Learning Styles Data and Designing Multimedia for Engineers

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Abstract

During the development of the multimedia learning environment Biology for Engineers, learning styles data from the Myers-Briggs Type Indicator (MBTI) and the Felder/Soloman Index of Learning Styles (ILS) was obtained from over 150 engineering students at the University of Washington and compared with a pool of existing data from six earlier studies. Although there are discrepancies, the UW data broadly corresponds with the data from the combined pool. L-styles data, despite significant limitations, can contribute to the multimedia design process when viewed as a kind of customer survey of user preferences and a heuristic for considering various design alternatives. Future designers can either utilize the data presented in this study or test their own users.

Keywords: *multimedia, instructional design, learning styles, MBTI, ILS*

Introduction

In Autumn 2002 the Biology for Engineers project was initiated by Prof. Mary Lidstrom of the Department of Chemical Engineering at the University of Washington. The Project, funded by a Howard Hughes Medical Institute Professorship, aims to prepare engineering students at the University of Washington and beyond to pursue careers at the boundary of biology and engineering. This project includes the development of courses in which engineering students learn cellular biology in a manner that leverages their engineering backgrounds. An important resource in these courses is the multimedia learning environment (MLE) Biological Information Handling: Essentials for Engineers (BIH). BIH was completed in 2004. It is available for viewing or downloading at www.biologyforengineers.org.

BIH includes explanatory text and graphics, flowcharts, interactive exercises, and other components. The most important components, however, are narrated animations of three key concepts in cell biology: replication, transcription, and translation. A screen capture of the replication animation is shown in Figure 1.

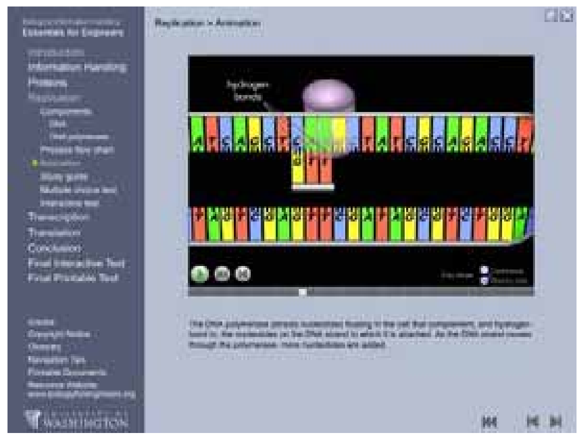

Figure 1. The replication animation. The main navigation column appears at the left.

Patricia Kirkham was given the task, also the topic of her master's thesis [1], of investigating the usefulness of learning styles ("L-styles") research in the design of BIH and, by extension, MLEs in general. Our premise was that L-styles tests could serve as a kind of customer survey similar to customer surveys performed in business settings and thereby enrich our design process.

Kirkham administered learning styles tests (L-tests) to 155 University of Washington engineering students and compared this data with published L-test data from six previous studies of engineering students. She then worked with the rest of the project team to apply what she learned to the design effort. These are the main lessons we learned:

(1) L-styles test data, carefully interpreted and applied, can be used to guide certain aspects of MLE design. L-styles data can serve as a heuristic for good design and as a means to evaluate design tradeoffs.

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(2) The ILS data proved to be more informative and easier to translate into specific design guidance than the MBTI data.

(3) Learning styles preferences reported by engineering students accord with mainstream guidance for multimedia design. Therefore, those designing MLEs for engineering students can proceed with some confidence that mainstream design choices for both multimedia content and the user interface will succeed with this audience. Concomitantly, departures from mainstream design may be risky for this audience.

(4) If engineering audiences exhibit highly atypical L-styles preferences, non-standard design decisions should be investigated.

In addition, we strongly endorse a broad range of user testing to ensure successful design, and we briefly describe some other kinds of user testing that were employed in this project.

