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Gender and Programming Language Preferences of Computer Programming Students at Moraine Valley Community College

Dawn Patitucci
Old Dominion University

Gender and Programming Language Preferences of Computer Programming Students at Moraine Valley Community College

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Dawn Patitucci
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Approved by:

John M. Ritz 7-21-05

Dr. John M. Ritz, Date
Advisor, Chair and Graduate Program Director
Occupational and Technical Studies
Old Dominion University

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Chapter I

Introduction

Women have been highly influential in the field of computer programming since its supposed inception in the 1830s. Ada Byron, Countess of Lovelace and famed collaborator of Charles Babbage, is often credited as being the world's first computer programmer. Perhaps even more influential to the field was naval officer Grace Murray Hopper, who in the 1950s wrote the first programming language compiler, whereby programmers could use natural language, as opposed to machine language, to write programs. Hopper contributed to the development of COBOL (Common Business Oriented Language), the first business-oriented programming language, released in 1960 and still in use today. These two women are the most notable from a tradition of female computer programmers that persisted throughout the 1960s. For example, in 1960, 65% of the nation's estimated 2000 computer programmers were women (Lockheed, 1993, p. 117). Interestingly, the percentage of female computer programmers began to decline sharply in the 1980s with the advent of the personal computer—or more specifically, when computers began to appear in homes. Even as job opportunities for programmers and software developers peaked in the 1990s, the number of women pursuing such opportunities continued to decline. Today, computer programming is very much a male-dominated field, with women making up only 25% of computer programmers nationwide, with not even half that percentage of women represented in software development and engineering jobs (U.S. Department of Labor, Bureau of Labor Statistics, 2004).

Meanwhile, the field of computer programming has advanced dramatically in the past twenty-five years. The development of the C++ programming language by AT&T Bell Labs researcher Bjarne Stroustrup in the early 1980s revolutionized business programming by allowing programmers to model real-life entities, such as employees or products, through code while promoting code reuse and, as a result, rapid application development. In the 1990s, Microsoft's release of Visual Basic provided a graphical environment to develop programs using drag-and-drop techniques coupled with traditional code writing. Also in the 1990s, the rise of Internet use gave way to platform-independent programming languages, most notably Java, and, later, Microsoft's .NET technologies, including VB.NET and C#. Even procedural languages such as COBOL and RPG, most often used on mainframe and midrange computers, are still relevant today.

In light of such developments, the options for computer programmers and software developers are many and varied, with programming languages differing in their performance, application, flexibility, and ease of use. Yet women have not enjoyed a strong presence in the field since the days when language options were few and the task of programming was considered far more difficult and tedious. Tracking enrollment patterns among computer programming students at Moraine Valley Community College, specifically with regards to gender and language selection, can possibly shed light on the motivation and preferences of the minority of women who do pursue careers in computer programming.

Statement of the Problem

The problem of this study was to determine if gender influences computer programming language preferences among computer programming students at Moraine Valley Community College.

Research Goals

The objectives of this study were to answer the following questions:

1) Are female programming students more likely to pursue study in certain programming languages than in other languages?

2) Are females more or less likely to pursue study in multiple programming languages than males?

3) As compared with the percentage of females working as computer programmers nationwide, are females over- or under-represented in certain language tracks at Moraine Valley Community College?

4) Which language(s) might be useful in attracting more females to computer programming and software development?

Background and Significance

There is no shortage of statistics to support the wide assertion that computer science, even in all of its diverse areas and applications, is a male-dominated field. According to the U.S. Department of Labor, in 2001, only three out of ten computer systems analysts, computer engineers, and computer scientists were women, while only one out of four computer programmers was a woman (U.S. Department of Labor, 2002). This scarcity of women in such positions has been a longstanding trend. According to the same source, women comprised roughly 40% of computer scientists and analysts in 1983, roughly 41% in 1993, and roughly 36% in 2001 (U.S. Department of Labor, 2002). The

Institute for Women and Technology, a non-profit group based in Palo Alto, cites even more dismal figures, with women accounting for only 15% of computer professionals in 1993 and a nominally better 20% in 2003 (Hafner, 2003). Of course, the dearth of women pursing technology is also exemplified in academia. For example, of the 61 Massachusetts Institute of Technology (MIT) students receiving doctorates in computer science and electrical engineering in 1993, 10 were women. In 2003, 63 doctorates were awarded; 10 went to women (Hafner, 2003, para. 8).

Furthermore, while women are under-represented in virtually all areas of technology, they are grossly under-represented in the most innovative areas of technology, namely product development and engineering, with those crucial areas being dominated by young, Western, white, male engineers (Rothke, 1999, para. 3). As technology increasingly shapes our lives, the fact that women have such a weak presence in the field is of great concern to educators, professional organizations, advocacy groups, and businesses alike. Furthermore, taking into consideration the employability and earning potential of women, which can no doubt contribute financial independence and improved quality of life, employment of women has lagged in most of the high-tech occupations that show promise for future growth (U.S. Department of Labor, Women's Bureau, 2002, What Can We Conclude?, para. 1).

