

Anatomy of the Introductory Cartography Course Revisited

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This paper reports the results of a survey sent to instructors of cartography in the United States and Canada during the fall of 1995. The intent of the survey was to determine if there was a common consensus among cartography instructors on the content and structure of the introductory course. In addition, the survey was designed to determine the impact of computer technology on the structure of the course. In an effort to identify changes and trends, results of this survey were compared to a similar survey conducted in 1989.

Keywords: cartographic education, map design, cartographic technology

INTRODUCTION

"The purpose of this paper is to provide a cross-sectional view of academic cartography through the examination of the introductory cartography course in the United States and Canada."

Cartography is a profession that has experienced considerable change over the past several decades. Many of the shifts in emphasis and methods of producing maps have been linked to advancements in technology and more specifically to the universality of the computer. Academic cartographers charged with training the next generation of professional cartographers often question their knowledge of current technological changes within the discipline. In addition, they often wonder how other academic cartographers approach the teaching of cartographic concepts and techniques.

The purpose of this paper is to provide a cross-sectional view of academic cartography through the examination of the introductory cartography course in the United States and Canada. The introductory course was chosen because it is the first, and perhaps only exposure students may have to actual map production. In addition, past research has indicated that the introductory cartography course accounts for approximately one-half of all cartography courses offered (Dahlberg and Jensen, 1986).

This cross-sectional view was obtained through a questionnaire designed to probe the current structure, content and level of computer technology found in the introductory cartography course. The questionnaire results were compared with a similar survey conducted in 1989. The comparison of responses over a six-year time period was used in order to identify changes in course structure and content.

BACKGROUND

The use of a survey to gain insight into the workings of the introductory cartography course specifically, and academic cartography in general, is not novel. As early as 1965, B. Moriarty used a survey to investigate the focus of cartography at academic institutions. He found that some schools exclusively stressed either drafting, or concepts of graphic communication. However, the majority of institutions achieved a balance between these extremes (Moriarty, 1965).

In 1978, a group of twelve Canadian cartography instructors were part of a session of the Canadian Cartography Association meeting that examined the introductory cartography course at Canadian universities. The published proceedings of this session revealed an emphasis on the practical components of mapping and very little attention to computer mapping (Coulson, 1981).

Andrew's 1985 survey of cartographic textbook usage included cartography textbooks at all academic levels. The dominant textbook used in the

introductory cartography course in the mid-1980's was *Elements of Cartography* (Robinson and associates, 1984).

The state of professional training for cartographers, and cartographic educators are topics covered in several articles by Dahlberg (Dahlberg; 1977, 1983, 1984). Much of his research was based on a comprehensive survey of departments offering cartography. The *Mapping Sciences Education Data Base* supplied information on cartography courses in 1978 and 1983. He found that the majority of cartographic training was taking place in a limited number of universities and that the thematic map dominated the course content in introductory cartography courses. Fryman and Sines (1990) used a questionnaire to survey cartography instructors in the United States and Canada in order to assess the structure and content of the introductory cartography course. Survey results found a prevalent use of thematic maps for exercises, little computer use and a predominant use of Robinson and associates textbook.

The 1995 questionnaire was designed to replicate the 1989 survey previously conducted by the authors. Questions were added that were overlooked in 1989 or that have become relevant since then. The 1989 survey served as a benchmark in determining changes in the content and structure of the introductory cartography course. Both surveys focused on the introductory cartography course, defined as the class in which students actually begin producing maps. Courses designed primarily for map use, interpretation or advanced courses in specific cartographic areas, such as reproduction, color and design were excluded from the survey. Both surveys targeted only geography departments in four-year colleges and universities. Past studies have indicated that cartography courses are taught primarily in geography departments (Dahlberg and Jensen, 1986).

The current survey was intended to examine four major aspects of the introductory cartography course: (1) the characteristics of the individual instructors, their department and institution, (2) the context and structure of the course, (3) the introductory cartography course content, and (4) the use of the computer in teaching and laboratory exercises.