The Design of Multimedia Learning Environments

Multimedia Learning Environments, which can be described with less precision as "online tutorials," are an important part of the digital revolution. Whether delivered on physical media, such as CDs, or else on the Web, MLEs are a prevalent and often highly successful means of instruction. Authoring environments such as Macromedia Flash, Macromedia Authorware, PowerPoint, and simply HTML web pages with animated GIFs are suitable technologies depending on the nature of the project. Our project was implemented in Flash.

We can speak usefully of three interrelated dimensions of MLE design:

The user interface (UI) refers to the means by which the user interacts with the MLE. This includes navigating through the MLE to find the various components of instructional content and operating the individual components—for example, pausing an animation. Figure 1 includes BIH's main navigation column for choosing the instructional components; the buttons (at the bottom right of the screen) for moving linearly through the content components; and the controls for the animation player (visible below the animated DNA molecule).

The content of an MLE consists of instructional content—the heart of the MLE—and, very often, subsidiary content such as instructions for using the MLE and tips about how to study and learn. The content takes the form of text, static graphics, motion graphics, and audio.

Look and feel is a broad concept that pertains to the entire MLE, both the content and the user interface. Look and feel includes the visual styling of both static and motion graphics but also includes the style of the UI behavior (e.g., how menus expand and collapse) and the audio (e.g., the narrator's voice). These choices must, of course, work with the UI and content, but, in addition, they have a broad influence on the overall user experience. As discussed below, Kirkham conducted informal experiments as a means to devise an effective look and feel for BIH.

In our design effort, we strove to ensure that each dimension accommodates the background and needs of the audience, accords with the inherent characteristics of the subject matter, and thereby furthers our instructional objectives.

Learning Styles and L-Styles Research

Learning styles and learning preferences data comprise a complex and often controversial topic. A detailed discussion is beyond the scope of this study, though see the references herein. The core idea is that individuals possess relatively stable traits, or preferences, related to how they prefer to receive and process information. Theory holds that everyone uses each learning style at times, but that individuals will respond more effectively in their preferred style.

The most widely used, cited, and verified L-styles test is the MBTI (Myers-Briggs Type Indicator). It is technically a personality test, but it is routinely applied to educational settings. Another L-styles test important for our purposes is the ILS (Felder/Soloman Index of Learning Styles). The ILS was developed specifically to further engineering education.

Studies that look at the match between students' learning preferences and instructional approach indicate effects in regard to learners' reported comfort and enjoyment and in some cases performance as well.[2, 3, 4, 5, 6, 7, 8] In addition, studies found that individuals with strong preferences will struggle and occasionally drop out if their learning style is not properly addressed.[9, 10, 11, 12, 13, 6, 14, 5]

There are various caveats associated with L-styles research. One is that data is self-reported and highly qualitative. Another is that it is not always clear how these preferences translate into a given pedagogical or design approach, so careful interpretation and application of L-styles data is necessary. Finally, responsible use of L-styles data is essential. It is wrong to say that anyone's L-style indicates that the individual cannot learn a particular subject, and for both scientific and ethical reasons it is highly inappropriate to employ L-Test data to determine aptitude for study or study in a particular area.

Despite these caveats, research studies speak positively for the integration of L-styles considerations into MLE design and support our reasoning that designing BIH in accordance with the L-styles preferences of engineers would increase the likelihood of a positive response from that group. Applying L-styles theory to MLEs is not a new concept, merely one that has not received adequate attention—though that is beginning to change.

In the most general sense, L-tests may provide a first glimpse at the likely success of an MLE. Hoffman, et. al.[5] found that Sensing types respond particularly well to MLEs. Dewar and Wittington [3] note that Introverts, Intuitors, and Thinkers are largely overrepresented in online environments, suggesting that these types have more interest and/or a higher comfort level with MLEs. These findings suggest that a target learner population with a high percentage of these learner types is more likely to use and respond well to an MLE.

