Preadmission Student Advising: A Prototype Computerized System

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One domain that is appropriate for expert system usage is student advising. For instance, students in universities can receive advising and counseling regarding financial aid, selection of majors, and course planning. This paper discusses the development of a prototypical computerized system designed to provide advice to high school students or college freshmen who are uncertain about the desirability of attending a university or undectded about a potential major. The on-demand consultation gathers information about a student's grades, interests, test scores, and aptitudes. It assesses student qualifications for admission and evaluates the student's qualifications for a variety of majors. It then recommends curricula the student should consider and recommends appropriate courses for the student's first year.

Preadmission Advising

Preadmission advising for incoming college students is the process of identifying admissions requirements, available majors, and program requirements of selected majors. Effective preadmission advising is important because students who are clear about the match between their needs and the institution's offerings (majors) and resources are (a) more likely to enroll, (b) less likely to take classes that don't contribute toward graduation (time and money wasters), (c) more likely to enjoy college, and (d) more apt to persist to graduation (Walz, 1984). Benefits of effective preadmission advising to the institution include a reduced need for postadmissions advising and increased state aid and/or tuition income to the institution from those students who remain. Further, undecided students usually choose to enroll when the match between their needs and the college offerings is clear.

Preadmission advising is labor intensive, requiring approximately one hour of counselor time for each potential student. This counseling process (a) educates students about the considerations they should use to select a major and (b) identifies majors appropriate for students seeking such information. Research on the predictors of success is uneven across curricula and in particular majors (Noel, Levitz, & Saluri, 1985). Consequently, human advisors use their accrued knowledge to fill in significant gaps in the research. Advisors use information about students' entrance test scores, achievement in high school courses, interests, aptitudes related to the requirements of specific majors, and initial course level placement to assist them. Good advice reduces failure and frustration experienced by students who are inappropriately scheduled. For most colleges and universities, however, preadmission advising is limited by the large number of students who require assistance and by the small number of available advisors. Delegation of advising to faculty, who may be poorly trained in counseling techniques, further limits the usefulness of such advising.

At the heart of student success in college is a close fit between the student's needs and the institution's offerings and resources (Novak & Weiss, 1988). The better the fit, the more likely students will enroll and successfully complete their educations. Efforts designed to help students make informed, even if tentative, career decisions prior to enrollment should reap benefits for the student by relieving some of the pressure that accompanies college entrance. Benefits should also accrue to the institution because effective preadmission advising should be a first step toward an effective student retention program.

This paper describes a prototype computer-based, expert system for preadmission student advising. The system provides a basis for designing other advising systems and for conducting research on the role of computer-based systems in preadmission counseling.

Computer-Assisted Programs

Computers have been utilized throughout the past decade in the preadmission advising process. Early computer-assisted informational programs identified potential colleges for students based on student-selected criteria such as location, tuition, majors offered, and other relevant information, but these programs were not always helpful to students who lacked confidence in their beliefs. Because these programs used data-base technology, student input had to be clear and limited to a specific selection of choices. The programs assumed, for instance,

that students know what majors they wish to pursue. Given the same criteria, the programs list the same sets of institutions for students of widely different backgrounds and aptitudes. With the exception of DISCOVER, a computerized guidance information system, most computer-based guidance systems are related to career education. Isaacson (1986) noted that 39 institutions use these early systems and cited the following objectives as being served by them:

1. Students learn about themselves.
2. Students learn about the world of work.
3. Students expand their options, narrow their choices,-and make decisions.
4. Students begin planning.

Expert systems are computer systems utilizing artificial intelligence technologies that are designed to replicate the decision-making process used by experts in a specialized area of problem solving. Expert systems utilize heuristics: the knowledge and rules of thumb held by an expert in a discipline. An expert system applied to academic advising can be tailored to specific student needs and specific institutions. Some of these systems are being applied to aspects of career advising and counseling. Diffenbach (1988) tested a system for selecting candidates for admission to a university. In separate projects Schwartz (1988), Valorta, Smith, and Loveland (1984), and Golumbic, Markovich, Tsur, and Schild (1986) developed systems for advising mathematics and computer science majors. These projects demonstrated the feasibility of using expert systems in situations where decisions were following procedurally clear instructions. They did not address advising in situations where rules for decision making were not well defined.