Two publicly accessible documents were used to identify potential survey recipients; the Association of American Geographers' *Guide to Departments of Geography in the United States and Canada* (AAG Guide, 1995-1996) and Schwendeman's *Directory of College Geography of the United States* (Schwendeman, 1995). All departments listed in the *Guide* that indicated cartography as a specialty or had a faculty member with a cartographic specialty were included in the survey. In addition, any departments that did not appear in the *Guide*, but were listed as departments reporting actual cartography enrollment in Schwendeman's *Directory* also were included in the survey.

Questionnaires were mailed to the chairs/heads of 311 departments of geography believed to offer cartography. They were asked to give the survey to the instructor offering the introductory cartography course. Approximately 47 percent (145) of the surveys were returned. Of these, six departments indicated that they did not offer courses in cartography at that time. Thus, the actual number of surveys used in the analysis was 138.

In 1989, 378 surveys were sent to 285 institutions with a return rate of 51 percent (190 surveys). The greater response rate of the previous survey was attributed to the fact that in 1989, surveys were sent to specific individuals who indicated expertise in cartography, rather than to institutions offering cartography. This resulted in several instructors at the same institution returning surveys. It should be noted that 86 geography departments were common to both the 1989 and 1995 surveys.

THE SURVEY

"... focused on the introductory cartography course, defined as the class in which students actually begin producing maps."

THE RESULTS

Characteristics of the School, Department and Instructor

The 138 completed surveys used in the study represented institutions ranging in enrollment size from 800 to 31,000 students. Most universities were on the semester system (83 percent) and publicly controlled (90 percent). One hundred and twenty-eight institutions were located in the United States (92.7 percent), the remaining were located in Canada (7.3 percent).

The Geography departments in the survey represented institutions at all three degree levels; 32 granted Ph.D., 38 offered Master's degrees and 68 departments offered only Bachelor's degrees. Departments ranged from two to eighteen faculty members with an average of eleven.

The average instructor had been teaching cartography for twelve years, with the number of teaching years ranging from two to thirty-five. The graduate schools attended by cartography instructors in the study are indicated in Table 1. The table includes only those institutions that had been attended by two or more instructors. The leading graduate institutions in 1989 were the University of Kansas (eighteen graduates or 9.5 percent), University of Wisconsin-Madison (thirteen graduates or 6.8 percent) and the University of Washington (thirteen graduates or 6.8 percent). These three universities have been the leading producers of cartographers for several decades. However, the 1995 survey indicated a more even distribution of cartography graduates.

"The average instructor had been teaching cartography for twelve years, with the number of teaching years ranging from two to thirty-five."

Rank	GRADUATE INSTITUTIONS	1989	1995
1	University of Kansas	9.3%	9.6%
2	Michigan State University	2.1%	5.9%
3	University of Oklahoma	1.0%	4.4%
4	University of NC - Chapel Hill	2.6%	3.7%
5	University of Washington	6.7%	3.7%
6	University of South Carolina	0.5%	3.7%
7	University of Wisconsin-Madison	6.7%	3.0%
8	University of Illinois - Urbana	2.6%	3.0%
9	State University of New York - Buffalo	1.0%	3.0%
10	The Penn State University	3.1%	3.0%
11	University of Georgia	2.6%	3.0%
12	Arizona State University	0.5%	2.2%
13	University of Iowa	2.6%	2.2%
14	Oregon State University	1.6%	2.2%
15	University of Tennessee	1.0%	2.2%
16	University of California-Los Angeles	1.0%	2.2%
17	University of Minnesota	1.6%	2.2%
18	University of Michigan	2.6%	2.2%
19	University of Kentucky	1.0%	2.2%
20	University of Northern Colorado	0.5%	1.5%
21	University of Utah	1.0%	1.5%
22	University of Oregon	1.0%	1.5%
23	University of Pittsburgh	2.1%	1.5%
24	University of Victoria	0.5%	1.5%
25	University of Florida	1.0%	1.5%
26	Clark University	4.1%	1.5%
27	Ohio State University	1.0%	1.5%
28	University of Colorado	2.1%	1.5%

Table 1. Graduate Institutions of Survey Respondents

Questions regarding course context and structure refer to the design of the introductory cartography course, and the administration and sequence of the course relative to the general cartography program at each university. Those questions and survey responses are given below.

