Introductory Computing Course Content: Educator and Student Perspectives

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ABSTRACT

Selecting the appropriate content for introductory computing courses is an important part of attracting and retaining students in computer related education programs. This paper reports the results of an educator survey including SIGCSE and SIGITE members designed to evaluate topics that member institutions currently include and would prefer to include in their introductory computing courses notably for non-majors. In addition, we contrast information obtained from the educator survey to a student preference survey and student outcome evaluations from our introductory computing course.

In this paper we show how the perspectives of computer science and information technology educators differ with regard to content of their courses and the differences between the currently offered content and what would be preferred. We also examine survey respondent perspectives regarding the teaching of the office suite, broadening participation, and interdisciplinary topics.

This analysis contributed to changes in our introductory computing courses. Specifically course content changes that improve alignment with the educator community recommendations, emphasize interdisciplinary assignments, and deemphasize office suite training (word processor, spreadsheet, presentation, and database) training. With these changes we have observed, that while approximately 10% of the non-majors attending our revised introductory computing course have crossed over to computing, we firmly believe that a significant percentage of non-majors now have an improved understanding of the importance of computing to their majors.

Categories and Subject Descriptors

K.3.2 [Computers and Education]: Computers and Information.  
Science Education—Information systems education;  
Curriculum

General Terms

Standardization

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Keywords

Introductory computing course, Survey, Curriculum Design

1. INTRODUCTION

For many non-majors, introductory computing courses may be the only involvement with computer related education during their undergraduate career. As educators, we believe this experience should not only teach and support fundamental computer literacy topics [4, 10], but demonstrate the power and value of computing overall and how it relates to the individual student’s major. What we intend to develop is not only effective users of computing technology, but to encourage students to become innovators within their educational disciplines. Moreover, there is evidence to support that making computing relevant to students from an interdisciplinary perspective has value [1, 2], and may attract students to major and minor programs in computing [11].

Four years ago, the only computer related program our University offered was a Management Information Systems (MIS) major in the portfolio of programs provided by the Business Division. At one time the University offered a Computer Science major, but the program was discontinued due to a variety of reasons. Our assignment was to construct, build, and grow an Information Technology program derived from the ACM’s Information Technology 2005 curriculum guidelines. Prior to the emergence of the Information Technology program, computer related general education requirements at the University exclusively involved the teaching of the latest version of the Microsoft Office Suite. However, while valuable, office suite training (teaching how an office tool functions) in our experience does little to instill innovative computational thinking [7]; in fact, many students commented that the office course was nothing more than a typing class. If a large percentage of students share this perspective, clearly a course designed exclusively around office training is not the best approach to generate excitement about computing. Moreover, such courses do not properly prepare our students for the digital world [6].

The ACM curriculum guidelines [9] include a variety of valuable computer literacy topics such as security and usage of the Internet that are relevant to non-majors, but is teaching computer literacy enough? To investigate this, we surveyed two elite groups of computing educators, SIGCSE and SIGITE, with the objective of assessing what these educators are presently teaching and would prefer to teach in their introductory computing courses and their view of interdisciplinary assignments and broadening participa-
tion issues. Note while SIGCSE/SIGITE membership backgrounds are likely similar, we were also interested in studying the course implementation and preference differences between the groups to influence future decisions regarding discipline specific course design. We then contrast this information to the results of a student survey designed to assess student introductory computing course interests and student outcome evaluations from the revised version of our introductory computing courses.

Section 2 describes the design of the surveys and how the data was collected and analyzed. Section 3 presents the results of the surveys and Section 4 evaluates the findings. Finally, Section 5 presents a summary and list of conclusions.

2. SURVEY DESIGN
To obtain input from educators and students three online surveys were developed and one course outcomes evaluation form was devised to capture input from students, SIGCSE, and SIGITE members. First, we developed a list of potential introductory computing course topics derived from IC3 [10] computer literacy recommendations and the ACM IT curriculum guidelines [9]. We included the teaching of the office suite in the list of topics to determine the extent to which educators offered and preferred to offer, the topic with respect to other computer literacy topics. In addition, we were interested in student preferences with regard to these topics as well. The list of topics is provided in Table 1 below.

