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Research Article

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Emotional Design Applied to Science Display of Gas Pressure

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Abstract Atmospheric pressure is a common phenomenon in life, and there are many ways to display it. We combine humorous and scientific phenomena to make the display items more acceptable to children. Under constant temperature, the volume of a certain mass of gas is inversely proportional to the pressure. When the gas is in a semi-closed container, the gas flows creates a sound at the diaphragm due to the difference in air pressure. Through the balloon between two interconnected confined containers, the change of pressure can be viewed and generate an acoustic sound. Our prior experience can link to current actions through emotional design and visual form. The action connected the emotion through the visual element. Children are happy to explore the scientific knowledge of gas pressure facility through the interactive activities.

Keywords Emotional design, science display, pressure, air

Introduction

Effective mentors need to display enthusiasm for science and involve mentees, not only in teaching science but also teaching it effectively with lessons. Pedagogical knowledge for articulating effective teaching practices are required in mentoring strategies [1]. Students were guided through various inquiry-based science activities, with specific aspects discussed with constructing instructional teaching aids regarding materials and equipment [2].

Atmospheric pressure has many critical applications in daily life. Hands-on physics teaching aids have been proposed to allow students to experience those scientific concepts. One of the facilities reveals mechanism of our lung. The outside of the outer water-filled balloon represents the atmosphere. The pressure in three compartments referenced to each other by making the atmospheric pressure. Simple, inexpensive models encouraged research-oriented learning [3]. A balloon fit moves means the air got pressure. The movement caused by pressure change of gas (Figure 1). The students appreciate objects and enjoy taking the models home to demonstrate to friends [3].

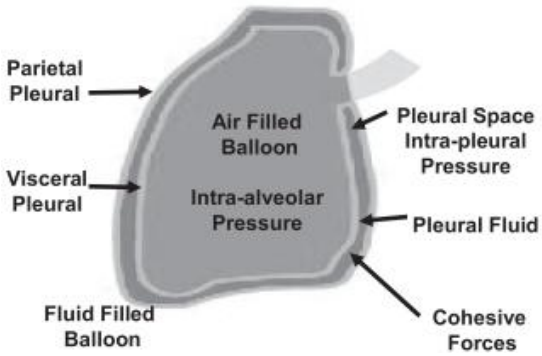

Figure 1: The respiratory system modeled as an air-filled balloon surrounded by a fluid-filled balloon. The fluid filled balloon represents the atmosphere. Two balloons represent the pleural space and intra-pleural pressure.

The pressure generated by the rapid movement of the molecules against the wall of the object. When there is a pressure difference, the gas flow between them. The students can quickly feel the presence of air pressure [4]. The gas pressure display facility presents the air flow caused by the gas pressure difference. Through the combination of humorous, designer provided interesting design for children aged 11 to 13.

Principle

Irish scientists discovered that a certain mass of low-density gas is inversely proportional to the pressure at constant temperature (the Boyles law) [5]. The pressure changes with the gas quantity within the container. When the volume of the container becomes larger, the gas pressure becomes smaller. From the ideal gas law, at temperature T

$$PV= nRT \quad (1)$$

Under the conditions of constant temperature and atomic mole number, P_i and V_i respectively represent the initial pressure and gas volume, and P_f and V_f represent the final pressure and volume of the gas, respectively.

$$P_iV_i = P_fV_f \quad (2)$$

Functional Design

The equipment required for this experiment contains: Two covered plastic containers of the same size, 5cm long water pipe diameter 20mm. Rubber sheet: Thickness 1mm, size 5cm*5cm, four sets of screws. Inflator, balloon and glue for leak prevention [6]. The assembly steps include:

- Insert the holes of the two plastic empty containers at the center with apertures of 20 mm in diameter. We place a 5cm long water pipe with a diameter of 20mm into the hole. Two caps glued together, and the pipes are fixed to each other.
- At the bottom center of the container (1), drill a hole as big as the bottle, and combine the container with the bottom of the bottle.
- Insert a hole as large as the steam nozzle at the bottom of the container (1) and insert the steam nozzle.
- Place an aperture of 20 mm in diameter at the center of the bottom of the container-2. An 1 mm thick rubber mat attached from the inside of the container, and the two locked with screws and spacers.
- Put the lids of the two plastic containers on a balloon and set them up with two containers. The balloon opening is toward the first container, while the balloon end faces the second container with a rubber gasket.

Emotional Design

Issues

Emotions consider the user's mood, beauty, and ease of use. There are three different levels of emotional elements: Visceral level (the appearance and texture of the product), Behavioral level (the function of the product is related to the use of the product), and the Reflection level (personal feelings, emotions, and cognition).Norman [7] explains why products must be pleasing and fun. Beauty and humor make people feel happy when they use it. Traditional designers consider the function of the product and do not take into account the user's mood and ease of use. "User sentiment" is an element designers need to consider [7].

Article [8] focused functionality and appearance in emotional design because these two are relevant to the relation between emotion and design. Differences between designer and user are particularly evident concerning the role of emotions. Product-induced feelings are often quite distinctive depending on memories the product invokes. Designers can provide opportunities for the experience of emotions [9].

