A Topic Analysis of ISECON Conference Proceedings from 1982 through 2014

Jon Clark
jon.clark@colostate.edu

Susan Athey
susan.athey@colostate.edu

John Plotnicki
john.plotnicki@colostate.edu

Jay Barnes
jjbarnes@rams.colostate.edu

Computer Information Systems
Colorado State University
Ft. Collins, CO 80523 USA

Abstract

The authors note a distinct shift in topics covered in curricula as well as in conference presentations. This research was undertaken to get a better understanding of what these shifts have been, and determine their magnitude over time. Since ISECON has published its conference proceedings in digital format since 1982, this was a logical source of topics on which to base the analysis. All proceedings were captured during the period of 1982 through 2014 and a series of keyword searches were undertaken based on approximately 130 topics. One significant finding is that technical topics, programming as an example, has seen a steady and substantial decline from 18% of topics to just 2.5%. The most precipitous drop occurred from 1993 through 1997. This paper discusses the various trends and hypothesizes as to the causes.

Keywords: Curricula topics, ISECON Topic Trends, Business education gap, Technical skills, Hirable IT skills.

1. INRODUCTION

Faculty that joined academia in the 1970's have seen many changes to the core knowledge required of graduates in information systems at the bachelors, masters and even the doctoral level. Standard curricula have changed as well with the emphasis shifting from very technical skills to softer skills. The IS'97 Model included programming and data structures in the curriculum requirements but the IS2010 Model specifically removes Application Development as a requirement (Topi, Valacich, Wright, Kaiser, Nunamaker, Sipior, deVreede 2010, p.27) .

The purpose of the paper is to illustrate the topical changes and the ISECON conference over the last 32 years and act as a catalyst for discussion about both Information Systems education, and the idea of the "business-education" gap that some feel exists. While the implication of the trends in topics is certainly debatable, it is important to note that the trends themselves are based directly on the data.

©2016 ISCAP (Information Systems and Computing Academic Professionals)

Clearly, some limitations and challenges exist with this approach. ISECON did not take place in 1984, 1989, 1991 and many of the conferences had a theme and would have attracted topics in keeping with the theme. During the years of 1999 to 2014, the ISECON proceedings were a joint publication of FITE (Foundation for Information Technology Education) and EDSIG/AITP (Education Special Interest Group of AITP).

2. METHODOLOGY

The ISECON digital library of conference proceedings http://proc.isecon.org/ (Foundation for Information Technology Education, 2015). The ISECON conference proceedings have been published since 1982. The conference was not held in 1984, 1989 and 1991. This research distilled over 8000 keywords from articles at conferences over a 32-year span into categories that could be quantifiably analyzed. As there is no set process for this type of data grooming, the categories were not determined in advance, but evolved and revealed themselves as the data was organized. While might argue that the categories are somewhat subjective in nature, we submit that the analysis results and trends are both usable and provocative. We would also like to point out that the terms Computer Information Systems, Management Information Systems and Computer Science (CIS MIS and CS), ALL specifically appear in the source data from the conference, and is mainly geared towards CIS/MIS, CS appears and has been increasing in discussion since the year 2000.

The goal was to obtain, sort and categorize keywords from articles published each year at ISECON. Papers from 2000 – 2014 use keywords supplied by the authors of the original papers. Keywords in other years were determined by authors of this paper by reading the papers themselves. This generated 8390 keywords.

The keyword list was inspected and "groomed" for consistency. This included changing whole word terms into acronyms when both were used (examples: AI / Artificial Intelligence, and MIS / Management Information Systems), correcting some misspelling and separating composite keywords that had two distinct meanings. The cleaned up keywords were then assigned to categories, which could have both a primary and secondary part such as EDU-Teaching for education group, teaching keyword. The categories evolved as the words were sorted. In the end there were 121 categories created.

3. SUMMARY STATISTICS

Table 1 shows the keyword and article counts by year and average keywords per article. There is a significant increase in the number of keywords per article starting in 1999.

Year	KW's	Articles	KW's / Article
1982	22	10	2.2
1983	49	14	3.5
1984	No conference this year		
1985	125	47	2.7
1986	204	74	2.8
1987	258	78	3.3
1988	146	48	3
1989	No conference this year		
1990	133	53	2.5
1991	No conference this year		
1992	101	34	3
1993	105	43	2.4
1994	109	40	2.7
1995	134	48	2.8
1996	59	26	2.3
1997	90	34	2.6
1998	142	60	2.4
1999	200	51	3.9
2000	519	118	4.4
2001	416	94	4.4
2002	338	75	4.5
2003	418	91	4.6
2004	508	105	4.8
2005	553	115	4.8
2006	545	112	4.9
2007	566	113	5
2008	403	76	5.3
2009	408	81	5
2010	456	89	5.1
2011	386	72	5.4
2012	341	66	5.2
2013	315	65	4.8
2014	341	73	4.7
Totals	8390	2005	
Ave.	254.2	60.8	4.2

Table 1: Keywords per Year

Years 1982 through 1998 show 2.2 to 3.3 keywords per article, averaging 2.5, and 1999 to 2014 show 3.9 to 5.4 keywords per article, averaging 4.9- almost double the number of keywords per article. We did not have details on article submission requirements that far back, but one possible explanation for the difference could be a change in the allowable or minimum required keywords for articles.

The keywords have been grouped into categories for analysis. The categories evolved as the data was organized and groomed. Table 2 shows the total number of unique categories for each year. As with the number of keywords, there is a related increase in categories beginning in 2000.

Table 12 in the Appendix includes the total list of categories and number of keywords in each category.

Year	Category Count		Year	Category Count
1982	13		1999	67
1983	25		2000	91
1984	N/A		2001	83
1985	40		2002	72
1986	55		2003	84
1987	57		2004	94
1988	54		2005	91
1989	N/A		2006	88
1990	56		2007	88
1991	N/A		2008	84
1992	49		2009	91
1993	49		2010	82
1994	52		2011	80
1995	62		2012	79
1996	33		2013	77
1997	41		2014	70
1998	60			

Table 2: Unique Categories per Year

Table 3 shows the top 10 categories by number of keywords in the category. Since the ISECON conference is about education, it is no surprise that the EDU-Curriculum category contained the most keywords at 734, about 9% of the total.