Over the past twenty-five years, there has been extensive research on the supposed different computing styles between males and females (Lockheed, 1993; Margolis, et. al., Work in Progress; Turkle, 1988), most in attempt to answer the question as to why females do not pursue careers in technology at the rate that men do. However, the existing body of research usually addresses the lack of women in high-tech careers

from a somewhat broad perspective, such as gender and the pursuit of computer science degrees, which can include a multitude of skill areas or specialties apart from computer programming, such as networking, computer engineering, systems analysis and design, database administration, and web design. In this study, the aim of the researcher was to identify any language selection patterns among female students who are pursuing study specifically in computer programming. If any such patterns existed, such information could be used to help identify the types of females who are likely to pursue the study of one or more computer programming languages. For example, if females were found to gravitate toward business-oriented languages as opposed to languages that dominate in academia, that may shed some light on the life circumstances and motivations of such students. Additionally, if certain languages were found to be preferred by females, such languages could be employed at the K-12 level to capture the interest of girls with regards to high-skills computing.

Limitations

This research study was limited to Moraine Valley Community College students enrolled in one or more computer programming language tracks between the spring 1996 and spring 2005 semesters. Additionally, computer programming refers only to full programming languages, which would exclude any markup languages such as HTML or scripting languages such as JavaScript, VBScript, and PERL.

Assumptions

The following assumptions were made for the study:

1. A student pursuing study of a programming language at Moraine Valley Community College was doing so for either academic or professional reasons.
2. Enrollments in programming courses at Moraine Valley Community College fluctuated according to programming job opportunities in the greater Chicagoland area and therefore were at least in part a reliable indicator of student career goals.

Procedures

Data on students enrolled in various computer programming language tracks at Moraine Valley Community College between spring 1996 and spring 2005 were provided by full time faculty members of the Information Management Systems Department in the form of class rosters. Student names served as unique identifiers, which in turn were used for tracking each student's language enrollment choices as she progressed in her study of computer programming. Names were also used to determine gender in obvious cases. In order to eliminate the many students who were already professional programmers and enrolled in courses to pick up additional programming languages, only students who first enrolled in MIS 105, Programming Principles, an introductory computer programming course, were tracked, as it was highly unlikely that a professional programmer would choose this elementary course as a starting point for additional language study. Data from the sample of introductory students were examined to determine which, if any, programming languages the students chose to study after completing the introductory

course. These data were then analyzed using basic descriptive statistics in an attempt to ascertain any enrollment patterns among female programming students, specifically in regards to language preference.

Definition of Terms

The following definitions will contribute to the reader's understanding of the study:

C++	An object-oriented programming language widely used in both business and academia; best-known for its reliability and high-performance.
COBOL	(Common Business Oriented Language) Procedural language released in 1960; the first widely-used business programming language.
Java	Object-oriented language developed by Sun Microsystems and released in 1994; best known for its platform-independence and built-in security, and therefore well-suited for Internet programming; heavily used in both business and academia.
Object-Oriented Language	A revolutionary style of programming that emerged in the 1980s, whereby programmers could represent business objects, such as products or employees, as reusable code modules; different from the procedural programming languages used up to that point in that it promoted code reusability and easier program management, theoretically driving development and maintenance costs down.
Preference	A student's tendency to pursue study in one programming language over another, as indicated by her enrollment choices. In the case of the student who pursued study in multiple languages, a preference was recognized for a language if the student progressed further in the study of that language than in others.

Procedural Language	A non-object-oriented language whereby variables of primitive data types, such as integers, floating point, and Boolean types, are manipulated by one or more procedures, or short, function-specific modules of code, which, in turn, are executed by a single controlling module.
Programming Language Track	At Moraine Valley Community College, a sequence of 2-3 semesters devoted to the study of a single programming language from beginning through advanced levels, usually resulting in degree or certificate requirements having been met.
RPG	(Report Program Generator) Procedural language used for programming on IBM's AS400, a popular midrange system widely used in business throughout the 1990s and still today, under the name iSeries.
Visual Basic	Developed and released by Microsoft in the early 1990s, an event-driven programming language that introduced drag-and-drop techniques into the program development environment, allowing for rapid development of GUI applications; controversial among some programmers as it abandoned certain object-oriented capabilities in favor of ease of use; widely used in business but, unlike C++ and Java, not in academia.
Visual Basic.NET (or VB.NET)	Released in 2002 by Microsoft; combines the easy drag-and-drop techniques of previous versions of Visual Basic with fully object-oriented capabilities found in languages like C++ and Java.

