Nutriopia: Nutritional Simulation

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Abstract

This theoretical paper explains how the different cognitive theories and instruction design principles are applied in “'Nutriopia': Nutritional Simulation”. Nutriopia is a simulation project based on nutrition and the impact nutrition has on the human body. It contains nutritional information about food and the biochemical interaction food has with the body; it is presented to the learner as an interactive 3D model of the Human Body along food catalogs and analytical tools that aid the learners run and learn from their discoveries.

Nutriopia uses the Cognitive Theory of Multimedia Learning (CTML), Cognitive Load Theory (CLT) and Cognitive Affective Theory of Learning with Media (CATLM) along with principles that were defined from studies by Mayer, Moreno, DeJong and others. In this paper the principles of Discovery, Explanatory Feedback, Navigation, Prior Knowledge, Interactivity and Animation are explained and discussed as far as how they were applied in the design of Nutriopia.

Other principles used in the development and design of Nutriopia are discussed by the project's co-authors, Anisha Sridhar and Rocio Almanza in their individual theory papers.

NUTRIOPIA: NUTRITIONAL SIMULATION

Digital multimedia technology is a great tool for learning as it allows us to explore information in ways that otherwise can not be accomplished. Digital multimedia technology gives the learner the power to interact with information and learn at their own pace and as the engagement between the learner and the learning material takes place, the learner becomes an “active sense maker” (Mayer, 2005). Information Technologies have demonstrated a great deal of ease when dealing with large sets of interactive elements, and through the use of digital multimedia we find efficient ways to design instructions that can transfer this information to the learner.

Multimedia uses both visual and verbal channels, which aid learners receive information into working memory to be analyzed, processed and committed to long term memory in the form of schemata. The Cognitive Load Theory of Multimedia states that a person learns better when is presented with information using both pictures and words (Mayer, 2005). When presenting information of complex nature, such as those posed by nutrition, design principles can address some of these issues that deal with budgeting the cognitive load of the learner. The cognitive load theory explains how the human mind's architecture processes information and it is concerned with limits on working memory. It identifies the three types of information processing loads: extraneous, intrinsic and germane. Multimedia instructions should be designed to reduce extraneous load, organize intrinsic information and promote germane or generative information processing. Since Nutrition is an important aspect of our personal well being, nutritional information is by nature something that is of the interest of the learner and the general public, which as the Cognitive Affective Theory of Learning with Media (CATLM) by Moreno (2009) suggests, learners' interest in the subject matter enables them to improve their transfer of information and apply it when necessary.

Nutriopia is a computer simulation tool that promotes discovery learning for teenagers between 13-15 but can be used by the general public, preteens, researchers, and students of nutrition. The learner first enters a meal on a text field and views the results on an interactive 3D model of the human body. The learner can explore with full control their experiments, they can view where in the body the nutritional biochemical reaction occurs, they can rotate, view and hide labels, zoom in and out, toggle between digestive system, nervous system, skin, etc. Furthermore, Nutriopia allows the learners to save their meals and provides them with analytical and statistical tools that aid the learner to observe cumulative data from their profile's Nutritional Journal.

Nutriopia contains information on the bio-chemistry of food of both organic and synthetic nature, information about the bio-chemical reactions of food and the human body, anatomical information about the body and its different systems, and simulated information about the production of energy and health based on the meal entered.

Friedler, Nachmias, and Lynn (1990) defined the following processes for scientific exploration: “a) define a scientific problem; b) state a hypothesis; c) design an experiment; d) observe, collect, analyze, and interpret data; e) apply the results; and f) make predictions on the basis of the results”. 'Nutriopia' follows the same system of learning as it promotes the scientific discovery process provided by Friedler, Nachmias, and Lynn (1990) . A problem is defined, which is “What impact does food have on the body?” and an experiment that prompts the learner to input meal food items is designed. The learner is responsible to state a hypothesis by entering their meal data, and view, save, and make sense of the data with the help of the interactive tools of simulation, animation and informational graphs. The aim is that possibly our learners will eventually apply the results for their personal nutrition, and learn to make predictions of how nutritional choices impact their bodies.