The Model

A computer-assisted model developed on a personal computer is being tested at our university in an effort to help answer the following questions: (a) Can the student be admitted as a freshman to the university even on probation? (b) From the 27 majors being considered, which are the most appropriate to the student? (c) Given the student's background, which mathematics and English courses should be taken?

The system uses software designed to facilitate the building of expert systems. This type of software (also called a shell) is widely used in business and industry to encapsulate the expertise of specialists at solving selected types of problems. Expert systems are most useful in settings that are diagnostic/prescriptive in that they identify the specific problem and its situational characteristics and then prescribe a remedy or solution. A well-developed expert system functions as well as a human expert even when data is uncertain or unknown and when recommendations cannot be made with certainty.

Preadmission advising is a situation that can be modeled with expert systems software. Many universities employ academic advisors who counsel incoming students as well as enrolled, undeclared students about their educational goals and about disciplines that may be of interest to them. These advisors (seen as experts by faculty, students, and staff) possess knowledge based on on-the-job experience and exposure to the experiences of other advisors or counselors. In addition to the formally designated advisors, colleges and departments within the university have faculty and other advisors who are knowledgeable about their programs and the success rate of students in these curricula. Little predictive information based on research is available to these counselors regarding the characteristics of successful students in these departments. Still, these advisors are expected to provide advice to students with questions about their academic goals.

While developing the system, it became evident that the clearly defined, procedural rules that are desirable when constructing an expert system were not uniformly available. Firm rules existed for recommending an initial mathematics course, for recommending an initial English course, and for deciding whether a student could be admitted, for instance, but firm rules for assessing the value of a specific major to a student were largely absent. Although advisors knew what questions they asked and what kinds of reactions they had to a variety of responses, verbalizing specific conclusions to be drawn from responses was difficult. For example, if a student expressed a preference for a career which involved working with small groups rather than with individuals, the experts found it difficult to suggest weightings by which particular majors would be increased or decreased in desirability. Failing to obtain these weightings from unstructured interviews, a formal method of securing the weightings was made by asking the experts to indicate whether positive and negative responses would have a very strong, a strong, a mild, or no effect. A scripting of typical interviews guided development of the ex-

pert system. Experts in the Advisement Center and the Career Development Center and faculty in the Department of Counseling and Educational Psychology reviewed the consultation to evaluate the "feel" for the interview, to comment on the presentation of the questions, and to suggest techniques for guiding the users to more useful responses.

How does the expert system work? Information is solicited from the student about (a) scores on standardized tests, (b) the degree to which the student enjoyed and did well in all the courses taken in high school, (c) personal aptitudes, interests, and characteristics, and (d) parental desires. Although some user responses are unambiguous, most responses are entered within a range of certainty. Students can indicate that they are 100% certain something is true, 100% certain something is not true, or that some other intermediate level of certainty is true. A response of "not sure" (0% certainty) is acceptable. For example, one question displays a list of twenty high school course titles and asks the student to indicate his/her relative level of academic success in each course. Responses could be art (10%), biology (40%), chemistry (-60%), English (0%), history (90%), and so on.

The core of the computerized advisor consists of more than 250 rules that look like "lf the ACT mathematics score is greater than 27, then recommend mathematics (30%), engineering (30%), etc." A rule may reach one or as many as thirty conclusions (over 3,000 in all). The system accumulates the levels of certainty discovered by rules throughout the consultation. As each piece of evidence is acquired, additional rules increase or decrease recommended outcomes. At the end of the consultation, the student is informed about (a) probable admission status, (b) majors that seem to be most reasonable to consider, and (c) most appropriate course placement in English and mathematics. The consultation takes about 30 minutes. A sample question is "ln high school to what extent did you do well in or not do well in the following classes: . . ." A list of 14 disciplines follows and students can indicate from -100% to + 100% achievement. Another question is "Some jobs and college majors are closely related to applying knowledge to problem situations: teaching, detective work, engineering. Is it important that your studies be related to real-life applications?" Again, a student can indicate the level of importance attached to this factor on a scale from -100% to + 100%.

