Analyses of Majors: Providing Interactive Web-Based Resources to Assist Students in Developing Informed Educational Plans

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When students are aware of and choose majors that are congruent with their interests and abilities, college retention rates improve. Systematic approaches that analyze and categorize majors help students make informed decisions by providing student-useable information about the educational environments of majors. Analysis and implications for academic advising of four web-based applications that provide this information are described in this article, along with student usage data. Course Preferences application allows students with low interest or abilities in some areas to find the majors that do not requiring certain courses. Major Themes application provides an interest survey that relates to majors. Science/Math Majors application provides information to help students understand the intensity of the science and math courses required in different majors. Alternative Majors application provides students with majors options that have similar content.

Providing Resources for Educational Planning

In his keynote address to the National Academic Advising Association's (NACADA) Mid-Atlantic Regional Conference, the President of Penn State stated, "With new technologies, students and advisers can focus less on what we consider to be the mechanics of advising—degree audits, signatures, and forms —and instead concentrate on more meaningful explorations of a student's interests and needs" (Spanier, 2002). Students are likely to persist and succeed academically when they understand how their interests and abilities fit with a chosen field of study. Many college and university publications and websites generally provide brief descriptive overviews of each major and list courses required to graduate. It is a difficult, time-consuming task for students, faculty, and advisors to do even the most rudimentary analysis such as comparing majors across common dimensions, let alone relating programs of study to students' interests, abilities, and needs. This is particularly true for institutions that offer a large number of majors and have a large enrollment of exploratory students.

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A systematic approach to the analysis and categorization of college majors can help students in their exploratory process by providing student-useable information about the "educational environments" of majors. The concept of educational environments is based on the idea that each major is built upon a particular body of knowledge, and that students in a major are required to become competent in a specific combination of subject areas. The type, extent, and quantity of the subject matter that composes each program's body of knowledge define that program's educational environment. With such information students can relate their personal characteristics and educational experiences to the various majors and make informed decisions about their educational plans (Levin & Hussey, 2007).

Relating personal characteristics to the educational environments of majors helps students make informed educational decisions. While, on the other hand, when informed decision-making is hampered by a lack of resources or advising strategies and technologies, student retention rates are negatively impacted. This is particularly true for students of color and students starting in science and engineering majors (Huang et al., 2000; White, 2005).

Using Systematic Analyses to Describe Majors

The reasons why students choose certain majors vary greatly. Some students are mainly influenced by extrinsic reasons such as money, prestige, parental pressure, or job opportunities. Others are influenced by intrinsic reasons such as interest in the subject area, special talents and abilities, or previous success in the discipline. The majority of students rationalize their choice of major by both extrinsic and intrinsic motives, such as, "I want to be an engineer because I like math and do well in it, plus there are lots of jobs in that field."

The reasons for considering a major can be complex and abstract, but the process of exploration often begins with students asking questions which are very concrete. Students may ask questions such as:

- I don't like foreign languages; what majors don't require any?
- I'm interested in helping people; what majors should I look at?
- I want a major that has a lot of chemistry but not much math; is there a major like that?
- I didn't qualify for the finance major; are there any similar majors?

Majors can be systematically analyzed to provide students with answers to these types of questions and concerns. Four different web-based interactive applications have been developed at Penn State to assist students and their academic advisors in the process of exploring and eventually making an informed decision about choice of major (Hart et al., 2006).

Course Preferences Application

"What majors do not require taking a foreign language?"

Often, students can express what they dislike more easily than they can describe what they do like. These attitudes about subjects are usually based on high school experiences. Students may not seriously consider a major because it requires a certain course. However, students often do not take into account that the total number of different courses in the major outweigh the number of courses they dislike. Therefore, when students compare the number of classes, they are more likely to accept the disliked course rather than eliminate a possible major. The Course Preferences application provides students with information about majors that are available to them based on the courses they decide not to take. (Hart et al., 2006).

Analysis

Penn State currently offers over 200 different baccalaureate degree programs. Listed below are courses that are required by many majors. The Course Preferences application allows a student to identify majors that are available based on the courses the student decides not to take. Thus, deciding not to take any of these key courses will limit the number of majors a student can consider. These courses are:

- biology: basic concepts and biodiversity (with lab)
- chemical principles (basic concepts and quantitative relations)
- economic analysis and policy
- foreign language
- techniques of calculus I (calculus without analytic geometry)
- calculus with analytic geometry I
- general physics: mechanics (calculus-based physics)
- introductory physics I (algebra-based physics)
- introductory psychology (principles of human behavior)

