibits already in existence clearly facilitates this activity, but it is possible to build simple exhibits to illustrate the main learning points.
- Offering a science show/theatre can be very effective if staff are appropriately trained. But alternative approaches to introduce the topic in an emotionally-engaging way are of course available.
- If hosting parent-teacher meetings in the institution is not already the norm, consider how to recruit and involve parents in attending the two meetings.

DETAILED DESCRIPTIONS AND ASSOCIATED WORKSHOP MATERIALS:

http://feastportal.wordpress.com/results/

WS.5

A ROBOT IN THE FAMILY: ROBOTICS

Developed by National Museum of Science and Technology Leonardo da Vinci, Milan, Italy

BRIEF OVERVIEW OF THE ACTIVITIES IN THE WORKSHOP

This workshop takes the theme of robotics as a stimulus for encouraging collaborative work between adults (parents) and children. It aims to shape basic knowledge of robotics through a practical building and programming experience.
The workshop starts with a group discussion on the idea of robot and with a demonstration of the importance of basic, clear programming instructions.
Family groups are thus asked to use specifically-designed software and LEGO kits to build a robot able to move along a set path as fast as possible.
The explainer gives the group an overview of the basic software commands so that all participating family groups can work autonomously on their own robot and pc. Once robots are ready the race starts; the fastest and most efficient robot wins.
Two different races (with different levels of complexity) have been developed for families with children between 7-9 and 9-11. During the last part of the activity the groups analyse and compare the way they undertook the task.

KEY METHODOLOGICAL PRINCIPLES GUIDING WORKSHOP RATIONALE AND PRACTICE

Support collaboration between parent and child.

- The choice of an unfamiliar (yet attractive) topic for both parents and children helps to start the activities with adults and children having a similar level of knowledge. This encourages adult-child interactions that are new to family routines, in contrast to the typical parental role of 'expert'.
- Parents and children are invited to form a team to participate in the competition. Explainers make sure that the competition does not create frustration, and instead use it as an element that fosters emotional engagement, and creates a sense of ownership amongst participants of both their efforts and their final robot.

Encourage work in which each member of the family finds his/her own role.

- Explainers lead parents to feel comfortable in the role of co-learners. This is done by suggesting that they 'play along' with their children, and be open to accepting suggestions from them. Anyhow, the activity leads parents to spontaneously take up the educator role when it comes to using logic and refined building skills. Their more mature adult competences are key to the success of the workshop.

Strengthen learning by linking it to family life.

- The choice of a theme related to current research and high technology can sound challenging but it also allows families to relate to everyday news in newspapers, on television etc. This may enhance dialogue and the emergence of "scientific conversations".

Use parents' and children's already-existing knowledge as the starting point for investigations.

- To solve the proposed challenges and to face this partly unknown realm, families can draw on their previous knowledge. The activity is profoundly interdisciplinary, which ensures that each member of the family can refer to his/her own interests and knowledge.

THINGS TO CONSIDER WHEN CHOOSING TO RUN THIS WORKSHOP

- The workshop requires the use of NXT Mindstorms LEGO kits and PCs.
- Explainers wishing to use the Lego software and robots must allocate time for self training. The software is quite intuitive but the more the explainers are familiar with it the more they will be able to help families to learn to use it and find personalised solutions.
- You will need one LEGO kit for each family group (from 2 to 4 individuals). You will need to have 1 explainer for every 3 groups when working on the more complex challenge, and a ration of 1: 5 when working on the more simple challenge.

DETAILED DESCRIPTIONS AND ASSOCIATED WORKSHOP MATERIALS:

http://feastportal.wordpress.com/results/

APPENDIX

A

LITERATURE REVIEW ON METHODOLOGIES FOR PARENT EDUCATION

1. ANALYSING PARENT ACTIONS AND BELIEFS

Downey, S., Krantz. A & Skidmore, E. (2010). The parental role in children's museums. *Museum & Social Issues.* 5:1, 15 – 34.

The study by Downey *et al.* (2010) offers FEAST partners and others a methodological framework for examining parental roles and perceptions, either before or after their participation in the FEAST programme. In particular, it focuses on gauging parents' understanding of the role of play as a way of enhancing children's (and their own) engagement with science content.

