Zazu – Investigating the Difference between Interaction Approaches in Advisory Support Systems for Curriculum Planning

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Abstract: Curriculum planning for students in a university which offers full-time as well as part-time courses is not a trivial task and is complicated by the fact that students can enrol for modules at different levels concurrently. A prototype advisory support tool was developed to address the problems related to document-based advising. The tool supports two interactive advice approaches – a top-down backward-chaining style and a bottom-up forward-chaining style. An experiment with 20 participants compared these two different interaction approaches within a natural curriculum-planning context. The results show important design tradeoffs for supporting people in curriculum planning. This paper presents the results of the experiment. We discuss the cognitive aspects and implications for each interaction approach and how some UI design guidelines are supported and then draw conclusions about how best to structure user interaction in an advisory support tool based on the results.
Keywords: interaction design, visualization, curriculum planning, cognitive support, information retrieval.

1 Problem description

Curriculum planning is done at tertiary institutions at least once a year. In order to provide for part-time students who make up their degree in successive years a student-oriented curriculum approach is permitted which allows students flexibility in setting their own pace and customizing the curriculum to suit their needs. This flexibility complicates curriculum planning. Complicated module requirements are used to ensure that prerequisites are met while offering students the widest possible choice. This requires advisors to deal with phased-out modules.

The consequences of giving the wrong advice need to be considered. Two possible undesirable outcomes could occur, incorrect advice or non-optimal advice. Most student registration departments have an electronic system that validates registrations. This validation identifies non-valid combinations of modules for a specified qualification and effectively prevents invalid registrations.

However, the electronic registration system does not identify non-optimal combinations of selections, based on ignorance and/or insufficient information. We are concerned with the long-term effects of non-optimal curriculum planning. The financial implications of students making the wrong curriculum choices are incalculable for the students, the training institutions and the state. These students are at a higher risk of failing and even if they do obtain the qualification they may not want to follow the planned career but will opt for retraining at further cost. The physiological and social effects of this dilemma are even more difficult to estimate.

The authors were unable to find an existing system to meet advisors' needs. The development of an electronic advisory tool that supports accurate curriculum planning, aimed at reducing the risk of giving wrong and non-optional advice, is the aim of the Zazu project. This paper compares and evaluates cognitive support in curriculum planning based on

two design approaches. Section 2 will describe the Zazu prototype. Section 3 explains how the usability experiment was conducted and Sections 4 discusses the results of the experiment. Section 5 concludes.

2   The Zazu Tool

2.1   Task Analysis

Task analysis is an essential step in eliciting the tasks performed in curriculum planning. The task analysis as depicted in Figure 1 provides a reference for the design of the prototype.
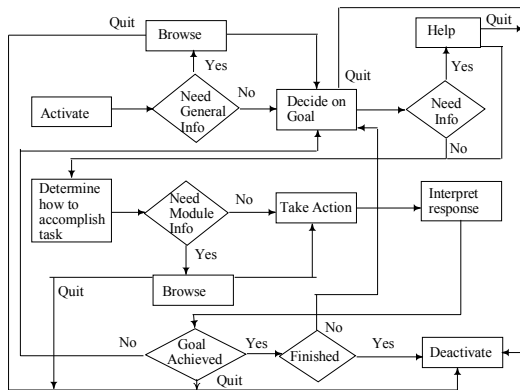

Figure 1: Task Analysis

Two main tasks were identified for giving advice namely fact-finding and decision-making. These tasks are interspersed as information is needed to make a decision and a decision is needed to decide what information is required. The interspersing is supported in two different interaction approaches.
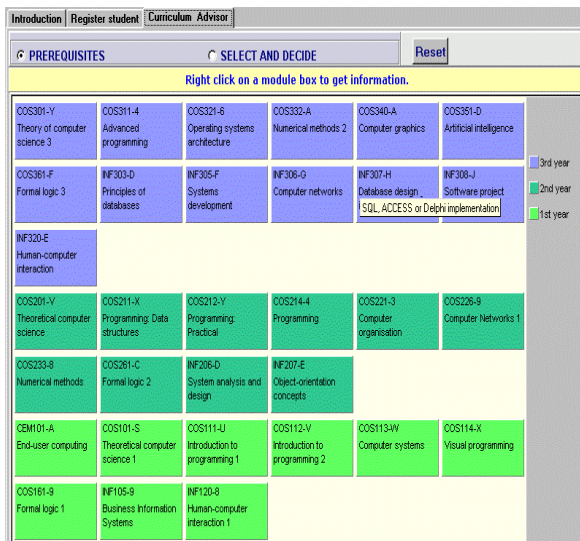