Montgomery [6, 15] argues that MLEs supplement conventional classroom or lecture hall teaching because they support learning styles that are not well supported in traditional learning environments. She also offers general precepts for multimedia design based on L-Styles theory and research. We agree with Montgomery, but our focus is how to use L-styles data in particular MLE projects. Also, whereas Montgomery tested a small number of students using the ILS, our effort entailed a much larger sample of both MBTI and ILS data.

The MBTI and the MBTI Data

The MBTI measures preferences on four scales: Extroversion-Introversion, Sensing-Intuition, Thinking-Feeling, and Judging-Perceiving—summarized as follows:

Extroverts (E) — Introverts (I)
Extroverts focus on the outer world, preferring to work in groups and discuss information with others. Introverts, in contrast, prefer to work alone and tend to focus inwardly on their own thoughts.

Sensors (S) — Intuitors (N)
Sensors want to know how information relates to the real world. They enjoy facts, hard data, and systematic approaches. Intuitors, on the other hand, are comfortable with the theoretical and abstract. They enjoy exploring possibilities and relationships between pieces or bodies of information.

Thinkers (T) — Feelers (F)
Objective and impersonal, Thinkers thrive in rational, data-driven environments. Feelers prefer the personal and subjective and typically see little value in information that does not include the human element.

Judgers (J) — Perceivers (P)
Well organized and decisive, Judgers like to plan things out and respond best when provided a clear, well-defined pathway. Perceivers, on the other hand, are spontaneous and flexible and may balk if faced with a rigid environment.

The four scales are based on Jung's Theory of Psychological Types [13,16], and the assessment is polar in that individuals are asked a series of questions to which they may choose one of two provided responses. An individual's type designation is then determined based on the number of responses chosen for each mode. Scores are typically reported as four letter type designations, e.g. INTJ. A percent preference value may or may not be reported in conjunction with each scale's preference designation, e.g. 78% N.

Between spring and summer quarters of 2003, Kirkham collected L-styles data from 155 University of Washington engineering students

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with a variety of majors. They were enrolled in writing courses taught by the University of Washington Department of Technical Communication. Students filled out a Human Subjects Statement of Informed Consent, accessed the L-styles tests online, recorded their results on a print data sheet, and returned the data sheet either to Kirkham or their instructor.

To complete the MBTI questionnaire, participants were directed to www.humanmetric.com/cgi-win/JTypes2.asp. (Last accessed 5/29/06.) Note: This test is not the official MBTI, for which the cost was prohibitive, but a non-proprietary equivalent. The questionnaire consists of 72 Yes/No choices. Examples are shown in Figure 2.

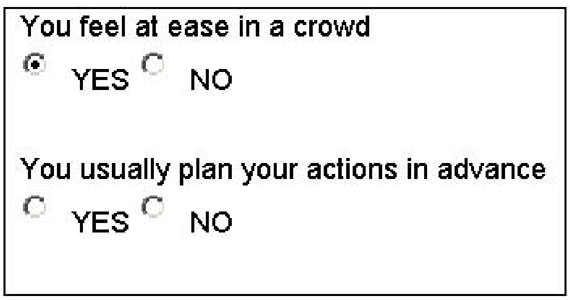


Figure 2. Sample questions from the online MBTI test.

Kirkham also examined the published results of MBTI data on 9084 engineering students from six previous studies. The results from these pooled studies are compared to the UW cohort in Figure 3.