(1) How many cartography courses are offered by your Department?

The number of cartography courses offered by geography departments ranged from one to twelve courses, with an average of 3.3, a median of 3 and a mode of 2. Figure 1 shows the number of courses per department for 1995 and compares these results with those of the 1989 survey. Because the number of cartography courses offered should correspond to the size of faculty and student body, a statistical correlation was calculated between the three variables. Results indicated a slight statistical association between the number of courses and the number of faculty ($r^2=0.184$) and institutional enrollment ($r^2=0.165$).

COURSE CONTENT AND STRUCTURE

"The number of cartography courses offered by geography departments ranged from one to twelve courses . . ."

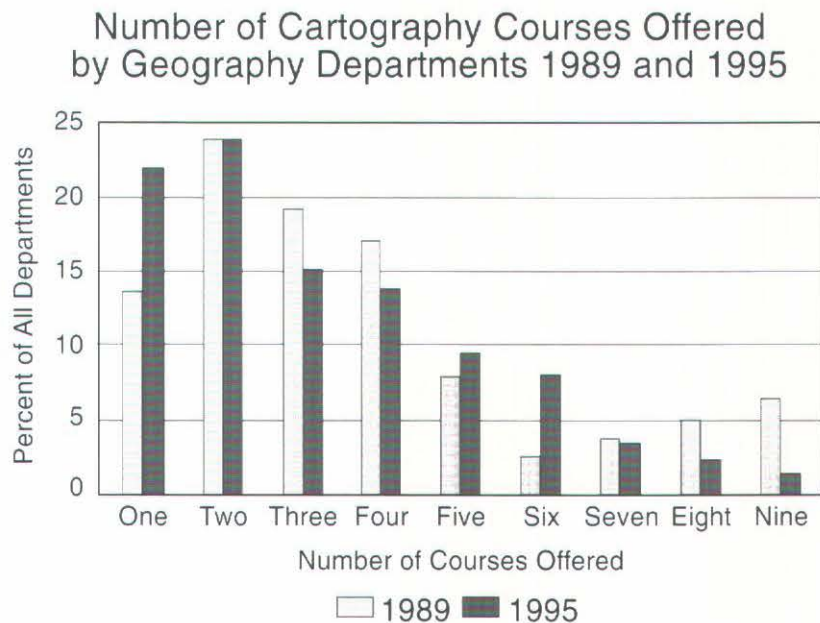


Figure 1. Number of Cartography Courses Offered in 1989 and 1995

(2) Does your Department offer a Cartography Certificate?

Approximately 14 percent of the surveyed institutions indicated that they offered a certificate program in cartography. Most of the certificate programs required a combination of cartography, remote sensing and geographic information systems courses.

(3) What is the course name?

The most common course name, representing 43 percent of all responses was *Cartography*. *Introduction to Cartography* accounted for another 18 percent. Other titles included the word *Computer*, *Principles*, *Thematic* and *Design* with *Cartography*. These combinations accounted for another 12 percent.

(4) What is the class size of the introductory cartography course?

Figure 2 compares the size of classes between 1995 and 1989. In both, 10 to 15 students is the most predominant class size. Small classes appear to be the mode. Class size traditionally was limited by the availability of drafting tables and now, perhaps, by the number of computers.

"Class size traditionally was limited by the availability of drafting tables, and now, perhaps, by the number of computers."