Overview and Summary

Chapter I discussed the history of women in computer programming as well as the dramatic decline of women pursing programming careers in the past twenty-five years. Also discussed were the problem and goals of this study, which were to determine if

female computer programming students at Moraine Valley Community College were inclined to pursue the study of one programming language over others, information that could ultimately be used to attract more females to computer programming as an area of study and, later, a career choice. It was made clear that this study was limited to students at Moraine Valley Community College who enrolled in full programming languages courses, excluding markup and scripting languages, from the spring of 1996 through the spring of 2005. Lastly, terms pertinent to the study were defined for the reader, with most of those being related to computer programming languages and techniques.

Chapter II will present just a few of the many studies that have been done in an attempt to explain why females do not pursue education and careers in technology in nearly the numbers that males do. Some such studies focus on the different computing styles of males and females, which supports the notion that male and female computer programmers may in fact choose their languages differently. Chapter III will address the methods employed in undertaking this study, specifically data acquisition and statistical analysis. Chapter IV will present the findings of this research, and, finally, Chapter V will conclude the study, offering recommendations for further study or teaching practice.

Chapter II

Review of Literature

Many of the studies done over the past twenty-five years on women and their pursuit of technology have indicated that gender does indeed influence the motivation, skill acquisition, and choices of technology students and workers alike. This chapter will review some well-known as well as some lesser-known studies of women computing in both academia and the workplace. More specifically, these studies focus on the role that gender plays in perceptions of and interaction with computers, and the choices women are prone to make when studying and working with computers.

Academic Computing: Women as Undergraduate Computer Science Majors

In a well-known, highly successful initiative to increase the recruitment and retention of female undergraduate computer science majors at Carnegie Mellon University, Margolis, Fisher, and Miller (Work in Progress) interviewed at length both male and female undergraduate computer science majors to assess each student's early interest in computing, his or her perception of computers, and his or her pattern of interaction with computers. Not surprisingly, the researchers found significant differences in the way the genders relate to computers.

Margolis et. al. (Work in Progress) found that male students were far more likely to develop an intense attraction to computers than female students were. They noted that, in their interviews, male students used words that associated the computer with fun, play, and fascination, and professed to spending long hours in front of the computer engaged in self-initiated exploration and tinkering, often as leisure activity rather than school-related

activity. Male students also expressed a strong desire to figure out the inner workings of the machine, often to the end of achieving a sense of power over it (Margolis, et. al., Work in Progress).

Female students, on the other hand, tended to exhibit a more practical attitude toward the computer, viewing it as less of a toy and more of a tool to help them with other tasks. Looking beyond Carnegie Mellon, this may explain the prevalence of females in applications courses, such as word processing and web-related technologies, as well as their undisputed presence on the Internet, from e-commerce to newsgroups to entrepreneurial endeavors. The researchers also found that females engaged in very little tinkering and unguided exploration and were all around far less enchanted with computers than their male peers were. The vast majority of young women interviewed expressed no desire to master the machine by learning it from the inside out, but rather were content to partake in a more distanced, outsider relationship with the computer (Margolis, et. al., Work in Progress).

Whereas mastery over the machine was a prevailing theme in male interviews, the notion of "computing with a purpose" prevailed in female interviews (Margolis, et. al., Work in Progress). Indeed, females were far more likely than males to express an interest in computers in the context of other arenas, such as teaching and medicine (Margolis, et. al., Work in Progress, p. 5). This was not to imply that women were not attracted to computers for more scientific reasons; a number of female programming students expressed a sense of pleasure in the systematic thinking and troubleshooting skills required for computer programming, and they also spoke of an attraction to the creative

aspects of programming, including the ability to express individuality through the programs they designed and wrote (Margolis, et. al., Work in Progress).

Through these interviews, Margolis et. al. were able to shed some light on the attrition tendencies of females in computer science classes. Because, as they concluded, the feminine take on technology focused on a social function as opposed to the technology itself, in courses where technology was introduced and studied as an end in itself, such as computer science and programming courses, young women were less likely to be interested than young men (Margolis, et. al., Work in Progress, p. 7). Indeed, since taking initiatives to make Carnegie Mellon's computer science curriculum more applications focused, the institution has seen significant increases in female enrollment and retention.

Similarly, a 2003 study examined female enrollments in technology programs at institutions of higher education in the State of Georgia. In undertaking the study, researchers Randall, Price, and Reighgelt noted that most studies illustrating the dearth of female students in technology programs focused on computer science curricula, which by nature emphasized the theoretical aspects of computing, while neglecting the more applications-oriented curricula such as Management Information Systems (MIS), Information Systems (IS), and Information Technology (IT). Randall et. al. theorized that, if it was true that females were attracted to the practical aspects of computing and put off by the theoretical aspects as the body of literature asserts, then females would be represented in MIS, IS, and IT curricula in healthy numbers. After analyzing enrollments statewide, the researchers found that this was indeed the case. In their conclusion, the researchers proclaimed to have found strong support for the hypothesis that there were

gender differences in enrollment patterns in computing degree programs (Randall, et. el., 2003, p. 58).

