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Studies in Applied Usage-Centered Design

Design Study 2: Structured Selection with a Multi-Modal Extended Selection List

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Abstract: *The design of a special-purpose selection list is reviewed. As part of a performance-support application for classroom teachers, a means was needed for rapid selection from a large number of alternative words. By taking into account the inherent structure of the terms in the list, instead of treating it as a simple list of unspecified objects, a more efficient and more easily used design was achieved. By incorporating the structure of the alternatives, the design was also able to reflect and support best practices in classroom lesson planning.*

Keywords: instructive interaction, selection techniques, usage-centered design, design innovation, user interface design, interaction design, usability, performance support, information architecture

General Background

The challenge of designing a performance-support system for K-12 classroom teachers presented us with many tough problems in visual and interaction design as well as multiple opportunities to devise innovative solutions through usage-centered design [Constantine and Lockwood, 1999]. (For more background on the application and project, see the first report in this series [Constantine and Lockwood, 2001].) A particularly important subsystem in this classroom information management system. was the lesson planning facility that enabled classroom teachers to quickly and efficiently prepare detailed lesson plans and to tie these plans to state or other curriculum standards. With an average of less than 15 minutes a day for planning, teachers needed a lesson planning tool that enabled them to work quickly in whatever way seemed most natural to them in creating, reviewing, and refining lesson plans.

One of the most important things in a lesson plan is its objectives. These objectives express the reason for the lesson and help define the criteria by which successful completion can be judged. A good lesson plan will be designed in its entirety to make it possible for students to meet these explicit and specific objectives. Common practice in contemporary teaching casts lesson objectives in a more or less standard form that

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begins with the phrase “The student will be able to…” or something very similar. For example, an elementary school introduction to flowering plants might include the following objectives.

> “The student will be able to list the major parts of a flower.”
>
> “The student will be able to explain the functions of each of the parts of a flower.”
>
> “The student will be able to compare reproduction in flowering plants to other forms of plant reproduction.”

In this example, some of the objectives are more advanced or at a higher level of sophistication than others. For example, listing parts requires only the ability to remember a set of terms, while explaining their functions implies a deeper level of understanding. Comparing one form or method to another draws on even more sophisticated cognitive processes.

The cognitive skills involved in learning are commonly classified into six levels based on Bloom’s Taxonomy {Bloom, 1956], ranging from simple knowledge, up through comprehension, application, analysis, synthesis, and evaluation. (Some educators now add a seventh level, but this is the subject of controversy and not widely accepted.) The key to Bloom’s Taxonomy is a classification of the verbs that can be used to describe objectives and cognitive skills. For example, listing, naming, and recognizing all describe skills at level 1, knowledge; explaining, locating, and showing describe level 2 skills evidencing comprehension; and comparing, applying, and sketching all represent level 3 skills.

Bloom’s Taxonomy is taught to almost all beginning teachers, and its use to structure and improve lesson plans and teaching has come to be regarded as exemplifying best practices in education. The taxonomy and its elegant classification of verbs—known among teachers as “Bloom verbs”—gives educators a powerful conceptual tool in their efforts to increase the depth and richness of learning.

Lesson plan objectives and Bloom verbs also serve another valuable function in making it easier for schools and teachers to connect classroom work back to educational standards and guidelines, which are typically expressed in similar language regarding what must be learned or accomplished in each subject area at each grade level. Among educators, connecting lesson plans to applicable standards is known as “correlating.” Teachers and administrators are responsible for seeing that students are learning what has been mandated, not only to ensure the quality of education, but also to demonstrate conformance with official requirements. On the other side, accountability is a growing concern among political and educational leaders. With potentially thousands of specific objectives in these standards and guidelines, correlating lesson plans to the right ones can be a daunting and onerous task. Anything that can simplify the process will be a boon to teachers and administrators alike.

Design Objectives

As explained in the first paper in this series [Constantine and Lockwood, 2001], we set high goals for ourselves in the design of the information management system in general and the lesson planning feature in particular. We sought to create a system that was so easy to learn that teachers could understand how to use it on first glance. It had to be efficient and flexible, allowing teachers to work quickly in their own preferred style. To achieve these objectives, we turned to the techniques of instructive

interaction, an approach to user interface design that makes systems self-teaching. With instructive interaction, help and guidance are intrinsic and integral parts of the user interface itself, not separate material contained in a tutorial or online help system.