The study, conducted at the Please Touch Museum, Philadelphia employed three methods of data collection:

- Questionnaire (to 409 adults leaving the museum)
- In-depth interviews (with 73 adults leaving the museum)
- Timing and tracking observations of 168 children aged 3–10 as they engaged with exhibits.

The analysis involved the researchers scoring responses to the in-depth interview on a four-level continuum. Parents who explicitly understood the role of play in learning scored highly. Parent who did not see the connection between play and learning were given a low score. The researchers were looking for instances in which the parents described their views as:

- Play being about fun and enjoyment
- Play being about enrichment
- Play being about skill-building
- Play being about learning

As part of the questionnaire, parents were asked to rank a series of statements. The results are as follows, with the highly ranked statements first:

I most value play at the Please Touch Museum because it:

- Provides opportunities for the children I'm with to have fun
- Enhances the imagination of the children I'm with
- Contributes to the healthy brain development of the children I'm with

- Enhances the abilities of the children I'm with to solve problems creatively
- Contributes to the social and emotional well being of the children I'm with
- Enhances the confidence of the children I'm with
- Provides opportunities for the children I'm with to be active and burn energy
- Contributes to the academic achievement of the children I'm with.

The parents also ranked their role from the following six statements, with the first being the highest ranked:

My role at Please Touch Museum is to:

- Play and have fun alongside the children I'm with
- Allow the children I'm with to direct / guide activities and play
- Facilitate the play of the children I'm with
- Learn alongside the children I'm with
- Supervise the behaviour of the children I'm with
- Give the children I'm with the freedom to play without adult intervention

Measuring the ranking of such statements provided the researchers with the opportunity to gauge how this relatively large sample of visitors understood learning, the value of play, and the role of accompanying adults.

From their observations at the Please Touch Museum, Downey *et al.* found that most adult-child interactions were 'hands-off' and supervisory, instructional or disciplinary in nature. Only one third of adults played with their children and less than one in ten knelt down to their child's level to play.

Their conclusions from Downey *et al.*'s study are that most parents lack a clear understanding of the learning benefits of play. They may assert that they value play, yet they do not engage in or facilitate play with their children. The authors suggest that many parents lack confidence in and knowledge of how to play with their children.

Clearly, the findings from this study raise questions about how best to help parents to appreciate and engage in playful activities. Further, they point to whether the physical design of the activity discourages parental involvement or not.

Implications for FEAST workshop design:

- Workshop leaders need to explain the value of play/active engagement on the part of parents for helping children to play, engage and learn.
- Workshop leaders need to model play / active engagement and support parents to do the same.
- Workshops need to be physically designed to enable play / active engagement of both adults and children.

2. UNDERSTANDING UNDERLYING VIEWS HELD BY PARENTS

Wood, E. & Wolf, B. (2010). When parents stand back is family learning still possible? *Museums & Social Issues*, 5:1, 35-50

In this discussion paper examining data from a series of evaluations on parent roles in family learning experiences at The Children's Museum, Indianapolis, Wood and Wolf offer valuable insights into why parents may behave as they do. The researchers examined 13 different studies representing 8000 observations of 400 families. In their analysis, they found that parents may not behave in the way that museums would like them to – they stand back rather than interact or collaboratively problem solve. In seeking to explain this behaviour, Wood and Wolf suggest that

'the parent preference to step back reveals an awareness of the exhibition design and content centred around hands-on learning activities, a perception of learning in the space, and the opportunity to "let them [children] figure it out".' (page 42)

In examining the data set and parents' responses to various questions, the researchers were able to collate a list of reasons for their standing back:

- Don't want to interrupt their child's experience.
- Don't want to take space from another child.
- Need a respite from playing with their child.
- Somewhat uncomfortable with playing in public.
- Like to socialise with another adult.

More positively, however, the researchers noted that some parents were often proactive in helping their children to avoid frustration, and in providing corrective interventions that led to continued play on the part of the child.