At this point, one might be inclined to discuss 'unique' keywords as well as 'categories'; however, due to the nature of the data, many keywords are quite similar, with virtually identical meaning. An example would be "online education" and "distance education". While these will show up as different "unique" keywords, they have a very similar, if not the same, contextual meaning. Some terms change over time, but have the same meaning and at times are used interchangeably in a given situation. This makes metrics about unique keywords potentially misleading as the numbers of keywords with different meanings could be considerably lower than the actual number of 'unique' keywords shown. The ambiguous level of granularity between keywords would prove difficult if not impossible to properly analyze. Therefore, the discussion in this paper is centered around trends found in the categories, and some generic matching of keywords that do not have this ambiguity of meaning. For example, COBOL and JAVA are both languages, but are discrete and different in meaning, so they can be matched as individual words, not just in PROG categories.

Category List	Keywords
Edu-Curriculum	734
General	561
Edu-Teaching	374
Edu-Distance Teaching	276
Edu-General	227
IT-Discipline	213
Software-Development	207
Edu-Course	200
Social-Human Factor	197
Edu-Learning	178

Table 3: Top 10 Keyword Categories

"Software development" is the only technical topic to show up in the top ten categories list. The category "IT-Discipline" contains general terms like "Computer Science" or "Information Systems" used by themselves as a keyword, with no other descriptive words. The "General" category is mostly single non-descript keywords such as "opportunity" or "methodology".

4. ANALYSIS AND OBSERVED TRENDS

This section presents a series of graphs and tables depicting the trends of various clusters of keywords from the first ISECON Conference held in 1982 through last year's conference in 2014. Three general topics are discussed with respect to the ISECON conference keyword data analysis:

The Industry / Education Gap, Specific programming and IT skill trends, and the impact of Social topics on ISECON topics.

The Industry Education Gap

The 1999 ISECON conference mission statement was "*Bringing Industry and Education together--Closing the IS resource Gap*". While the industry education gap is a common topic in both business and academic circles, how to address this issue sparks much discussion and debate, yet remains elusive. Some aspects of this are curriculum, in terms of what skills to teach in the changing technology field, how to keep up on current technology without getting lost on fad or dead end developments, and how much and how fast students can learn and still retain the knowledge and skills.

Technical, education and business keyword clusters were plotted (Figure 1) and several important observations can be made: 1) from 1982 through 1995 education topics dropped from 40% to around 27% of the proceedings; 2) technical topics saw a rather precipitous drop from a peak of 56% in 1990, to under 20% by 2014; 3) business topics have been remarkably consistent in the range of 2 to 12% over the entire 32 year period, but have remained under about 8% since 2000. (Note: All figures are included in the appendix in a larger more detailed format.)

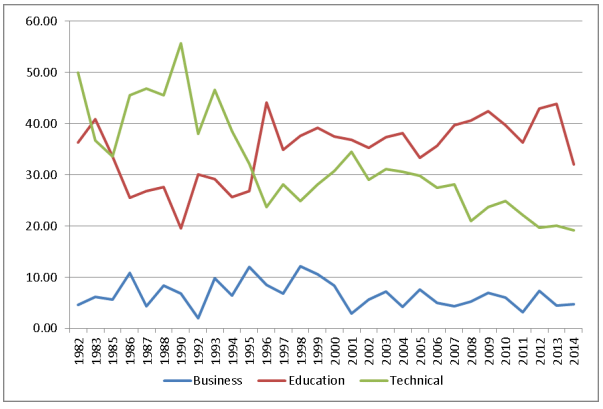

Figure 1: Technical/Education/Business (As a percent of total KW's by year)

Since ISECON is an educator's conference, it's not surprising that a large proportion of the material submitted is instructional in nature. The period from 1983 through 1995 is interesting because of the decrease in education related keywords, but this may be explained as an increase in new technical topics in the rapidly evolving environment of the computer field during this time frame. The apparent inverse relationship between education and technical terms between 1985 and 1996 deserves exploration, as well as the trends that took place from 1996 through 2014. These two seemingly distinct time frames are worth conjecture and further study.

The overall drop in technical topics at the conference since 1990 is counter intuitive. One would think that a technical field whose very origin is computer programming would not have seen such a precipitous drop of coverage in the conference. In fact, based on feedback we receive from the departmental advisory council for CIS at Colorado State University, programming is still a foundation skill for the graduates they want to hire. Are technical topics are being abandoned for educational topics in a disproportionate amount? If this is a reflection on the subjects covered in an undergraduate IS degree, this would seem to increase the Industry - Education gap by lowering the focus on skills that business wants graduates to have.

Figure 2 shows the coverage of MIS, CIS and CS as **disciplines** of the technology field over time. One trend is the increase in conference articles mentioning CS (computer science) as compared to CIS/MIS (Computer Information Systems / Management Information Systems), indicating the more technical computer science degree is discussed more, while technical topics like programming are discussed less.

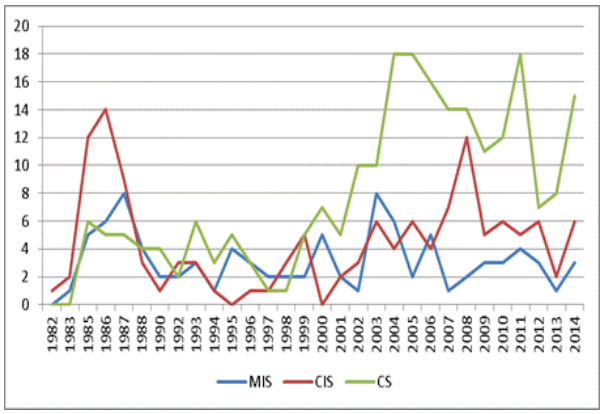

Figure 2: MIS/CIS/CS keywords (As number of keywords by year)

Figure 3 shows just two keyword clusters, programming and education, as a clear example of the gap between education and demand for technical skills. Although education topics saw an early drop from 40% in the period of 1982 through 1995, there was resurgence in

publication activity on these topics following 1995 and a relatively stable 35% to 40% level of publication coverage since. Programming, however, began at 18% in 1982 and has stumbled along after dropping throughout the 1990's to under 5% since 2008.

This widening gap clearly shows that topics at ISECON have moved from more technical topics in IS education, in this case, programming, to Education in IS. The data seems to show that the conference has shifted from "what technologies to teach", to "how to use technology to teach".