Art Meets Science: An Examination of Women's Roles as IT Professionals

In 2001, Thevar, Schinzel, and Ben, addressed the World Conference on the WWW and Internet Proceedings in Orlando on the roles being played by male and female workers in creative, technical, and management areas of web development at the University of Freiburg (2001, p. 3). While their report only addressed programming as a minor aspect of the larger profession of web development, some parallels can be drawn between web development and the greater computer programming profession.

In their report, Thevar et. al. (2001) compared the roles of men and women web development workers across various skill-specific divisions within the field, such as the creation and maintenance of web pages, content development, graphic design, server support, programming, and database management, and found that, by and large, men were associated with "computer science" work whereas women were mostly associated with "applied science" work (Thevar, et. al., 2001). Furthermore, in their assessment of the knowledge base of web design teams, they found that, in the majority of cases, women represented the non-technical members of the team, noting that women web workers exhibited strong backgrounds in a variety of arts and sciences, thus providing the creative input required for effective web design, while men were more likely to exhibit formal backgrounds in computing, thus providing the technical expertise required for effective web development, support, and maintenance.

These findings support the research of Margolis et. al., reviewed in the previous section, which found that female students viewed technology as a tool to be used in tandem with other professions, whereas males were more apt to pursue technology out of interest in the technology itself. This may explain why many women seem to "stumble upon" technology from other professions rather than entering the field as recent college graduates. Thevar et. al. also found evidence supporting the theoretical assumption that women were deemed highly competent in the creative and artistic elements required for web related works, which may explain why, in recent years, web design had attracted more women than any other field of technology (Thevar, et. al., 2001, p. 6).

Like web design, e-commerce was another area of technology that was attractive to women because it put less emphasis on a hardcore technical background and more emphasis on "soft" skills, such as creativity and artistic talent—the kind traditionally attributed to women (Vargas, 2000, p. 32). Despite the complex technologies involved in e-commerce applications, it was still first and foremost "commerce", with technology being an enabler, and therefore skills that were good for service and customer contact, areas where women no doubt rival men, were deemed highly valuable (von Hellens, Pringle, Nielsen, & Greenhill, 2000, p. 156).

The findings of Thevar et. al. (2001) and others raised the issue of breadth versus depth of skill among men and women working in technology. While women web workers did exhibit considerable technological skill at the University of Freiburg, men exhibited greater depth of skill. Moreover, men's skills were more focused, specifically on technology itself, than were those of women, who were more likely to know "a little bit about a lot of things", which tended to be characteristic of people in management

positions. Perhaps not surprisingly then, of three domains examined by the researchers—specifically creative, management, and technical skills—women were more likely to be working in management and creative skills domains, in that order, whereas men were most likely to be found in technical domains and least likely to be found in management domains.

This trend was widely supported in the body of research on the supposed different computing styles between the sexes in the workplace. For example, in a survey of women working as senior IT managers in Australia, many interview subjects suggested that, among systems workers, women were commonly found in areas of business analysis and the business processes of software systems, which were deemed less technical and more organization- and human-oriented than software development. Men, on the other hand, were more likely to be programmers or engaged in hardware, both of which were highly technical and, it could be argued, narrowly focused on technology (von Hellens et. al., 2000). In fact, von Hellens et. al. found that, not only did women exhibit a preference for non-technical areas of IT, but even those women with core technical training gravitated toward less technical or non-technical areas over time (von Hellens et. al., 2000, p. 155).

Even back in 1988, before the fields of web design and e-commerce existed, sociologist Sherry Turkle, in addressing gender differences in technology, identified two different styles of computing exhibited in large part along gender lines (Miller, Chaika & Groppe, 1996, p. 28). Turkle posited that the male approach to computing was often characterized by a desire to test the limits of both machine and self through mastery and manipulation of the computer environment (i.e., "hard mastery"), whereas a typically female relationship with the computer was marked by an artistic, almost tactical style of

identifying with computational objects (i.e., "soft mastery") (Turkle, 1988, p. 50). Once again, the literature supported the notion that men were more likely than women to try to "dig deep" in their approaches to computing. In a somewhat dramatic but nevertheless provocative statement in their presentation to the American Educational Research Association in 1990, Brunner, et. al., based on their research with both adults and adolescent computer users, concluded that women commonly saw technological instruments as people connectors, communication and collaboration devices, while men, in contrast, tended to envision technology as extensions of their power over the physical universe (Brunner, et. al., 1990, p. 2).

This was not to imply that women's propensity toward "soft" computing styles put them at a disadvantage; it was merely an alternative approach to computing that was well-accommodated in industry, if not favored in some business sectors. Nor did the possession of a soft computing style negate the desire or ability to learn about computers. As Alison Berke Morano, President of the well-established web design company bworks.com pointed out to Crain's New York Business in 1997, "Women are predisposed to figuring out computers. Many have a background in record keeping, writing and word processing. They learned to be simultaneously organized and creative, which happen to be the skills you need to become adept on the computer" (Baraban, 1997, p. 31). In other words, women did strive for mastery of the computer, just not the mechanical mastery that many men strived for. von Hellens, et. al, came to similar conclusions in their study, where many of IT managers interviewed conceded that men were more likely to be technically oriented than women but failed to recognize this as an advantage, even in an industry centered around technology. In fact, the most successful

workers were seen to be those who exhibited a flexible combination of technical, organizational, and people skills.