Use in academic advising

Two outcomes result from highlighting majors that do not require courses in which the student is either not interested or for which the student does not have strong abilities. One outcome is that the student will see how he or she has limited the available opportunities by deciding not to take certain courses. For example, by eliminating calculus the student has reduced his or her options by 43% (from 283 to 160 majors). By eliminating calculus and foreign language the student has reduced his or her options by 75% (from 283 to 70 majors). Because students often do not conceptualize majors as an interrelationship of groups of courses, these results are often surprising. With this information, many students decide that the reduction in options is not worth eliminating disliked courses and will reconsider taking the designated course. Another outcome is that students who definitely do not want to study a particular course or courses are provided with a list of majors that are congruent with their interests and abilities. Within seconds, Course Preferences analyzes 283 majors to provide the student with this list.

Major Themes Application

"What majors will allow me to help people?"

It is common for students to express broad unspecified interests such as helping people, working outside, life sciences, and business. They may not realize that there are many majors that relate to these interests. For example, "helping people" can be a descriptor of a kindergarten teacher or a neurosurgeon. The Major Themes application provides lists of Penn State baccalaureate majors that are categorized based on students' self-reported interests in areas that range from the arts to wildlife science.

Analysis

For this application, Penn State undergraduate majors have been classified into different themes generally based on the similarity of the topics studied in each major, but not on potential career opportunities. For example, the biological (life) sciences theme includes not only the biology major, but also agroecology, secondary education (biological science teaching option), nursing, psychology (neuroscience option), physics (medical physics option), statistics (biostatistics option), and many more. Even though these majors are in different colleges, they are all in the same theme because they all involve the study of the structure and function of living things and the application of these studies.

Because many majors involve the study of more than one topic, some majors are listed in more than one theme. For example, the psychology major is listed in six different themes: helping and human services, social sciences, biological (life) sciences, business (people oriented), health sciences and medicine, and mathematical sciences, representing the different options this major offers.

Use in academic advising

Many students feel overwhelmed when choosing a major. Some students have difficulty expressing their academic interests, while other students may have a specific interest, but are uncertain as to which majors will help them to develop skills and critical thought in that subject area. This application assists students in, first, identifying their areas of academic interests by completing a self-assessment interest survey. These interest areas are then clustered into one or more themes. The student is next instructed to review the definition of each identified theme and indicate which subject matters are of interest. From each selected theme a group of majors are listed. Each major is linked to a description, so the student may further research each possible choice. Additionally the student can share the results of this application with their academic advisor in order to elicit more discussion and analysis.

Science/Math Majors Application

"What science majors don't require a lot of math?"

The analysis of science and math majors across eight content dimensions provides students with a list of majors that are congruent with their interests and abilities. These eight dimensions are the number of credits in biology, chemistry, physics, and mathematics and the number of credits from courses that require biology, chemistry, physics, and mathematics as prerequisites. Students can design their "ideal major" by specifying the number of courses they would like to take in each of the eight dimensions. This ideal major is then statistically compared to existing majors at Penn State (Levin & Hussey, 2005).

Analysis

In this study, the operational definition of a science- or math-related major is any major that requires at least one of the following technical science or math courses: BIOL (biology: basic concepts and biodiversity), CHEM (chemical principles), MATH (calculus with analytical geometry I), or PHYS (calculus-based general physics: mechanics). Using these criteria, 160 programs of study were identified as being science-math related. In addition to finding ideal majors that correspond to their interests, students can view majors in ascending order by the number of courses required in each of the four subject areas (biology, chemistry, mathematics, and physics).

When designing their ideal major, students focus on two categories of courses: 1) the depth to which they would like to study the four foundation courses, and 2) the extent to which they would like to apply the foundation knowledge by taking courses that have the foundational courses as prerequisites. Students' ideal majors can be compared to the educational environments of Penn State's science- and math-related majors, resulting in a ranking of majors from most to least similar to students' ideal majors.

Use in academic advising

The following examples illustrate additional uses of Science/Math Majors application other than designing an ideal major.

Scenario 1: A student who dislikes or is doing poorly in a specific science course (e.g., math), but still wants to pursue a science/math related major. The student can search a static table of MATH, (which is included in the application) in ascending order for science/math related majors that require the least number of mathematics courses.

Scenario 2: Student interested in science/math related majors with preferences for one or more specific dimension(s). In this scenario, a student wants to emphasize a study of chemistry, but wants a minimum of both mathematics and physics courses. The student assumes at first that he or she should pursue the chemistry major. However, the educational environment analysis shows the chemistry major requires an in-depth study of chemistry (12 courses), along with a strong emphasis in mathematics (4 courses plus 8 courses based on MATH) and a strong emphasis in physics (4 courses plus 3 courses requiring PHYS as a prerequisite).