Implications for FEAST workshop design:

- It may be necessary to explicitly invite parents to join in with an activity and explain that they will not be interfering, or taking the space of another child.
- It may be necessary to allow parents to talk together (rather than only in family groups) so that adults can interact at an adult level also.

3. THE IMPORTANCE OF PARENTS IN SUPPORTING CHILDREN'S INTERESTS

Zimmerman, H.T., Perin, S. & Bell. P. (2010). Parents, Science and Interest. The role of parents in the development of youth interests. *Museum & Social Issues*. 5:1 67-86

This paper highlights the social supports needed to pique and maintain interest for youth around science. Zimmerman et al. note that children's interests are facilitated by friends, peers and parents. For young children parents play a particularly significant role in influencing interest. Furthermore, the authors note that parents have a knowledge and understanding of their children's provisional interests and experiences and thus 'parents can act as bridges from youths' prior experiences to their developing STEM expertise' (page 70 – 71).

In order to understand how families experience a museum/science centre visit, and how any interests may be piqued or developed, the researchers studied 15 families, all of whom were regular visitors to the Pacific Science Center. They conducted pre-visit and post-visit interviews with the families using open-ended questions in a conversational style to gauge each family's prior experiences with science and something of their typical routines on a science centre visit. They also filmed the family during the course of their visit and then examined their spoken interactions.

From this, Zimmerman *et al.* found that:

- Parents support existing interests through gestures and conversation that connect interests to exhibits
- Parents make observations and read museum signage.
- Families use storytelling, jokes and analogies to transfer their understanding across different domains of knowledge.
- Families readily use knowledge from pop culture, literature and other everyday experiences to make strategic learning connections.

However, in discussing their data and their findings, Zimmerman *et al.* note that even parents who had a scientific background sometimes struggled to develop proper explanations and connections for science. Thus they conclude that informal science settings need to provide suggestions to adults about how best to successfully support youth in exhibits.

Implications for FEAST workshop design:

- Parents know their children's interests and enact particular social practices that support their children. Such practices need to be recognised, accepted and supported where possible.
- Zimmerman *et al.* promote the funnel metaphor (developed by Schauble and Bartlett, 1997) as a way of facilitating interest development. Thus it is recommended that experiences [workshops / exhibits] should 'narrow' from general interest and focus in on increasing opportunities for specialised, detailed learning.
- Explicit guidance is needed for parents on how best to enhance their children's experiences (much in the same way that 'teacher guides' are provided for teachers accompanying school groups).

4. PARENTS AS FACILITATORS?

Palmquist, S. & Crowley, S. (2007). From teachers to testers: How parents talk to novice and expert children in a natural history museum. *Science Education*, 91: 783-804

This study involved the analysis of family conversations that occurred during a visit to a natural history museum. Findings suggest that parents with children who did not have prior knowledge or prior interest in dinosaurs (termed novice children) were more actively engaged in learning conversations than parents with children who had considerable knowledge (termed expert children).

In families with expert children, parents no longer acted as a teacher or co-investigator, instead they acted as tester or evaluator of knowledge. Palmquist and Crowley argue that new pedagogical tools are needed to help parents break through the glass ceiling above their child's particular area of expertise in order to continue to support and extend learning.

Implication for FEAST workshop design:

- Workshop designers and leaders need to recognise that participants – both children and adults – may come to the experience with varied backgrounds and levels of knowledge. Care needs to be taken that possessing some knowledge doesn't limit the opportunities for children to engage, or for parents to become effective facilitators of family engagement. Unfortunately, there are, as yet, no answers about how to best address this issue.

5. ASSESSING LEVELS OF ENGAGEMENT AND EXAMINING THE POTENTIAL ROLE OF PARENTS

van Schijndel, T.J.P., Franse, R.K. & Raijmakers, M.E.J. (2010). The Exploratory Behaviour Scale: Assessing young visitors' hands-on behaviour in science museums. *Science Education*, 94: 794-809.

This paper presents a tool for assessing the level of engagement on the part of young visitors to a museum. The researchers developed the Exploratory Behaviour Scale (EBS) – a quantitative measure of pre-school's hands-on behaviour. The tool considers the child's exploration in the physical environment of the museum against three levels:

- Passive contact.
- Active manipulation.
- Exploratory behaviour (involves repetition, variation, experimentation).