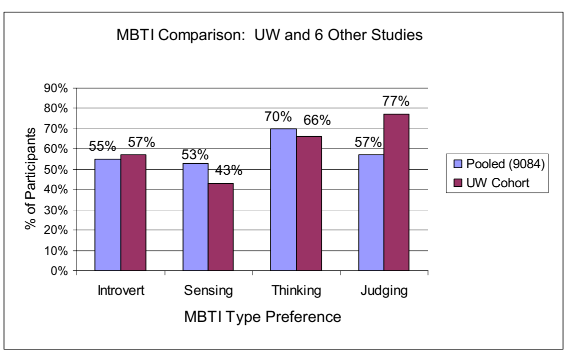


Figure 3. MBTI Comparison of UW and 6 Other Studies

An analysis of each MBTI preference scale shows that the combined pool exhibits a mild preference for Introversion (vs. Extraversion)—as does the UW cohort. The UW cohort shows a preference for Intuition (shown by the 43% on the Sensing scale), whereas the combined pool shows a mild preference for Sensing. The combined pool—and the UW cohort as well—show a strong preference for Thinking over Feeling. The combined pool shows a mild preference for Judging over Perceiving, while the UW cohort shows a strong preference for Judging over Perceiving. Because these data are highly qualitative and are best viewed as a kind of customer survey, we describe the findings in terms of strong or mild preference rather than looking for statistical significance.

The ILS and the ILS Data

In 1988 Dr. Richard Felder, an engineering professor at North Carolina State University, and Dr. Linda Silverman, an educational psychologist with the Institute for the Study of Advanced Development, devised a learning styles model to specifically address learning styles dimensions relevant to engineering education.[17] The Index of Learning Styles (ILS) was developed three years later as a corresponding psychometric assessment tool and was made available on the web in 1996. Preferences are explored on four dimensions and can be mild, moderate, or strong. The dimensions are summarized as follows:

Active — Reflective
Active learners like to do something with the information they receive and work well in groups. Reflective learners prefer to think things through, work best alone, and tend to be theoreticians. This dimension has commonalities with the MBTI. “The active learner and the reflective learner are closely related to the extravert and introvert, respectively, of the Jung-Meyers-Briggs model.”[17]

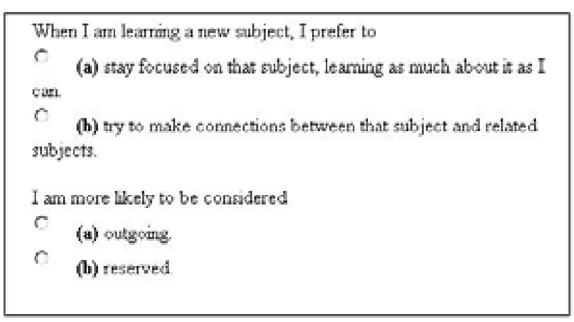
Sensing — Intuitive
Sensing learners favor observation. They gather information through their senses and favor facts, details, and standard methods of problem solving. Intuitive learners gather information indirectly through speculation or imagination. They prefer ideas and theories, they like to be innovative, and they quickly get bored with details and repetition. This learning styles dimension stems from Jung’s theory of psychological type and is considered equivalent to the Sensing/Intuition scale of the MBTI.

Visual — Verbal
Visual learners prefer graphs, diagrams, and other pictorial devices that allow them to see the information. Verbal learners prefer explanations in the form of words, either written or spoken. This learning styles dimension comes out of learning modality preference research.

Sequential — Global
Sequential learners prefer the step-by-step, linear presentations of information and can be highly analytical. Global learners tend to learn in jumps. They may struggle with even rudimentary concepts, but will then suddenly “get it” and proceed to have a thorough understanding of the material often considerably beyond that of the Sequential learners.

Similar to the MBTI, each learner is evaluated for their preference on each of the four scales, which combine to describe their learner type. Unlike the MBTI, learners are not assigned a specific type designation.

Between Spring and Summer Quarters of 2003, 153 individuals from the same group of UW students completed the ILS questionnaire. Two students did not provide ILS data. The questionnaire is available on this website: http://www.engr.ncsu.edu/learningstyles/ilsweb.html. (Last accessed 5/29/06.) Examples of typical questions are shown in Figure 4. A sample learner profile is shown in Figure 5.


When I am learning a new subject, I prefer to
(a) stay focused on that subject, learning as much about it as I can.
(b) try to make connections between that subject and related subjects.

I am more likely to be considered
(a) outgoing.
(b) reserved.