Figure 4 substantiates the previous assertion. It shows that there were discussions about the industry / education gap from 1982 to 1996, when this topic virtually disappeared for the next 18 years while topics about technology in education soared by comparison. Conference paper topics shifted to technology as tool, rather than a job skill to be taught.

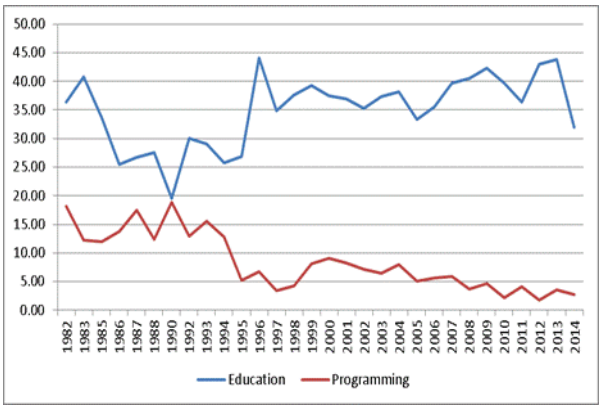

Figure 3: Programming/Education (As a percent of total KW's by year)

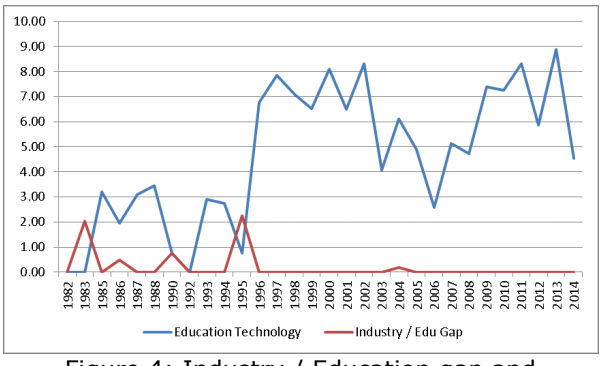

Figure 4: Industry / Education gap and Education Technology (As a percent of total KW's by year)

IT Skill/Programming Trends

A prevalent question in both the business and academic worlds of technology is "What programming languages are in demand?". Business needs graduates with these skills to fill new positions in an ever expanding field, and educators want to teach the correct "in demand" skills to their students.

2015	**2014**	**2013**	**2012**	**2011**
Java	Java	SQL	Java	Java
Java Script	C	Java	XML	C
C#	C++	HTML	Java Script	C++
PHP	C#	Java Script	HTML	C#
C++	Python	C++	C#	Java Script
Python	Java Script	C#	C++	Perl
C	PHP	XML	AJAX	PHP
SQL	Ruby	C	Perl	Visual Basic
Ruby	SQL	Perl	PHP	Python
Objec-tive C	MatLab	Python	Python	Ruby
2010	**2009**	**2008**	**2007**	**2006**
Java	Java	PHP	Java	Java
C#	C	C#	C	C/C++
C/C++	C++	AJAX	C++	C#
Java Script	Visual Basic	Java Script	PHP	Perl
Visual Basic	PHP	Perl	Visual Basic	Java Script
PHP	C#	C#	Perl	Visual Basic
Objec-tive C	Python	Ruby	Python	PHP
Perl	Perl	Java	C#	AJAX
Python	Delphi	Python	Java Script	Python
Ruby	Java Script	Visual Basic	Ruby	Ruby
Sources: "10 programming languages" (2015), Cass (2014), Hein (2013), Finley (2012), Sheenan (2011), Taft (2010), Connolly (2009), "10 computer Programming languages" (2008), "Most Popular Languages" (2007)				

Table 4: Top 10 programming language Lists by Year 2006-2015 (See sources.)

Table 4 shows the top 10 "in demand" programming languages from various sources over the last ten years. Java and variants of C (C,

C++, C#) have been in demand all ten years, with PHP, Python and JavaScript in all but one or two lists.

With this consistency of demand across a decade and multiple sources, it should be easy for educators to see what they should be discussing and teaching. Below, Table 5 shows many of programming languages from Table 4 as they appeared as topics at ISECON.

Programming Language	First Year	Last Year	Total Keywords
C++	1994	2011	44
Java	1999	2013	27
Visual Basic	1995	2011	16
XML	2000	2008	9
HTML	1995	2001	7
C	1984	2006	6
AJAX	2006	2009	4
ASP.Net	2004	2007	4
C#	2004	2009	4
Python	2005	2011	3
JavaScript	2000	2004	3
Perl	1998	2009	3
PHP	2010	2010	1
Ruby	None	None	0

Table 5: ISECON Appearances of Top in Demand Programming / Scripting Languages

While C++ and Java are the top two by appearances, the third entry, Visual Basic is over represented compared to others in the list. C and C# have only 6 and 4 appearances at the conference, respectively, despite their consistent demand (Table 4), and C was not mentioned at ISECON after 2006, but is in the number 2 spot for demand for 4 years after 2006. PHP and Python seem quite neglected at ISECON, with only 4 keywords combined, but make the top 10 lists virtually every year. Perl is underrepresented with only 3 papers mentioning it, but was on the in demand lists for 7 out of 10 years. Ruby was left out in the cold at ISECON with no keywords, and yet was on the top 10 most demanded skills for 6 of the last 10 years. This comparison shows a very clear gap between what programming skills educators are talking about and what skills are in high demand with businesses.

Web-based programming and scripting skills are also in high demand. Some of these appeared in the top ten programming lists above. Table 6 shows 10 web specific skills that appeared in ISECON papers. Note the very low keyword counts. Web programming and website development are high demand skills and yet have very low representation at ISECON possibly because of the nature of ISECON over time.

Web development Technology	First Year	Last Year	Total Keywords
AJAX	2006	2008	4
Apache	2010	2010	1
ASP or ASP.NET	2001	2007	6
CGI	1996	1996	1
XML	2000	2008	9
HTML	1995	2001	7
JavaScript	2000	2004	3
PHP	2010	2010	1
XHTML	2002	2002	1
XSL or XSLT	2002	2006	4

Table 6: Web-based Programming Skill List

Figure 5 illustrates the overall trend of the Programming topic, both traditional and Web-based, over the entire 30 year period. Figure 5 isolates two clusters of keywords, one capturing programming in general and the other on web topics. Web topics began to appear in 1994 as one would expect. Although there are year to year variations, the coverage of web topics remains relatively consistent in the 2% to 8% range. The most surprising result is the significant drop in programming topics from a high of 19% in 1990, to around 3% by 2014.

