One Size Does Not Fit All:
Learning Style, Play, and Online Interactives

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Abstract

In creating educational experiences, developers often target audience segments based on demographic groups. However, we all know that people vary in other ways; one size does not fit all. This paper presents results from a research study funded by the National Science Foundation that explores the effects of three possible influences (learning style, age, and gender) on user preferences for computer-based educational activities. Using David Kolb's Experiential Learning Theory (Kolb, 1984) as a lens, we examined online learners' preferences for, and responses to, different types of activities ranging from deductive puzzles to open-ended design. Building on prior work presented at Museums & the Web (Schaller et al., 2002, 2005), we found that learning style *does* influence an individual's preferences for learning activities, particularly among adults. For example, adult social learners prefer role-play activities while intellectual learners prefer reference-style presentations. The relationship between learning styles and these preferences is stronger in adults, with adults showing more learning style-based preferences. On the other hand, among children ages 10-13 (middle school) the perceived play value of an activity has the strongest influence. While adults agree with children's play ratings, play value is not a primary consideration for adults. Age is more influential than gender in affecting activity preferences. Children prefer structured activities like Role-Play and Design. Adults prefer Interactive Reference and Puzzle-Mystery.

Keywords: learning style, learning preferences, online learning, computer interactives, play value

Introduction

One of the long-standing challenges in creating informal learning experiences for the Web is how developers can visualize their remote, often anonymous audiences. Because many Web users surf as individuals, it is helpful to look for ways to understand their diversity and uniqueness. We have become increasingly convinced that in order to create more engaging and effective learning experiences for all types of learners, Web developers must deepen their understanding of the ways that factors such as learning style, age, and gender influence user preferences for particular types of interactive digital learning activities. Evaluation methods and analysis of the effectiveness of specific informal online learning sites have continued to mature (Bearman and Trant 2004). As insightful as these studies are, drawing generalizations from them is quite difficult, and there has been less specific research into broader patterns of user preferences. This study is therefore an effort to approach the issue as a research question, rather than an evaluation problem.

This research study is the result of collaboration between two educational Web developers (Schaller and Allison-Bunnell) and two museum researchers (Borun and Chambers). It explores the role of learning style, along with age and gender, in shaping the user experience of Web-based informal learning materials. We hypothesized that when the learning experience fits an individual's dominant learning style, the experience will be more engaging and more satisfying, and thus a more successful, informal learning experience.

Learning Styles

There has been little research into the role of individual preferences or learning styles in the effectiveness of computer-based informal education. The task is confounded by the many different models of learning style that have been proposed. The models do not describe the same aspect of this complex and not easily reduced phenomenon; they focus variously on information acquisition, processing, storage, retrieval, or application. While learning style models have become unfashionable in academic circles, they are commonly applied in public education and corporate settings as a framework to recognize and accommodate individual differences.

Our research employs David Kolb's Experiential Learning Theory (ELT) (1984), which fits well with our pre-existing typology of educational Web activities (Schaller et al. 2002). Kolb draws on research by Dewey and Piaget, among others, to identify two major dimensions of learning: perception and processing. The dimensions are visualized as two intersecting axes (see Figure 1). Each axis has two poles: *perception* ranges from concrete experience to abstract conceptualization, and *processing* ranges from active experimentation to reflective observation. The two axes form a four-quadrant field for mapping individual learning styles. Researchers have applied various labels to each of the styles represented by Kolb's quadrants. We will use our preferred labels in place of Kolb's labels (in parentheses) as follows: Social (Accommodating), Creative (Diverging), Intellectual (Assimilating), and Practical (Converging).