Average Class Size 1989 and 1995 Introductory Cartography Courses

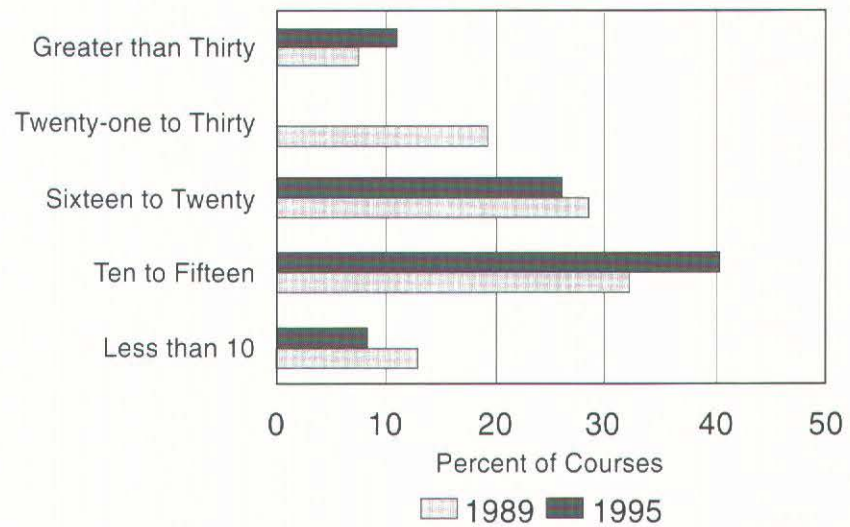


Figure 2. Average Class Size Compared Between 1989 and 1995

(5) How frequently is the introductory cartography course offered?

Approximately half of the departments surveyed offered the introductory cartography course one time each year (Figure 3). This represents very little change from 1989 to 1995.

Frequency of Course Offerings 1989 and 1995 Compared

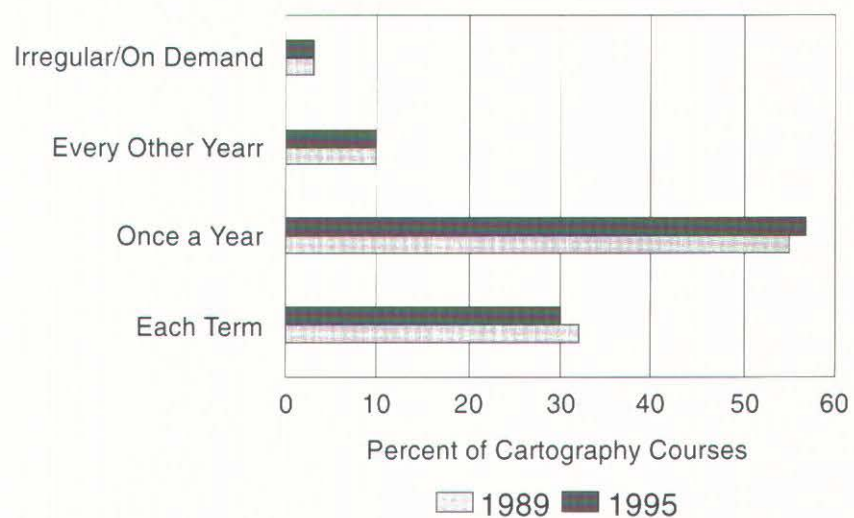


Figure 3. Comparison of 1989 and 1995 Frequency of Course Offerings

(6) Does the introductory cartography course have a prerequisite? If yes, what is it?

Forty-five percent of the departments surveyed in both 1989 and 1995 indicated that their introductory cartography course had a prerequisite. The most frequently cited prerequisites in 1995 were: (1) the student must have had a geography course (42 percent); (2) a student must have had a course in map interpretation (30 percent); (3) the student must have taken a course in computer science or mathematics (16 percent); and (4) students must have a specific class standing (sophomore or junior) or have declared geography as a major (13 percent).

(7) What are the average number of class hours devoted to lecture and laboratory each week?

The average time spent in lecture was two hours per week, with an average of three hours devoted to lab exercises. These averages are almost identical to those of 1989.

(8) Does the introductory cartography course have a laboratory assistant?

Thirty-eight percent of the departments surveyed indicated that the introductory cartography course did have a lab assistant. When departments were compared by degree level, the percentage of courses with a lab assistant was as follows: Ph.D. granting departments (79 percent), Master's programs (42 percent) and Bachelor Degree only programs (20 percent). It would appear that laboratory assistance is a function of program size and the availability of graduate students.

