# What Lactose Intolerance, Peristalsis, and Chicken Nuggets Have in Common: Using Card Sorting to Inform the Content of a Digital Game

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**Abstract:** *Down With Food* is a tablet game designed to teach upper-elementary school children about systems thinking within the context of human digestion. Prior research has guided the implementation of the game's mechanics and its interactive narrative that improves the game's functionality and user's experience. The goal of the present research was to optimize players' motivation to engage with the game's educational content. To do so we adapted a simple method of gauging users' interests known as *card sorting*. Preliminary analyses show that the most popular topics were either personally relevant to children's lives or were situationally-framed problems that drew on new knowledge. Future directions of our research along with limitations of card sorting in educational game design are discussed.

## Introduction

*Down With Food* is a game designed to teach children ages 7 to 9 about the human digestive system. In the e-book layer, the game's main character, Zyme, takes users through a virtual tour of the various digestive organs. Each organ is associated with a mini-game to teach players about that organ's role during digestion by utilizing systems thinking—the ability to understand cause and effect. For example, the stomach game requires players to think about cause and effect as a system that can be nonlinear. Players must activate enzymes that digest food in the stomach by increasing the stomach's acidity, but the increased acidity also damages the stomach's inner lining, and so they must protect the stomach with a layer of mucous. To complete the mini-game, players must understand that increasing acidity may have multiple effects on the body and thus need to balance food digestion with the levels of acidity and the mucous barrier.

An important component of the research-based design of this educational game was to facilitate an intrinsic motivation to learn. Our research was guided by the expectancy-value framework (Wigfield & Eccles, 2000), which posits that students are motivated to learn if they expect that their efforts will lead to success and if they value the activity. Here we used *card sorting* to understand what digestive topics children may already know, what they are not interested in discovering, what they are most interested in discovering, and why they were interested in such topics.

## Method

Rooted in cognitive psychology, *card sorting* is a user-experience development method used frequently by website designers. Researchers ask participants to sort cards that represent different topics into predefined groups and then the participants are asked about their reasoning for their sorting choices. *Card sorting* has shown to be especially useful when designing games for children because their knowledge and mental schemas differ considerably from those of adults (Joly, Pemberton, & Griffiths, 2009). Here we used this *card sorting* to understand children's interests in biological processes so that the content of the game could be aligned with their curiosity.

We gave groups of eight- and nine-year-olds (n=7) a deck of 30 cards with questions related to the digestive system such as, "What is peristalsis?" and, "What would happen if you swallowed your chewing gum?" They individually sorted each question into one of three piles: 1) I Want to Find Out; 2) I Do Not Want to Find Out; or 3) The Question Doesn't Make Sense to Me. We then asked why they were interested in the questions placed in the "I Want To Find Out" pile. For instance, their justifications could stem from interest in a new word (e.g., "I have never heard of that word before and it sounds interesting!"), relevance to their lives (e.g., "My sister isn't able to eat ice cream and I want to learn why that is"), or prior exposure to a situation (e.g., "Sometimes, you just have a certain thought like, 'I want to eat chicken nuggets.' I want to know why you suddenly want to eat that certain food!"). Similarly, we also asked participants for their reasons for placing cards into the "I Do Not Want To Find Out" pile. Questions placed in the third pile were clarified by researchers, after which the participant was able to sort it into one of the other piles.

Following the individual sorting task, each participant chose the top three questions from their "I Want to Find Out" pile. The group of participants was then asked to come together and to combine their top-three questions. They were then asked to discuss which three of the top-three-questions that were overall most interesting. Researchers concluded the session by providing answers to the overall chosen questions. *Card sorting* sessions were videotaped and conversations were transcribed and analyzed.

## Preliminary Results

Although data collection is still in progress, patterns have emerged from our early participants. We found that participants had various reasons for sorting cards into the "I Don't Want to Find Out" pile. For example, one subject thought that the topics were "too gross," and others already knew answers to the questions. They made use of prior knowledge and formed connections to what may have seemed familiar to them. One participant who placed "What happens when we choke?" in the "I Don't Want to Find Out" pile reasoned, "I think, the food, when you swallow it, it goes down the esophagus. So it might go to another place inside your body and then you choke."

We found that questions pre-designated by researchers as "fun fact" questions were most likely to be sorted into the "I Want to Find Out" pile (e.g., "How long can you go without eating or drinking?" and "What would happen if you swallowed your chewing gum?"). This revealed how important framing is to appeal, since these questions were framed in a way that made digestion topics situationally interesting. Participants were also intrigued by words they were unfamiliar with, such as the digestive term "peristalsis." Other participants were also interested in learning about topics they had a personal connection or prior exposure to (e.g., "My sister is lactose intolerant; I want to know why").

## Discussion

We found *card sorting* to be effective in our game design and would recommend other designers and researchers to consider adapting the method for their needs. The method is robust, allowing researchers to ask pointed questions that reveal why participants are interested or not interested in certain topics. Our extension of *card sorting,* asking participants to collaborate in a group, gave us a better understanding of children's interests as a whole, which is especially important for participants of this age group. For example, after hearing the answer to one of the final cards they chose, participants in one group applied their understanding to themselves, actively and enthusiastically discussing how long each one of them could go without eating or drinking anything.

As patterns in *card sorting* results become more pronounced, we will incorporate participants' responses into the content of the game by including these facts into the narrative or the e-book and framing them in ways that will optimize their appeal. Data collection is still ongoing and we are looking forward to seeing if the observed themes continue to hold across a greater number, and more diverse pool, of participants.

## References

Joly, A. V., Pemberton, L., & Griffiths, R. (2009, September). Card sorting activities with preschool children. In *Proceedings of the 23rd British HCI Group Annual Conference on People and Computers: Celebrating People and Technology* (pp. 204-213). British Computer Society.

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