In order to increase the value of exploratory behaviour, van Schijndel *et al.* developed an instrumental video that aimed to show parents how best to guide their children. They tested the efficacy of this video and found that children whose parents had seen the instructional video showed more high-level exploratory behaviour than those who had not. Interestingly, however, they found that if an explainer was present at an exhibit and leading or modelling 'good' exploratory behaviour this tended to limit the level of behaviour on the part of the children. It seems that the presence of the unknown explainer hampered exploratory engagement, whilst the judicial use of pedagogical instruction by a parent supported exploratory engagement.

Implications for FEAST workshop design:

- The presence of explainers may not help engagement! It would appear that it may be better for parents to learn necessary facilitation skills instead.

6. ANALYSING THE IMPACT OF GIVING PARENTS SPECIFIC FACILITATION EXPERTISE

Haden, C.A. and Wilkerson, E. (2010). Enhancing building, conversation and learning through caregiver-child interactions in a children's museum. *Developmental Psychology*, 46:2, 502-515

This study sought to examine the impact of providing caregivers with explicit information and guidance about the value of asking their children 'wh' questions (why, what, where, who) as a mechanism for enhancing their engagement with a building task. The value of providing explicit pre-experience information about a topic (in this case building and structure) was also examined.
Five experimental groups of caregiver and child dyads were examined:
Group 1 – received instruction about the building task and the value and use of 'wh' questions*
Group 2 – received instructions about building task only
Group 3 – received instruction about the value and use of 'wh' questions
Group 4 – a control group that received no advance instruction at all
Group 5 – a group that saw models of building designs and watched video clips of caregiver-child interactions but received no verbal instruction about the use and value of questions or the building task

*The instruction relating to the use of 'wh' questions included examples such as 'Why would a workman wear goggles? When have you worn goggles? What inside us holds up our bodies?'. The instruction relating to the building task gave the experimental groups concerned information and insights on the value of bracing buildings to provide strength and so on.

Each group of caregiver-child dyads then took part in activities in an exhibition entitled 'Under Construction'. There were no signs about how or what to build, simply materials for visitors to build as they wished. All interactions between caregiver and child (talk, and collaborative building activities) were observed and recorded. Following their exhibit experience each adult-child pair was asked to comment on various structures presented in a series of photos. Some also took part in an in-home assessment (conducted at a later date) of the child's memory of the event.

The analysis of the observations and verbal interaction yielded the following findings:

- Caregiver-child dyads in the groups who had received explicit information about the topic (building and structure) built stronger buildings than those who had not received guidance.
- Dyads in the 'wh' question instruction only condition talked more (prompted by parental questions) than the other groups.

In their discussion, the authors noted that *'wh-questions may be particularly important for shaping understanding and encoding in that they can call attention to specific aspects of an event that are perhaps particularly salient, interesting, and/or key for understanding, while at the same time helping an adult to determine what a child may or may not know'* (page 513). Furthermore *'when a caregiver's questioning is followed by the child's verbal elaboration, an enriched representation of the experience may be established.'* (ibid)

The authors also pointed to the value of explicit content guidance noting that it was the combination of building and question instruction that appeared to be important for the children's abilities to spontaneously report information about their experiences at later points. Finally, the authors noted that it was surprising that the group who had only seen models of building, and video clips of interaction did not perform better than they did. This raises questions about the value of models but again highlights the value of explicit instruction.

Implications for FEAST workshop design:

- Providing parents with explicit instruction about key facilitation techniques, such as asking 'wh' questions to prompt greater exploration and discussion, is key in enhancing engagement with content and recall of the experience.
- Providing parents with content information is also important in engendering content/skill acquisition on the part of children that lasts over time.

7. PEDAGOGICAL TOOLS TO SUPPORT FAMILY ENGAGEMENT

Allen, S. & Gutwill, J.P. (2009). Creating a program to deepen family inquiry at interactive science exhibits. *Curator*, 52, 3: 289-306

Gutwill, J.P. & Allen, S. (2010). Facilitating family group inquiry at science museum exhibits. *Science Education*, 94, 710-742

These papers report on findings from the GIVE (Group Inquiry by Visitors at Exhibits) project at the Exploratorium in the US. The project sought to answer the following questions: can intergenerational groups of museum visitors such as families be coached by museum staff to learn a set of inquiry skills that they can use on their own? What forms of facilitation techniques work best?