The system may be used by students without the involvement of system developers, although assistance is useful. Help screens are available throughout the advising session. They provide the user with instructions in the entry of responses, as well as in the interpretation of the conclusions.

Although this system is primarily an advice-giver and not an instructional program, the student using it learns from the experience. The questions that are asked raise consciousness about factors to consider when selecting a major. Similarly, the prompts often relate a rationale for why a question is being asked.

Analyzing the Expert System

Three measures of effectiveness are used to assess expert systems: verification, validation, and evaluation (Leibowitz, 1989; Stachowitz & Chang, 1987). Verification of an expert system is conducted by determining whether the rules being used by the experts are consistent with the software's implementation of those rules. Our advising system has firm rules for determining student admission prospects and recommending English and mathematics courses based on achievement test scores and high school grade point average. Hence verification of these rules is feasible. For instance, the advisor uses a catalog that states that a student who scores between 1 and 16 on the ACT or between 200 and 399 on the SAT must register for English 1. The expert system rule that reaches this conclusion is easily matched with the catalog description. The rule is: IF (ACT bt 1 16) or (SAT bt 200 399), THEN English course = ENGL 1.

Validation of an expert system is conducted by determining whether the system's recommendations are consistent with the conclusions of the experts. Validation focuses on evaluating the outcomes rather than the process by which the outcomes are determined. The methodology for recommending possible majors was built without the benefit of unambiguous rules, so validation is only partially feasible. This situation is, apparently, typical of many expert systems (Green & Keyes, 1987). The conclusions for recommended majors are currently being validated. The system is only being validated for the 27 majors used in the prototype. Although the majors are quite diverse, many majors have not been addressed. The system allows the user to print the conclusions of a consultation. This report contains the responses the student en-

tered for all questions, as well as the conclusions reached by the system. Twenty high school and college students consulted the prototype during development. The coordinator of academic advisement was given the data input by the students but was not given the system's conclusions. The process allowed similar input to a computer system and to the advisor. The recommendations of the computer were compared with the conclusions of the advisor as a basis for improving the system. Changes were made as the reasons for discrepancies between the expert and the expert system became clear. The reactions of the students were also used to revise and improve the wording of the questions.

The entire list of conclusions with regard to selection of an academic major was reviewed to see whether majors that might be compatible did appear in close proximity to one another in the rankings or, if they did not, to see why they did not. The top five recommendations of the system were studied especially closely. Differences between the independently conducted rankings of the expert system and the advisor were calculated. After the differences were calculated, the advisors reviewed the differences and either changes were made in the program to bring the two recommendations closer or the advisors revised their rankings. Following each group of 10 student interviews, the program was modified to accommodate the changes identified. Since the prototype was changing regularly, no formal statistical correlations of results could be made. However, the two sets of recommendations showed very heavy overlap and concurrence of order in the majors recommended.

Evaluation of an expert system involves an assessment of the usefulness of the system. Do users believe the system? Do the users act on the recommendations? An evaluation of a prototype is necessarily incomplete. Even when the system was in an early stage, however, the students reported that they enjoyed using the program, that it appeared to communicate with them in a natural manner, and that the techniques for obtaining their responses seemed appropriate and realistic. The recommendations often duplicated some of the choices already made by students, matched recommendations by counselors, and paralleled suggestions from aptitude tests. Initial testing of the model examined users' responses and their ability to read questions and to understand questions. Faculty in technical writing and in educational counseling also reviewed the questions. This led to (a) substantial reductions in the amount of explanatory text in questions, (b) better use of color and highlighting to emphasize key words, (c) provision of sample exercises to show the user how to express varying levels of preference, enjoyment, and achievement, and (d) the addition of warnings when the computer was not going to respond immediately because it was involved in processing data.