<table>
<thead>
<tr>
<th>Table 1: List of Survey Topics</th>
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<tr>
<td><strong>Topic</strong></td>
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<tr>
<td>1. Office application software</td>
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<td>3. Programming with Scratch or Alice</td>
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<tr>
<td>7. Database concepts</td>
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<tr>
<td>11. Robot programming</td>
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<tr>
<td>13. Application and software development</td>
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<tr>
<td>17. Computer programming (Visual basic)</td>
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<td>21. Operating systems concepts: file systems, virtual memory, and interfaces.</td>
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<tr>
<td>23. How to build a PC</td>
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We considered using a subjective importance/priority scale for each topic, but elected to simply capture the frequency upon which a particular topic was of interest to educators and students. Note each question included a means of capturing a free-form response to facilitate inclusion of topics not in our list.

Next we developed questions to gauge educator experiences with interdisciplinary courses, projects, and assignments. And finally, we included a survey question designed to evaluate recommendations regarding broadening participation in computing (BPC). We decided to implement the interdisciplinary and BPC questions by using free-form responses. Table 2 lists the responses by survey.

<table>
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<th>Table 2: Response Information</th>
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<tr>
<td><strong>Survey</strong></td>
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<td>Educator</td>
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<tr>
<td>Educator</td>
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<tr>
<td>Student</td>
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<td>Student</td>
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For the educator surveys, we initiated survey collection through an approved communication to the SIGCSE and SIGITE email groups; responses were collected using a web based survey system. The student surveys we initiated via a direct email request and responses collected in a similar online manner. Course outcomes evaluations were distributed to students as part of the end-of-course evaluation process.

3. RESULTS
The first two questions were designed to identify topics currently covered in introductory computing courses. Figures 1a and 1b present the top ten topics indicated by respondents from the SIGITE and SIGCSE educator groups respectively. The value indicated is the percentage of respondents selecting the given topic.

![Fig. 1a: SIGITE Top 10 Current Topics](image)

![Fig. 1b: SIGCSE Top 10 Current Topics](image)
In contrast, student responses to similar topic related questions are illustrated in figures 1c and 1d. Note the primary difference between the residential and online student groups, beyond modality, is age and maturity. For residential students, note that only two topics exceeded a majority of students while the more experienced online students reached or exceeded a simple majority on five topics. This suggests to us that there is greater consensus with maturity.

Our second set of questions examined educator preferences with respect to course content. We requested that educators select their recommended topics from the list and/or provide free-form responses to the question. Figures 2a and 2b examine educator recommendations from the provided list of topics. Other recommended content captured from the free-form responses include: algorithms, artificial intelligence, graphics, and logic circuits.

Figures 2c and 2d depict the top positive and negative changes from current to recommended selections by the educator respondents. The “preference change” value shown is the difference between the current and recommended selection percentages. Note that the teaching of office represents the largest decrease of interest of all topics listed.

Questions three and four (figures 3a, 3b, 4a, and 4b) attempt to capture educator feedback related to interdisciplinary assignments and approaches to broadening participation in computing within underrepresented groups. Free-form responses to the questions were reviewed and upon analysis various categories established. For the interdisciplinary assignment question, we collected 55 and 41 responses from SIGITE and SIGCSE members and the broadening participation question resulted in 50 and 32 collected responses from SIGITE/SIGCSE respectively. Note that multiple responses from individual respondents were also included.
Figure 5 shows the summarized results of student outcome evaluations for our revised introductory computing course. The outcome evaluation form requests that each student rate course topics and assignments for effectiveness and value.

