# An Artificial Intelligence Approach for Recommending Curriculum: Analyzing the Knowledge Gap between the Association for Computing Machinery Information Systems (ACM-IS) Recommended Curriculum and Skills Desired by Employers

**by**
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# Ethics Statement[1]

The author, whose name appears on the title page of this work, practiced ethically throughout the research:

- Any type of misleading information, as well as representation of primary data findings in a biased way were avoided.
- Any deception or exaggeration about the aims and objectives of the research were avoided.
- Acknowledgment of works or other authors used in any part of the thesis were properly referenced using APA6 format.
- The highest level of objectivity in discussions and analyses throughout the research were maintained.

[1] Ethical considerations - research methodology. (n.d.). Retrieved March 26, 2021, from https://research-methodology.net/research-methodology/ethical-considerations/.

# Abstract

Management Information Systems (MIS) prepares students for a wide scope of careers. The curriculum recommended by the Association for Computing Machinery (ACM) uses the European e-competency framework (eCF) framework which accounts for over 30 possible careers. These careers include various combinations of technology and business knowledge, it's a tall order to prepare graduates adequately. A curriculum is recommended every 10 years and is prepared by reading similar research to this study. Most research is qualitative, there have been very few quantitative studies. Many schools follow this curriculum strictly to be ABET/AACSB accredited.

The systems analyst career is one considered to be in the middle, half business and half technology. The goal of this study is to prove that the MIS graduates pursuing a systems analyst career, a career in the middle, are not adequately prepared for the workforce. The curriculum may be teaching topics too much, too little, or simply missing knowledge all together. The second goal was to prove that the recommendation process can be automated, so that curriculum can be recommended more frequently, thus be up to date.

To capture skills sought by employers, the methodology was to scrape Indeed.com for job postings and count how many times certain skills appears. Then this data was compared to what knowledge ACM recommends for MIS graduates. SPSS was used to count the skills from the job postings, and that was verified by an excel workbook made. The ACM recommended knowledge was manually written down after analyzing all 21 courses core competencies.

The study results of the study suggest that MIS students who wish to pursue a systems analyst career are learning some unnecessary material, learning too much of one topic, and some material was missing. I recommend dividing MIS major into 5 concentrations: MIS Business, MIS Database, MIS Developer, MIS Data Analytics, MIS Cybersecurity. This would narrow the scope on potential careers for graduates and produce a higher quality workforce.

This methodology can be used for the curriculum recommendation for other degrees, even those outside of technology. The only thing that would need to be changed is the job title from "systems analyst" to whatever career being analyzed.

The primary issue with using the methodology is that employers write more general job descriptions. For instance, they may say Microsoft excel, but not the specific knowledge like pivot tables, VLOOKUP, etc.… This methodology can be used to identify the core competencies, but a qualitative study may need to be done to determine the specific knowledge.

# Dedication

Thank you to Professor Robert Goodwin, who also served on my thesis committee. In High School, I was a below-average student who hated school (82 average). No honors, no passion, only went to school because I had to. In my first semester at Tampa, I was put into Professor Goodwin's Financial Accounting course. His course was not easy; it was fair and honest. He somehow made accounting enjoyable with his witty humor and real-life experiences. He inspired me to push myself and work harder; I earned my first A ever in that course. Nothing felt better than earning that A. It inspired me to get a 4.0 the following semester, earning the dean's list every semester after, and eventually graduating Magna Cum Laude. One day I will return to academia to teach and touch lives as Professor Goodwin touched mine.

Thank you to my Aunt Katie, who has helped me more than anyone in college. She helped improve my writing prowess and was continually pushing me to get better. She also inspired me to chase what I enjoy and not settle. She's also extremely passionate about social justice and equality. She has helped me develop into a morally upright person, someone who is inclusive and has high integrity. Every Christmas she would give me money. Half of that money was to invest in college, and the other half was to donate to a charity. I remember donating to a lower opportunity school district, and the money was used to buy them gym equipment. The whole class wrote me personalized letters, this sparked a passion for volunteering and giving back.

Thank you to my best friend, Tony, whom I have known since kindergarten. Tony is the most intelligent person I know; he is attending Northeastern and is currently an undergraduate. He has worked at a Harvard-affiliated lab and contributed to published work. He will soon pursue his Master's and eventually his Ph.D. I know he will make a difference in this world; I can even see him winning a Noble Prize in Chemistry one day. People like Tony lift up those around them. I enjoy learning about his new knowledge, and I contribute to those conversations by sharing mine.

