The Role of Individual Learning Styles in the Design of Interactive Tutorials:

an Evaluation of "Age of Empires II" Tutorial.

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What is a learning style.

In "Style, Strategy, and Skill in Learning" John Kirby organizes cognitive processes in a continuum, essentially dividing it into two domains: strategies and skills (Kirby, 1988, p.230). He refers to skills as "cognitive routines for performing specified tasks," and to strategies as the "means of selecting, combining, or redesigning those cognitive routines" (p. 230). Within this framework he defines cognitive (or learning[1]) styles as the "habitual use of a class of similar strategies" (p. 231). For example, an analytic style could include strategies such as breaking the problem into parts, writing down information, and so on (Kirby, 1988, p. 231). Therefore, we can say that an individual's use of a particular set of strategies defines his or her learning style. This conclusion is consistent with Gordon Pask's definition of style as "a disposition to adopt one class of learning strategy" (Pask, 1988, p. 85).

Do styles belong to specific people or can individuals adopt different styles? The general consensus in literature seems to be that while individuals can adopt different learning styles to a varying degree (Pask, 1988, p.85), there seems to be a 'natural' learning style that results in highest learning performance[2] (Riding, 1998). Riding states that "strategies can be learned and modified while style is a relatively fixed core characteristic of an individual" (1998, p. 79).

In "A Capsule History of Theory and Research on Styles" Robert Sternberg and Elena Grigorenko make an important distinction between cognitive (or learning) strategies and styles: "styles operate without individual awareness, whereas strategies involve a conscious choice of alternatives" (2001, p. 3). In fact, "individuals develop learning strategies to deal with learning material which is not initially compatible with their cognitive style" (Riding, 1998, p. 79). It follows, then, that instruction should be tailored to an individual's learning style to be most effective. This way learners would not be burdened with developing new strategies to cope with situations when content structure and presentation does not match the requirements of their learning style.

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[1] The terms cognitive and learning styles so close that they are sometimes used interchangeably in literature. One way to differentiate between the two is to think of a learning style as a cognitive style in a learning environment: "learning styles are simply cognitive styles applied when individuals go about learning something" (Schmeck cited in Das, 1998, p. 102).

[2] Learning performance can be defined as amount/quality of recall for newly learned material. This measure is used by Riding and others in experiments designed to determine the effects of content structure and presentation on people's ability to learn given the differences in their learning styles.

Cognition-centered styles.

Sternberg and Grigorenko group cognitive styles into three broad categories: cognition-centered, personality-centered, and activity-centered (Sternberg & Grigorenko, 2001, pp. 2-18). Cognition-centered styles include dimensions such as field dependence vs. field independence, holistic vs. serial processing, leveling vs. sharpening, reflection vs. impulsivity, and so on. Meyers-Briggs' personality indicator is based on personality-centered styles. Finally, Kolb's experiential learning theory is based around activity-centered cognitive styles (Sternberg & Grigorenko, 2001, pp. 2-18). The focus of this paper is on cognition-centered styles.

A useful way to think about cognition-based styles is by grouping them along two fundamental dimensions: wholist-analytic and verbal-imagery (Riding & Rayner, 1998, p. 18-19). Let's examine several of the wholist-analytic styles in more detail.

Witkin's field dependence vs. field independence is perhaps the "original" wholist-analytic cognitive style. He based the distinction on the observation that some people depend more than others on "the structure of the prevailing visual field" (Sternberg & Grigorenko, 2001, p. 5). For example, "a field-independent person can look at a complex drawing and find embedded in it a figure or a shape" (Sternberg & Grigorenko, 2001, p. 5). On the other hand, "a field dependent person has more trouble separating a hidden form from its surrounding context" (Sternberg & Grigorenko, 2001, p. 5). Several studies cited by Alomyan reveal that field dependent learners have more difficulty (confusion, cognitive overload, etc.) in non-linear environments such as the hypertext environment of the Web (Alomyan, 2004, p. 189).

Pask's holist-serialist style dimension divides learners into holists, who "grab" generalities first and add details as needed, and serialists, who focus on details first (Pask, 1988, p. 83). Holists take a global approach to learning, processing several aspects of a topic at once. Serialists are more detail-oriented and prefer to work step by step (Riding & Rayner, 1998, p. 29). Holists are more likely to reconstruct what they have learned to suit their needs, while serialists tend to reproduce learned material verbatim (Ford & Chen, 2000).

The division of learners into levellers vs. sharpeners was proposed by Holtzman and Klein to explain that some people tend to see things that are different as almost or completely alike, others see things that are similar as very different (Riding & Rayner, 1998, p. 23; Sternberg & Grigorenko, 2001, p. 7). As people mature and gain experience they move away from being levelling towards sharpening (Riding & Rayner, 1998, p. 23). Experts, marked by a high degree of sharpening can make distinctions they could not make before as levellers (Sternberg & Grigorenko, 2001, p. 8).