Using this application, the student learns that there are many possible majors to consider that emphasize the study of chemistry with a range of emphasis in mathematics and physics. Such analyses encourage students to broaden their options and make informed educational decisions.

Scenario 3: Student is misinformed about curricula of majors. A student begins the first year with an interest in civil engineering (CE), and completes two calculus courses and one calculus-based physics course. The student has difficulty with the physics course, receiving a "D" as a final grade, and decides that engineering is not for him or her. The student still wants to remain in the sciences, remembers that he or she has always been interested in weather and did well in high school earth/space science courses, and decides that meteorology (METEO) would be a good major and would reduce the physics course work.

With the use of educational environment analyses, the student can compare the science environments of the CE major with the METEO major. From the comparison, the student learns that even though there is less emphasis on physics in meteorology than in civil engineering, the METEO major still relies heavily on the study and application of physics. The student decides to explore other options that would accommodate earth science interest but with less emphasis on physics, and determines that other possibilities include earth science (EARTH), geosciences (GEOSC), and soil science (SOILS). All of these majors require less physics.

Alternative Majors Application

"I didn't qualify for the finance major; are there any similar majors?

The Alternative Majors application provides a list of Penn State baccalaureate majors that are similar to a specific major that a student is considering.

Analysis

For this application, Penn State majors (and options or areas of emphasis), have been classified into different themes based on similarity of topics studied in each major/option. For example, the biology/life sciences theme includes not only the biology major but also agroecology, secondary education (biological science teaching option), nursing, psychology (neuroscience option), physics (medical physics option), statistics (biostatistics option), and more. Even though these majors are in different academic colleges, they are all in the same theme because they involve either in-depth study of biology or applications of biology to other fields of study. In most cases, majors have not been categorized into these themes based on potential career opportunities but on similar course content.

Use in academic advising

This application is used by students in two ways. The first is when students do not qualify to enter their preferred majors and want to find another major with similar characteristics. For example, a student interested in finance would find 11 alternative majors that include economics, accounting, and statistics.

Another use of this application is when students want to expand their decision set of possible majors. There are hundreds of majors available in large universities, yet most students are familiar with only the most popular—such as psychology, communications, biology, or business—and are not aware of the many other majors that are related to their interests. For instance, there are more than 20 alternative majors to psychology that include human development and family studies; biobehavioral health; or crime, law, and justice.

Students' Use of Applications

Figures 1 through 4 illustrate student usage of the four applications described in this article for the 2009-2010 academic year. The total number is the frequency of times the application was accessed. This includes all students who used the application multiple times. The unique number is the frequency of individual students who accessed the application compared to the total number of times the application is used. The graphs show that for all applications, the most activity takes place in August when the new academic year begins and many students are in the process of deciding upon a major.