Thank you to my father, who is pursuing his Ph.D. despite working a full-time job. It was inspiring, and I felt like I was competing with him in our academic pursuits. The reality is that academia and the pursuit of knowledge is a joint venture. Moreover, by pushing one another, we pushed ourselves higher.

Thank you to my brother, Andrew, for keeping me on my toes. When I started my freshman year at college, he was beginning his journey through High School. He is brilliant and hard-working. As an older brother, it is my responsibility to be a good role model and not let him surpass me too quickly.

Thank you to my Mother and Mima for constantly checking in on me to make sure I was doing well. I am the oldest in my family, and they loved to remind me of that, and I had to inspire all of my cousins, who are younger than me.

# Acknowledgments

Dr. Veltri helped me develop a plan, schedule, and structure for my thesis. This allowed me to stay organized. Dr. Veltri also met with me frequently to keep my eyes on the prize. She was honest with me, which I greatly appreciated. There were times when I would get in a rut and not produce quality work, and she made sure to get me out of that rut. Dr. Veltri also recommended edits.

Dr. Farkas spent a whole weekend developing the workbook which was first used to see what skills employers wanted. The workbook ended up being used to verify SPSS. Dr. Farkas also provided the SPSS recommendation, which allowed me to perform the highest quality review. I had Dr. Farkas as a professor my last semester and he kept me on the ball during the thesis. He's brilliant. He challenged me to learn and come up with the best solutions/arguments for the thesis.

My Aunt Katie, Professor Goodwin, and Father provided comments/edits for the thesis. This helped to make it a better read and increased the quality/professionalism of the research.

Dr. J.B. Kim answered a last-minute call to help and provided a recommendation to fix the SPSS stream.

Dr. Gourd served on my thesis committee and helped oversee the thesis.

The thesis template used was provided by Simon Fraser University. [2]I adjusted the template to meet the requirements of the University of Tampa thesis.

[2] SFU Library. (n.d.). Retrieved April 04, 2021, from https://www.lib.sfu.ca/help/publish/thesis/templates

# List of Acronyms

| | |
|---|---|
| AACSB | Association to Advance Collegiate School of Business |
| ABET | Accreditation board for Engineering and Technology |
| ACM | The Association for Computing Machinery |
| AIS | Accounting Information Systems |
| AITP | Association of Information Technology Professionals |
| ARIS | Architecture of Integrated Informaiton Systems |
| AWS | Amazon Web Services |
| BI | Business Intelligence |
| BPM | Business Process Management |
| BPMN | Business Process Model and Notation |
| CIS | Computer Information Systems |
| CMMI | Capability Maturity Model Integration |
| CNIL | The Commission nationale de l'informatique et des libertés (National Commission for Computing and Liberties) |
| COBIT | Control Objectives for Informaiton and Related Technology |
| COBOL | Common Business Oriented Language |
| CRUD Matrix | Create, Read, Update, Delete- Matrix |
| CSS | Cascading Style Sheets |
| DBMS | Database Management System |
| DDOS | Distributed Denial of Service |
| DNS | Domain Name System |
| DOS | Denial of Service |
| DPMA | Data Processing Management Association |
| eCF | European e-competence framework |
| ERP | Enterprise Resource Planning |
| FTC | Federal Trade Commission |
| GDPR | General Data Protection Regulation |
| HIPPA | Health Insurance Portability and Accountability Act |
| HTML | Hyper Text Markup Language |
| IS | Informaiton Systems |
| ICT | Informaiton Communications Technology |
| IoT | Internet of Things |
| ISO | Internal Organization for Standardization |
| ITIL | Informaiton Technology Infrastructure Library |

| | |
|---|---|
| MIS | Management Informaiton Systems |
| MISRC | Management Information Systems Research Center |
| MS SQL | Microsoft Structured Query Language |
| O/RM | Object-Relational Mapping |
| OCC | Office of the Comptroller of the Currency |
| OCR | Optical Character Recognition |
| OSI | Open Systems Interconnection Model |
| PCI-DSS | Payment Card Industry- Data Security Standard |
| PMBOK | Project Management Body of Knowledge |
| RDBMS | Relational Database Management System |
| SDLC | Software/System Development Life Cycle |
| SEC | U.S. Securities and Exchange and Commission |
| SOA | Service Oriented Architecture |
| SOX | Sarbanes-Oxley Act |
| SPSS | Statistical Package for the Social Science |
| SQL | Structured Query Language |
| SWOT | Strengths, Weakness, Opportunities, Threats |
| TOGAF | The Open Group Architecture Framework |
| U.M. | University of Minnesota |
| UCD | User-Centered Design |
| UDP | User Datagram Protocol |
| UI | User Interface |
| UML | Unified Modeling Language |
| UX | User Expiereince |
| XML | Extensible Markup Language |
| XPDL | Extensible Markup Language Process Definition Language |