4. ANALYSIS
To begin, we review our research objectives.

1. Assess the extent to which the office suite is taught as a topic of introductory computing courses.
2. Evaluate educator feedback regarding interdisciplinary courses and broadening participation opportunities.
3. Review educator recommendations for introductory computing course content and contrast this to student feedback.

4.1 OFFICE TRAINING
Based upon the survey results, SIGITE and SIGCSE members presently include office suite training in the mix of topics offered to students. For SIGITE members, figure 1a shows that office training ranks 5th in the list of current topics and, although not shown, office ranks 12th in responses from SIGCSE.

Figures 2c and 2d examine the top differences between current and recommended topic selections. The results indicate that office training decreased by 20 and 18 percentage points respectively for SIGITE and SIGCSE members from what is currently offered to what is recommended. In addition, recommended rankings place office training 11th (SIGITE) and 21st (SIGCSE) and no respondent selected office training topics as their only recommended topic. Assuming the responses are representative of SIGITE and SIGCSE members, we conclude therefore that any introductory computing course that exclusively covers office training is not aligned with mainstream recommendations for computing education.

4.2 BPC & INTERDISCIPLINARY TOPICS
Broadening participation in computing (BPC) is an important and worthy goal, as educators we need to do what we can to eliminate barriers to entry both real and perceived [8]. Moreover, interdisciplinary topics demonstrate how computing can be applied to other disciplines [2, 11]. With regard to non-majors, we as educators can provide instruction that helps students become effective “users” of information technology. Clearly this is an important objective; however, we can also help non-majors learn how to apply computing to their disciplines in innovative ways. Computing majors can also benefit, by improving their understanding of how computing is applied in other disciplines.

Figures 3a and 3b examine the responses from SIGITE and SIGCSE respondents respectively in response to the BPC question. Both groups seem to agree that providing relevant prob-
lems, instruction that illustrates how computing can help society, and interdisciplinary topics are important. Some responses, however, strongly voiced the opinion that content will not impact participation in the field. We believe that content is only one component of a larger set of issues impacting participation. However, given the relatively large number of thoughtful responses to the BPC question suggests that many educators believe that content can be a contributing factor.

Figures 4a and 4b summarize the responses with regard to cross / interdisciplinary courses. Business and Science & Mathematics make up the top choices for SIGITE and Science & Mathematics and Engineering are the top ranked topics for SIGCSE. Although not shown, approximately 62% of member institutions do not currently offer interdisciplinary courses, but 11% of those indicated that interdisciplinary courses are planned. We also do not currently offer an interdisciplinary course at our University; however, we do assign projects in our introductory computing course that invite students to explore how computing is used in their majors.

4.3 EDUCATOR/STUDENT FEEDBACK

This section contrasts educator survey responses to student feedback obtained from two sources: a student preference survey and end-of-class course outcome evaluations. From the student survey, figures 1c and 1d list the top ten response categories for residential and online students respectively. Note how the top responses differentiate between the groups involved. The top category, “Careers - emphasizing topics that help me obtain a job,” in the residential group in comparison to the top response, “Solving Problems - topics I can use to solve business problems,” in the more experienced online student group suggest a gap in maturity. Not surprisingly, the younger (residential) group’s immediate interest is to secure employment while the more established online group is interested in the application of computing to solve business problems.

Student responses indicate that beyond careers and problem solving, security, web development, and office training are important. However, again no student respondent selected office suite training as their only topic of interest.

Our interpretation of the differences between the educator and student groups is as follows: Student responses (especially non-majors) tend to be driven more by general knowledge of the field, for example, information that appears in the news media and communications in their social circle. Educators are experts in the discipline and as a result understand the importance of educational topics beyond general knowledge required to be effective in the field. This suggests to us, that some balance is needed. Educators need to provide topics that interest students while including topics that are important to the understanding of the discipline. Note figures 2c and 2d suggest that educators already recognize the need to include discussions of careers in course content. Careers received the highest positive increase in preference change.