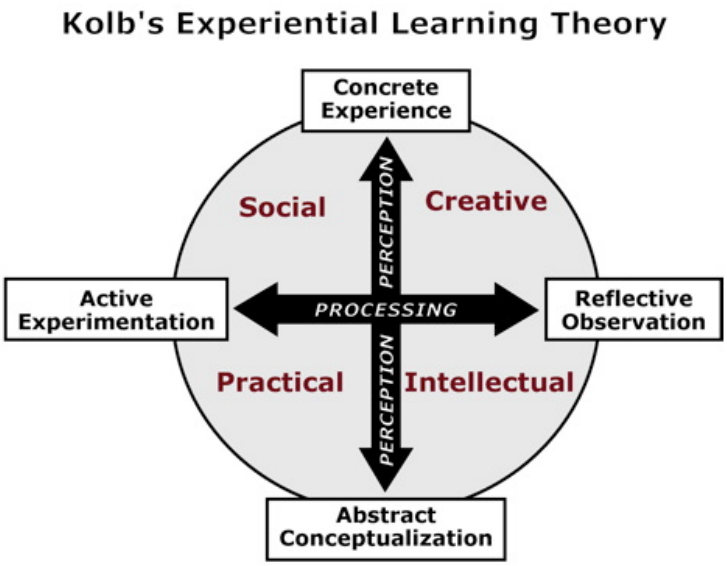

Figure 1: Learning Styles defined by Kolb's Experiential Learning Theory.

The intersection of the processing and perception dimensions creates a set of learning styles, members of which are both distinct and related to adjacent styles:

- **Social learners are leaders.** They learn best by tackling a problem as a group, relying on their own intuition and information from other people rather than books and lectures. They

seek out new experiences, often take risks, and employ hands-on methods to accomplish their goals.

- **Creative learners are imaginative.** They bring an open mind to new ideas and seek out multiple points of view. They enjoy brainstorming with a group, though they often will listen and observe before sharing their own ideas. They rely on concrete examples to learn, and trust their own hunches and feelings when making decisions.
- **Intellectual learners are organized, logical, and precise.** They like to learn from lectures, reading, and contemplation. They find facts, ideas, and information fascinating and preferable to people and emotions. More scientific than artistic, they often like to conduct experiments, but can find it hard to make decisions or to take action on a matter.
- **Practical learners are both thinkers and doers.** They learn through experimentation, seeking out new ideas and finding practical applications for them. They can focus intently on a few subjects, preferring technical challenges to interpersonal matters. They are goal-oriented and make decisions easily.

We find this characterization of learning styles to be valuable to us because it emphasizes how people like to interact with content, rather than being an internal mental model of cognition. Kolb's characterization of the modalities of engagement can therefore guide developers in shaping an activity's structure to support these modalities.

Research Study

This research study, funded by the National Science Foundation, explores the relationship between learning style and online interactives. Adapting an online activity typology developed for an earlier study (Schaller et al. 2002), we hypothesized that users will prefer an activity that matches their dominant learning style over one that does not. Table 1 summarizes our hypothesized correlations between activity type and learning style.

Table 1: Hypothesized activity type preferences by Learning Style.

Activity Type	Learning Style
Role-Play Allows users to adopt a persona and interact with other characters.	***Social*** Might prefer this since information is gathered from other characters in the activity.
Simulation Employs a model of the real world that users can manipulate to develop an understanding of a complex system.	***Intellectual*** Might find an abstract representation of the world more readily appealing.
Puzzle-Mystery Involves analysis and deductive reasoning to reach a logical conclusion. The user relies on evidence from people, nature, or reference material.	***Practical*** Might be attracted to problem-solving in the real world.
Design Emphasizes open-ended inquiry and experimentation, with a personal creation as the product of the experience.	***Creative*** Might be more engaged by the opportunity to create something unique.
Interactive Reference Provides multimedia content in a topical or thematic structure, for self-directed browsing.	***Intellectual*** Might appeal to those with self-motivated research goals.
Discussion Forum Facilitates interpersonal communication among users and subject experts.	***Social*** Might be preferred as an opportunity to interact with other people.

We also hypothesized that if an activity type aligned well with a user's learning style, the user would perceive that activity to be more like play than work, whereas activities that did not easily align with learning style would be perceived to be more like work.

Our research focused on children age 10-13 (hereafter referred to as "children") but we gathered data from all ages, allowing us to test our hypotheses with both children and adults.