Consumers need a sense of participation in the product; the intrinsic value of the product lies in the emotional bond between the product and the customer. The fun of emotional design often occurs in interesting links to past experiences. The operation wakes up the prior experience and represents the past emotions in the current action. In [9], theoretical issues related to semantics and the emotional content of design were reviewed to design products triggering 'happiness' in one's mind. “Based on selected examples in recent design awards, the common attributes of their design language were analyzed. The attributes enhancing desired feelings may hide in childhood socialization where thoughts are taking shape.”[9] A questionnaire was developed to measure

emotional responses. The relationship between product design and emotional reactions to mobile telephones was reviewed [10].

Case Study

When we use a cup to hold water, the cup is just a container, and the function is only different in size. When we attach the texture of different fruit peels on the surface of the bowl, it awakens our past taste and touch experience of the fruit, causing a happy feeling.

When the tea bag placed in the cup for a long time, it will make the concentration of the tea high and bitter. We often use our fingers to lift the tea bag, which is like fishing. The design in Figure 2(a) turned people into polar bears and explored the fish under the ice on the ice sheet, creating an interesting connection.

When we sit in a chair, we often unconsciously lift our legs, which mean a kind of relaxation. The designer anthropomorphizes the chair and mimics the person's leg movements (Figure 2b). We also became free when we saw the chair.

Figure 2: Emotional design cases (a) lift the tea bag [11], (b) chair [12]

Combine humor in Facility

Transfer

How does experience connect with current actions through emotional design? The visual form is the central element to awaken the background memory.

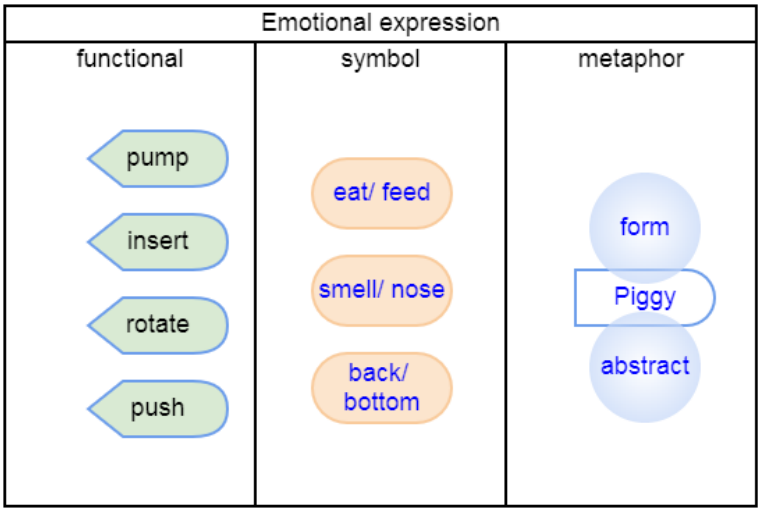

Figure 3: Emotional expression for gas pressure facility

Referring to Figure 3, we review the related actions of the functional action. For example, there are pumping, venting, turning the knob, and releasing the pressing; these actions can link with the symbol. The gas injects analogy to the mouth; the stomata is also similar to the mouth; the vent releasing linked to the body's fart experience.

Many living experiences collected from films or comic, we summarized the metaphor of the piggy in design. The knob shape is similar to the pig's nose, and other design elements such as ears, legs, and eyes were integrated in the form (Figure 4,5). Incorporating these elements to embody metaphors with barometric pressure, we connect interesting experiences in gas pressure facility.

Figure 4: Front view of the gas pressure display facility

Figure 5: Side view of the gas pressure display facility

Prototype

The detail implementations are as follow:

- The balloon is placed at the junction of the two caps to fill the air in the can, and the pressure inside the container increases. The pressure difference causes the air in the container (1) to flow into the balloon in the container (2), and the balloon gradually rises. At this time, the container (2) squeezes the air inside because the balloon is pressed, so that the rubber pad is in close contact with the bottom of the can.
- Turn the bottle cap of the container (1) gently to allow a little air to flow. As the inside air reduced, the pressure inside the container decreased too. The balloon between the two vessels also becomes smaller due to the lower pressure.

- While the balloon becomes smaller, a vacuum formed. At this point, user presses the bottom rubber pad of the container (2) with finger. The rubber mat is no longer tight, and a slight pressure causes the internal air to flow out. Due to the outflow of the container (2), the volume of the balloon became smaller and generated a high frequency sound.

Conclusion

This experiment mainly uses atmospheric pressure. We manually put the air into the storage tank (1), the pressure inside the container increases and the balloon expands. At this time, the second storage tank is the same pressure. There is change in balloon volume when opening the bottle's cap. Pressing the rubber pad causes the internal pressure changes when the gas flows changes the volume of the balloon. Emotional design had applied to gas pressure science display. The willingness of user's participation increases by combining humor, fun and emotion.

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