(9) Are field trips a part of the introductory cartography course? If yes, what type of field trips?

Field trips were part of the curriculum for one-third of the introductory cartography courses. Few were identical because of the diversity of opportunities at individual locations, but those most often mentioned were private mapping firms (28 percent), governmental mapping offices (25 percent), and GIS centers (13 percent).

(10) Over the past five years, how would you classify enrollment in the introductory cartography course?

Three response options were available on the survey: increasing, decreasing and stable. Only three percent of the respondents indicated a decrease in enrollment over the past five years, while thirty-four percent indicated an increase. Sixty-three percent of those surveyed indicated stable enrollment. Many of those indicated that their enrollment would increase if classroom capacity were expanded.

(1) Is a textbook required? If yes, which textbook is used?

Eighty-six percent of those surveyed indicated a textbook requirement. Two instructors required two textbooks. The most commonly used textbooks, each accounting for approximately one-third of the total text notations, were Dent's *Principles of Thematic Map Design* (1985) and *Elements of Cartography* (1984,1995) by Robinson et al.

Table 2 lists all textbooks cited by two or more instructors and indicates the change in textbook usage between 1989 and 1995. Texts that were not included were map reading, computer cartography or specialized texts. Several textbooks, including Cuff's *Thematic Maps* (1982), were out of print in 1995.

(2) How many lab exercises are required for the course?

The number of exercises required ranged from three to sixteen exercises, with a mean, mode and median of eight exercises. This is slightly higher than the average of 7.5 in the 1989 survey.

(3) What types of exercises are required?

The exercises required in the introductory cartography classes in 1995

"It would appear that laboratory assistance is a function of program size and the availability of graduate students."

"Many . . . indicated that their enrollment would increase if classroom capacity were expanded."

COURSE CONTENT

REQUIRED TEXTBOOKS Introductory Cartography Courses			
AUTHOR	TEXT	1989	1995
A. Robinson, et al.	Elements of Cartography	50%	33%
B. Dent	Principles of Thematic Map Design	19%	32%
J. Campbell	Introductory Cartography	4%	11%
J. Tyner	Intro to Thematic Cartography	0%	5%
P. Muehrcke	Map Use	5%	3%
T. Rabinhorst	Applied Cartography	2%	2%
J. Campbell	Map Use and Analysis	0%	2%
J. Keates	Cartographic Design and Production	0%	1%
G. Brannon	Practical Cartography	0%	1%
D. Cuff, M. Mattson	Thematic Maps	12%	0%
D. Greenhood	Mapping	2%	0%
Others		6%	10%

Table 2. Required Textbooks

"The popularity of the choropleth map reflects the fact . . . that they are often available in computer mapping programs."

are ranked in Table 3. They are compared with required exercises from the 1989 survey. Because the actual number of responses was not the same between time periods, figures were converted to percentages for comparison purposes. Only those 1995 exercises noted by four percent or more of the instructors are included in the table. The popularity of the choropleth map reflects the fact that choropleth maps are not only seen more often in the media, but that they are often available in computer mapping programs. The increase in the frequency of graph construction exercises may be attributed to the availability of programs and spreadsheets such as Excel, Quattro Pro and Lotus 1-2-3 that produce graphs and charts. The decline in the frequency of the dot map exercises could also be related to software availability. Because the algorithm in computer dot map programs generally places dots randomly, realistic patterns are not created.

(4) What percentage of exercises are computer-aided?

Sixty percent of the laboratory exercises in the introductory cartography courses were computer-aided. Because each instructor indicated the percentage of lab exercises completed with the assistance of a computer, it was possible to examine the extremes in the range of computer usage. Overall, the use of computers for lab exercises ranged from 23 instructors who indicated that the computer was not used at all in their lab exercises, to 30 instructors who stated that all of their lab exercises were computer-aided.

(5) What topics are discussed in the introductory cartography course?

Each respondent was asked to check those topics covered in the lecture component of their introductory cartography course. An extensive list of topics was included in the survey as well as instructions to add any topics not covered in the survey list. All topics ranked by percentage of response greater than 20 percent are shown in Table 4. Comparison with the 1989 survey was not possible because this question was not asked in that survey.