Methods

Kolb's 12-question *Learning Style Inventory* (LSI) has been validated for high school-age youth (ages 14-18) and adults (Kolb et al., 2000). Our first step was to modify the LSI for use by our target audience of children age 10-13. We changed eight words to simpler terms. We then deployed an online survey consisting of the modified LSI plus age and gender questions. Figure 2 shows a sample question from the Flash-based survey, which was designed to be more fun and interactive than Kolb's paper-based LSI in order to appeal to our younger audience. We used the results of this survey to create a normalized distribution of learning styles for children, such that each learning style was represented by 25% of the sample.

Figure 2: Survey question from Learning Style Inventory for children.

We also piloted a two-sentence description of each activity type, refining each for maximal understanding by middle school students. We then ran a preliminary online survey that asked respondents to rank order their three preferred activity types based on our written descriptions of the activities and to take the LSI. Figure 3 shows how respondents were asked to rank order their top three activity types.

Figure 3: Activity Type ranking question in survey.

This survey was placed on several eduweb sites and linked from 11 additional museum sites. The survey ran from June to October 2005 and collected a sample of 3013 respondents: 1226 middle-school-aged, 545 high school, and 1242 adults. Applying the normalized distribution to these data, we found significant correlations between learning style and activity preference. Individuals whose scores fell on an axis between style quadrants were eliminated.

In the next phase of research, five of eduweb's existing educational activities, all dealing with the topic of animal ecology, were selected, abridged, and modified to provide brief (3-4 minute) experiences that exemplified five of the six activity types: Design, Role-Play, Puzzle-Mystery, Simulation, and Interactive Reference. The sixth type, Discussion, was omitted since it did not lend itself to one-way interaction and proved least popular in the preliminary survey. Figure 4 shows a sample screen of the Design activity.

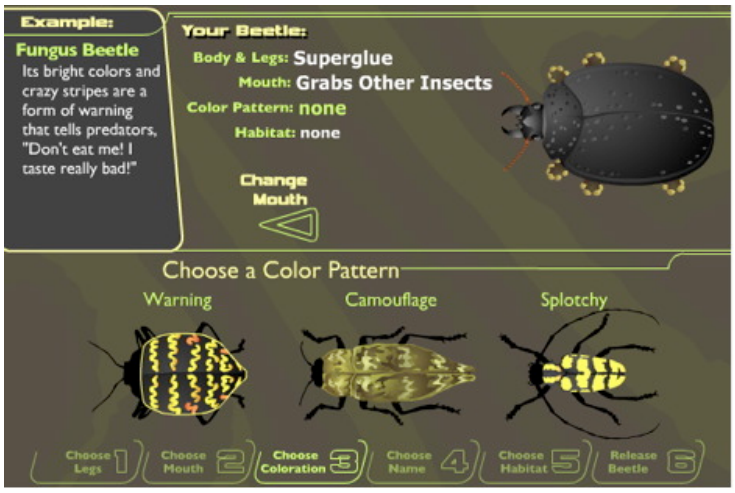

Figure 4: Sample Design activity survey item.

A laboratory-style face-to-face study of 154 children (age 10-13) was conducted with groups visiting The Franklin Institute Science Museum and at a nearby school (Friends Select School). The study consisted of the activity type rank ordering and the LSI (as in the online survey), followed by the sample activities (presented in randomized sequence) and a Likert scale rating for each one. Interviewers asked each child to discuss their ratings and to explain what they liked and did not like. In addition, children placed each activity on a 5-point bipolar scale (semantic differential) from play to work. Results of the laboratory study gave us insight into the aspects of the activities that appealed to individuals with each of the learning styles. The laboratory study also gave us interesting illustrative quotes from children.