Van De Jong (1991) stated when referring to simulation environments, “The learner's basic actions are changing values of input variables and observing the resulting changes in values of output variables” (de Jong 1991). Alessi in the year 2000 outlined what an effective simulation should contain and include dynamic graphs and animations (Alessi, 2000), which adopted in Nutriopia's interactive simulation and in the learner profile's Nutritional Journal in the form of graphs.

Discussion

In this section, a detailed discussion on how the guided-discovery principle, explanatory principle, advanced principles, and navigation principles have been applied in the design of ‘Nutriopia’.

a) Guided-Discovery Principle: The principle of guided-discovery states that people learn better when guidance is provided into the discovery-based multimedia environments. Discovery learning is a way of learning where the learner is solely responsible of the planning and monitoring of the information processed (De Jong, 2005). Some studies suggest that learners learn better when the instruction has guided-activities integrated, more so than pure self-discovery learning approaches (Shulman & Keisler, 1966). However, Moreno, Mayer, Spires & Lester conducted a study in 2001 that consisted in designing a plant. Learners were given the freedom to choose the traits that the plant would need in order to survive in a given weather condition, the group of learners that were free to make their choices outperformed their counter part that was guided in the designing process of such plant. Moreno and Mayer in 2007 were able to identify five common types of interactivity: manipulating, dialoguing, controlling, searching and navigating (Moreno and Mayer, 2007). 'Nutriopia' is built using the interactivity by manipulation approach, in which the learners run their own experiments by entering the values or food items prior to running the simulation. In addition, using the types of guidance distinctions proposed by De Jong and Njoo (1992), which are directive and non-directive. 'Nutriopia' adopts a non-directive approach, the simulation is an “open system” or “hypothesis sketch-pad” in which learners can test any values they want. Nutripoia has a monitoring tool, as proposed by Veerman, De Jong and Joolingen (2000), which enables the learners to save, organize and replay experiments that they performed in the past. Both of these tools, the “Hypothesis Sketch-pad” and “Monitoring tools” are non-directive guidance approaches because they do not make suggestions of what the learners should enter in the simulation making the experience a self-directed one. Furthermore, we integrated interpretative support and experimental support (Reid, Zhang, and Chen, 2003), which basically is activating the learner prior knowledge by posting the question “What did you eat for your last meal?” to the learner so that S/he knows the type of data that needs to be entered. Lastly, in order for the learners to be able to transferred what they have learned into the real world, fidelity needs to be taken into account (Alessi, 1988). High fidelity, not only supports the visualization of the processes through animations (Rieber, 1991), but also may raise the motivation and engagement from the learner (De Hoog, De Jong, and De Vries, 1991).

If the learner is actively engaged with novel information, by either selecting it, organizing it or integrating it, or a combination of those three, essential and generative information processing is likely to occur (Moreno and Mayer, 2005).

b) Explanatory Feedback Principle: The Explanatory feedback encourages essential and generative processing by providing guidance to the learner through the selection and organization of the new information when no mental model is available (Shauble, 1990). A study performed by Moreno and Mayer in 2005, students that obtained knowledge with Explanatory Feedback produced higher scores in transferring information and also decreased their misconceptions over time. Novices learn better when presented with explanatory feedback during learning (Moreno and Mayer, 2005). In Nutriopia, verbal and visual explanatory feedback is given to the learners for each of the food items in order to identify whether or not they are organic or synthetic. We do this by using a green checkmark and a red exclamation mark icons that are located in the roll-over menu information for each food item entered and located on the scrollable area on the right of the 3D model screen. This will allow the instruction to gradually fix and override misconceptions that the learner may have for certain food items, such as iced tea or vitamin water, which, at least for some, might be considered good for the body, additionally, for those food items that the learner is not familiar with, they will be able to determine the nature of those products.