When seven counseling and educational psychology department faculty compared this program with other computer-based counseling programs, there was general agreement that the program was more sophisticated and useful than those that were already in the field.

Conclusions

Although the system was initially developed to assist high school students in selecting a major, it could also be adapted to students who have already been admitted to, and who have had experience with, college-level course work. The system works effectively now. It can be extended in breadth by adding majors, and it can be extended in depth by refining some of the conclusions and by meeting the unique needs of other institutions. A conclusion of education as a possible major, for example, could be refined to suggest secondary education, with the addition of rules.

Institutional benefits realizable from the eventual implementation of the system include: (a) improved enrollment marketing potential by having a full-time "counselor" in high schools where it is placed, (b) increased retention of students by enhancing the likelihood that students select an appropriate major, (c) consolidation of institutional knowledge about advising—with poor advising systems upgraded by an expert system that integrates the information held by the best advisors on campus—and (d) increased efficiency of time that advisors spend with students by having the computers do the work of assembling base information that does not depend on face-to-face contact, allowing advisors to see more students or to counsel in greater depth.

Another outcome of the development of this system has been the emergence of a consistent protocol for inserting new curricula into the model. We can expand the system to include new majors more rapidly and be able to describe the weightings assigned to student responses that are used to make that recommendation.

These weightings can then be reviewed by interested parties.

Potential Limitations

Students using the system are advised to avoid using the expert system as their sole source of advice. Although the system is capable of providing useful information and suggestions, it is not complete as it stands. An important decision pertaining to a student's future should involve parents and school personnel. Even though assistance from others is valuable, many of the potential users of the system are without any advising services. Useful advice from the computer is more useful than no advice at all.

Another potential limitation is that this system emulates advisors at one institution. Different institutions espousing a different intellectual environment will have to adapt the system so that it leads to different conclusions.

The program is not validated by psychological assessment instruments. It is an expert system that represents the heuristics of selected advisors and career counselors. It is expected to provide responses whether or not the student has taken the batteries of aptitude tests that may be available.

The Pre-Admissions Advisement expert system may be accurate, but it is not necessarily persuasive on its own. The system can recommend a major and can provide useful information about the curricular decision it suggests, but the system is not designed to convince the student that the recommended curriculum is best. The decision to enroll in a major remains the responsibility of the student.

Another limitation of the system is that it may suggest a major that the student does not understand. A recommendation to consider sociology, for example, may hold no meaning for a student who has not yet had the opportunity to take a sociology course. Similarly, students may have a naive view of what some majors involve. In these cases there needs to be follow-up advising to assist the student in evaluating the recommendation clearly. The final expert system could initiate this learning process.

Summary

The process of advising students is an uncertain one in many respects. Despite this uncertainty, students must select majors. We conclude that the system can effectively recommend possible majors for a student at a level close to that of human counselors given the same exposure to the student's background. In validating the prototype, we contrasted the conclusions of the experts (advisors and counselors) with those of the expert system. Since an advisor must provide follow-up counseling, the expert system offers an effective means of collecting base information from the student and for giving the student options to think about before meeting with the counselor. When an advisor is available, the expert system augments but does not replace the human advisor. The system then serves as an intelligent preadvising or introductory orientation or advising tool. The student has the benefit of working through the system and begins to think about factors that need to be taken into account. The computerized advising system can reduce the time needed to acquire complete information from the student. It may be used to educate the student about the types of questions that can help resolve the choice of major. If a human advisor is not available, the expert system may provide valuable starting assistance.

The authors are interested in obtaining support to extend the system. This could include joint development opportunities with other institutions. The system is not for sale. We hope that the system can be made more useful and sophisticated through interaction with others.

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