Figure 2: The Top-Down Approach

2.2   Interaction Design

Two main approaches to solving the problem of curriculum planning were identified. A top-down strategy that uses a backward-chaining mechanism and a bottom-up strategy that uses a forward-chaining strategy are shown in Figures 2 and 3. An example of the top-down approach is where the student majors and the other modules planned for the third level, are selected first.
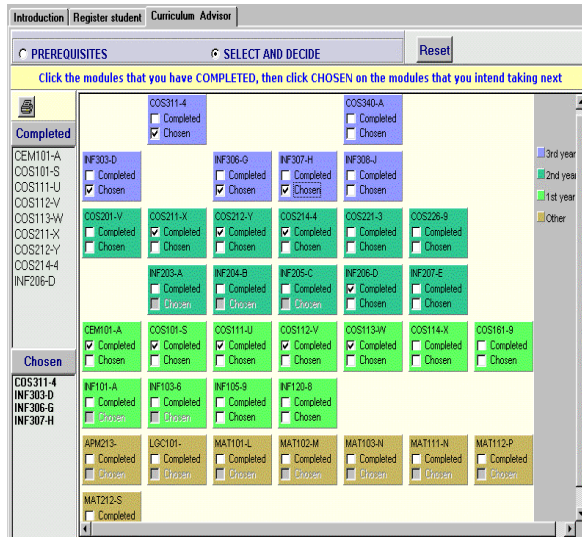

Figure 3: Bottom-Up Approach

In the bottom-up approach the modules that a student has completed are selected by the user, and the system dynamically displays the modules which become available (for which the prerequisites have been met). The modules completed and modules chosen are also shown in the list box on the left as depicted in Figure 3. In both windows the modules are represented by square objects, colour coded to represent the level. The Zazu interface was designed for supporting cognition. Table 1 indicates the support offered by each of the approaches.

	Top-down	Bottom-up
Mental model	Closer to paper based model	New mental model
Information processing	Limited support	Full support
Externalising to reduce memory load	Supported by presentation and interaction	Supported by presentation and interaction
Computational offloading	Limited support	Full support
Cognitive tracing	Limited support	Full support

Table 1 : Cognitive Support

Computational offloading is the use of a tool or device in conjunction with an external presentation to help us to carry out a computation [Rogers, 2002]. This is implemented by the selection of modules from the external presentation for computing valid choices. Cognitive tracing is the external manipulation of items into different structures as performed by selecting modules. Flexibility and cognitive support are the issues under consideration. The top-down approach provides more flexibility but less cognitive support and less system protection against errors. The bottom-up approach is more prescriptive but less error-prone with built-in validation functions.

3   Usability evaluation

In the first Zazu usability investigation into the differences between expert and novice advisers it was found that experts had a preference for the top-down approach [Van Biljon, 2002]. We also found that experts tended to rely more on their experience and knowledge of the system than on the information being presented by the Zazu system.

During the experiment a difference in interaction styles was noted, but the distinction between expert and novice users made it difficult to draw any conclusions about style preference. Thus a further experiment was conducted, this time only with novice advisors, to determine preference of approach and impact on subject performance.

3.1   Experiment

The evaluation was aimed at evaluating the factors that influence the preference of an interaction approach, specifically the correlation between preference and performance as measured by performance metrics of effectiveness and efficiency [Van Greunen, 2001].

Usability testing was based on observation and an empirical evaluation by means of questionnaires. The testing was performed in a natural environment using the Zazu prototype. The questionnaire consisted of three parts. The first part concerned biographical detail, in the second part the user was required to perform typical curriculum planning tasks. User performance was evaluated on the performance measure of effectiveness encompassing efficiency and completeness. Efficiency was measured as the time needed to complete the tasks. User satisfaction was measured by a workload questionnaire and questions on preferences [NASA, 1987]. The experiment subjects were given two sets of similar questions. One set was to be answered by using the top-down strategy and the other by using the bottom-up strategy.