Searching for Connections to Computer Programming

This chapter cited just a few of many studies that have been done to describe the differences between males and females with regards to general computing in both academia and the workplace. While computer programming was just one of many areas of the vast field of Information Technology, it in itself was a diverse profession yielding many options and career paths, and often the language of study steered a programmer down one path over another. For example, C++, widely used in academia, was deemed a "serious" language that was likely to lead to advanced study in computer science and, later, high-level jobs in software and computer engineering. Conversely, a language like Visual Basic, which had historically been deemed a "lightweight" in the industry, was more likely to lead to lower-level, business application programming positions, where, perhaps not coincidentally, female programmers were largely concentrated. Java, while used in some advanced computer science curricula, also happened to be the language of choice for web development, which, as noted earlier, was the area of Information Technology where women were best represented.

Thus, it may be theorized that gender does play a role in programming language selection among computer programming students, and certain languages may be more likely to attract females if those languages 1) allow for creativity on artistic and communicative levels, 2) mask or hide machine operations, such as memory management or interfacing with the underlying operating system, which, given their considerable

technological depth, may elicit disinterest among most females, or 3) ultimately lead to careers in technology which are deemed more female-friendly, such as web development and e-commerce. Chapter III will discuss the methods and procedures used in determining if any such enrollment patterns among females existed.

Chapter III

Methods and Procedures

This chapter describes the methods used to acquire and analyze data for this descriptive study. In it, the research population, methods of data collection, and statistical analysis are discussed.

Population

The population for this study consisted of all students enrolled in at least one computer programming language track at Moraine Valley Community College between the spring 1996 and spring 2005 semesters, where each student began his or her study in MIS 105, Programming Principles, before proceeding into a specific language track. By targeting only those students who began their studies at the introductory level, the researcher aimed to effectively eliminate from the sample professional programmers enrolled in language tracks to enhance their skill sets by picking up additional languages.

This study was limited to full programming languages, thus excluding students studying scripting languages such as JavaScript and VBScript as well as markup languages such as HTML. Programming language tracks included in this study were: C++, Java, and Visual Basic (which, as of fall 2003, transitioned to its modern variation, Visual Basic.NET, in Moraine Valley's curriculum). Only those students who studied a language up to the 200 level (i.e., sophomore) were said to be enrolled in a track. Thus, any students who enrolled in 100 level (i.e., freshman) language courses beyond the prerequisite introductory course but did not continue in the study of the language(s) beyond that level were not included in the population. Such students could have been

dabbling in one or more programming languages and could not have been said to exhibit a preference without committing to a second semester of study. Out of 905 students in the data pool who enrolled in Programming Principles, 163 went on to pursue the study of a specific programming language up to the 200 level.

Methods of Data Collection

Data on student enrollments were provided by full-time programming faculty in the Information Management Systems Department at Moraine Valley Community College in the form of class rosters. This resulted in a data pool that was adequate but not comprehensive since sections taught by adjunct faculty were not included. However, courses of particular interest to this study, specifically 200 level (i.e., sophomore) programming courses, were almost invariably taught by a full-time faculty member and were therefore largely included in the data pool. It should be noted that, while C++ and Visual Basic data were available dating back to 1996, data on Java enrollments were only available dating back to 2000.

From the class rosters, student names, gender, and course(s) taken were entered into a database. Gender was determined by student names, and, in cases where it was not obvious or not provided by the faculty member, those student records were simply not used. The database would be queried for only those students who began their course of study at the introductory level (thus effectively eliminating professional programmers) and pursued study up to the 200 level in any of the language tracks.

Statistical Analysis

Basic descriptive statistics were used to compare female programming students' enrollment patterns with those of males. Specifically, Chi-Square analyses were employed to determine if female participation in the study of a language was higher or lower than expected. Language pairs used in the Chi-Square analysis included:

- C++ and Visual Basic – C++ was a language of computer science and software engineering, while Visual Basic was a business language designed for rapid application development.
- C++ and Java – While both were widely used in computer science and software engineering, Java was the language of web development, the area of Information technology where women were best represented (Thevar, et. al., 2001).
- Visual Basic and Java – Up until the release of Visual Basic.NET in 2002 (introduced into the curriculum at Moraine Valley in fall of 2003), Visual Basic was mostly regarded as a business language designed for rapid desktop application development, while Java was the more obvious choice for web development, the area of Information technology where women were best represented (Thevar, et. al., 2001).