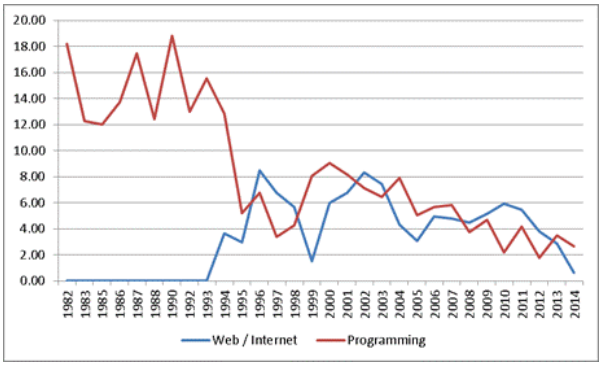

Figure 5: Programming/Web (As a percent of total KW's by year)

In 1993 or 1994 a significant decrease in traditional programming topics occurred, reducing the proportion from an average of 14% for a decade, to a mere 3% by 1997. Perhaps the

development of the World Wide Web, and HTML programming displaced traditional programming, but even adding the two categories together, there is still a significant reduction.

Tables 7 and 8 contain three lists each from three different sources for the years 2009 and 2015, respectively, of the "Top 10" in demand I.T. skills for each year. This snapshot of skills six years apart was chosen to show what a student graduating from High School in 2009 might see as "in demand" skills and what educators might see as a guide to setting their curriculum for the next few years. Once the student finishes college in the typical five years, he or she would be looking for a job in the market portrayed by the 2015 table.

Skill List 1 (Marson, 2009)	Skill List 2 (Johnson, 2009)	Skill List 3 (Hoffman, 2009)
Business Process Modeling	Adobe Flash	Business Intelligence
Data mining	Article Writing	Data Center
Database	Content Writing (Web)	Help Desk Technical Support
IT architecture	CSS	Networking
IT optimization	Graphic Design	Programming Application Development
IT security	HTML	Project Management
Messaging Communi-cations	MySQL	Security
Networking	Photo-Shop	Telecommuni-cations
Project management	PHP	Web 2.0
Web development	Word- Press	(Only nine in list)

Table 7: Top I.T. skills for 2009

Note how different the skills are between the two years (2009 and 2015) as well as within one year. There is little agreement on the top I.T. skills, but one that stands out is data / database work, although it would be difficult to decide on specific skills to learn / teach based on these lists for both students and educators. This may explain some of the Industry / Education gap. Some of these "skills" are related to more applied skills like networking and others to more IS development skills such as programming. Some skills are very narrow single application or non-education skills like "Security Clearance (Federal - Active)" or "Share Point" that one would really just attain on the job. The lists contain a combination of very general and highly specific skills that would be near impossible to define or include in a college curriculum that is designed to be stable for a number of years.

Skill List 1 (Pratt, 2015)	Skill List 2 (Wadlow, 2015)	Skill List 3 (10 Fastest, 2015)
Big data	Cloud Security	.NET
Business intelligence analytics	Data Management	C#
Database administration	Data Science	Database administrator
Help desk/technical support	Enterprise Architecture	Java
Mobile applications and device management	Hacking	Oracle (applications)
Networking	Mobile Application Development	SAP
Programming application development	Network Penetration	Security
Project management	NoSQL	Security Clearance (Federal - Active)
Security compliance governance	Secure Coding	Share Point
Web development	Virtualization	Software developer

Table 8: Top I.T. skills for 2015

Figure 6 shows the trends for IS Development such as programming and database design and non-development IS skill groups as presented at

ISECON. If discussions about CS are overtaking discussions about CIS/MIS (as shown above in Figure 2) one might expect IS Development skills (ex. programming, database design) to be overtaking Non-development skills, and if CIS/MIS topics were more prevalent, Non-development IS skill discussions should be increasing. However, Figure 6 shows that Development skill topics are in decline and Non-development IS skill topics remain low and steady, indicating an overall trend away from covering technology skills of all types at ISECON.

Another example of this divergence can be seen in the keywords that cover computer/server operating systems. Table 9 shows occurrences of common operating systems in decreasing order of frequency in the proceedings. "Open source" has the most mentions, although LINUX is not mentioned once since its inception in the early 1990's. The second operating systems is the most interesting, but perhaps not surprising - Apple.

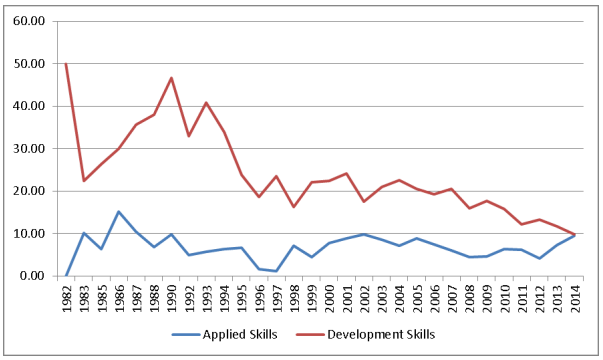

Figure 6: Applied vs IS Development skills

Apple markets strongly to the education community - students, institutions, and faculty. The problem here is that Apple has very low penetration into the business market, so "Apple" skills are niche and not in high demand (Table 10). This represents an education-centric view which puts emphasis on technology that is high in educator/student use, but low in "hirable" paid skills. This represents a "we are the world" education-centric view which puts emphasis on technology that is high in consumer use, but low in "hirable" paid skills. Windows seems to be underrepresented since it is the most common business desktop and server platform. Unix and DOS seem relatively in line, but having NO direct mention of LINUX seems very out of touch, since it is the most common web server installation in use. Android is arguably the most common mobile device OS, and yet it only has one entry.

Overall, the number of operating system entries seems quite low. Operating systems are the basis of all computer systems, and only 33 keywords out of 8390 directly reference an operating system, 0.4 percent of all keywords.

