

## EXPLORATORY LESSONS USING POP-UP CARDS AND MAKING OF CARDS

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### (1) Making of cards as the teaching materials of the space figure

We have been continuing workshops on ICME11, ICME12, and ICME13 about teaching spatial figures using pop-up cards.

A static figure is used in the learning of the plane figures. In contrast, it is important to present the shapes of the spatial extent and dynamic movements when a teacher teaches a space figure. There are the following advantages in pop-up card creation as teaching materials. When making a card, a three-dimensional card is completed by trial and error, making a cut in a plane (card) plan, and opening and closing a card repeatedly. In this making process, instruction which connected plane figures and space figures is attained. Especially, the popup card called "the origami architecture" is effective as the teaching material from this respect. When you open a card that is folded in two to  $90^\circ$ , the three-dimensional shaped object appears. When you fold this card, this card is returned to its original state. Work of origamic architecture may look at the home page of Masahiro Chatani. <http://www.japandesign.ne.jp/IAA/chatani/>

The person who saw the work of the pop-up card is wondered first, saying that 'How is the solid made from one sheet of paper (plane)?'. A child and a student will observe a spatial motion of a work first. He will understand that a three-dimensional work can be made from a card, opening and closing a card repeatedly. Then, he should want to make an original popup card. He will consider how to write a plan on a flat card while he images the state a card is opening and shutting. He will infer how a line on a plan is changing into a solid edge. He probably comes to observe opening and shutting on a card from the front, put a viewpoint in the various directions and observe a card.

### (2) Exploratory classes using pop-up cards

Let's create the pop-up card as shown in Fig. 2. If you open this card, building blocks as shown in Fig. 1 will appear. For this purpose, you should draw the plan of this card on the squares paper. You'll notice that you should start by placing a building block on graph paper and drawing lines around the bottom and sides. As shown in Fig.3, it is more effective to fill the upward surface of the building blocks. Through repeated trial and error, you will discover that if you make the cards correctly, you can fold the cards and stack. This is a meaningful discovery that easily checks the correctness of the design drawing. While repeating the card making by changing the number and position of building blocks, various questions will arise and discover many properties. For example, they are as follows. "In the blueprint, where are the cut lines? Where are the folds? Are there any secrets to these lines?" In this workshop, we perform a class to discover these mathematical properties for searching with a participant of the part of student.

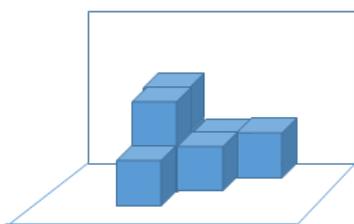


Fig.1

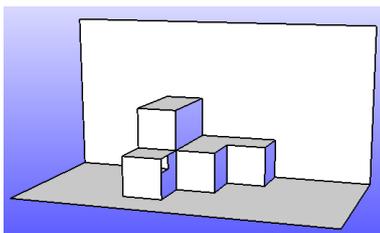


Fig.2

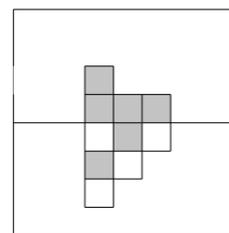


Fig.3

**(3) Making works**

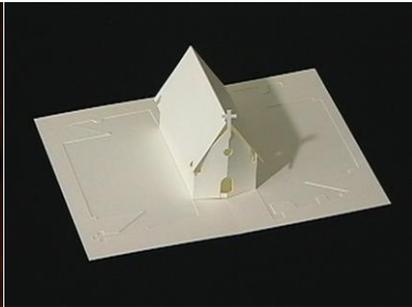
Make the following works with Kihara. Teaching material 1 is a pop-up card that opens at 90 °, where the house appears. Teaching material 2 is a pop-up card, where the house appears when it opens at 180 °.



Workshop in ICME13



Teaching material 1



Teaching material 2

**Planned structure:**

Planned timeline	Topic	Material / Working format / responsible person
20 minutes	Discovery of exploratory mathematical properties through pop-up card creations	Projector and PC/Lecture / Kazumi Yamada
30 minutes	<b>Exploratory class using pop-up cards</b>	Tools prepared by us / Activity / Kazumi Yamada, Anri Yamada
30 minutes	Making of pop-up cards	Tools prepared by us / Activity / Takaaki Kihara
10minutes	Question and answer	

**References**

Kihara's works on YouTube:

<https://www.youtube.com/playlist?list=UUQpSbIb89mGgIqRUIW7eMgg>

**Venue requirement:**

**Online**