Cognition and Motivation in Interactive Museum Exhibits

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INTRODUCTION

The Science Museum of Oklahoma offers chances to learn science in creative and engaging ways that make people want to be present and discover new knowledge. Many of the exhibits at the Science Museum of Oklahoma are engaging, educational, and exciting for the people who come and visit. However, the museum staff and administration recently noticed that the light and color exhibit is vacant more often than not. The exhibit is currently made up of four different panels of textual information and two slightly interactive elements involving simple buttons and a complicated wheel and gear system. The exhibit is located in a high trafficked area of the museum, so it seems likely that people would notice the exhibit, yet it continues to go unused.

To bring people back to the exhibit, the museum administration asked design firms to brainstorm ideas on how to make the exhibit more engaging, educational, and exciting to any visitors of the museum. As a designer, I am qualified to assess the situation and provide my opinion on plausible changes to reengage the users. To meet the museum's goals of engagement, education, and excitement, cognition and motivation perspectives will be thoroughly explored. Cognition will support education goals while motivation will support engagement and excitement.

DIAGNOSIS

Perspective 1: Cognition

When approaching the current light and color exhibit, **attention** of the visitors is only drawn through the sense of sight from the informative boards describing how light travels and how colors come from light. Attention allows information to be moved from the sensory register to working or short term memory. Only the information that is paid attention will move from the sensory register to working memory (Ormrod, 2016). The only other visual example is a series of buttons that allows visitors to see how different lights affect the coloration of an object sitting inside a display case. This currently only allows the **information processing model** to move to the sensory register, and in a few cases of overly curious people, short term memory. The information processing model was developed by psychologists Richard Atkinson and Richard Shiffrin and was developed into a three process model (Ormrod, 2016). The first process is the sensory register which receives inputs from the environment. Attention, as mentioned above, moves information to the working or short-term memory. Finally, in-depth processing moves information to long-term memory storage. In each stage, information can be lost. The central executive works in the short-term memory to determine the flow of information throughout the processing system (Ormrod, 2016).

Another interactive component of the current light and color exhibit is a wheel and gear system that manipulates shades, tints, and hues of the six broad color categories, which are red, orange, yellow, green, blue, and purple (Assistant Secretary for Public Affairs, 2015). However, this component is not intuitive like pushing a button, so new **procedural knowledge** must be developed to operate the specific interaction. Procedural knowledge is knowledge on how to do something; it can literally be anything (Ormrod, 2016). Developing new procedural is not an inherent issue, but many visitors do not grasp how the system works and remain in the **cognitive phase** of the **ACT* model**. The ACT* model was developed by John Anderson as an expansion of Paul Fitts and Michael Posner’s three stage cognitive model (Tenison & Anderson, 2016). The ACT* model is a process of skill acquisition broken into three phases- the cognitive phase, associative phase, and autonomous phase (Anderson et al., 2018). The cognitive phase is declarative knowledge chunks that together are translated into actions. In this stage, procedures are slow and mechanical. The associative phase is tuning of the cognitive phase to create larger chunks. This occurs over time and the tasks become easier and more natural for the person performing them. The autonomous phase is the peak performance level when the former individual knowledge chunks are put together to form one large information chunk (Anderson et al., 2018).

The goal of interactive and educational museums is to apply what they learn and observe to the outside world. The light and color exhibit does not support any forms of **transfer**. Transfer is the process of using something you learned in one situation in a new situation (Ormrod, 2016). There are many types of transfer, but for this paper we will discuss **positive transfer** and **near transfer**. Positive transfer occurs when learning from one situation helps learning and performance in another situation. Near transfer occurs when a person uses an old skill in a new and similar setting (Ormrod, 2016). Therefore, the exhibit is deemed a failure for not meeting this application goal.

The exhibit does support **schema** of **accretion, tuning,** and **restructuring**. A schema is a closely connected set of ideas or concepts about a specific thing or in other words, an organized framework of declarative knowledge (Ormrod, 2016). Declarative knowledge is knowledge of facts. Accretion is learning factual information; no schema existed for the subject being learned in the past experience of the user, so accretion occurs, and a new schema is developed (Rumelhart & Norman, 1976). Tuning involves changing our existing schema to make them more accurate and congruent with new information learned or discovered (Rumelhart & Norman, 1976). Restructuring schema happens when new information is learned that is in opposition to our already developed schema (Rumelhart & Norman, 1976). While schemas can currently be developed in the existing light and color exhibit, the information needed to grow these schemas is presented in a lackluster way that causes the needed information to go unnoticed.

Perspective 2: Motivation

Maslow's extended hierarchy of needs, or motivation model, outlines three new areas of needs from Maslow's hierarchy of needs. These are **cognitive** and **aesthetic** needs and transcendence. Cognitive needs are needs for knowledge and the need to understand things. Aesthetic needs are needs for beauty and order; humans have a natural desire for beauty. Both of these needs are part of growth needs because they involve becoming the best person you could be (youtube). The current light and color exhibit meets basic cognitive needs of knowledge but does not meet all areas of cognitive needs of understanding, as mentioned in the previous section. The exhibit also does not meet aesthetic needs. The excessive use of textual boards does not appeal to human standards of beauty and does not contain the design elements of balance, form, or order (Ziauddin, 2020).