In designing the lesson planning facilities for defining objectives, we had some additional goals in mind. We wanted the system to encourage better lesson planning by making it both easy and natural to conform to recognized but informal standards of best practice. We also wanted to speed and simplify correlation with official standards. In addition, we wanted the system to subtly influence the quality of lesson planning and teaching by raising the level of awareness and knowledge of teachers regarding the Bloom Taxonomy and to gently reinforce teaching to higher standards in terms of levels of cognitive skills.

Design Process

Since the system was being developed in "Web-time" [Constantine, 2000] under tremendous pressure from upper management to deliver sophisticated capability almost instantaneously, we quickly ruled out some techniques that are easy to think of but hard to achieve. For example, free-form, natural language input might be easy and natural for teachers, but would require devising sophisticated parsing facilities. Equally important, completely free-form input did not support our objective of encouraging standardization to best practices. On the back end, we had to rule out complex "artificial intelligence" for magically matching objectives to mandated standards.

In short, we needed an interaction design that would get teachers to use a conventional format for objectives and standard terms from Bloom's Taxonomy, but do this so gently and straightforwardly that almost no one would object.

Structured English

After studying a large number of lesson plans, we settled on a structured narrative form that reflected common, even if not universal practice. Objectives would be numbered and would always take the form:

> The student will be able to [*Bloom verb*] [*completing phrase*].

A design based on this concept presents a tradeoff to teachers. They are forced to choose part of their vocabulary from a restricted list of verbs, but are allowed to express the subject matter of the skill in any way they wish. In return for a small loss in flexibility, the teacher gets a moderate reduction in the amount of typing required for each objective. Of course, the big payoff is in the software support for correlation that this approach facilitates.

The portion of the input form for defining objectives starts with one blank objective, since every lesson plan must have at least one objective. Figure 1 shows the design mockup for this part of the user interface. Additional blank objectives can be added by a click on the "Next Objective" button, which carries a glyph used throughout the user interface wherever an "add one more" function is offered.

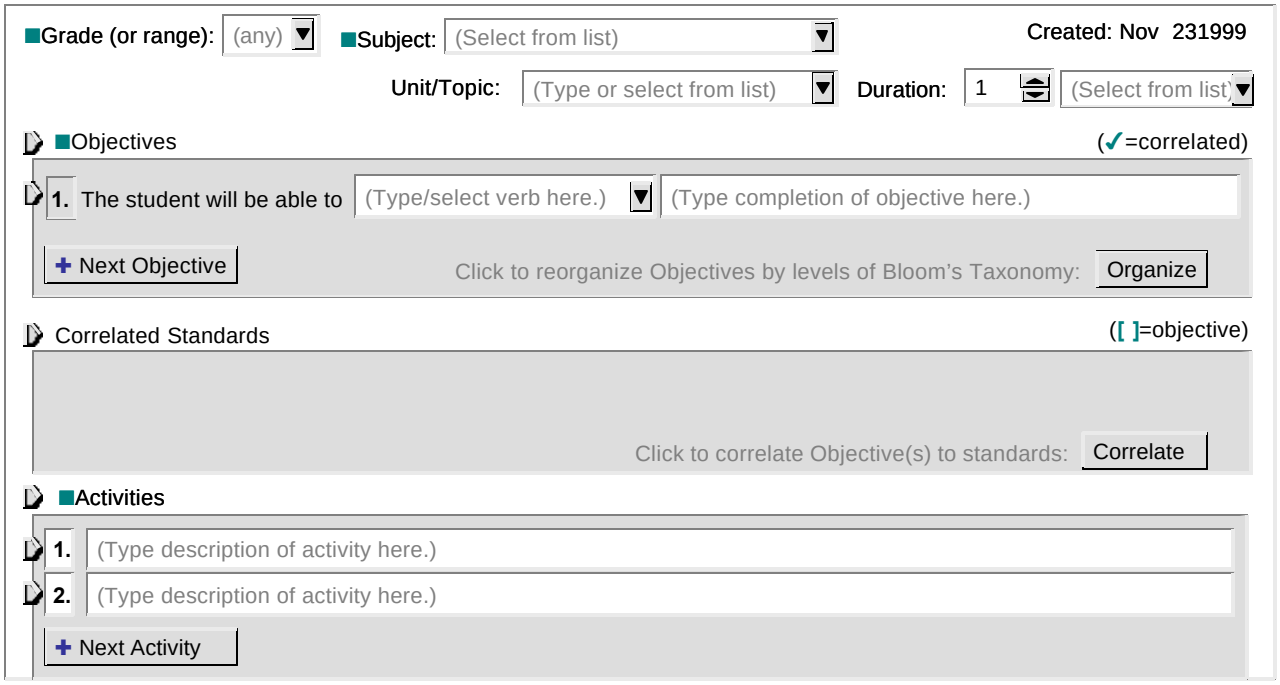

Figure 1 – Portion of lesson planning form

Embedded prompts

Embedded prompts, in which brief explanations or instructions appear within the user interface controls, are among the versatile techniques of instructive interaction. For the first-time user, embedded prompts provide guidance in context, exactly where and when needed; for the more experienced user, embedded prompts are easily ignored. As implemented here, embedded prompts are ephemeral, appearing as gray text and disappearing when user input is supplied or the control receives focus. Several examples of embedded prompts can be seen in Figure 1.