Figure 4. Example of ILS questions

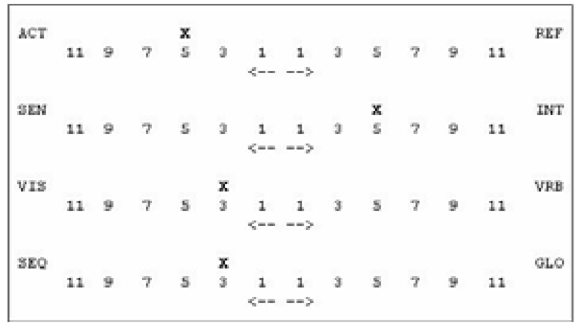


Figure 5. Example of an ILS profile

Kirkham also examined the published ILS data on 1978 engineering students from six previous studies. In Figure 6, the results from these pooled studies are compared to the 153 UW students.

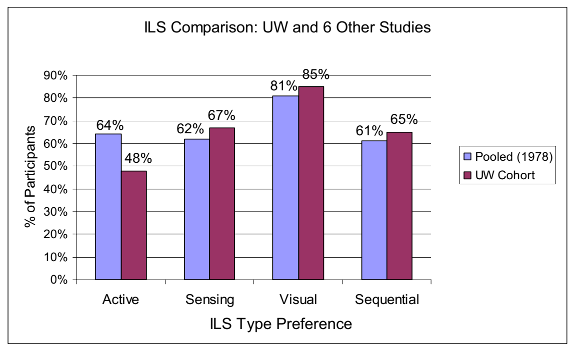


Figure 6. ILS Comparison UW and 6 Other Studies

An analysis of each ILS preference scale shows that the combined pool exhibits a pronounced preference for Active (vs. Reflective) learning, whereas the UW cohort exhibits a slight preference for Reflective learning (the 48% score on the Active learning scale). Both the combined pool and the UW cohort exhibit similar and definite preferences for Sensing (vs. Intuitive) learning, Visual (vs. Verbal) learning, and Sequential (vs. Global) learning. The preference for Visual learning is especially strong.

Notice that the preference for Sensing vs. Intuitive learning for the UW cohort on the ILS conflicts with the Intuitive preference on the MBTI. In other words, the two L-styles tests appear to give contradictory findings in this regard, which is disconcerting since on this scale the ILS was modeled after the MBTI.

One possible explanation is strength of preference. On the MBTI, only 60% of the participants indicated a moderate-to-strong preference on the Sensing/Intuitive scale, and the percentage is even lower on the ILS at 52%. The 40 to 48%, percentage, respectively, of participants who indicated only a mild preference might account for the apparent lack of consistency, as these individuals often shift between preferences.[18]

Taking the results of the MBTI and ILS as a whole, the L-styles research suggests that engineers in general are more visual, objective, concrete, systematic, sequential, and active in their learning style preferences. However, all L-styles are represented to a significant degree and need to be considered in the MLE design process.

Design Issues

Here we explain some design issues we faced and the choices we made. Our operating assumption is that the design has proven successful. This judgment is supported by the results of usability testing (discussed below), successful use of the MLE in teaching, and two national awards. BIH received a Merit Award in the Online Publications Competition of the Society for Technical Communication in 2004 and the Premier Award for Excellence in Engineering Education by the National Engineering Education Delivery System (Needs.org) in 2005.

Our strategy in regard to L-styles preferences was to emphasize the preferences of the majority of our learners but to work hard not to hinder students who exhibited the less prevalent learning styles. Because we had a broad representation of L-styles in our cohort and expect that this will be the case generally, we determined to accommodate every L-style. Furthermore, we often found that the design choices that L-styles research directed us toward were also standard design wisdom or were logical choices for the subject matter. We are delighted when this was the case. We fully believe in following standards and the expectations of users.[19, 20] At the same time, there was a significant design space in which L-style research proved influential.