As mentioned previously, the exhibit is straightforward with textual information and simple interactions. This limits the users in exercising **self-determination theory**. Self-determination theory was originally developed by Richard Ryan and Edward Deci and states that motivation, especially intrinsic motivation, can only be achieved if the needs of **competence, autonomy**, and **relatedness** are satisfied (Ryan & Deci, 2000). Competence is the need for a person to feel they are effective in dealing with their environment. Autonomy is the need to participate because a person chooses to. Relatedness is the need to establish bonds with others and the environment around themselves (Ryan & Deci, 2000). There is almost no autonomy within the exhibit minus the choice of which button to push or which way to turn the color wheel. The current exhibit offers no chances to display competence and the exhibit has no inherent relatedness.

The light and color exhibit only engages the mind, not the entire body, which is essential in order to achieve **flow**. Flow was developed by Mihaly Csikszentmihalyi and is a form of intrinsic motivation at an intense level that “is characterized by a state of complete absorption, focus, and concentration in a challenging activity, to the point that a learner loses track of time and completely ignores other tasks” (Ormrod, 2016, p. 426). The exhibit also requires minimum effort, has no way to measure what the users learned, provides minimal feedback (other than the outputs from the color wheel), and does not present **optimal challenge**. Optimal challenge is an element of flow where the challenge is manageable but should also be a high level challenge for the participant (Rani et al., 2005).

Self-efficacy is measures how likely a person is to engage in certain behaviors when they believe they can succeed at the behavior or task; self-efficacy is essential for people to feel that they can accomplish any task set before them (Ormrod, 2016). Part of self-efficacy is **mastery experience** and **vicarious experience**. Mastery experiences, or performance accomplishments are important so that a person develops resilient self-efficacy and further believes in their ability to perform a task (Ormrod, 2016). Vicarious experiences occur when a person observes someone else succeeding at a task that they themselves are about to perform. In order for self-efficacy to be a form of motivation, cognitive processes must also take place. Learners must attribute their accomplishments to their abilities and must have perceived similarity with the person they are observing in a vicarious experience in order to improve self-efficacy. There are no ways to achieve mastery experiences within the light and color exhibit because ultimately there is nothing to accomplish. There are also no instances of vicarious experience within the exhibit itself because there are no instructions or guides on how to interact with the space. Vicarious experience could be present by observing others interact with the exhibit successfully, but this is left up to chance.

Currently, **motivation** is lacking within the light and color exhibit as a whole and does not allow users to move along the **motivation continuum**. Motivation is defined as reasons for acting or behaving in a particular way or the general desire or willingness of someone to do something by the Oxford Language dictionary. In addition to developing the self-determination theory, Deci and Ryan also developed a sub theory called organismic integration theory, or the motivation continuum (Ryan & Deci, 2000). This continuum details motivation on a scale from amotivation, extrinsic motivation, to intrinsic motivation. Extrinsic motivation has different regulations; these are external regulation, introjected regulation, identified regulation, and integrated regulation. External regulation is motivated by some sort of reward. Introjected regulation is motivated by ego goals or relation. Identified regulation is motivated by the usefulness of what is gained in the situation. This could be personal importance or conscious valuing. Internal regulation is motivated by interest, awareness, and synthesis with self (Ryan & Deci, 2000). The first step in the motivation continuum, external regulation, is not supported by the exhibit because there are not rewards from interacting with the exhibit, so no motivation past the first step can be reinforced (Ryan & Deci, 2000).

Situational interest is one the easiest design goals to implement in a physical space. Suzanne Hidi and K. Ann Renninger developed a four phase model of interest development. The first two phases are triggered situational interest and maintained situational interest (Hidi & Renninger, 2006). Triggered situational interest is sparked by a surprising feature, contains personal relevance, involves puzzles, group work, and computers, and is typically externally supported (Hidi & Renninger, 2006). Maintained situational interest is focused attention over time, reengages the user, utilizes group work and project-based learning, and is also usually externally supported. The second two phases are emerging individual interest and well-developed individual interest. Individual interest must be performed by the individual but can be reinforced and supported within the external environment (Hidi & Renninger, 2006). Interest is not triggered within the exhibit because there is not anything unique about it or any element of surprise. Further, there are no opportunities for group work, no puzzles are used, and effort on the confusing wheel interaction goes unrewarded. Since triggered situational interest is not supported, maintained situational interest is not supported either.

Finally, the light and color exhibit does not provide very many opportunities to perform any of **Maehr's goals**. Martin Maehr outlined four goal categories- task goals, ego goals, extrinsic goals, and social solidarity goals (Urdan & Maehr, 1995). Task goals are goals of learning new information. Ego goals are goals to display personal abilities. Extrinsic goals are goals to earn some sort of reward. Social solidarity goals are goals to "demonstrate commitment and faithfulness to others" (Urdan & Maehr, 1995, p. 222). Task goals are reinforced because learning can still occur through the text information given on the display panels, but chances of this happening are slim because of lack of interest and attention as mentioned previously. Ego goals can also be achieved through the interactions with the buttons and color wheel, but again, these are not fully supported because of the processes of the ACT* model and information processing model. Extrinsic goals, social solidarity goals, and future utility goals are nonexistent in the current exhibit design.