Summary

Data were provided by full-time faculty of the Information Management Systems Department at Moraine Valley Community College in the form of class rosters, which were used to determine student gender and enrollment in one or more major programming language tracks offered at Moraine Valley since 1996: C++, Java, and Visual Basic. Student names, genders, and course enrollment data were incorporated into a database, queried by the researcher, and then subject to Chi-Square analyses with C++, a popular academic and engineering language, being paired with Visual Basic and Java, a popular business and web language, respectively, and their gender distributions. Visual

Basic and Java were also paired with each other for analysis. Chapter IV will discuss the findings of such analysis.

Chapter IV

Findings

While there have been many studies addressing the lack of female participation in high-skills computing (Margolis, et. al., Work in Progress; Thevar, et. al., 2001; von Hellens, et. al., 2000), none have focused exclusively on gender within the diverse field of computer programming. The problem of this study was to determine if gender influences language preferences among computer programming students at Moraine Valley Community College. This chapter will report the statistical comparisons of male and female programming students in each of three major language tracks offered at Moraine Valley since 1996: C++, Java, and Visual Basic.

Overview of Gender Composition of Programming Track Enrollments

Of the 905 students in the data pool who enrolled in MIS 105, Programming Principles since the fall of 1994, 60 went on to pursue the study of C++ up to the 200 level between the spring of 1996 and spring of 2005. Of these 60 C++ students, 41 (68%) were male and 19 (32%) were female. Twenty-eight students pursued the study of Java up to the 200 level between the fall of 2000 and spring of 2005 with 17 (61%) of those being male and 11 (39%) being female. Seventy-five students pursued the study of Visual Basic between the spring of 1996 and spring of 2005 with 41 (55%) of those being male and 34 (45%) being female. These numbers are illustrated in Figure 1.

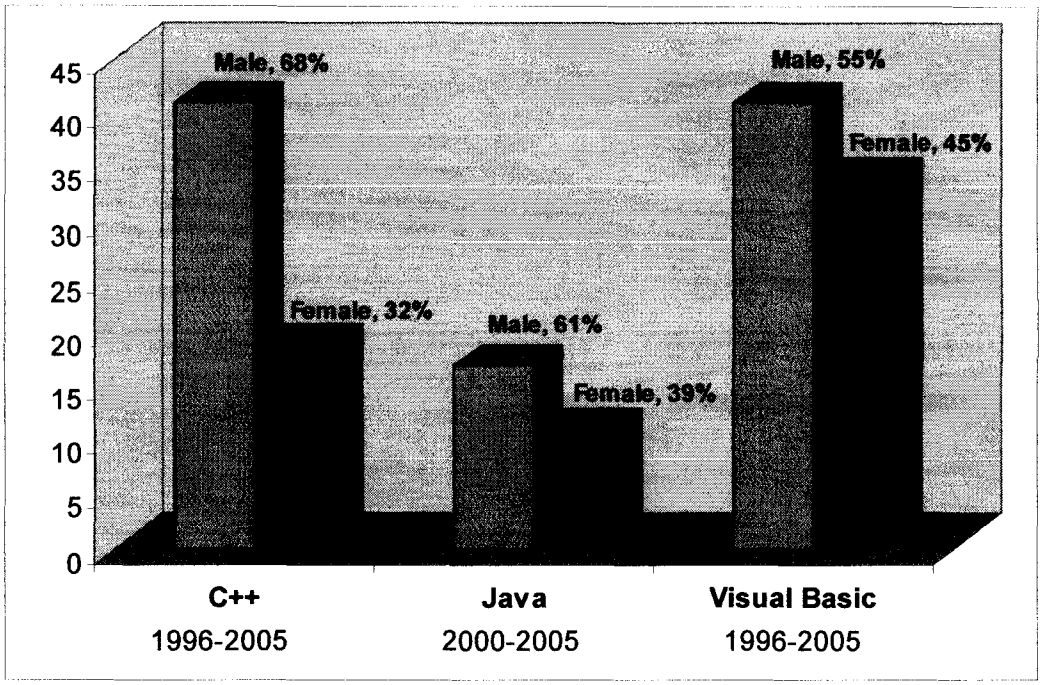

Figure 1.
Gender Composition of Programming Track Enrollments at
Moraine Valley Community College

Chi-Square Analysis of Males and Females in Specific Language Tracks

Chi-Square analyses were used to determine if frequencies of males and females enrolled in specific programming language tracks were statistically significant. In all comparisons, the critical Chi-Square (χ^2) value was 2.71. A comparison of males and females in C++ and Visual Basic tracks produced a χ^2 value of 2.61. Comparison of males and females in C++ and Java tracks produced a χ^2 value of .49, and a comparison of males and females in Java and Visual Basic tracks produced a χ^2 value of .30. These findings are summarized in Table 1.