Linearity vs. Nonlinearity

Leeder discusses linearity as an important design consideration: [21]

"Multimedia can operate in both the narrative [linear] and interactive [non-linear] modes. At one extreme, a purely narrative product would involve no student interaction at all. This is rather like a traditional lecture, a video or series of web pages with 'next' as the only option. Progress is unidirectional and non-branching. At the other end of the scale, a totally interactive product might offer a myriad of routes and user choices, many entry points, no perceivable middle or end. If not carefully designed, this might prove hyperactive; exhaustion or bewilderment could result."

Our decision was to favor linearity. A review of the L-test data indicated strong ILS Sequential and MBTI Judging preferences. These results suggested that a clear, systematic, highly organized, largely linear presentation would be preferred. This design choice accords with mainstream multimedia design and our sense of the linear (building-block) nature of the subject matter: In BIH one concept often serves as a foundation for the next.

As shown in Figure 1, the user can start with the introduction and progress through the program in a completely sequential manner. This can be done either by following the vertical list of links in the navigation column or by repeatedly clicking the next buttons at the bottom of the screen. At the same time, however, users can make their own choices in the navigation column and tackle the material in any order they choose. This navigational freedom suits ILS Global and MBTI Perceivers.

Within the main text components of BIH are small rollover pop-up windows that display definitions of technical terms. These pop-ups constitute nonlinear digressions from the overall linear structure of the tutorial. On the other hand, the digressive nature of these pop-ups is limited in that they contain no hyperlinks; the user's only choice is to dismiss them and return to the main flow of text. This design choice, we believe, appropriately accommodates both linear and non-linear learning preferences.

Visual Presentation

We recognized from the beginning that our subject matter was inherently visual because we are teaching the appearance and interactions of a complex and unfamiliar set of agents.[22] For this reason static graphics are plentiful throughout BIH and text components are relatively brief. We also recognized that animation was called for because these agents move in complex ways that would be difficult to show using static graphics. For this reason, the central component of each module is an extended animation sequence. Fortunately there is an excellent correspondence between these design requirements and the very strong preference for Visual vs. Verbal learning that the ILS shows in both the UW cohort and the combined pool.

Abstract vs. Concrete Content

Because of the complexity of the processes being described and because the operations of cells are far removed from direct human experience, one major challenge was to make the MLE sufficiently concrete and, when possible, familiar. This design imperative was reinforced because our L-styles data indicated a general preference for Sensing, which indicates a preference for concrete, factual, detailed information.

One of our design choices was for the explanatory material preceding the animations to employ a continuing analogy between biological organisms and computer systems. In part, this represents Professor Lidstrom's broad vision for how engineering students should understand cell biology, but it also has the value of grounding the new information in a familiar context. Another instance of concreteness in the explanatory material is a table showing the actual chemical structure of the 20 amino acids.

An important strategy informing the visual design is showing cell components as mechanisms. Working within the constraints of fidelity to the actual biological system, cell components are depicted with sharp, distinct borders, and their interactions often have a mechanical quality. For example, as shown in Figure 7, the appearance and movements of the Transfer RNA molecules as they carry and transfer amino acids recall the operation of large cranes. This strategy also informs the narration. For example, the ribosomes are referred to as "molecular machines," and they employ a "ratcheting mechanism" to advance the movement of strands of Messenger RNA. Fortunately, the standard terminology of cell biology worked for us. It includes the very concrete and mechanical phrase "docking sites" to refer to the components of ribosomes.

And what about Intuitive learners who prefer abstraction and theory? We believe that the abstract and theoretical is already inherent in the subject matter. Ultimately, by combining good instructional design with awareness of L-styles preferences, we created content that satisfies the needs of a broad range of learners.