Other notable educator preference changes include providing topics related to Social Media/Networks and Python. This suggests, as expected, that educators are driving or adapting to current trends in the field. However, our student course outcome evaluations with regard to Social Media are mixed and the ratings for our Python topics so far have not been positive.

From our observations, many students today are frequent users of social media so our assignment that requests that they create and maintain a blog and join and communicate on a social network has been unexpectedly met with little enthusiasm. The blog/social network assignment ranks second to last (figure 5) with a 3.15 rating on a 5 point scale.

Although virtual reality is an application of computer graphics, when applied to virtual worlds there is a social media/networks aspect as well. One of our most engaging assignments (ranked 1st: rating 4.71), from a student outcome evaluation perspective, is our virtual world building competition. Students form teams, login to an OpenSim [3, 12] system, and learn about constructing virtual environments and communicating in a virtual world.

As shown in (figure 5) only the Python topic ranks lower than blogging with a 2.82 rating. With regard to Python, we have varied the instructional content and assignments, for example, solving basic problems algorithmically, photographic image analysis, and animated graphics with little success. Comments from non-majors with regard to the Python topic range from the content being too difficult to being irrelevant.

Majors on the other hand, enjoy the assignment and overall do well. Clearly we need to be more creative with the blog and Python assignments to improve the course outcome evaluation results with respect to non-majors.

It is interesting that the same group of students who rated Python low, ranked Scribbler robot and Scratch programming 2nd and 3rd with average ratings of 4.44 and 4.38 respectively. In both cases, however, the assignments used a visual programming language (Scribbler Program Maker and Scratch) as opposed to the text based Python language. This suggests that the low ratings for Python are less about programming and more about the tool used and the problems assigned.

Another interesting point is that the popular assignments (based upon student outcome evaluations) such as: robot programming, Scratch programming, and PC Construction topics appear to be only of limited interest to educators. SIGITE respondents ranked these topics (25th, 21st, 24th) while SIGCSE survey responses ranked the topics (22nd, 17th, 24th) respectively. With regard to the PC construction lab, the students perform this task after several lectures on computer hardware. The hands-on nature of the PC Construction lab seems to appeal to most students [9] and represents an approach to reinforcing the lecture material related to computer hardware which educators ranked first in the list of recommended topics.

5. SUMMARY AND CONCLUSIONS

Based upon our analysis of the survey results we have formed the following conclusions:

1. Assuming the responses are representative of SIGITE and SIGCSE members, we conclude therefore that any introductory computing course that exclusively covers office training is not aligned with mainstream recommendations for computing education.

2. We believe that content is only one component of a larger set of issues impacting participation in the field by underrepresented groups. However, given the relatively large number of thoughtful responses to the BPC question suggests that many educators believe that con-
tent can be a contributing factor. Educators seem to agree that providing relevant problems, instruction that illustrates how computing can help society, and interdisciplinary topics are important.

3. Sixty two percent of SIGCSE/SIGITE members responding to the survey indicate that their institutions are not currently offering interdisciplinary courses; however, 11% of these respondents indicate that offering interdisciplinary courses is a future objective.

4. Based upon our student surveys, students are interested in topics such as careers, how to solve business problems, security and web development.

5. Educator content recommendations suggest that educators already recognize the need to include discussions of careers in course content. Careers received the highest positive increase in preference change.

6. For introductory courses with predominately non-majors enrolled, teaching programming with visual program languages such as Scratch seem to be preferred by students based upon our course outcome evaluations. For many non-majors, an introductory computing course is their first and only exposure to computer related education. In our view this represents an opportunity for educators to help students realize the importance of computing with respect to their majors.

6. ACKNOWLEDGEMENTS

We would like to express our sincere appreciation to the members of SIGCSE and SIGITE who took the time to respond to the survey and to the leadership of these groups, Bruce Maxwell and Mark Stockman for approving the communications. We also express our appreciation to Matthew Hertz [5] for his inspiration and encouragement.

7. REFERENCES