Instructors were asked two questions regarding equipment used in the cartography lab: **(6) What equipment is required to be purchased by the student?** And **(7) What equipment is supplied by the department?**

These questions were included in order to determine whether the cost of purchasing equipment as well as a textbook had the effect of lowering

EXERCISE	PERCENT	PERCENT
	1989	1995
1 Choropleth	82.1%	88.5%
2 Graduated / Proportional Circle	77.4%	65.4%
3 Isarithmic	60.0%	54.6%
4 Map Projection	55.8%	53.8%
5 Dot	60.5%	48.5%
6 Redesigned Published Maps	29.5%	35.4%
7 Maps to accompany an article	32.6%	32.3%
8 Cartogram	33.7%	28.5%
9 Land Use	30.0%	22.3%
10 Smooth Statistical Surface	26.8%	21.5%
11 Maps from Aerial Photos	16.3%	20.0%
12 Flow	4.2%	18.5%
13 Large Scale Survey	15.3%	17.7%
14 Situation	19.5%	14.6%
15 Graphs	0.5%	10.0%
16 Dasyetric	14.7%	7.7%
17 Scale	3.2%	6.2%
18 Topographic	3.2%	6.2%
19 Drafting / Equipment Familiarization	3.7%	6.2%
20 Lettering	2.6%	5.4%
21 Data Capture / Digitizing	1.1%	5.4%
22 Generalization	1.1%	4.6%
23 Data Classification	1.1%	4.6%

Table 3. Laboratory Exercises Used in the Introductory Cartography Course

student enrollment. In addition, the question was to determine the degree to which departments were willing to allocate money for manual drafting. Table 5 compares the 1995 and 1989 survey results. In both, expendable items were usually required to be purchased by the student, while the more costly equipment was provided by the departments. Fewer departments were requiring students to purchase equipment in 1995 than in 1989.

(1) Are computers used in the Introductory Cartography course?

A major interest of this survey was the change in computer usage over time. The findings in 1989 indicated that computers were being used infrequently in the introductory cartography classes. Indeed, only 53 percent of those surveyed indicated that they used a computer in their introductory cartography courses. Of those using computers, only 16.2 percent of the laboratory exercises were executed with a computer. The results of the 1995 survey found that 82 percent of the respondents used a computer in their cartography course. Instructors also indicated that 60 percent of their laboratory exercises were completed using a computer.

(2) What type of computer is used in the Introductory Cartography course?

In 1989, approximately 71 percent of the departments using computers indicated that the personal computer was used in their classroom exercises. In the 1995 survey, the percentage of personal computer users had risen to 94 percent. This could reflect the greater availability of software for use on a personal computer and a trend reflecting decreasing costs and

"... expendable items were usually required to be purchased by the student, while more costly equipment was provided by the departments."

COMPUTER AIDED DRAFTING

"A major interest of this survey was the change in computer usage over time."

LECTURE TOPIC	1995 PERCENT
Scale	96.2%
Choropleth maps	94.7%
Map design	91.7%
Thematic mapping	91.7%
Generalization	89.4%
Symbolization	88.6%
Dot maps	86.4%
Base map compilation	86.4%
Map projections	83.3%
Classification	82.6%
Proportional symbol maps	82.6%
Computer maps	80.3%
Data sources	79.5%
Data analysis	79.5%
Coordinate systems	78.0%
Isarithmic maps	71.2%
Figure-ground	71.2%
Color	70.5%
Measurement scales	69.7%
Visual hierarchy	69.7%
Cartographic analysis	67.4%
Cartograms	65.2%
Map reproduction	62.9%
Flow maps	60.6%
Communications	58.3%
Linework	58.3%
Topographic maps	57.6%
Typographics	56.1%
Reference maps	53.8%
Manual cartography / drafting	53.8%
Ethics in cartography	50.8%
History of cartography	50.0%
Relief maps	44.7%
Aerial photos	43.9%
Graphs	36.4%
Historical maps	26.5%
Scribing	23.5%

Table 4. Most Frequently Cited Lecture Topics

"... it should be noted that the top ten most cited software packages accounted for 60 percent of the total software usage."