Languages Compared	χ^2 Value
C++ and Visual Basic	2.61
C++ and Java	.49
Java and Visual Basic	.30

Table 1.
χ^2 Analysis of Programming Language Pairs

Gender Composition of Enrollment in Multiple Language Tracks

Only six of the 905 students in the original MIS 105 data pool pursued the study of all three programming language tracks from the introductory level to the 200 level (two were female). Data on paired tracks were more abundant and are shown in Table 2. Twenty-eight students studied both C++ and Visual Basic with 16 (57%) of those being male and 12 (43%) being female. Twelve students pursued C++ and Java together with 9 (75%) of those being male and 3 (25%) being female. Ten students pursued both Java and Visual Basic with 7 (10%) being male and 3 (30%) being female.

Language Tracks	Number of Students Enrolled in Both Tracks	Males	Females
C++ and Visual Basic	28	16 (57%)	12 (43%)
C++ and Java	12	9 (75%)	3 (25%)
Java and Visual Basic	10	7 (70%)	3 (30%)
TOTALS	**50**	**32 (64%)**	**18 (36%)**

Table 2.
Gender Composition of Students Enrolled in Multiple Language Tracks

Summary

The findings presented in this chapter included an overview of gender composition of programming language track enrollments, specifically C++, Java, and Visual Basic. Also included were the resulting values of Chi-Square analyses performed to assess any statistical significance in the frequencies of male and female students across all possible language pairs. Lastly, the gender composition of students enrolled in two or more language tracks was presented. Chapter V will include a summary of this study as well as the researcher's conclusions and recommendations.

Chapter V

Summary, Conclusions, and Recommendations

This chapter includes a summary of and conclusions drawn from this study as well as some recommendations based on the results. Conclusions will be presented in order according to the research goals, which are reiterated in the next section.

Summary

The problem of this study was to determine if gender influences computer programming language preferences among computer programming students at Moraine Valley Community College. The goal of this study was to answer the following questions:

1) Are female programming students more likely to pursue study in certain programming languages than in other languages?

2) Are females more or less likely to pursue study in multiple programming languages than males?

3) As compared with the percentage of females working as computer programmers nationwide, are females over- or under-represented in certain language tracks at Moraine Valley Community College?

4) Which language(s) might be useful in attracting more females to computer programming and software development?

The nearly two hundred year history of computer programming includes many key players who were women, from legendary pioneers like Ada Lovelace and Grace Hopper to the working women programmers of the 1960s who enjoyed a majority in that job market for years. However, as computer technology evolved dramatically toward the end of the 20th century, women's participation in high-skills computing rapidly declined,

prompting many investigations into the nature of modern computing along gender lines (Margolis, et. al., Work in Progress; Thevar, et. al., 2001; von Hellens, et. al., 2000). The existing body of research usually addresses the problem from a somewhat broad perspective, such as gender and the pursuit of computer science degrees, or gender and the pursuit of careers in the vast IT industry, which encompasses a multitude of skill areas or specialties, such as networking, computer engineering, systems analysis and design, database administration, computer programming and software design, and web design. This study aimed to narrow the focus to computer programming by assessing enrollment patterns of female programming students at Moraine Valley Community College. The revelation of such enrollment patterns (or lack thereof) would contribute to a better understanding of the computing interests of females, particularly those who have committed to the study of computer programming for either vocational or academic purposes. If any such patterns existed, they could be exploited to attract more women and girls to computer programming as an area of study and, ultimately, a career choice.

This study was limited to Moraine Valley Community College students enrolled in one or more of three major computer programming language tracks—C++, Java, and Visual Basic—between the spring of 1996 and spring of 2005. The population included only those students who began their study of programming at the introductory level, thus eliminating any professional programmers who might have been picking up a second or third language, and sustained study in their language(s) of interest for at least two semesters, thus establishing a preference for the language(s).

Data were provided by full-time programming instructors in the Information Management Systems Department at Moraine Valley Community College in the form of

class rosters from which student names were extracted, used to determine gender where appropriate, and added to a database along with course enrollment data. The database was then queried for those students pursing the study of a specific language from the introductory to the sophomore level, or a three semester sequence. The resulting numbers were, from a pool of 905 students enrolled in MIS 105, or Programming Principles, the prerequisite introductory course which feeds into the three language tracks examined in this study, 60 students pursuing C++, 28 pursuing Java, and 75 pursuing Visual Basic.

In addition to calculating straight percentages of males and females in the various language tracks, Chi-Square analyses were performed on all possible language pairs with gender frequencies in mind. Conclusions drawn from such statistical analyses will be presented in the next section.

Conclusions

Here, the research questions posed at the onset of this study will be answered in turn.

Are female programming students more likely to pursue study in certain programming languages than in other languages?

Chi-Square (χ^2) analyses on all possible language pairs within the limitations of this study revealed no statistical significance in the gender composition of any one language track over any other. A comparison of males and females in C++ and Visual Basic tracks produced a χ^2 value of 2.61, which, while close to the critical value of 2.71, was not considered statistically significant. Comparison of males and females in C++ and

Java tracks produced an insignificant χ^2 value of .49, while a comparison of males and females in Java and Visual Basic tracks produced another insignificant χ^2 value of .30. Thus, it could be concluded that females who studied computer programming at Moraine Valley over the nine year period (or five year period in the case of Java students) did not exhibit a preference for any programming language.