Yet another wholist-analytic style was introduced by Kagan in order to account for individual differences in the tempo of decision making under conditions of uncertainty (Riding & Rayner, 1998, p. 25). The two main categories of learners identified were cognitive impulsives and cognitive reflectives. Impulsives reach decisions quickly, completing more work, but with more errors. Reflectives are essentially the opposite: they take longer to carefully consider all options, but make fewer mistakes (Riding & Rayner, 1998, p. 25; Sternberg & Grigorenko, 2001, p. 10).

Considered collectively the two style dimensions yield the following general characteristics for the individuals who possess them (from Riding, 2001):

- Wholists can easily see the big picture, but may miss details and are less able to impose their own structure on material. They benefit from getting an overview of the material to be learned. Riding's own studies show that wholists benefited from being presented with a clear heading before being presented with the material rather than after (Riding, 2001, p.140).

- Analytics see the situation as a collection of parts. They focus on one or two parts at the expense of the others and may exaggerate the significance of a single part. A study done by Riding and Grimley points to reduced performance of analytics with smaller screens, most likely because they had "difficulty attaining the whole view of the material" (Riding & Grimley cited in Riding, 2001, p.142). Riding also proposed that analytics are the ones who are more likely to print documents to "obtain a feel for the overall structure" of the document (Riding, 2001, p.143).

- Visualizers learn better from pictorial representations. They form spontaneous mental pictures of objects or concepts about which they are thinking.

- Verbalizers (or imagers) learn better from verbal representations. They consider information in word or verbal associations.

Due to these individual differences in learning styles instruction content must be structured and presented to take into account all four of these learning style dimensions. It should be easily accessible by both wholists and analytics as well as by verbalizers and visualizers. For example, Richard Riding's experiments lead him to conclude that, in general, complementing text with images "meets the needs of a wider variety of styles and results in better learning by more people" (Riding, 2001, p. 148).

The Case Study: Age of Empires II game tutorial.

Microsoft's real-time strategy game "Age of Empires II: The Age of Kings" (AoE II) has received a lot of praise since its release in 1999. "In many cases the tutorial was singled out as excellent" (Medlock et al., 2002). The rest of this paper examines how well the design of the AoE II tutorial satisfies the needs of the different learning styles discussed above.

Instead of a non-interactive, movie-like demo (or worse yet, a series of screens with text instructions), the tutorial is a "hands-on" exercise. AoE II's designers created a series of learning scenarios that introduce the basics of controlling the game by having the player actually play through the scenarios. The tutorial starts off by teaching the player the basics of creating characters, controlling their movements and assigning them to tasks like building houses, gathering food and so on.
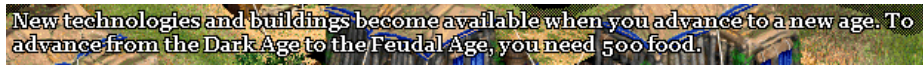
Each scenario has a title like "Training the Troops," "Research and Technology," and so on (see illustration on the next page). These titles should work well for holistic learners who can base their expectations on what they are about to learn from these headings. They can use what they already know about these subjects to help them make sense of the new material As a group, the titles also provide a structure on which learners can "hang" the knowledge and skills they acquire. Of course, the titles also help more experienced players decide which scenarios they can skip.
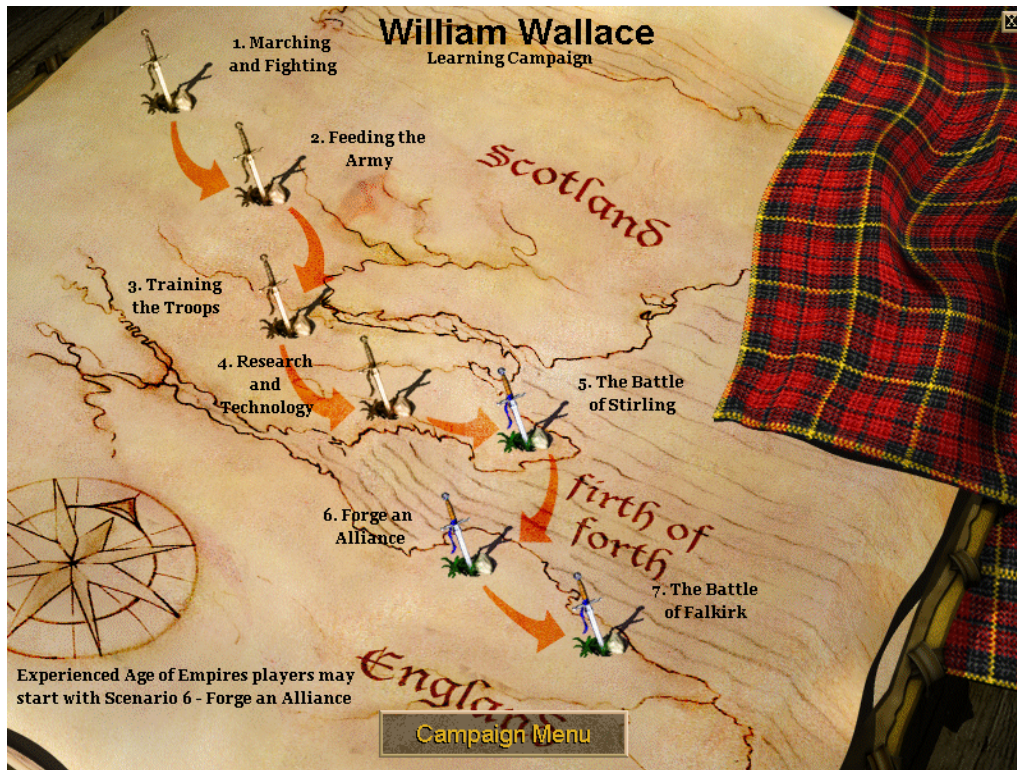
Once the mission is under way, a more specific task is given before the learner is asked to perform actions. For example, the narrator may say "Follow the path to the blue flag" before giving more detailed instructions on what actions to take to accomplish this task. This way, once they receive more detailed directions like "click the soldier" and "right-click the flag," the learners will not be left wondering why they're performing the actions and can easily estimate their progress toward accomplishing the task. Holistic learners can use these tasks to organize their newly-gained knowledge into a mental model.