# Preface:

When I started this thesis, my scope was unfocused. To be candid, I didn't know what I really wanted to write about.

I had just completed an honors tutorial as a substitute for an honors class. This is a semester long research project, and I did it on software/system development life cycles (SDLC) under guidance from one of my professors. He had me take three online courses that were about 10 hours each, then I wrote a summary of what I learned. I was an MIS major, yet three semesters before graduation, I had no idea what an SDLC even was. Management Information Systems is about technology management, and I didn't even know the core management principles.

I was frustrated about that, and in my ignorance, believed it wasn't included in the curriculum (I ended up learning about it the following semester in Systems Analysis and Design). However, I ended up talking to a few professors about it, and they informed me that a lot of material is missing from curricula. It takes a ton of time and work to prepare a curriculum, especially for majors like MIS that prepare students for a wide scope of careers.

I am extremely satisfied with my education, and I wanted to give back to my school and contribute to academia. I decided that I would attempt to figure out what knowledge is missing from the curriculum so that, in the future, students could receive a higher quality education. That was a cocky statement from a 20-year-old, but that ignorance allowed me to give it an honest go. Dr. Veltri and my thesis committee were extremely supportive from the very beginning of my venture. In Spring 2020, Dr. Veltri helped me develop a plan to conquer this lofty goal.

I spent the whole summer, and fall, learning as much as I could about MIS and the curriculum. You'll see that my literature review is a large portion of my thesis; it

practically tells the history of information systems' recommendations. In retrospect, I really enjoyed reading those countless journals.

In my literature review, it was evident that recommendations were made using qualitative studies. I didn't agree with this, as the samples were often too small. Additionally, the recommendation would be based on one career, rather than the many careers for which the MIS curriculum prepares students.

The second item that was evident was how far apart the recommendations were. Curriculum was established approximately every ten years by ACM. Think about how quickly technology changes. The last curriculum recommended was from 2010, and I was learning this curriculum in 2021. (A new model curriculum was just recommended, but it takes time to implement.) In 2010, there was no Apple watch; the iPad had just come out; cryptocurrency and self-driving cars weren't popular; very few people knew about blockchain: artificial intelligence was almost a fantasy; commercial drones were few and far between; the Amazon Echo and Google cloud didn't exist; and that is just the sample of the technological changes that have occurred since 2010. Technology is the most rapidly changing field, but I'm learning from a curriculum based on what they needed a decade ago? I understand that the core foundation stays similar, but not similar enough to warrant a 10-year gap in recommendations. Further investigation showed how much time, money, effort, and resources went into developing a curriculum.

Thus, I decided that I wanted to automate a quantitative career study. This would streamline a curriculum recommendation process. I used the systems analyst career, an MIS career in the middle, as a proof of concept.

I spoke with Dr. Farkas, who served on my thesis committee, and is brilliant in most things tech-related. While I believed we should use Excel, he recommended that I use SPSS, an artificial intelligence technique called natural language processing. He wasn't familiar with how this specific tool worked and advised me to do independent research. This was the hardest part of the study, and it gave me a lot of anxiety. I was reading forums, watching YouTube videos, and anything else trying to learn the tool as best as I could. I'm not a very technical person, and I never taught myself a tool like this. I ended up getting it to kind of work, but not at the level that the research required. I wanted to try using Excel again.

I asked Dr. Farkas if he could help me make a count function utilizing Excel, because I knew that would work. He ended up spending an entire weekend making the tool. It worked exactly how I asked him to do it. However, it also showed me why he recommended using SPSS instead of Excel. Excel counted the words but wouldn't give me the context of the word. So, words like "excel" could mean to excel in something or Microsoft Excel. I hold my work to a very high standard; I couldn't publish work with

low quality like this. There were also many missing words and phrases in the dataset that I found. It worked for analyzing the systems analyst but wasn't sustainable for understanding other careers. For me to contribute to academia and be proud of my work, I needed an approach that could be used for other degrees. I did feel awful that Dr. Farkas spent all weekend making the tool, it ended up being used to verify the SPSS stream which is extremely important. It also was also used to identify missing skills from the curriculum.