EQUIPMENT AND SUPPLIES	1989	1995
Computer disk	26.1%	46.2%
Pencil and ink eraser	55.3%	28.5%
Drafting pens	60.0%	26.9%
Gum eraser	58.4%	26.9%
Drafting paper	44.7%	26.2%
Drafting pencils	51.1%	25.4%
Hand calculator	30.5%	24.6%
Masking tape	56.3%	23.8%
Exacto knife set	54.2%	20.0%
Scale	11.1%	16.2%
Triangle, 45 degrees	33.2%	14.6%
Scale, engineers, 10ths	37.9%	14.6%
Triangle, 30-60 degrees	32.6%	13.1%
Protractor	23.7%	10.8%
Screen patterns	31.1%	9.2%
Curve, irregular	15.3%	8.5%
T-square	17.9%	7.7%
Rub-on letters	31.1%	6.9%
Compass set	11.1%	4.6%
Flexible curve	9.5%	3.8%
Map distance measure	2.6%	1.5%
Ship's curves	6.8%	1.5%
Planimeter	1.6%	0.0%
Beam compass	1.6%	0.0%

Table 5. Percent of Equipment/Supplies Required to be Purchased by Students

increased power and capacity of computers between 1989 and 1995. Of those using personal computers, 28.8 percent indicated they were Macintosh users in 1995. This is in contrast to 20.2 percent using the Macintosh in 1989.

(3) What software programs are employed in the Introductory Cartography course?

Another question of importance to the cartography instructor is the availability of software to produce the variety of maps necessary for a well-rounded laboratory experience. The 105 instructors who responded that they used a computer indicated 71 different software applications, ranging from word processing to Geographic Information Systems programs. While this represented a wide variety of software being used, it should be

noted that the top ten most cited software packages accounted for 60 percent of the total software usage. The most used software packages are indicated in Table 7.

Written comments often accompanied the returned survey forms, particularly in reference to computers and software. A common comment was that "software is but a tool to the overall mission of teaching cartography." Several instructors remarked on the problems associated with the use of computers in the classroom, such as inadequate budgets for computer equipment and software, the lack of multiple computers for laboratory use, and the reluctance of some instructors to use computers because of inadequate computer training.

(4) Additional questions attempted to determine the importance instructors placed on the student experience making maps using pen and ink or with the aid of the computer. The two questions were stated as follows: **Do you feel that it is imperative for students to have pen and ink drafting experience as a part of your introductory cartography course?** and **Do you feel that it is imperative for students to have hands-on computer experience as a part of your introductory cartography course?** Each question was followed by a secondary question, **If yes, to what extent?** A one to ten ranking system, with one indicating little importance to the student and ten being very important, was used.

Forty-five percent of the respondents indicated that they believe pen and ink drafting is an essential part of the introductory cartography course. When asked to rate how important this experience is on a one to ten scale, responses averaged 6.9.

Response to the second question on the importance of having computer experience was overwhelmingly (84 percent), yes, that computer experience is essential. When asked to determine how important this experience was, they gave an 8.6 rating out of a possible 10.

Eight respondents indicated that both pen and ink and computers were essential elements of the introductory cartography course. Overall, instructors placed more value on the computer experience in teaching cartography. However, many still support the premise that students should be exposed to both manual and computer-aided drafting.

SUMMARY AND CONCLUSIONS

This research identifies the characteristics, content and structure of the introductory cartography course. Results are based on a 1995 survey of instructors responsible for teaching the introductory cartography courses, and compares these results with the results from a similar survey conducted in 1989. The latest survey was sent to 311 academic cartographers, with 138 completed forms (44.4 percent) being returned. Specific subjects examined in the survey included the background of the cartography instructor, required textbooks, types and quantity of laboratory exercises, lecture topics, and extent of computer usage in the introductory course.