c) Animation and Interactivity Principles: Both principles of animation and interactivity state that learners do not necessarily learn better or more by the use of animations (Betrancourt). 'Nutriopia' is a simulation that enables learners to enter data that interact with the 3D model, providing the learners many benefits over static graphics due to the model's interactive nature. With the system reacting to learners' input, the simulated animation enables learners to predict the behavior of the system, and thus promoting and in some cases even improving deep meaningful learning (Betrancourt). This animation is used in combination with high fidelity that is intended to create motivation in the learner (De Hoog, De Jong, and De Vries, 1991) as well as promoting a visual aid as to how those processes are distributed in the human body (Rieber, 1991). Due to the cognitive cost that animation yield to learners , as well as the illusion of learning that animation may create on the learner (Betrancourt, 2005), the Animated simulation is presented as an option and not as the main learning tool. Rather, we use the interactive simulation as the main instruction, which enables the learner to zoom in and out, rotate and calibrate the layers for each of the human body systems, that is, the circulatory, digestive, muscular, skeletal and neural systems, this is known as the Flexibility Principle, which basically is giving the option to the learner to activate the animation at their leisure, provided by clicking on the “SIMULATE” button on the left of the screen.

d) Navigation Principle: According to Roue and Pottelle, the navigation principle states that learning increases in hypertext environments when appropriate navigation is provided (Mayer, 2005). 'Nutriopia' has a series of simple navigation tools that assist the learner to explore. On the top right corner, there is a simple site navigation to go between the interactive simulation, catalog and journal pages. Also within each of these pages there are other types of navigational devices that activate when the learner clicks, rolls over and drags over objects. To the left of the Interactive Simulation 3D model, there is a slider that allows the learner to toggle between the anatomical layers of the body. In addition, there are tools that can be used to enable labels or to take the learner to watch a simulated animation based on the learner's input. Furthermore, the 3D model is fully interactive and it also provides hyperlinked information situated on the labels and circled areas on the body. To the right of the screen, a roll over menu drops down on each food item listing the chemical composition of the item; each one of these items is hyperlinked to a catalog where more information about that item can be found. In the catalog section, the info graphic device, a word cloud, represents the quantity of vitamins and other relevant nutritional chemicals that the food item on screen contains, each of these words are hyperlinked to additional information about each of the chemicals and vitamins. The catalog version behaves like a picture slideshow or flash card system, arrows are provided on the left and right of the screen to be able to navigate easily between the list of food items in the database.

e) Prior Knowledge Principle: The prior knowledge principle states that Instructional design principles that enhance multimedia learning for novices may hinder multimedia learning for more expert learners (Kalyuga, Ch 21).

The learners or 'Nutriopia' users are computer literate; they know about the digestive system and its basic functions; they know that food breaks down into chemicals in their body; and they know about the periodic table and basic chemistry concepts. The interface also features an option to turn labels on and off for more elaborate explanation of the food interaction and also the different parts of the body in the model for novices. The “Labels” functionality will cater to both novices and experts as they can choose to use labels.

Conclusion

Nutriopia's target audience's age range use mobile devices more and more to keep up with their social life and to coordinate personal information of their everyday life (Rich, 2004). By using the mobile devices extension of Nutriopia, learners will always be able to upload their meal information on the cloud, in order to track their meal habits, observe and learn about their nutritional life, eventually enabling to adjust and even make dietary predictions based on this now accessible knowledge.

Food is a necessity and nutrition is at the core of the well-being and of the prevention of poor health conditions such as diabetes, heart disease, obesity, etc. Learning about good nutrition is an important aspect of life for both being healthy and strong and to live longer. (The University of the State of New York, 2008)

We aimed to create a nutritional learning platform where the learner can learn about nutrition and its role in the body and most importantly that they learn from their simulations and experiments how to apply more conscious and healthy eating habits to their own diets.

References:

Driscoll, M. P. (2005). Part VI: Learning and motivation. *Psychology of learning for instruction* (3rd ed., pp. 307-345). U.S.A.: Pearson Education, Inc.

Mayer, R. E. (2005). Cambridge handbook of multimedia learning (10th ed.). New York: Cambridge University Press.

Plass, J., Kalyuga, S. and Leutner, D. (2010) Cognitive Load Theory. New York: Cambridge.

Rich, L. (2004) The Mobile Connection, San Francisco, CA: Morgan Kaufmann.

Tacken, G. M. L., de Winter, M. A., van Veggel, R., Sijtsema, S. J., & Ronteltap, A. (2011). *Beyond the packed lunch: Teenagers and their interest in food.* No. 2010-040). The Hague: LEI.

The University of the State of New York, The State Education Department, Office of Curriculum and Instructional Support Albany, New York 12234 (2008), Food and Nutrition.

Retrieved: http://www.nylearns.org/module/standards/downloadpdfs.aspx