

Facilitating STEAM Learning among Children with Paper Circuit Activities

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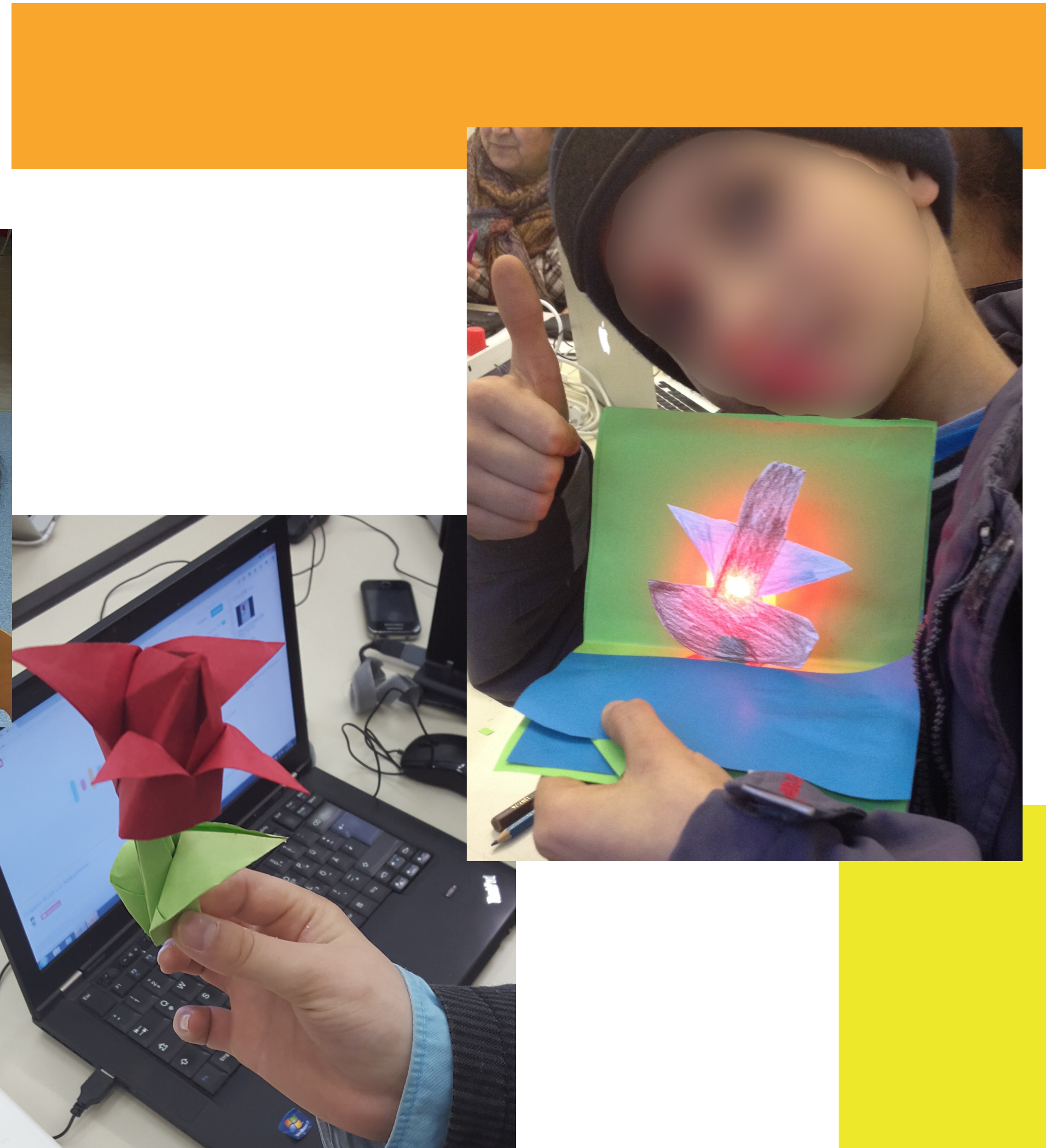
Introduction

Paper has long inhabited a key role in the production, storing and management of knowledge [2]. Paper is also a material that has begun to emerge as a possible lens to understand creative skill building within craft principles and informal learning contexts [4,5]. We explore paper from an ethnographic perspective. Our study focuses on paper as a material that facilitates the production and retention of STEAM (Science, Technology, Engineering Arts, and Maths) knowledge in children, a type of mindset that can be nurtured in this population [1].

In an after-school activity with elementary and secondary school children in culturally diverse neighborhoods in Germany, we explored the STEAM philosophy of education, which promotes the idea that skill building in children needs to support both creative engagement and technical self-efficacy as indicators of success. With this approach, our activity expands previous works of Rode et al. (2015) arguing for computational making as an educational framework for teaching computing [3].



- Paper was a good material to foster creativity among the participants,
- Paper allowed easy prototyping
- Hesitating participants („I cannot do handicraft work“) could not resist to start experimenting with shapes, colors and sizes in the designs of their artifacts.
- ‚Breakdown‘ situations led to frustration, but ultimately to a deeper understanding of making and crafting processes
- The construction process involved a variety of physical skills:
 - + sketching drafts
 - + reconsider how to materialize the idea using paper
 - + face different challenges using utensils and materials (lack of practice with this equipment)
- ‚Understanding materials‘ was a needed skill to determine the course of action



Method

- Mixed gender sample of boys and girls, aged 8-13
- Creation of various paper artifacts:
 - + popup-cards
 - + paper flowers
 - + 3D paper models
 - + individual creations (paper airplane, Minecraft characters)
- Illumination of those creations with built-in paper circuits

Findings and their Discussion

- Different visualization of the childrens' ideas were constructed (e.g. chalk drafts, Sketch-pads with a pencil, virtual 3D models)
- Children had to understand how to transfer 2D drafts into real world representations
- Challenge to incorporate the circuit without short-cutting it
- Paper projects promoted a strong sense of aesthetics among the participants
- Participants rebuilt their projects over and over again, until they were confident with the appearance
- Aim for the artifacts to simultaneously ‚look good‘ and ‚function properly‘

Conclusion

Identifying key structural elements of the projects, we argue that this kind of paper crafting activity can function as a transformative investigation providing opportunities for collaboration and learning among children. The process of using, creating and questioning through, with and for the technology inherent to the paper project activities permitted the children to gain both access to STEAM knowledge and thereby build creative agency and technical self-efficacy.

References:

1. Chu, S. L., Quek, F., Bhangaonkar, S., Ging, A. B., & Sridharamurthy, K. (2015). Making the Maker: A Means-to-an-Ends approach to nurturing the Maker mindset in elementary-aged children. *International Journal of Child-Computer Interaction*.
2. Murer, M., Jacobsson, M., Skillgate, S., & Sundström, P. (2014, April). Taking things apart: Reaching common ground and shared material understanding. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 469-472). ACM.
3. Rode, J. A., Weibert, A., Marshall, A., Aal, K., von Rekowski, T., el Mimoni, H., & Booker, J. (2015, September). From computational thinking to computational making. In *Proceedings of the 2015 ACM International Joint Conference on Pervasive and Ubiquitous Computing* (pp. 239-250). ACM.
4. Shorter, M., Rogers, J., & McGhee, J. (2014, June). Enhancing everyday paper interactions with paper circuits. In *Proceedings of the 2014 conference on Designing interactive systems* (pp. 39-42). ACM.
5. Shorter, M., Rogers, J., & McGhee, J. (2014, June). Practical notes on paper circuits. In *Proceedings of the 2014 conference on Designing interactive systems* (pp. 483-492). ACM.