Subtle details of the interaction design can profoundly influence usability. Consider the text box supplied for the user to complete an objective. If this had a fixed-size, then either some text might not be visible to the user without scrolling or each box would take up valuable screen real estate to allow for the maximum expected length. Our design used elastic text boxes that always sized to fit whatever the user typed. Voila! No hidden text, no extra scrollbars, no wasted screen real estate.

Well-chosen words

So far, so good, but the success of this approach hinges on the drop-down combo box for typing or selecting a verb. An ordinary drop-down list will not work. Hundreds of possible verbs have been classified in Bloom's Taxonomy. Even a "short-list" of the most common ones that are both widely used and unambiguous in interpretation runs to more than a hundred. Searching for a word in a scrolling drop-down list would be an exercise in tedium. The goal must be to minimize the expected time needed to find and then select a verb, which requires making the most frequent verbs, as many as possible, immediately visible. However, strict organization by frequency will actually impede selection, because users can scan an alphabetical list much faster than a (seemingly) random one.

Keyboard input using the incremental search capability of a combo box (typing the first few letters into the box) cuts down the search and selection time if the teacher already has a verb in mind, but will be no help for a teacher looking for the right but unknown word. Moreover, incremental search with a combo box tends to be a power-user skill; tyros are often unfamiliar or uncomfortable with this technique.

The problem-solving approach we took was to explore how the inherent structure of the information itself could be used to allow for effective presentation and efficient selection. The list of verbs can be subdivided into those used most frequently and others used less frequently. In addition, the verbs are organized into the six levels of Bloom's Taxonomy. However, teacher's are not all on equally intimate terms with the taxonomy. They may or may not know which level a particular verb connotes. Furthermore, the teacher might think of skill level first and be seeking just the right verb or a particular one; conversely, the teacher might have a verb or verbs in mind but be uncertain about the level in the taxonomy.

A tabbed dialog structure would organize the verbs by level but would not allow for seeing them all at once, leading to an inefficient scanning of successive tabs. A seventh "summary tab" that lists all verbs would address this problem, but in a somewhat clumsy and inelegant way.

If one of the goals is to increase teacher awareness of the place of various skills in the taxonomy and encourage teaching to higher levels, what is needed is a scheme to highlight verbs by levels. A well-designed widget will reinforce learning the association between specific skills and cognitive level.

Bloom-Verb Widget

The solution we designed, which came to be known as the Bloom-Verb Widget, is shown in Figure 2. (The words shown were part of the mockup, not the final set used in the working system.) A multi-column format allows for getting all the most frequently used verbs into the first display, and tests confirmed that an alphabetized list in this format could be visually scanned efficiently. A later design enhancement added a visual separator to highlight the grouping of words by initial letters.

The remainder of potentially usable verbs are available on a secondary alphabetized list that scrolls horizontally into view when the "More" button is clicked; a "Back" button to return to the earlier set then appears. (The "logical" place for such a button is at the lower left of the panel, but immediately to the left of the "More" button is more efficient, since the most likely need for this action is when the user has just inadvertently gone too far or has reconsidered using an infrequent alternative.) In practice, the vast majority of selections would be made from the first group of verbs, not only because these cover some 80-90% of actual usage, but because the very structure of the display favors the use of these choices.

In keeping with the instructional objectives of the design, the verbs carry a parenthetical number representing the Bloom level. The buttons across the bottom serve like footnotes—as reminders of what each level represents.