Operating System	First Year	Last Year	Total Keywords
Open Source	2005	2012	12
Apple/Mac	1990	2012	8
Windows	1994	2006	5
UNIX	1992	2007	4
DOS	1990	1994	3
Android	2012	2012	1
Linux	None	None	0

Table 9: Operating Systems

Desktop O/S	Percent market Share
Windows	87.8
Linux	1.7
Apple	7.5
Other	2.5
Web Server O/S	
Windows	32.9
Linux	67.1
Other	< 0.1
Mobile O/S	
Android	82.8
iOS (Apple)	13.9
Windows	2.6
Others	0.7

Table 10: Market Share
(Sources: "Desktop Operating System Market Share" (2015), "Global Market Share Held …" (2015), "Smartphone OS Market Share, 2015 Q2" (2015), "Usage of operating systems for websites" (2015))

Social I.T. Trends

Despite the dependence on the World Wide Web for social and business activities, not much attention seems to be paid at this conference to the tools needed to develop websites. Even if CIS students are not going to be web developers, one could argue that they need to at least understand

what goes on behind the scenes from a technology standpoint, as well as the relationship to e-commerce and the underlying data that is collected by various online social and commercial websites. Table 11 shows several social media related topics.

Social Media Topics	First Year	Last Year	Total Keywords
Social Networking	2008	2013	11
Social Media	2011	2014	6
Social Networking and SNS	2005	2011	8
Blogs / Blogging	2004	2011	8
Facebook	2011	2014	3
Twitter	2009	2011	3

Table 11: Social Media Topics

As could be expected, social media and its uses began to be discussed in 2004 and their popularity has continued. The topics have included the general as well as the specific applications of social media with technology (Facebook, Twitter).

Social Career topics (Figure 7) appear nearly every year, but show a distinct increase in the 1990's and again in the 2000's after a drop off in 2002, with a peak in 2006 followed by another decline. A variety of different topics are discussed with the largest number of papers discussing "outsourcing" from 2005 through 2008.

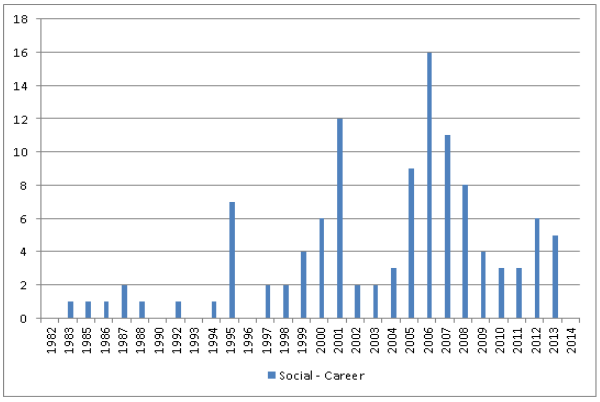

Figure 7: Social Career Keywords by Year (As total keywords)

5. CONCLUSIONS

CIS/MIS is a discipline that has seen a significant evolution over the past fifty years or so. This paper analyzed topics presented at ISECON from 1982 through 2014 to look for trends in the topic coverage as a surrogate for what is important in the IS field of education. The decline in technical topics, especially programming and web development, seem the most significant. Based on the findings here, these technical topics appear to have been totally replaced by teaching methodology than rather than technical skill content. Is this because these topics are "old" technology? Are they not interesting any ore to researchers who present at this conference?

These findings should encourage the discussion of what is important in teaching Information Systems – both topics and techniques – as well as what is important in the industries who hire new graduates.

6. REFERENCES

"10 Computer Programming Languages You Might Want to Know" (2008). QuinStreet. Retrieved June 24, 2015 from Source 2008: http://www.computer-schools.org/software/top-10-computer-programming-languages/.

"10 Fastest-Trending IT Skills: Spring 2015", (2015). IT Business Edge. Retrieved June 28, 2015 from http://www.itbusinessedge.com/slideshows/the-10-fastest-trending-skills-spring-2015.html.

"10 programming languages you need to know in 2015", (2015). Times of India Retrieved June 24, 2015 from Source 2015: http://timesofindia.indiatimes.com/tech/slideshow/10-programming-languages-you-need-to-know-in-2015/itslideshowviewall/46286489.cms.

Cass, Stephen (2014). Top 10 Programming Languages. IEEE Spectrum. Retrieved June 24, 2015 from Source 2014: http://spectrum.ieee.org/computing/software/top-10-programming-languages.

Connolly, Shaun (2009). Programming Language Popularity. spring.io Retrieved June 24, 2015 from Source 2009: https://spring.io/blog/2009/02/23/programming-language-popularity.

"Desktop Operating System Market Share" (2015). Net Market Share. Retrieved Sept. 2nd 2015, from https://www.netmarketshare.com/operating-system-market-share.aspx?qprid=10&qpcustomd=0

Finley, Klint (2012). 5 Ways to Tell Which Programming Languages are Most Popular. readwrite. Retrieved June 24, 2015 from Source 2012: http://readwrite.com/2012/06/05/5-ways-to-tell-which-programming-lanugages-are-most-popular.

Foundation for Information Technology Education (2015). ISECON Proceedings. Retrieved March 31st, 2015 from http://proc.isecon.org/.

"Global Market Share Held by Operating Systems Desktop PCs from January 2012 to June 2015" (2015). Statista. Retrieved Sept. 2nd 2015, from http://www.statista.com/statistics/218089/global-market-share-of-windows-7/

Hein, Rich (2013). Top 10 Programming Skills That Will Get You Hired. CIO. Retrieved June 24, 2015 from Source 2013: http://www.cio.com/article/2368943/careers-staffing/97819-Top-10-Programming-Skills-That-Will-Get-You-Hired.html#slide1.

Hoffman, Thomas (2009). The 9 Hottest IT Skills for 2009. Computerworld. Retrieved June 27, 2015 from http://www.cio.com/article/2431399/careers-staffing/the-9-hottest-it-skills-for-2009.html.

Johnson, Dave (2009). The Top IT Skills in 2009. MoneyWatch. Retrieved June 27, 2015 from http://www.cbsnews.com/news/the-top-it-skills-in-2009/.

Davis, G., Gorgone, J.T., Couger, J.D., Feinstein, D.L. and Longenecker, H. E. Jr. (1997). IS '97 Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems, ACM, New York, NY and AITP (formerly DPMA), Park Ridge, IL, .

Marsan, Carolyn D (2009), Top 10 Tech Skills in a Downturn. Network World. Retrieved June 27, 2015 from http://www.pcworld.com/article/162324/top_10_tech_skills_in_a_downturn.html.

Most Popular Programming Languages (2007). DevTopics. Retrieved June 24, 2015 from Source 2007: http://www.devtopics.com/most-popular-programming-languages/.