FIGURE 1

Usage of Course Preference Application

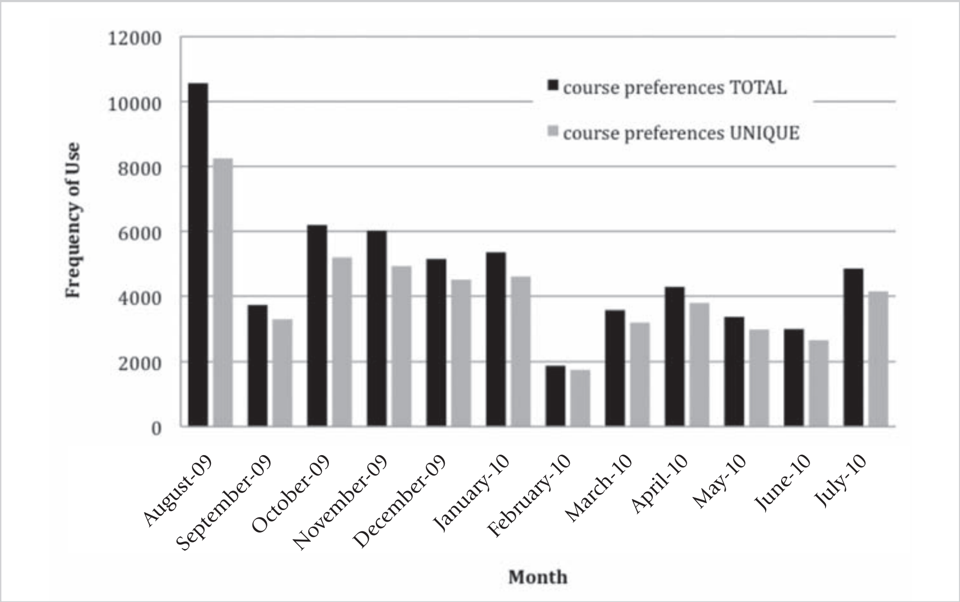

FIGURE 2

Usage of Major Themes Application

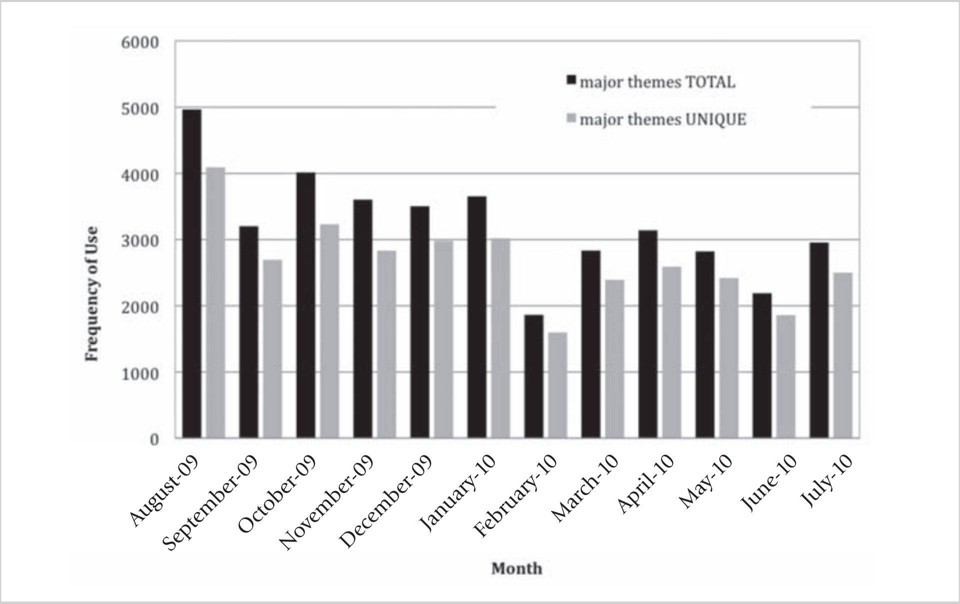

FIGURE 3

Usage of Science/Math Majors Application

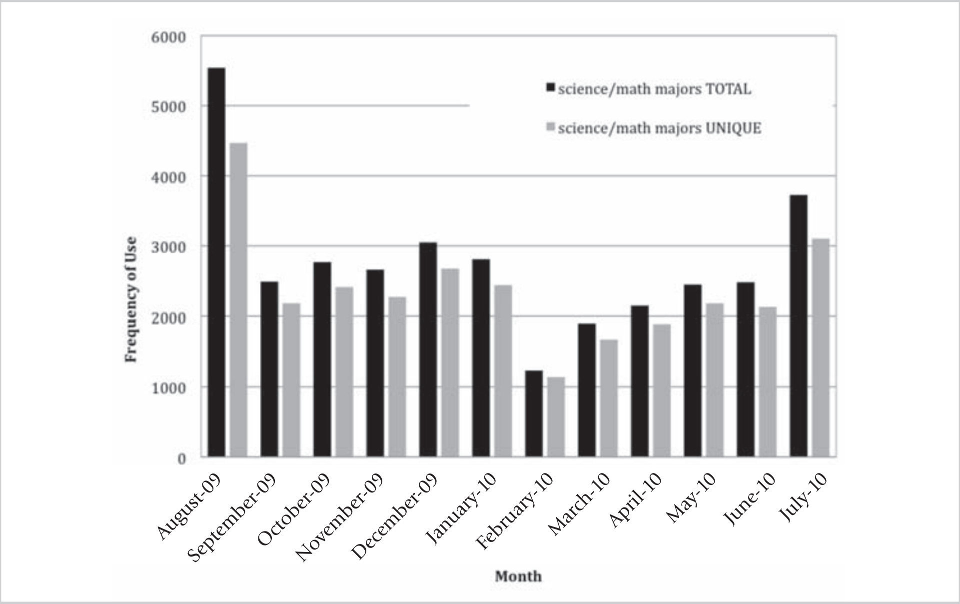

FIGURE 4

Usage of Alternative Majors Application

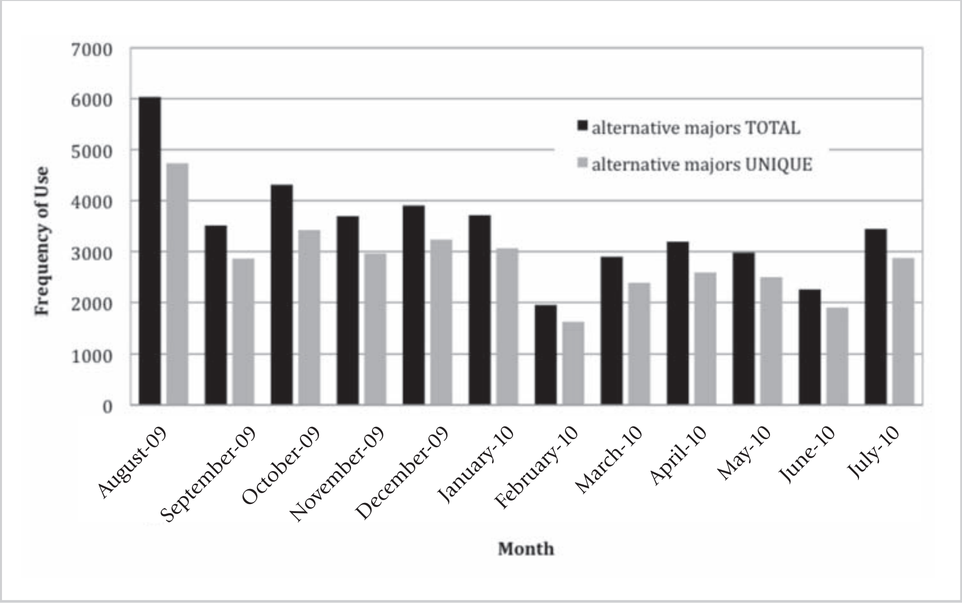

Table 1 lists the grand totals and unique totals for each application. Such usage indicates that students find the applications and student-oriented information about educational environments of majors helpful in their exploratory and decision making process. Table 2 shows the monthly averages over the 2009–2010 academic year for each application, which indicates that student usage is high throughout the year.

TABLE 1

Totals of Student Usage of Applications

	Course Preferences		Major Themes		Science/Math Majors		Alternative Majors	
	Total	*Unique*	*Total*	*Unique*	*Total*	*Unique*	*Total*	*Unique*
	57955	49308	38762	32220	33263	28574	41904	34161
Unique Total								144263
Grand Total								171884

TABLE 2

Monthly Averages of Student Usage of Applications

	Course Preferences		Major Themes		Science/Math Majors		Alternative Majors	
	Total	*Unique*	*Total*	*Unique*	*Total*	*Unique*	*Total*	*Unique*
Average	4676	3986	3167	2632	2668	2300	3393	2766

Summary

NACADA recommends that one student-learning outcome of academic advising should be that students be able to "use complex information from various sources to set goals, reach decisions, and achieve those goals" (2006, p. 2). For students making decisions regarding choice of major, a critical piece of information—how one's interests and abilities relate to the different majors—is not readily available. A search of literature results in an article (Levin & Hussey, 2005) that attempts to help students understand the characteristics of the majors by detailing the content of what a student will study in each major. In most cases, descriptions of majors focus more on career opportunities and do not help students understand how their interests and abilities will relate to the courses required by a major.