A comparison of characteristics of the cartography instructor between 1989 and 1995 revealed very similar statistics. The only significant difference was in the graduate institution of the instructors. Although most academic cartographers come from only a few graduate schools, a more varied list of schools was represented in 1995.

The questions designed to probe changes in course context and structure also revealed similar patterns over the six-year span of time. However, the question regarding cartography enrollment identified a stable to increasing pattern of enrollment.

A number of changes appear to have taken place in the content of the cartography course. Dent's *Thematic Mapping* textbook (1985) now has an equal share of the introductory cartography textbook market with Robinson and associates' *Elements of Cartography*. This could have been due to *Elements of Cartography* being a decade old and needing revision. A new edition was released in 1995 (Robinson, et. al., 1995), while Dent has also updated his book (1996).

EQUIPMENT AND SUPPLIES	NUMBER	1995
T-square	59	44.7%
Protractor	48	36.4%
Compass set	44	33.3%
Triangle, 45 degree	44	33.3%
Masking tape	42	31.8%
Drafting paper	40	30.3%
Triangle, 30-60 degree	40	30.3%
Scale	39	29.5%
Drafting pens	35	26.5%
Beam compass	34	25.8%
Scale, engineers, 10ths	33	25.0%
Curve, irregular	33	25.0%
Flexible curve	32	24.2%
Rub-on letters	31	23.5%
Ship's curves	30	22.7%
Exacto knife set	24	18.2%
Screen paftems	24	18.2%
Computer disk	22	16.7%
Planimeter	22	16.7%
Map distance measure	21	15.9%
Drafting pencils	18	13.6%
Gum eraser	18	13.6%
Pencil and ink eraser	15	11.4%
Hand calculator	10	7.6%

Table 6. Percent of Equipment and Supplies Provided by Geography Departments

"Comparison of characteristics of the cartography instructor between 1989 and 1995 revealed very similar statistics."

SOFTWARE PROGRAMS	IMPORTANCE TO COURSE	PERCENT WHO USE
Atlas*GIS	11	21.5%
Corel Draw	14	19.2%
ArcView	5	15.4%
Macromedia Freehand	15	14.6%
CAD programs	8	13.8%
MicroCAM	0	12.3%
Adobe Illustrator	4	11.5%
Surfer	1	10.8%
ArcInfo	2	9.2%
Atlas*Draw	0	7.7%
MapMaker	3	6.9%
Atlas*Pro	4	6.9%
Atlas*Graphics	1	6.9%
Map Info	3	6.2%
Map Viewer	2	5.4%
Superpaint	3	4.6%
Word Perfect / MS Word / PageMaker	1	4.6%
Idrisi	1	4.6%
MS Excel / Quattro Pro / Lotus 123	1	3.8%
GeoCart	0	3.1%
PCPaintbrush	1	3.1%
PCMap	1	3.1%
Claris Draw / Mac Draw	2	3.1%
Erdas Imagine	0	2.3%
Designer	1	2.3%
Canvas	1	2.3%
Classy	0	1.5%
SPSS Graphics	0	1.5%
Harvard GeoGraphics	0	1.5%
Roots	1	1.5%
MacAtlas	0	1.5%
Adobe PhotoShop	0	1.5%

Table 7. Computer Software Used in the Introductory Cartography Course

"The most notable changes identified in the introductory cartography course were in the realm of computer usage."

The amount of equipment that students were required to purchase has declined significantly between 1989 and 1995. The percentage of laboratory exercises produced by computers has increased substantially. However, the number and type of exercises, and the major topics covered in lecture have remained similar over the six-year period of time.

The most notable changes identified in the introductory cartography course were in the realm of computer usage. At the beginning of this article, the technological revolution in cartography was addressed and a goal was set to measure technological changes in the introductory cartography course over a six-year period of time. The most significant changes identified were the shift from mainframe computers to the personal computer, greater use of computers in producing maps, and changes in the types of software used to produce maps. This is mirrored by the survey response that over eighty percent felt that computer experience in cartography was essential. Nevertheless, a significant number of instructors felt that manual drafting techniques still have a place in the introductory cartography course.

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