The finely grained, step by step instructions work well for analytic—or serialist—learners, who prefer to deal with learning problems one piece at a time. The only negative comment about instructions is that sometimes several instructions are given at a time before letting the player carry them out. The player has to memorize several instructions at a time, which increases the load on working memory. This increases the chance that the player will forget a step and have to read the on-screen instructions in order to proceed. Unfortunately, the instruction text is rendered over a "contrasty," textured background,

making the text difficult to read:

New technologies and buildings become available when you advance to a new age. To advance from the Dark Age to the Feudal Age, you need 500 food.

Using a dark, uniform (non-textured) background would help set the text apart from the background. This is an example where two factors—a high-order cognitive and a low-order perceptual—conspire to make the tutorial more difficult to follow.

The tutorial's instructions constantly refer to graphical objects on the screen, but are given in a verbal form. Verbalizers should have no difficulty "mapping" the verbal references to the screen objects. Visualizers, on the other hand, may have to work a little harder to mentally translate the words into their pictorial representations on the screen. One way to make this process easier for visualizers is to highlight an on-screen object as the narrator mentions it. Graphically, this could take the form of a halo drawn around the object or a pointer drawn next to it. In fact, this technique could help all users in case it is unclear what object the narrator is referring to. For example, at one point the learner is instructed to click the town center. Since the town center looks a lot like a market, a novice player—especially a highly field-dependent leveller—may not be able to tell the two apart.

As the tutorial progresses and the player gains a better grasp of the basic actions, he may be tempted to work "ahead" of the narrator, clicking on objects before being instructed to do so. This is especially true of impulsive learners who are more tolerant of making errors if it means getting through the material faster. Unfortunately the tutorial is somewhat insensitive to the speed with which the player is working and can sometimes instruct a player to perform an action he already completed. The tutorial also does not provide extra help to users who are having trouble carrying out the correct action. For example, there is no additional assistance given no matter how long the user stays inactive after being given an instruction. In addition, clicking wrong objects does not produce any response from the narrator. Only positive feedback is given: for actions that are completed correctly. This makes it more difficult for the players to learn from their own mistakes. A general suggestion, here, then, is to make the tutorial

more sensitive to what the learner is doing (or not doing) by providing useful feedback in cases when an incorrect or no action is carried out.

Conclusion and summary of recommendations.

Overall, the AoE II tutorial is easy to follow for learners of most styles. There is structure for the wholists and step by step instructions for the analytics. There are also verbal instructions for the verbalizers. The fact that there is no explicit "visual" guidance for the visualizers may make it more difficult for them to follow the tutorial's instructions. This, however, is offset by the fact that the game's objects and controls are highly graphical in nature. This means that once a visualizer learns them, he should have no trouble applying this pictorial knowledge to navigating the game's interface.

To make the tutorial better, the game designers should:

- avoid giving too many instructions in a row before letting the learner start completing the actions; studies show that smaller content chunks result in better learning and recall for all learning styles (Riding, 2001, p. 147).

- make the tutorial more responsive to what the user is doing and adjust to the user's pace: offer more feedback and skip instructions when necessary.

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