The goal of the applications discussed in this article is to present ways in which one institution helps students understand the relationships between their personal characteristics and the characteristics of Penn State majors. Understanding these relationships will assist students in making well-informed educational decisions. Essentially, advisors teach decision-making skills, and students learn how to become effective decision makers (Levin & Brazil, 2008). Therefore, advising should teach students the skills necessary for processing information, making personally beneficial decisions, and achieving goals.

One likely outcome of teaching and learning effective decision-making would be a decrease in number of students switching majors. Nationally, 50% of college students change their educational plans at least once, with many doing so two and three times (Ronan, 2005). This statistic indicates that students' initial major choices are not well informed and lack congruency with their interests and abilities. This situation is particularly acute for students of color who have lesser rates of retention and graduation (Huang et al., 2000; White, 2005). In addition, students in science and engineering majors also have low rates of retention (Hayes, 2006). The applications described in this paper are tools that can aid in the decision making process.

Making informed decisions when choosing a major will increase the likelihood that students will persist and succeed in their major. Students in all disciplines are more likely to perform well academically and eventually graduate when they understand how their interests and abilities relate to their chosen field of study (Levin & Wyckoff, 1988, 1995). It is necessary for faculty and professional academic advisors to have effective informational and conceptual tools to assist students as they explore and develop their educational plans (Melander, 2002). According to the usage data, the four applications discussed in this paper are effective informational and conceptual tools that students can access to systematically analyze the large number of majors offered by their university.

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