PROGRAM OF STRATEGIES

The first step in creating a more engaging, educational, and exciting exhibit is to draw in the attention of visitors. In a light and color exhibit, this can be done by installing different types of lights that emit different colors and color temperatures. This would engage the senses of the users which is key to grasp and hold attention (Ormrod, 2016). Having these lights would also be a form of triggered situational interest that would encourage visitors to come over to the exhibit. The lights also meet aesthetic needs from Maslow's motivation model.

Next, fixing the display of information would make learning the information easier and clearer. Perception is supported because the information would be displayed in a logical way that is repeated throughout the textual and graphic information. This also would again support aesthetic needs in Maslow's motivation model, and it would also support cognitive needs because information becomes easier to process and retain. Now, schema would be able to be developed in all areas- accretion, tuning, and restructuring. To further support tuning and restructuring, information should be presented in a form of "you may think this about light and color, but did you know…". This form could both tune and restructure schema. The textual and graphic information would also support Maehr's task goals.

Creating new interactive elements is key for design an engaging exhibit. A simple interactive element in the exhibit to add is hanging different colored spotlights to see how color mixing affects shadows and perception of other colors. This new exhibit would allow users to include not only their minds, but their bodies as well which is essential for users to get into a state of flow. Being able to manipulate the lighting also allows for exploration and autonomy. Including a short video to demonstrate ways to manipulate the lighting would allow for vicarious experience. Successfully mimicking the video to create light combinations would create ego goals for the users. This exhibit would also allow for a few people to manipulate the lighting and others to interact with the shadows and perceptions which could create opportunities for social solidarity goals.

To measure what has been learned in the exhibit, another interaction in the form of a color mixing game could show mastery experiences, new schema developed, and rehearsal because they would need to use new learned knowledge to effectively perform in the game. Learning how to play the game is an example of using procedural knowledge and the ACT* model. It would be easy to observe the users in all three stages of the ACT* model- cognitive, associate, and autonomous- as they learned how to play and how to play effectively. Games and puzzles also support situational interest and can help move a user along the motivation continuum from external regulation through integrated regulation depending on how interesting individuals find the subject. Having the game continue through levels is a good way to measure feedback, problem solving, concentration, completing goals, and demonstrating rehearsal. These elements are part of situational interest, information processing, flow, goals, and procedural knowledge. Games that require using recently learned information through board displays and the other interactive elements allow for positive transfer and low road transfer.

Towards the end of the exhibit, it is important to reinforce what was learned in the exhibit for retention. This would be a great time to demonstrate future utility goals and explain how light and color influence us in our everyday lives. This could be done through a short video with different prompts along the way to demonstrate what was learned. Opportunities for transfer could also be discussed in the video by explaining how they could use the skills learned in the exhibit in the outside world. Having a wrap up would support information processing, new schemas, relatedness, and interest.

As a whole, the exhibit should have a positive impact on the users' wellbeing and provide many different autonomous environmental options. Wellbeing is heavily influenced by the indoor environmental quality of the space including air quality, thermal comfort, noise and acoustic control, lighting, and the general sustainability of any materials used (U.S. General

Services Administration, 2021). All of these factors should be tested and addressed by the designer and recommendations should be made based on what is lacking. The light installation should be installed in a way that does not disrupt viewing or lighting intensity for the users. All of the information should be printed and presented on sustainable materials with low to no VOCs. Any opportunity to reuse old components or unused items in the museum storage should be taken. Finally, having sign to represent these wellbeing practices informs users on the purposeful design of the space to show that the museum does care about their presence and health. The emphasis on wellbeing will help increase relatedness throughout the space and the informational signs will allow for a direct connection to relatedness.

Autonomous environments include emphasizing individual needs, encouraging choice and initiative, providing rationale, providing feedback, and providing structure. The entire exhibit will emphasize individual needs by space planning for ADA, which is the Americans with Disabilities Act that has standards on disability design considerations. Choice and initiative will be provided by giving users the option to interact with different pieces of the exhibit. Rationale and feedback is given through the games and the information reinforcement at the end of the exhibit. Structure is given through the information presented textually, graphically, and visually and audially through the videos.

CONCLUSION

The Science Museum of Oklahoma staff and administration would see an increase in participation and interaction with the light and color exhibit by implementing the changes made above. Visitors would be drawn into the exhibit with situational interest strategies, and they would stay and use the exhibit because of the aesthetic appeal, fantastic use of interactive elements and games, and the new and engaging information that they would learn. Visitors would also experience this in an environment that promotes relatedness through wellbeing and autonomy through thoughtful environment design and implementation. All of these changes can and will lead to increased cognition and motivation not only within the science museum, but in application opportunities in the futures of all the visitors.

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