A second online survey, also linked from multiple eduweb and museum sites around the country, was conducted from May to November 2006 and produced a sample consisting of 1161 middle-school aged children, 376 high school aged children, and 1056 adults. This survey was similar to the lab study, but since subjects did not necessarily complete all five of the sample activities, they were not asked to rank order the activities, and were scored only for the activities they did complete. T-tests and X^2 tests determined that there were no significant differences in the populations by number of activities completed. The raw sample (with the exception of subjects who scored 0 on either axis) was used to calculate frequencies of learning styles in the population. All other tests for correlation used the normalized distribution. Results of this online survey are reported below.

Results

Distribution of Learning Styles

There is a marked variation in the distribution of learning styles among children age 10-13 and in comparison to adults. Over two-thirds of all children are Active learners with a Practical or Social learning style. In comparison, the majority of adults are Abstract learners exhibiting Intellectual or Practical learning styles. Kolb's research on teens and adults shows a similar shift towards abstraction as people get older (Kolb 2005). It is interesting that the Practical learning style, at the intersection of Active and Abstract, is the most common style for both children and adults.

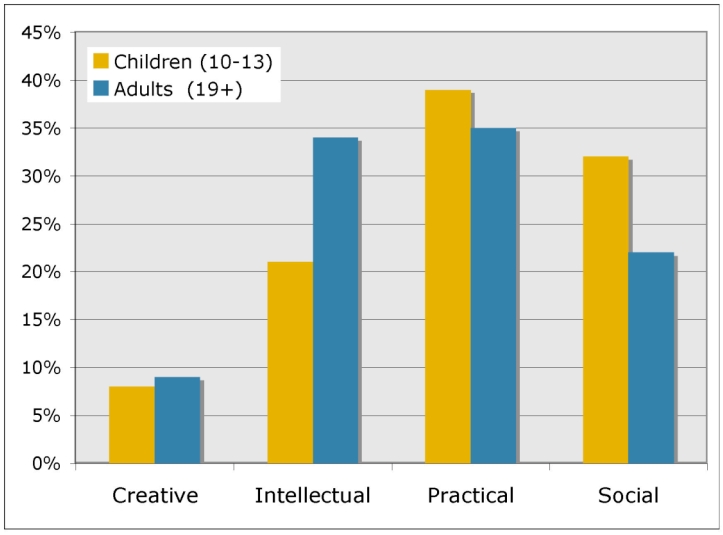

Figure 5: Learning Style distributions for children and adults.

Comparing age groups, children are more likely to have a Social learning style, while adults are more likely to have an Intellectual style (Figure 5). This pattern reflects the shift toward Abstract and Reflective modes as people mature.

With respect to gender and learning style, we found no difference between boys and girls. Among adults, on the other hand, more adult females had a Social learning style in comparison to adult males.

Age, Gender, and Activity Preference

Based on responses to our brief written descriptions (not the sample activities themselves), there is significant variation in activity preference by age group (Figure 6). Children prefer Role-Play (30%) and Design (29%) activities more than the other activities. Adults prefer Interactive Reference (33%) and Puzzle-Mystery (24%).

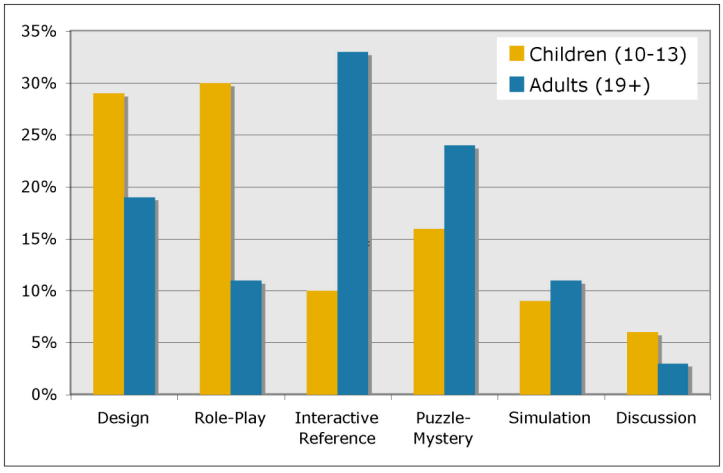

Figure 6: Activity type preference for children and adults

Gender also plays a role. Among children age 10-13, boys prefer Role-Play significantly more than girls, while girls prefer Design more