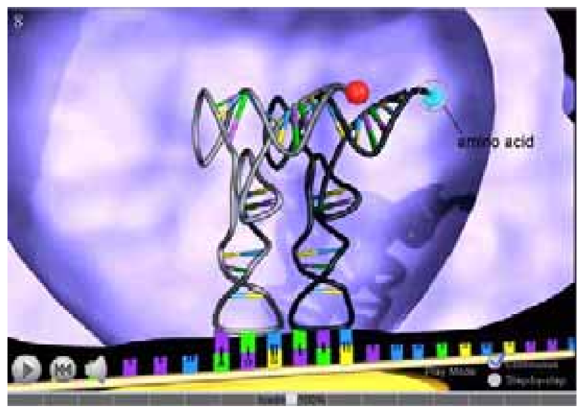


Figure 7. The mechanical appearance of Transfer RNA and other cell components

Discussion of the Human Element

An important instructional goal of the MLE was to create an awareness of the human dimension of cell biology. Engineers with a broad outlook are both better citizens and better engineers. Consequently, a special effort was made to include human-oriented content in the MLE. This ranges from showing the function of micro-organisms in everyday life (e.g., baking and the fermenting of alcohol) to pointing out diseases that arise from errors that occur in cellular information handling. In teaching her courses in cell biology, Professor Lidstrom looks for opportunities to situate cell biology in the context of human health and well-being.

The MBTI data showed a strong preference for Thinking over Feeling. This is not surprising given the analytical nature of science and engineering. So whereas our usual strategy was to use L-styles data to create instructional content that accommodates the preferences of our learners, here is an instance in which L-styles data helped reveal a disjunction that needed to be addressed between their preferences and our instructional objectives. Furthermore, we knew that the human-oriented content accommodates the preferences of the MBTI Feelers, who represent 30%+ of the learner population we studied.

Interactivity

A certain amount of interactivity is inherent to MLEs, multimedia, and most digital content. The kinds of navigation found on navigation bars and columns and the Previous and Next buttons that take the user through digital content are all interactive elements. So are many kinds of quizzes and exercises. However, designers of an MLE have the opportunity to add more interactivity and to tie it to the learning components rather than just to the navigation. This is an area in which the L-styles research led the team's design thinking.

On one hand, the combined pool shows a fairly strong preference for ILS Active learning. On the other, the UW cohort shows a preference for Reflective over Active learning. Because the nature of the subject matter inherently accommodates Reflective learners, we sought opportunities to add Active learning to the MLE.

The highly interactive components that we created include a graphic that allows the user to rotate a DNA molecule and an exercise, shown in Figure 7, in which the user drags nucleotides to create strands of DNA. (Incorrectly chosen nucleotides do not bind.)

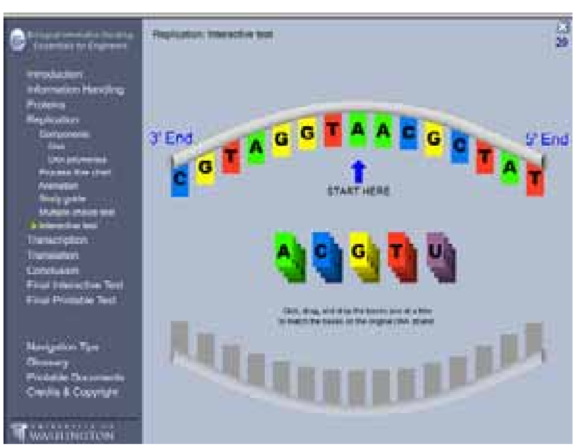


Figure 8. An interactive exercise in which students create DNA molecules by dragging nucleotides

Exposing Navigation Options

Early in the design process the team favored a navigation column that was clean and uncluttered but which exposed only links to the first level in the navigational hierarchy. Links to the second and third levels of each branch were provided on small pop-up windows. However, because L-test data indicated majority preferences for Sensing and Sequential learning, Kirkham hypothesized that our users would prefer a design in which all navigation options were continuously exposed, even if it added visual complexity. An "all-exposed" navigation column was therefore built along with a compromise design in which each top-level link, when clicked, displays content and expands to display the second- and third-level links on that branch.