Initially, the team hoped to equip families with a set of six skills to support their inquiry at exhibits on the museum floor. These skills (and their manifestation as questions or comments) are as follows:

- Exploration (What does it do?)
- Question-generation (What makes it do that?)
- Generation of multiple alternative models (Maybe what's going on here is...)
- Choice of explanatory model with empirical or theoretical justification (What we think is going on is...)
- Significance (This exhibit 'speaks to me' in terms of...)
- Metacognitive self-assessment (But what we still don't know is...)

These objectives were based on the team's understanding of good inquiry practice. However, they were also keen that the training would be appropriate for the museum context. Thus, they stated that the skill training should also be:

- Appropriate for groups with a broad range of ages, interests and backgrounds.
- Accessible enough to be non-intimidating to visitors without strong science backgrounds.
- Simple enough to be remembered without much effort.
- Intrinsically enjoyable so that it would be used spontaneously, beyond the practice period with a staff educator.
- Quickly learnable over a 20-30 minute experience to fit easily within the timeframe of a typical museum visit.
- Applicable across a very broad range of exhibit types and topics, so that visitors would find them useful during the rest of their visit, no matter which exhibits they chose to use.

The team found that it was not possible, given the constraints, to equip families with all six skills. In particular, metacognitive reflection seemed inappropriate to expect: it may happen later, or it may not be a focus when there are so many other exhibits to explore. However, the team found that it was possible to support family groups to engage in proposing an inquiry action and to interpret the results of this action. They did this by teaching families to use juicy questions and to play the hands-off game.

JUICY QUESTION GAME

Family members learn to propose and investigate a juicy question that is explicitly defined as one that can be answered at the exhibit and to which nobody knows the answer.
(Initially this requires a facilitator – e.g. a museum educator – then a member of the family can take over).

HANDS-OFF GAME

The hands-off game was in part developed to help ensure the engagement activities were 'fun' as well as educational. At any time, anyone can call out 'hands-off' at which point the others must stop their explorations and listen to the caller. The caller can share either a proposal for something they wish to investigate or a new discovery. Once agreed or noted by the others in the group, the caller may shout 'hands-on'.

Gutwill and Allen in the two papers above note that such games are based on strong pedagogical principles. They:

- Build on learners' prior knowledge.
- Teach via modelling, scaffolding and fading.
- Identify skills explicitly / explicitly support skill development.
- Support metacognition.
- Foster collaboration.
- Make the activity intrinsically motivating.

- Minimize cognitive load (not too much needs to be remembered).
- Allow family and personal motivations to lead direction of inquiry.

To examine the success of the training, the researches examined the interactions between family groups that had had the training, and those that had not. They found that:

- The juicy question activity was effective at improving visitor-driven inquiry at interactive exhibits. It had less effect on number of actions proposed, but afforded a substantial impact on the number of interpretations made.
- The juicy question condition also fostered more consecutive interpretations which lead to collaborative explanations and coherent investigations.
- Visitors mentioned that the game helped them think, focus and collaborate (although some participants also noted that sometimes the activity was forced and that it was difficult to get everyone to participate and agree on a question to investigate).
- Significantly, almost half of the families made correct interpretations (so not only engaged in inquiry, but also acquired science content knowledge).

Implications for FEAST workshop design:

- 'Offering parents a structured, co-investigative role in exploring phenomena may significantly enhance families' inquiry' (Gutwill and Allen, 2010: 738).
- By prompting the asking of questions to which no-one knows the answers, both parents and children are challenged and motivated. By articulating ideas, the inquiry may become deeper and more coherent.
- By explicitly teaching parents and children the skills of collaborative inquiry, parents are prevented from falling into what may be their usual role of being overly didactic, i.e. telling children the answers rather than letting children discover answers for themselves.

APPENDIX

B

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