than boys. These differences affect the average ranking of the two activities: Role-Play and Design were ranked first and second by boys, and vice versa by girls. However, these gender differences are secondary to the influence of age. When considering children and adults together, gender no longer predicts activity preference. Girls are more like boys of their age, in that both prefer Design and Role-Play, than they are like adult women, who, like adult men, prefer Interactive Reference and Puzzle-Mystery. Therefore age remains the dominant factor in determining activity preference.

Note that these relationships are statistically significant *in that they differ from what would be expected in the sample using* X^2, but the relationships are relative to other groups and should not be equated with popularity. For example, girls preferred Discussion more than did boys, but Discussion is the least popular of the six activity types. Only 6% of children and 3% of adults chose Discussion as their favorite activity. Each activity has a degree of appeal for a given audience. Chi squares compare various categories of user (e.g. child/adult, male/female, and the four learning styles), whereas Figure 6 shows *frequencies* of preferences within the population.

Learning Style and Activity Preference

There are significant relationships between learning style and preferences for online educational activities.

Children

Figure 7 shows the following relationships between learning style and activity preference among children:

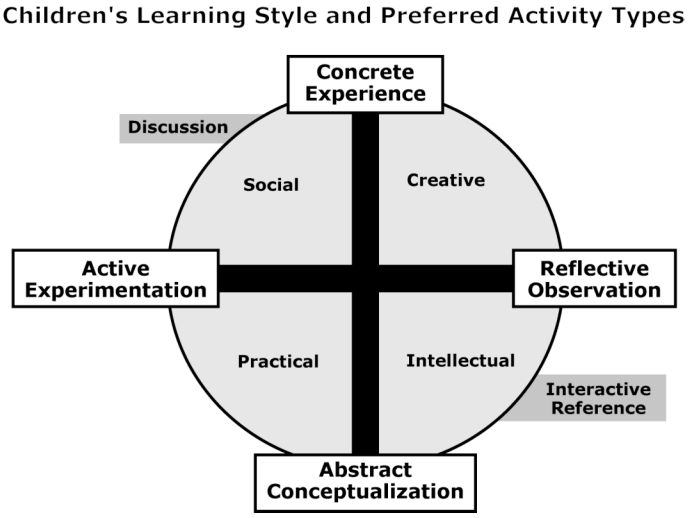

Figure 7: Children's preferred activity type mapped to learning style.

- **Social** learners prefer Discussion more than those with other learning styles. Social learners rely on other people when gathering information and accomplishing goals, making Discussion activities an ideal medium. As one Social girl put it, *"Because I can ask other people for help and compare answers, and it would make learning more fun!"*
- **Intellectual** learners prefer Interactive Reference more than those with other learning styles. A hypermedia encyclopedia allows for exploration of a wide range of information, particularly abstract ideas and concepts. As one Intellectual child said, *"It's easy for me to observe on my own. Reading or looking at something is easy for me."*

These two associations support our research hypotheses. However, there were no significant associations for Creative or Practical learners within our target age group (10-13).

Adults

The relationship between learning style and activity preference is stronger in the adult age group. Among adults, all four learning styles are associated with activity preferences. Figure 8 shows the following relationships between learning style and activity type preference among adults:

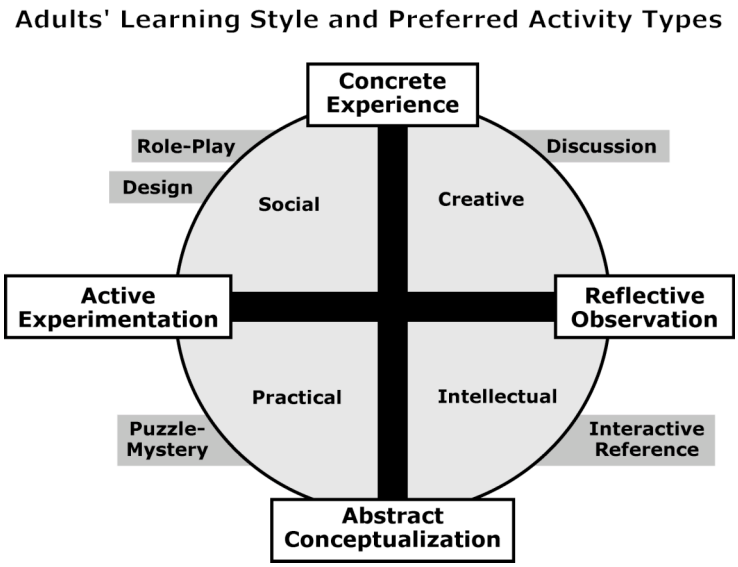

Figure 8: Adult's preferred activity type mapped to learning style.

- **Creative** learners prefer Discussion more than those with other learning styles. Like Social learners, Creative learners learn best from concrete experiences, such as interacting with other people. Creative learners also seek out new ideas and perspectives from others. As one Creative adult said, *"It gives me new ideas...I get to meet new people and learn through the interaction."*
- **Intellectual** learners prefer Interactive Reference more than those with other learning styles. As with children, adult Intellectuals seek out direct contact with information, whether in print or online. *"This has always been my favorite approach to learning. I read the entire Encyclopedia Britannica before I was 12 years old." "I am in constant search for knowledge."*
- **Practical** learners prefer Puzzle-Mystery more than those with other learning styles. This activity type puts abstract content into a real-world problem or mystery, appealing to Practical learners' desire to solve problems and find useful applications for ideas and theories. *"It's fun to investigate things and determine solutions."*
- **Social** learners prefer Role-Play more than those with other learning styles. Social learners rely on people for information, so an activity like role-play that embodies information in character voices is appealing. *"I like playing outside my own character and exploring other personalities."*
- **Social** learners also prefer Design more than those with other learning styles. Design activities appeal to Social learners' desire for active, hands-on learning. *"Design is the ultimate problem-solving exercise."*

These results generally support our hypotheses. Three of our predictions are borne out:

- Intellectual adults prefer Interactive Reference.
- Social adults prefer Role-Play.
- Practical adults prefer Puzzle-Mystery.

Two additional associations are close to our predictions:

- Social adults (rather than Creative, as we predicted) prefer Design activities.
- Creative adults (rather than Social, as we predicted) prefer Discussion.

Both Social and Creative are on the Concrete side of the Concrete-Abstract axis, but differ on the Active-Reflective axis. Both Design and Discussion involve active participation as well as reflective contemplation. Respondents appear to have reacted to different aspects of these two activity types than we predicted.

Sample Activity Rating and Play/Work Score
When testing the sample activities, children nearly always liked those activities that they scored as high in play value. That is, children gave high activity ratings to the same activities that they thought were more like play than work. Play value seems to be more influential than learning style in predicting children's responses to a given activity.

Adults, however, *do* differentiate between the two ratings. On average, adults gave each activity a play/work score that was similar to that given by children. But their activity ratings did not follow suit. For example, adults scored Role-Play as second in play value, but last in activity rating—behind Simulation and Interactive Reference, which had lower play scores. Play, it seems, is a secondary consideration for adults, with Simulation and Interactive Reference offering something valuable to adults that overrides the appeal of play.

In modifying activities for use in this research, we sought to emphasize the core attributes of each activity type, rather than to strengthen its play value. It would certainly be possible to design a simulation with high play value if that was a goal. A commercial game like *The Sims* is a good example of just such a thing.

Conclusions
While museums and informal learning institutions have embraced the Web as a medium for public outreach and education, we still are grappling to understand our online audiences in their rich diversity and individual uniqueness. This research identifies several important factors that developers should consider when creating computer-based learning materials. Our central hypothesis, that activity preference and learning style are related, has been confirmed for adults. This relationship is weaker for middle school-age children, presumably because their learning styles are not yet as fully solidified as adult's learning styles. We have also found that activity preferences differ significantly between groups of children and adults. Finally, gender differences in activity preferences are weaker than learning style or age.