Kirkham conducted usability tests on ten participants and determined that the all-exposed design was preferred, with the expandable design a close second, and the pop-up design a distant third. Ultimately, there was not enough room on the navigation column for the all-exposed design, and so the expandable design was implemented. This was an instance in which L-styles data guided us through design tradeoffs.

Evaluating Learner Progress

The design team decided that opportunities for learners to check their understanding are an important part of any educational experience. Therefore, evaluations were included at the end of each major unit and a final test was included as well.

This decision accords well with Sequential learners because they like to check their progress step by step. On the other hand, Global learners, who may well want to obtain the "big picture" before attempting any evaluation, can use the navigation column to bypass the section tests and return to them later, or else to complete only the final test.

Step-by-Step Mode

One distinctive feature of the BIH is the Step-by-Step mode implemented for each animation. Having toggled into Step-by-Step mode, the user clicks through a succession of static graphics that are actually carefully chosen frames of the animation. Each graphic is supplemented with a text excerpt from the script of the audio narration. In Figure 1, the animation sequence is shown in Step-by-Step mode.

Kirkham's investigation of L-styles data was the direct inspiration for Step-by-Step mode. Sequential learners not only prefer moving linearly through learning materials but want a controlled step-by-step experience. Furthermore, because users can freely drag the Step-by-Step progress bar, our design simultaneously accommodates Global learners who wish to pick and choose among the graphics.

As we further considered Step-by-Step mode, we determined that it offered other benefits as well. It allows learners to learn the complex processes at their own pace, and it addresses the concern, expressed by Tversky et al. [23], that animation may mask the key moments in a process that learners should focus on. Furthermore, Step-by-Step mode meets the needs of hearing-impaired learners and others who prefer text to audio. One way to look at L-styles data is that it serves as a kind of heuristic for sparking alternative design ideas.

Other Testing

Here we describe other aspects of our user-centered design process:

Informal Testing for Look and Feel

We sought to design the look and feel of BIH to engage and motivate an engineering audience. Kirkham, who is herself an engineer, conducted informal user tests and investigated digital products such as computer games that are known to intrigue engineering students. After testing four different color combinations, she chose two shades of steely, "techno" blue (blues desaturated with a light and a medium gray). She also recommended lines with sharp edges.

In addition, the black background chosen for the animations and static graphics not only provides high contrast for the visual elements being depicted, but evokes the metaphor of "outer space." Indeed, some of the cellular processes suggest objects floating in outer space and even the docking of a space station. All this appeals to an engineering audience.

Broad-based User Testing

Team member Alicia McBride conducted broad-based usability tests in November 2003. Nine engineering students explored the Replication module, offered extensive comments, and filled out a questionnaire in which they rated their learning experience on Likert-scale questions. The responses were positive, but prompted a variety of design changes. In January and March of 2004, students who were using the MLE in class filled out questionnaires. Again the responses were positive, and this time they resulted in fewer design changes.

What L-Styles Data Tells Us

We believe that L-styles research offers encouragement for those designing MLEs for engineering students. First, because engineering students show a mild preference for Introversion, they are likely to be receptive to MLEs. Second, the L-styles of engineering students point toward mainstream MLE design solutions, as was shown repeatedly in this paper. This is especially true when designers are committed to supporting a wide range of learner preferences. On the other hand, if you're departing from mainstream design, you may be making choices that L-styles data do not support.

While you can rely on national data, you may also want to conduct L-styles tests on your own students to gain assurance that your students have the L-styles characteristics typical of engineers. This especially makes sense if you suspect that your students are atypical—for example engineering students with humanities backgrounds or students who are pursuing hybrid academic majors such as engineering and psychology. Note that as the UW cohort data shows, even traditional engineering majors may show some deviation from the pooled data.

What if you are designing for working engineers? L-styles theory suggests that student data should be applicable because L-styles preferences are supposed to be relatively stable.

In conclusion, using L-styles data is one among many ways to gain useful information about your users. It is not without controversy and not without significant limitations, but when employed judiciously, as it was in the BIH project, it can strengthen your design effort.

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