Pratt, Mary K. (2014), 10 hottest IT skills for 2015. Computerworld Retrieved June 28, 2015 from http://www.computerworld.com/article/2844020/10-hottest-it-skills-for-2015.html.

Sheehan, Tom (2011), The Top 10 Programming Languages for 2011. myITview Retrieved June 24, 2015 from Source 2011: http://myitview.com/it-management/the-top-10-programming-languages-for-2011.

"Smartphone OS Market Share, 2015 Q2" (2015). IDC. Retrieved Sept. 2nd 2015, from http://www.idc.com/prodserv/smartphone-os-market-share.jsp

Taft, Darryl K (2010), Application Development: Top 10 Programming Languages to Keep You Employed. eWeek Retrieved June 24, 2015 from Source 2010: http://www.eweek.com/c/a/Application-Development/Top-10-Programming-Languages-to-Keep-You-Employed-719257.

Topi, H., Valacich, J., Wright, R., Kaiser, K., Nunamaker, J., Sipior, J., de Vreede, G. (2010). Curriculum Guidelines for Undergraduate Degree Programs in Information Systems. http://www.acm.org/education/curricula/ IS 2010 ACM final.pdf

"Usage of operating systems for websites" (2015). W3Techs. Retrieved Sept. 2nd 2015, from http://w3techs.com/technologies/overview/operating_system/all

Wadlow, Thomas (2015), Top 10 IT Skills in Demand for 2015. Business Review Europe Retrieved June 28, 2015 from http://www.businessrevieweurope.eu/technology/380/Top-10-IT-Skills-in-Demand-for-2015.

Appendix (Additional Tables and Figures)

Categories	Keywords		Categories	Keywords
Bus-Company	13		Prog-Concept	112
Bus-Discipline	10		Prog-Game	16
Bus-Edu relationship	28		Prog-General	94
Bus-Education Gap	7		Prog-IDE	6
Bus-Experience	41		Prog-Language	34
Bus-General	85		Prog-Object Oriented	67
Bus-Management	48		Prog-Scripting	14
Bus-Model	10		Skills	73
Bus-Organization	7		Skills-Communication	23
Bus-Process	61		Skills-Computer	54
Bus-Project-Management	64		Skills-Group	98
Bus-Skill	6		Skills-IT	45
Bus-Technology	51		Skills-Math	38
Bus-Tool	5		Skills-Writing	35
Bus-Training	21		Social	120
Bus-Type	60		Social Media	49
Data-Analysis	59		Social-Career	114
Data-Dbase	98		Social-Ethics	103
Data-Dbase-Development	38		Social-Game	3
Data-Dbase-Language	29		Social-Human Factor	197
Data-Dbase-Online	3		Social-International	74
Data-General	88		Social-Law	52
Data-Management	21		Social-Privacy	16
Data-Modeling	65		Software	36
Edu-Accreditation/Org	153		Software-Application	50
Edu-Certification	41		Software-Computer Aided	47
Edu-Cheating	20		Software-Development	207
Edu-Course	200		Software-Game	8
Edu-Curriculum	734		Software-Graphics	14
Edu-Degree	74		Software-Model	50
Edu-Distance Teaching	276		Software-OS	12
Edu-Enrollment	76		System Administration	5
Edu-Faculty	31		System-Analysis	121
Edu-General	227		System-Architecture	31
Edu-Grading	23		System-Decision Support	52
Edu-Graduate School	23		System-Development	69
Edu-Graduation	9		System-General	87
Edu-High School	8		System-Security	137
Edu-Learning	178		System-Specific	99

Edu-Materials	30		Technology-Communication	30
Edu-Performance	62		Technology-Development	23
Edu-Project	56		Technology-General	92
Edu-Research	42		Technology-Hardware	33
Edu-Standards	19		Technology-Malicious	17
Edu-Student	121		Technology-Management	5
Edu-Teaching	374		Technology-Media	61
Edu-Technology	156		Technology-Mobile	39
Edu-Testing	95		Technology-Storage	10
Edu-Undergraduate	20		Technology-Support	2
General	561		Technology-Telecom	15
Government	18		Technology-Use	102
IT-Discipline	213		Technology-Virtual	24
Networking	104		Web-Application	22
Networking O/S	11		Web-Commerce	63
Networking-Server	18		Web-Development	96
Prog-1GL	2		Web-General	89
Prog-2GL	1		Web-Information	7
Prog-3GL	100		Web-Infrastructure	25
Prog-4GL	71		Web-Media	7
Prog-AI	18		Web-Service	44
Prog-Application Interface	39			

Table 12
Full Category table with total Keyword counts per category

Full Sized Figures for Greater Detail by Year

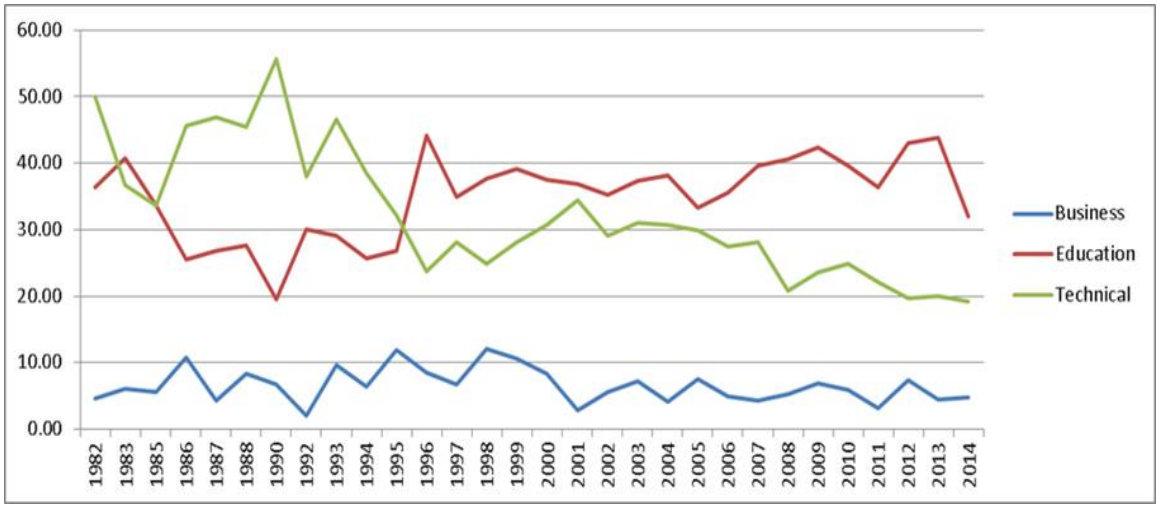

Figure 1: Technical/Education/Business (as a percent of total KW's by year)