Learning Style
Learning style is indeed a major determinant of adult activity preference. The adult preference for Interactive Reference supports our previous findings that many adults have instrumental information-seeking goals for their online activities (Schaller et al. 2004). Adults' preference for Puzzle-Mystery accords with the widespread popularity of puzzle-type "casual games" such as Bejeweled and Solitaire among adults on- and off-line. It remains an interesting challenge for informal education developers to create Puzzle-Mystery content for adults that contains both casual game puzzle-solving elements and real-world educational content.

Children, on the other hand, do not have as strongly-differentiated learning styles, and the relationship between learning style and activity preference for children appears to be correspondingly less strong.

Age Group

While the data and statistical analysis employed for this paper do not allow us to tie activity preference or learning style to a particular age, it is clear that the relationship between learning style and activity preference is different in children and adults.. Other factors besides learning style shape people's activity preferences. Children scored our sample Design and Role-Play activities as being most like play on the play/work continuum; they also gave these two activity types the highest overall ratings. Play value seems to be more important than learning style for children.

Gender

With regard to gender differences, there has been considerable discussion about designing girl-friendly video games and other electronic media (Chu et al. 2004). We found some influence of gender on children's activity preferences, with boys preferring Role-Play and girls preferring Design, However, these differences are not related to learning style, and they are secondary to age. To bridge gender differences, developers should consider ways to incorporate attributes from Role-Play and Design into any activity designed for children.

Implications and Applications

Our results for the adult sample suggest that diverse pedagogical methods are critical to successfully engaging the full spectrum of adult learners. In particular, it is vital for developers to recognize that their own learning style is just one of multiple ways to learn, and to consider designs for interactives that will appeal to other types of learners. For example, computer science students tend to be Intellectual learners (Kolb, 2005). Developers who are Intellectual learners would need to look beyond their own intuitive personal preferences to find ways to engage Social, Creative, and Practical learners. Two different solutions to this problem are possible. First, developers can create custom activities for each learning style, offering a suite of a la carte activities ranging from searchable reference content for Intellectual learners, puzzles or mystery activities for Practical learners, hands-on design interactives for Social learners, and an opportunity to share ideas and perspectives for Creative learners. Alternatively, developers can incorporate attributes that appeal to each of the learning styles into a single integrated activity.

This research study informed eduweb's development of such a project, a Web site about black holes in collaboration with the Space Telescope Science Institute (http://hubblesite.org/explore_astronomy/black_holes/). The site offers encyclopedic content in both a reference section and as an on-demand pop-up window within interactive modules. These modules present puzzling questions (e.g. *How do you find an invisible object?*) as well as hands-on experiments for active, trial and error exploration (*Can you find a safe orbit around a black hole?*). The site did not offer social interaction with other users, as this requires staff moderation, --a challenge for many organizations. Since Discussion was not especially popular even with Creative learners, this was not a high priority.

The fact that adults and children generally agreed on the play value of our sample activities indicates that play value should be a central goal. On the other hand, Interactive Reference was relatively low in children's activity preferences and placed last in both play/work scores and

sample activity ratings. Children's aversion to Interactive Reference should limit its use to homework and research sites and to topics in which children have an intrinsic interest.

For children, the open-ended, exploratory nature of Design and Role-Play activities seem to mesh well with their desire for playful activities, across learning styles. For topics with content that is suited to Puzzle-Mystery or Simulation activities, developers may want to incorporate design or role-play elements to broaden their play value and appeal.

Overall, learning style does influence preference for online activities, and is yet another way that one size does not fit all. The results of this study provide new insight into our unseen audiences, helping us anticipate the kinds of experiences to which they will respond. It is a valuable addition to any Web developer's approach and can help them create experiences that will appeal to all kinds of learners.

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