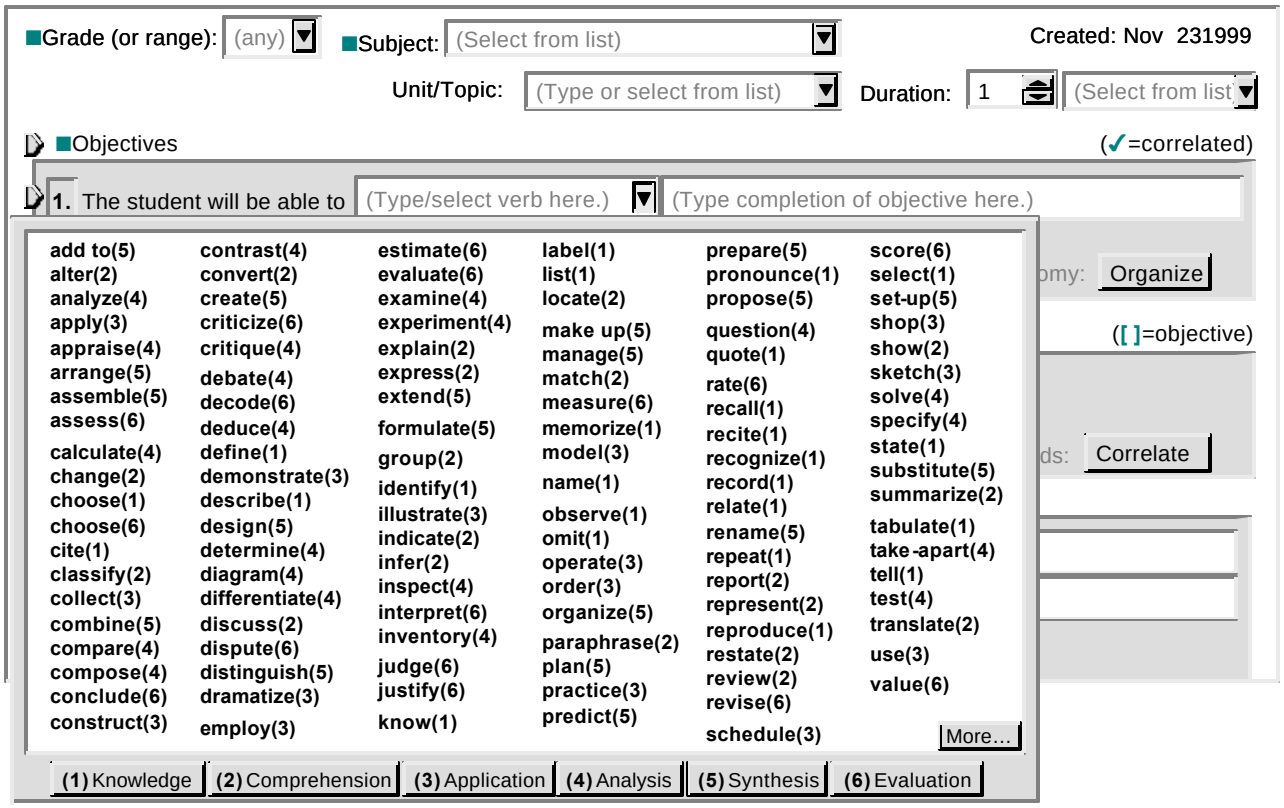

Figure 2 – Design for Bloom-Verb widget shown open.

