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Tinkering with the Universe: a primary school project

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Abstract. In this paper we describe the workshop “Tinkering with the Universe” held at the Communicating Astronomy with the Public (CAP 2018) in March, 2018 at the Fukuoka City Science Museum, Fukuoka. The goal of the workshop was to have our community tinkering together with simple material mixing low tech and hi-tech to build something new and unexpected. We want to engage people with this way of learning, have feedback from the community and hopefully sparkle some collaboration.

1. Introduction

Our attempt was to bring to the international astrophysical community at CAP an approach that was extremely successful in our local community.

Since 2012 we have been working together with teachers (mainly primary school) to design, promote and deliver hands-on, self-directed and playful activities to engage children with STEAM. Our most powerful approach is tinkering. Tinkering is a holistic way to engage people with STEM disciplines mixing them with Art, contaminating hi-tech material with low-tech and recycled material. Knowledge is not simply transmitted from teacher to learner, but actively constructed by the mind (and the hands) of the learner. Constructionism [1] suggested that learners are more likely to develop new insights and understandings while actively engaged in making an external artifact. This method supports the construction of knowledge within the context of building personally meaningful artifacts, and the more self-directed the work is the more meaningful the learning becomes. In this playful context, the kids just play and learn, they do not psychologically classify the activity as math or science so they are finally free to enjoy science and free from their self-prejudice. We strongly believe this approach could be important for kids and young-adult too and that it is a matter of democracy and gender equality (especially in Italy) [2] to allow people to engage with this empowering tools. This method is extremely powerful but also extremely onerous in term of time and organization. The materials used, the physical spaces involved and the strategies of facilitation require a huge amount of work; at the same time to do tinkering is not expensive in term of money so it is a suitable activity for schools.

As researchers we know that science is not just

literacy and instead the real research happen when we use our creativity to imagine new ways, new path to follow. Doing that we fail without fear because we know this is how research works. We believe we have to tell also this part of the story. For someone tinkering is not “enough” disciplinary and this may be true: we are passing an attitude, a way to tackle our world, a first technological literacy not astrophysical concepts that are “accidentally” learned but in an indirect and personal way. We strongly believe that tinkering could be also successfully embedded in a project based learning experience where other more traditional methodologies are exploited too. Tinkering deeply engage people, could help to build some learning building blocks and stimulate cooperation in a playful environment.

2. The workshop

To understand tinkering you have to try it! So we let our colleagues play at CAP2018 with one classic tinkering workshop “the scribbling machines”. To provide a bit of context and to illustrate how tinkering works for us we provided a very brief introduction of about 18 minutes. The presentation with videos and the speaker notes is available [here](#). In the presentation we provide some coordinates to understand tinkering and we highlight the wonderful work of the Tinkering Studio at San Francisco Exploratorium [3] [4] [5] and also how tinkering is relate with another very powerful, successful and popular way to engage children: coding [6].

We allow about one hour and half of pure play where participants organized themselves in group of 3 people and they made different type of scribbling machine e.g. a “noisy machine” (noisy Martian), an animal-like machine (pig?), a super tall one and other wondrous creatures decorated also with “courtesy set” items such as toothbrushes and shower caps; an incomplete gallery of media is [here](#) hoping the participants will update with personal video, pics and comments.

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3. Feedback from participants

We asked the participants to fill in a short questionnaire to understand if, for this audience, tinkering is a good idea in astrophysics, hoping to get people involved and hopefully collaborate for future co-creation. We are very pleased about the results. We had back 43 filled questionnaires. The first question was about childhood and a personal memory of building something and people went wild. We asked in the second question if the participant liked to build the contraption and in the fourth question if tinkering can be a viable approach for astrophysics. Unanimously people liked very much to build the machine especially if we take count of all the hearts and stars sketched on the questionnaire.



Fig. 1. The tinkering workshop at CAP2018. Participants playing with Scribbling Machines.

The participants stated also that tinkering can be a viable approach, in some cases adding comment about related possible difficulties. For some of the participants is very suitable for technology related astrophysical issues. One person was unsure. The third question was about previous knowledge of this method. We got six people that already knew tinkering as an educational tool (3 from Philippines and 3 from Netherlands), the 4 facilitators from INAF, 8 people knew from articles, tv, newspaper and colleagues but the majority of this people stated that the workshop provided a more deep knowledge and above all provided an useful context. In this group we got a lot of comments maybe the line more rewording for us was the comment of Thea – I have seen it on TV and books but it's a completely different experience doing it by myself – and this is a great reward that pay back all our organization efforts. We got 6 people that recognized something in the tinkering they already knew but they didn't categorize as tinkering and 19 people

that didn't know tinkering at all. We got creative ideas about possible future contraption to build; the majority are technology based ideas: rover, landers, rockets, adaptive optics, moon exploration, pressure gun, spectroscope, resonant cavities, radio transmitter and detector, high energy particle detector, analog film camera and telescopes. Some people proposed science based ideas: planetary science, asteroids, solar system, supernovae, binary stars, spiral galaxy, orbits, dynamic, gravity, celestial mechanics, ET design, black holes, inflating universe. We would like to go deep and understand better those participants ideas. In the last yes/no question we asked if people want to be involved in a co-design and co-creation of a novel tinkering lab. We got 2 people not interested, 4 people unsure, 10 people didn't answer and 27 people interested and we hope to interact soon with them. Some of the participants got very excited and a lot of them believe that this material/approach could really works in their local community for this reason the majority of the material we brought at the workshop is now around the world to allow people to try and hopefully let us know. We will provide our full support to the local communities in this experimentation.

6. Summary

We brought tinkering in the welcoming community of CAP and IAU. We got an amazing feedback from participants and we hope this will be a start for a co-design and co-creation of new tinkering ideas around the world.

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