Work in Progress - Initial Evaluation of an Introductory Course in Programming that Assists in Career Choices

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Abstract **- We present initial results from an effort to investigate the effectiveness of programming-centric computer literacy courses at the University of Texas at El Paso (UTEP). UTEP is an urban university serving a largely Hispanic student population principally drawn from the sister cities of El Paso, TX, USA, and Ciudad Juarez, Chihuahua, MX. This course is based on the creatively engaging "Media Programming" approach of Dr. Mark Guzdial of Georgia Tech. In this course, which was designed for Liberal Arts students, students are introduced to the Jython programming language. Class projects implement and extend algorithms that directly manipulate multimedia and expose students to digital representations of images and sounds in a sequence of aesthetically focused projects. We are investigating whether (1) there is value in modifying this curriculum to complement common occupational traits for student cohorts enrolled in engineering and computer-science programs and (2) such courses can assist students in career choices and improve long-term student success.**

INTRODUCTION

"…Computer Science is like the process of thinking. It helps you organize your thoughts by writing programs…. It helps you think better, finding new ways to do things, and solve problems at a higher level."
(Student statement at the end of the course.)

Several observations lead to our introduction of a programming centric computer literacy course:

- Declining enrollment in Computer Science despite increasing need for graduates with expertise in programming and computation-related skills;
- High attrition rates for entering college students intending to study of Computer Science; and
- Observations that many incoming students with an intention of studying computer science had little or no prior exposure to programming or other engineering fields.

The approach introduced at UTEP has been largely successful. A majority of the students who attended these newly structured courses:

- Succeeded at learning the course content including gaining familiarity with programming;
- Achieved a high degree of self-confidence;
- Believed that programming is a creatively engaging activity; and
- Desired to learn more about programming and computation.

A variety of highly motivational and creatively engaging programming centric programming-literacy curricula are available. Dr. Guzdial's "Media Programming" [1] approach was chosen primarily because it exposes a diversity of modes for creative expression and analysis. Programming assignments in Python can allow both aesthetic expression through the manipulation of media and the exploration of numerical algorithms that dramatically manipulate media data.

For example, while some students may be engaged by the creation of artwork, others can explore the design of convolution filters that blur or sharpen images. Regardless, Dr. Guzdial's course, which has successfully introduced liberal arts students to computation principally, emphasizes aesthetic expression.

Our assessment includes qualitative observations by the instructor, and informal interviews by Education students, and quantitative results from anonymous questionnaires presented by an external evaluator [2]. These results are preliminary and introduce new research questions. We are in the process of extending our experiments to better understand student attitudes and to track student academic performance after attending this course. This course is offered as an extension of a required freshman "University Studies" curriculum that also includes components on library skills oral and written communication, and career guidance and therefore provides an opportunity for students to reflect upon their experiences with programming in the context of class essays, presentations, and career selection.

ASSESSMENT OF ATTITUDE TOWARDS PROGRAMMING

Both anecdotal and quantitative evidence is consistent with a hypothesis that many students with little background developed a high sense of self-efficacy in programming and computers. For example, 64.9% of the students that started the course initially reported that they had no experience programming. Approximately the same fraction (63.9%) of the students at the end of the course felt that the class had increased their confidence in using computers. This is consistent with (but does not prove) a hypothesis that most

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students who entered with little experience developed substantially increased confidence.

In interviews and in discussions with the instructor, many students indicated satisfaction and pride in the results of their efforts in overcoming challenges posed by more advanced projects such as the creation of combinations of image and sound. At the end of the course, students reported that they had an increased ability to apply problem solving skills beyond the coursework. Nonetheless, in post-course questionnaires (see Table 1), a significantly larger number of students agreed with the statement "computing is boring" than prior to attending the course. Our future research will include an investigation of whether this superficially discouraging result indicates that we are inappropriately discouraging students from pursuing careers in computation or facilitating a helpful career selection process.

TABLE 1
STUDENT PERCEPTIONS OF COMPUTATION AND PROGRAMMING

	Strongly Agree	Agree + Strongly Agree
I am confident in my problem-solving abilities.		
Before (Pre-Survey)	7.1 %	33.3%
After (Post-Survey)	18.9%	67.5%
I enjoy problem solving.		
Before (Pre-Survey)	33.3%	88.1%
After (Post-Survey)	18.9%	91.9%
Computing is boring.		
Before (Pre-Survey)	0.0%	2.4%
After (Post-Survey)	13.9%	25%
Programming is a creative activity.		
Before (Pre-Survey)	29.3%	85.4%
After (Post-Survey)	41.7%	94.5%
Programming languages can be learned through practice.		
Before (Pre-Survey)	35.7%	95.2%
After (Post-Survey)	51.4%	97.3%

RELEVANCE OF INTENDED MAJOR TO COURSE PROJECTS

"Other things being equal, people experience more satisfaction in environments where the mix matches their salient personal characteristics, that is, their interests and specific skills or abilities" (Gottfredson, 1996).

Our initial findings indicated that some students in the course indicated a lack of interest in the principally aesthetic focus of the course's open-ended programming projects. While these results may be an anomaly, it's important to note that the UTEP students were incoming freshmen who had identified computer science, engineering, or science as their degree choice as opposed to the students at Georgia Tech who were principally Liberal Arts (LA) students. One hypothesis is that the UTEP students who were unengaged with the labs may be due to our creation of a learning environment ill tuned to the interests and proclivities of our particular group of students.

John Holland conducted the seminal research on career selection and satisfaction, and his results [3] are widely used by the career counseling community. Holland observed that individuals whose inherent traits and interests match their environment and vocational setting find their work motivating and experience greater job satisfaction. Table 2 summarizes the traits identified by Holland and a set of vocations for which they are generally observed.

According to Table 2, a cohort of students with traits similar to those correlated with successful visual and performing artists and journalists (typical majors of students enrolled in LA programs) are likely to have many members who possess Holland's artistic trait. Students with this trait are would be expected to be motivated by aesthetic-based projects as exemplified by the advanced labs in Dr. Guzdial's curriculum.

In contrast, people working in engineering and science, are not likely to possess Holland's dominant artistic trait, but instead frequently have a dominant investigative trait. We will investigate the effectiveness of replacement projects whose creative challenges map to a broader range of dominant traits including those common among professionals engaged in computer science, engineering and science.

FUTURE WORK

Our research focuses on understanding how to attract students who can succeed in computing. The results given in Table 1 were surprising, and we will be comparing these results to newly collected data to determine whether they are consistent or an anomaly. The introduction of career options is a critical and valuable part of the course. The questions related to this are: Does the pace and perceived challenge (or lack) impact how students perceive computing? How are career options presented? How do invited speakers from different areas present work in their field? Do lab choices impact how students perceive computing? If so, can Holland's model help in lab choice selection?

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TABLE 2
PARTIAL LISTING OF TRAITS AND DOMINANT PROFESSIONS IDENTIFIED BY HOLLAND.

Holland Trait	Personality Attributes	Likely Proclivities	Dominant Professions
Investigative	Analytical, intellectual, reserved, independent, scholarly.	Working with abstract ideas, intellectual problems.	Biologist, chemist, historian, researcher, doctor, engineer, mathematician.
Artistic	Complicated, original, impulsive, independent, expressive, creative.	Using imagination and feelings in creative expression.	Artist, musician, actor, designer, writer, photographer.