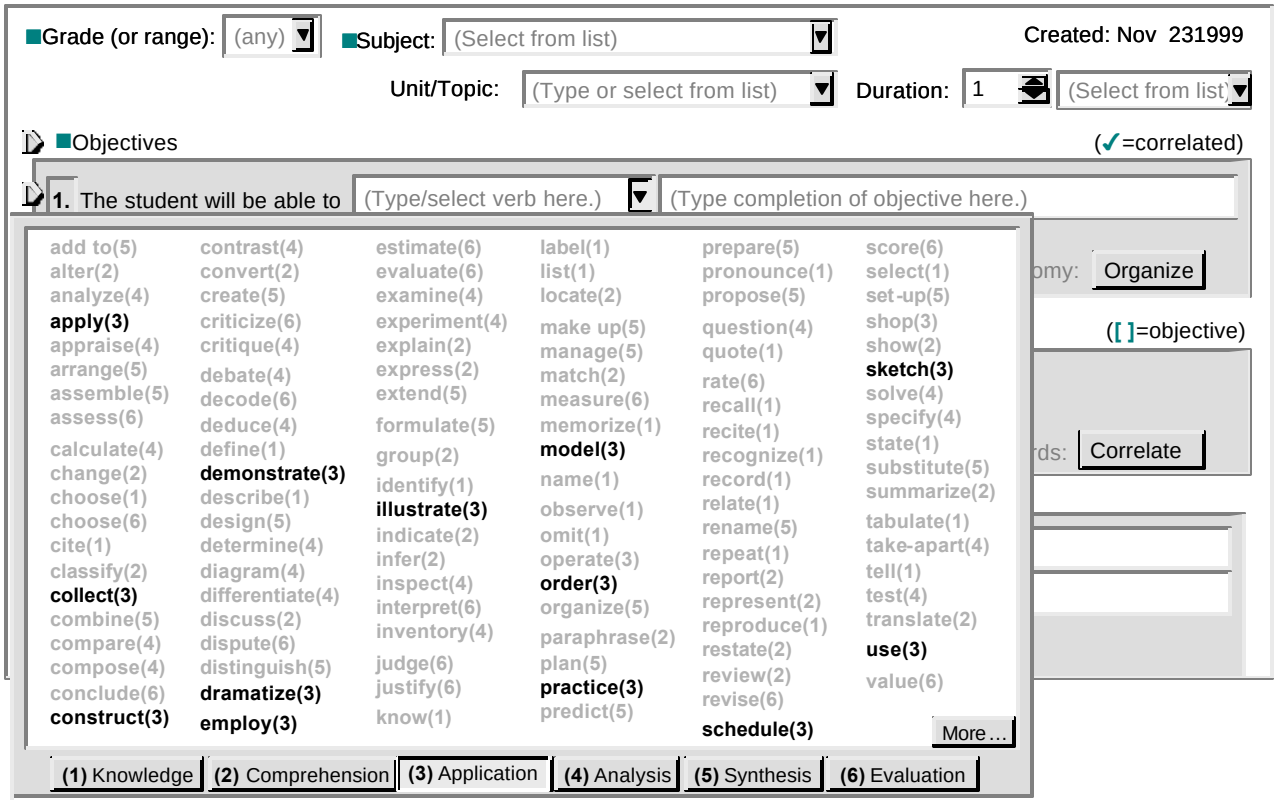

Figure 3 – Design for Bloom-Verb widget with level (3) selected.

Should the teacher wish to select by a particular level or to see what verbs are associated with a given skill, a click on the corresponding button grays out and disables all verbs except those at the selected level. (See figure 3.) In contrast to the rejected tabbed dialog scheme, this filtering technique preserves the visual context in which words appear. Because the same words always appear in the same place within the visual field, users will unconsciously learn the position of their favorite or most used words.

In response to keyboard input, behavior is much as with a conventional combo box. The drop-down panel opens with the highlight on the first word beginning with the typed letter. Typing additional letters moves the highlight to the first word having the same initial letters, or arrow keys can be used to move the highlight. Pressing <Enter> selects the highlighted verb and closes the widget.

Back on the lesson plan form itself further support is provided for the use of Bloom's Taxonomy and structured objectives. Referring to figure 1, an "Organize" button on the lesson plan itself, divides the objectives by level in the taxonomy and labels each section with the name and number of the levels. (Note that this is a toggle button so that the teacher's manual organization can be restored.) In the following section, a button allows one-click correlation to standards, bringing up a dialog for selecting the appropriate set of standards and for searching for possible matches. The matching process is facilitated by the restricted vocabulary and set structure of objectives and by the fact that the standards have also been coded according to Bloom's Taxonomy. (The search engine that made it all function was designed by the software engineering lead, Larry O'Brien, and lead analyst Lucy Lockwood, who devised an elegant and clever matching scheme that worked magic in finding the right specific standards without resorting to artificial intelligence.)

Remarks

The Bloom-Verb widget itself is a rather special-purpose design. Unless other developers of classroom technology "borrow" the design, it is unlikely to see wide use in interfaces. However, the general scheme solves a class of problems that is rather broad.

The novel features of a generic "multi-modal, extendable drop-down selection list with selectable subsets and prioritized content" include:

1. multi-column display in a selection list to maximize the number of initially visible options;
2. separation of most-used from less-frequent options while preserving another primary order (alphabetical in the case of the Bloom-Verb Widget);
3. use of a single selection list for presenting both a complete set of selections and for highlighting different selected subsets or views;
4. user control of the selectable highlighted subset from within the drop-down list;
5. intrinsic reinforcement of the meaning of selectable options in relation to the subsets.

Perhaps the most important lesson that we learned had to do with exploiting the structure of the information to guide the structure of the visual design. By understanding the structure of the list of verbs and taking advantage of this in the design, we were able to achieve not only a more efficient interaction design, but one

that helped to support best practices and reinforce the prior knowledge of users. We have continued to use this line of thinking to solve related problems in other settings. For example, we recently helped clients design a user interface control for simple and efficient selection from among over 10,000 alternatives. Now that's a drop-down!

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