These findings were encouraging in that they revealed that women who committed to the study of computer programming did not shy away from languages that had a reputation for being difficult to learn, such as C++, in favor of languages that had a reputation for being easy to learn, such as Visual Basic (prior to 2002, when it became the more powerful and serious Visual Basic.NET). The findings also suggested that women pursuing programming were not necessarily limiting themselves to areas of IT where females were well represented, such as web work (Thevar, et. al, 2000), which might have shown a higher percentage of women in the Java track, but were perhaps pursuing languages for the sake of job market value, personal interest, or university transfer potential.

Are females more or less likely to pursue study in multiple programming languages than males?

Students in the data pool pursuing any combination of two languages from the introductory to the sophomore level were only 50 in number with 64% being male and 36% being female. This 36% female composition was comparable to that found in any single track, specifically 35% for C++, 39% for Java, and 45% for Visual Basic (recall from the previous section that Chi-Square analyses did not find Visual Basic enrollments

to be characteristically high in female composition). Since female enrollment in multiple language tracks was neither higher nor lower than expected but rather was predictable given the gender compositions across the three programming tracks, it could be concluded that females were neither more nor less likely to pursue multiple languages than males.

As compared with the percentage of females working as computer programmers nationwide, are females over- or under-represented in certain language tracks at Moraine Valley Community College?

Data on the percentages of female computer programmers working in the U.S. were obtained from the U.S. Department of Labor and Statistics for the years 1998 (Women Professionals and Executives, n.d.), 2002 (U.S. Department of Labor and Statistics, 2004) and 2004 (U.S. Department of Labor and Statistics, 2005) as shown in the table below:

Year	Female Composition of Computer Programmers Working in the U.S. (%)
1998	28.6
2002	26.5
2004	26.7

Table 3.
Female Composition of Computer Programmers Working in the U.S.

Note that there was little fluctuation in these percentages despite dramatic changes in IT employment opportunities between 1998 and 2004. The stability in these

figures suggested that 26-28% would be a suitable range with which to compare the percentages of females enrolled in the various programming tracks included in this study.

As noted earlier, 35% of the C++ students included in this study were female, along with 39% of Java students and 45% of Visual Basic students. It could be said that all tracks reflected an overrepresentation of females as compared with the national range of 26-28%. However, it could also be argued that enrollment in a programming track is merely an indicator of career intentions which may or may not be realized in the job market. It is possible that women pursuing the study of programming are less likely to fill jobs as programmers than their male counterparts, which might explain a discrepancy in the percentages of female student programmers and female professional programmers.

Also, while the Visual Basic figure (45% female) was significantly higher than those of other language tracks, when considering all students enrolled in the Visual Basic track irrespective of whether or not they started at the most introductory level, the composition of females dropped to 32%. One explanation for this might be that introductory programmers were more likely to be swayed by Visual Basic's ease of use and graphical tools, while programmers who may have begun their course of study at a higher level due to previous programming experience were more apt to choose a language for other reasons, such as marketability in the workplace or, if employed, company needs.

Which language(s) might be useful in attracting more females to computer programming and software development?

Since gender was not found to influence language selection among computer programming students at Moraine Valley Community College, any language could

potentially be useful in attracting more females to computer programming and software development. This was especially encouraging for institutions with limited technology funding because it implied that low-cost or no-cost compilers could be just as effective in attracting females to programming as some of the flashier, more costly development suites.

Recommendations

Based on the findings and conclusions of this study, the researcher recommends the following courses of action:

1. Partner with secondary school mathematics and computing teachers in efforts to expose girls to computer programming early on. Since language seems to be inconsequential in eliciting a gender-based language preference, many low-cost or free compilers could be just as effective in the classroom as expensive software development suites.

2. Investigate the retention rates and attitudes of the large percentage of introductory programming students, male and female alike, who abandon their course of study before reaching the sophomore level to determine why the loss of interest in programming occurs and what might be done to counteract it.

3. Investigate the observed drop in the percentage of female programmers as they transition from school to the workplace to determine if and why such students are abandoning their career plans and what might be done to better prepare them for entry into the workplace.

4. Encourage all committed programming students, male and female alike, to pursue study of multiple languages, which can greatly increase employability in the field.

5. Appeal to female programmers' alleged attraction to practical computing (as opposed to the study of computing for its own sake) by incorporating exercises into computer science and programming classes that draw from multiple disciplines, particularly those that traditionally attract females, such as education and healthcare.

6. At the college level, work with marketing departments in creating a more gender-neutral image of computer programming and information technology in general. This may include a de-emphasis of gaming and machine-level computing while

emphasizing the social function of computing and its relevance to other fields such as medicine and teaching.

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