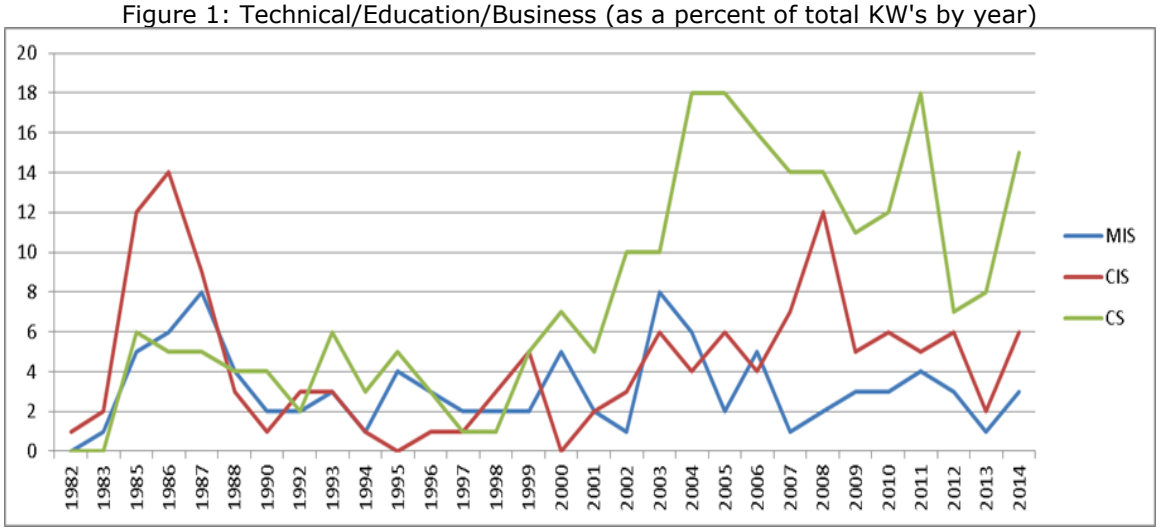

Figure 2: MIS/CIS/CS keywords (As actual number of keywords)

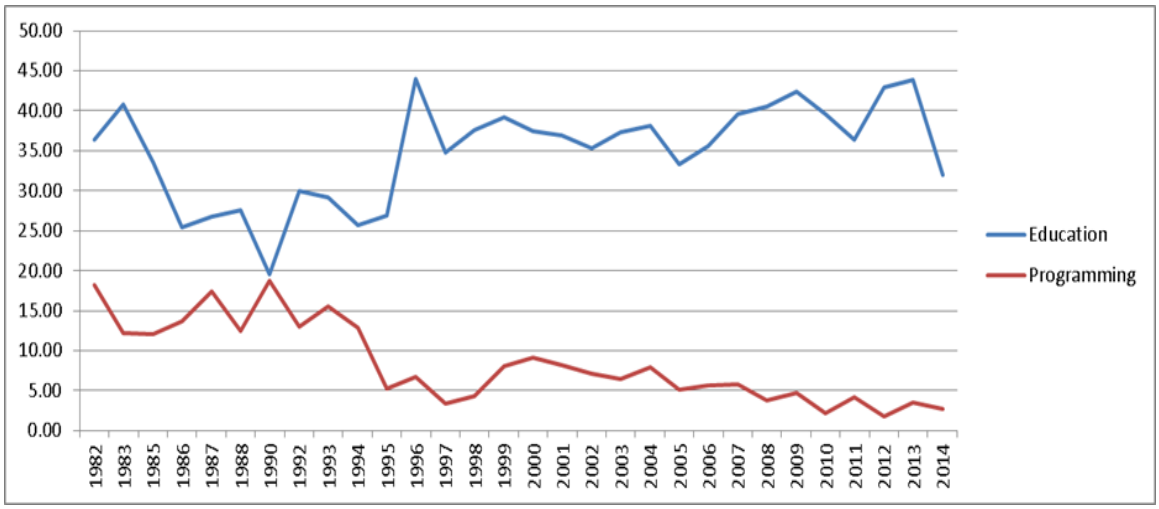

Figure 3: Programming/Education (As a percent of total KW's by year)

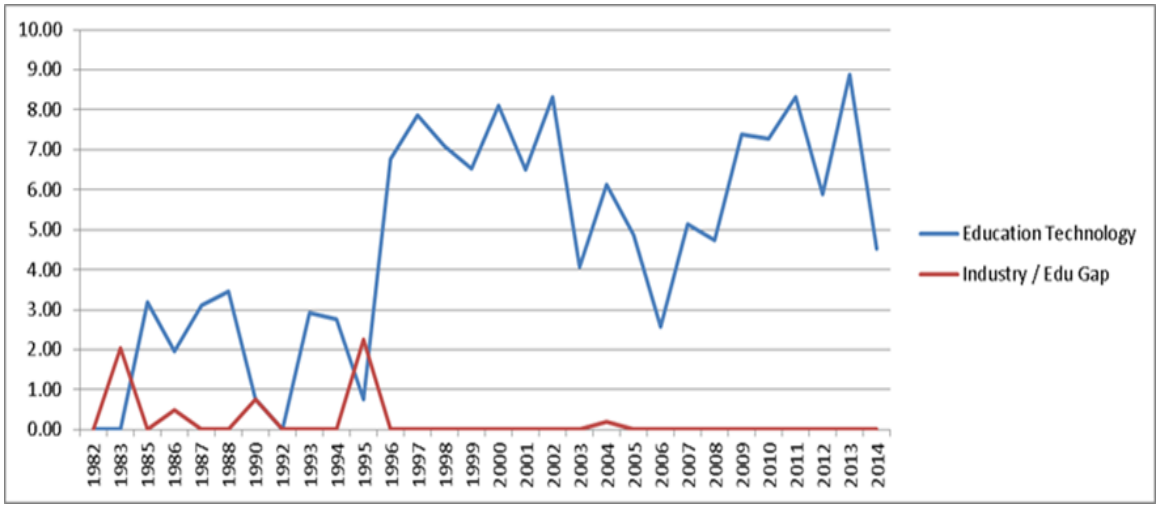

Figure 4: Industry / Education gap and Education Technology (As a percent of total KW's by year)