Twenty academic assistants with no previous advising experience were selected for the empirical evaluation. These people were novices with the system and the Unisa model and therefore representative of the students for whom the Zazu system was being developed.

4   Findings

There was a marked difference in the time taken for the task between the top-down and bottom-up interaction approaches, as shown in Figure 4.
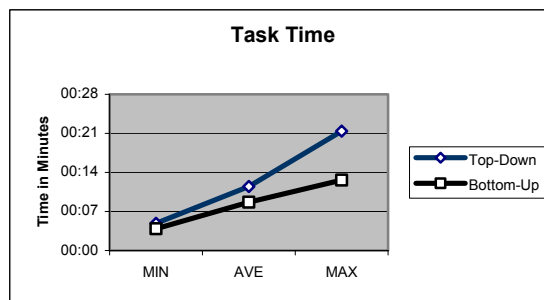

Figure 4: Task Time

Subjects were asked why they preferred the bottom-up approach. Figure 5 shows their responses.

Whilst the average time shows an improvement it should be noted that 5 subjects actually took more time doing their task with the bottom-up approach. Four of these had prior experience of the Unisa system, and of using current documents to work out curricula. The fifth seems to have rushed through the task, and made significant errors in the top-down task.
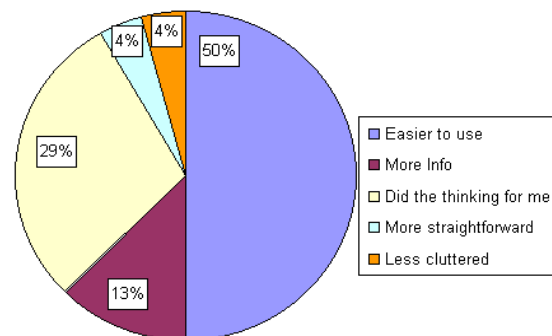

Figure 5: Reasons for Preferring Bottom-Up Approach

The results of the workload questionnaire are given in Figure 6. It is interesting to note that people perceived their performance to be better in the bottom-up approach, and the average number of correct answers supports this perception.

We analysed the time differences between the two tasks for each subject and linked this to each subject's first exposure to computers. People who had first used computers in the context of word processing seemed to exhibit the smallest time variation. A greater variation was exhibited by people with first exposure to computer games, educational computer programs, ATM machines or programming.

Windows-based word processors provide a large measure of external cognitive support, easing memory retrieval and supporting the Recognise-Act cognitive processor cycle [Card, 1983]. In other applications the user often has to rely on his/her internal mental model of the system.

The sample size does not allow us to draw reliable conclusions but it could be that people whose expectations are first formed by word processors are most comfortable with the support provided by a system such as Zazu, unlike people who prefer to rely on their own internal mental model rather than using the support system.

5 Conclusion

Users make mistakes when cognition is not fully supported through techniques such as cognitive tracing and computational offloading.

If our findings are confirmed by further studies it suggests that once a mental model has been established, advisors will not make full use of a support system.

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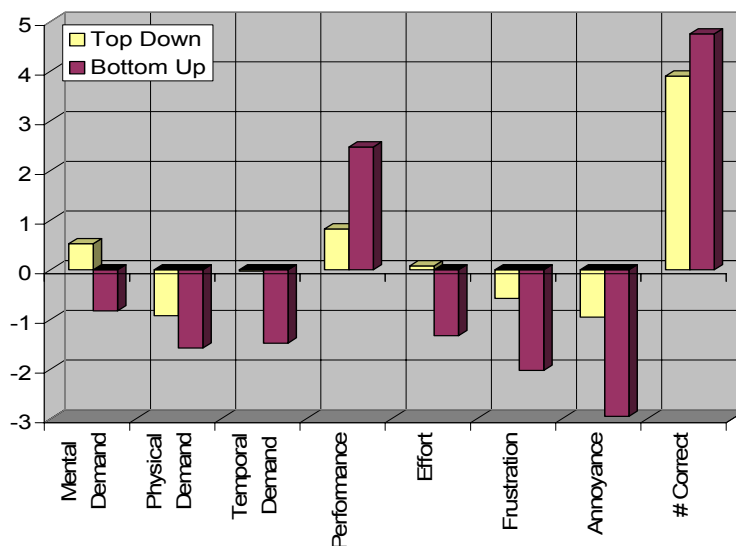

Figure 6: Workload Task Index