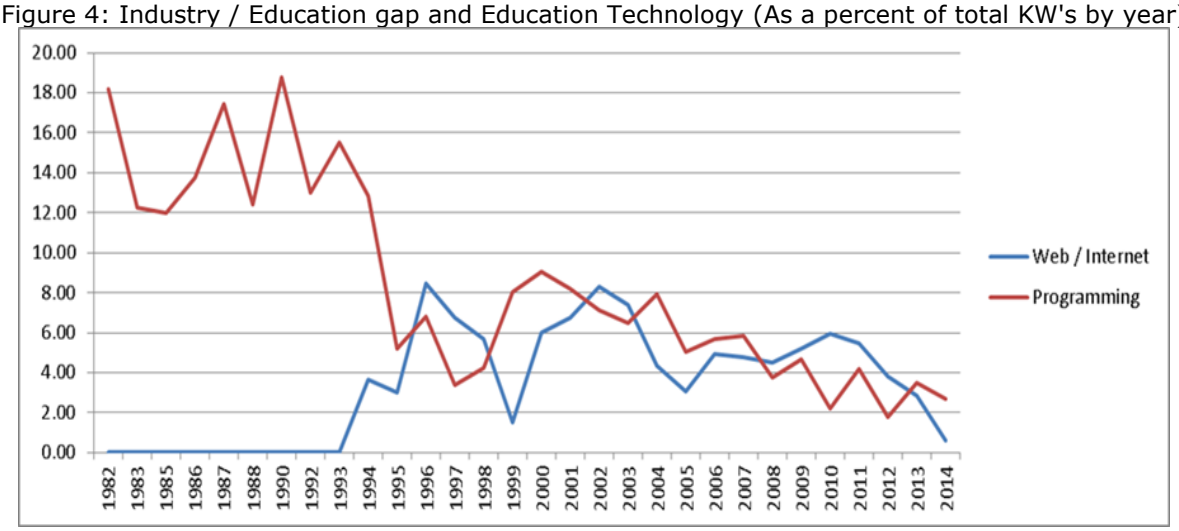

Figure 5: Programming/Web (As a percent of total KW's by Year)

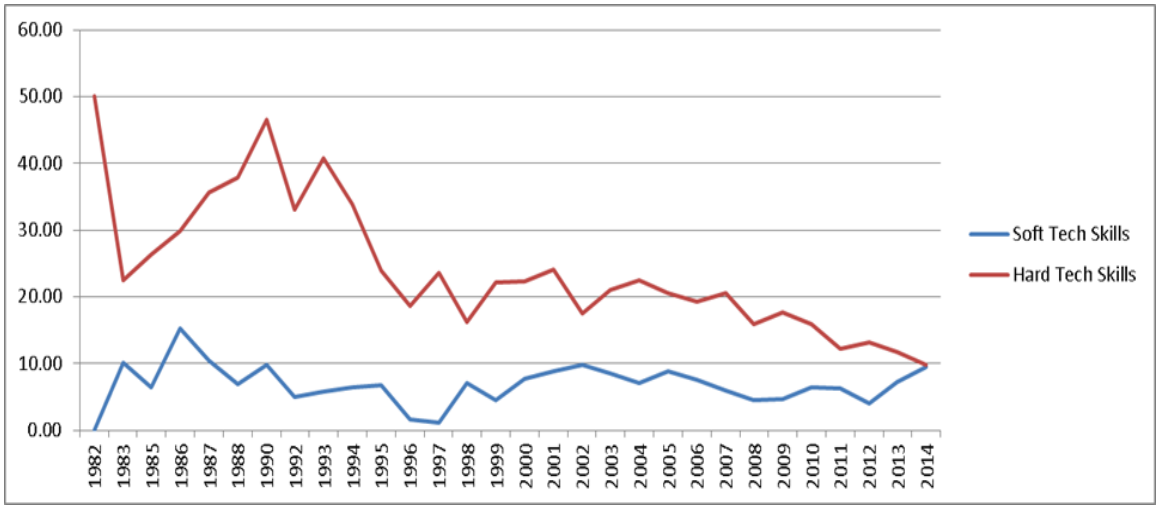

Figure 6: Hard vs. Soft Technical skills (As a percent of total KW's by Year)

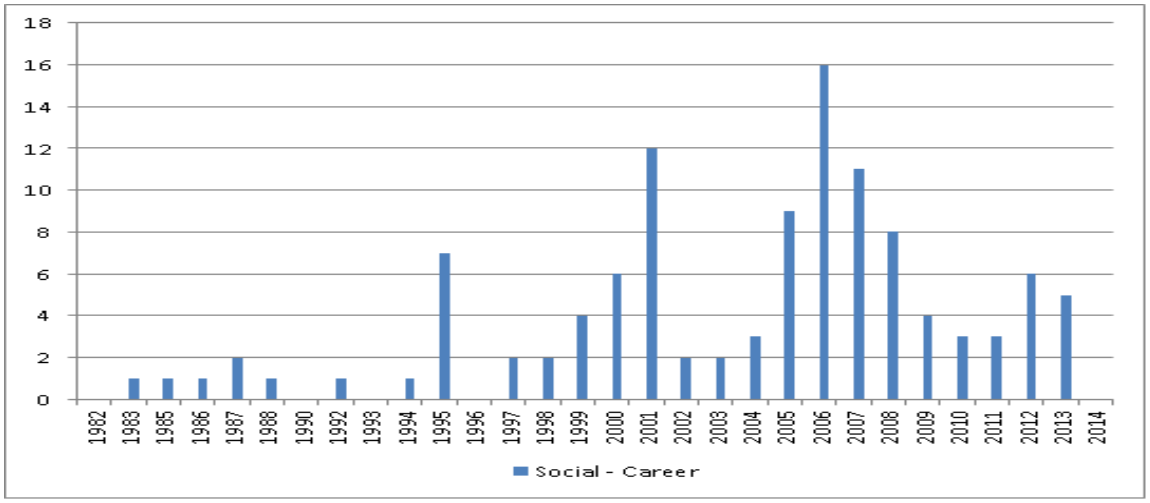

Figure 7: Social Career Keywords by Year (As total keywords)