If I wanted to create a publishable thesis, I needed to use SPSS. Dr. Farkas was completely right that this was the best tool for the job. I spent all of my free time over the next several weeks trying to figure out how to properly use SPSS. I ended up getting it to work and the rest was history. I then spent weeks writing up my thesis with the data.

Two weeks before my defense date, I realized that I hade made a horrible mistake. The data in SPSS was not entirely matching the accurate data from Excel within reasonable margin of error. Dr. Farkas recommended me to Dr. Kim, who teaches an SPSS course. He was able to figure out the problem right away, there were 3 options that were wrong in the stream. I then spent days into the early mornings cleaning up my mess, making sure the work was 100% accurate. This was my first large research project, it issafe to say I'll be much more careful going forward.

I learned a lot from pursuing this thesis. I would do it again, and I would recommend all students to do one. I learned research skills and how to navigate credible sources. I learned how to effectively collaborate and utilize the strengths of your network. I learned that it is possible to teach myself technical tools, as long as I stick with it and put in the work. I learned to appreciate how much goes into making a single course.

Most importantly, I believe I achieved my goal of giving back to academia. There were moments over the last few months that I didn't think it would be publishable. At the end of writing this, I can proudly say that there are takeaways from this thesis.

My next goal is to polish it up with Dr. Veltri, Dr. Farkas and Dr. Kim to get it published. I would also like to begin discussions with my school, The University of Tampa (UT), to serve as a flagship for the methodology; Specifically, the MIS program or the University's new Computer Science program. The methodology can be used to assist UT in designing curricula that is up to date and higher quality, ultimately creating more career-ready graduates. In tune, giving UT a better reputation from the workforce and offering future students up to more opportunities. Their goal is "to be recognized as the leading business school in the Southeast for preparing future world business leaders." Sorry UT, but you can't get there if you don't differentiate yourself. I believe this methodology will provide the University of Tampa with the highest quality curriculum, resulting in the most prepared graduates!

# Chapter 1 - Introduction

Many universities listen to national organizations that recommend curriculum, to decide what courses to teach to their students. Doing so provides the universities with accreditation, funding opportunities, and may increase their national rankings. These recommenders usually specialize in one topic or degree, sometimes a collection of related degrees. They work with journals, related academic societies, and other related groups to come up with a well-supported recommendation. It takes large amounts of time, money, effort and resources to recommend a curriculum.

One such organization is the Association for Computing Machinery (ACM)[3] which recommends many technology-related curriculums including computer engineering, computer science, cybersecurity, information systems, information technology, software engineering, and data science. Historically ACM has made a curriculum recommendation approximately every 10 years, with the last one being made in 2010. However, technology changes rapidly. In 2010, there was no Apple watch; the iPad had just come out; cryptocurrency and self-driving cars were not popular; very few people knew about blockchain; artificial intelligence was almost a fantasy; commercial drones were few and far between; the Amazon Echo and Google Cloud did not exist; and that is just a sample of the technological changes that have occurred since 2010.

This research will specifically be looking at ACMs information systems curriculum recommendation. ACM used the European e-competency framework (eCF) to understand what careers information systems students could pursue and then design a model curriculum that best prepares the students for their careers. The eCF framework identified over 30 vastly different careers that Information Systems graduates pursue. Thus, ACM recommended a curriculum that would prepare students for over 30 jobs. Naturally, there will be some information being taught too much, some information missing, and some information not taught enough for one specific career. Students pay a lot of money to attend college, and everything that they learn should prepare them for their anticipated career.

As you can see on page 24, increasing complexity and autonomy chart, the systems analyst career is in the middle of the 30 careers that information systems graduates pursue. Information Systems allows graduates to pursue careers utilizing a mixed combination of technology and business knowledge. This study will analyze the systems analyst career; to determine if graduates are prepared for a career in the middle.

[3] [3] About the ACM Organization. (2020). Retrieved December 16, 2020, from https://www.acm.org/about-acm/about-the-acm-organization.

Systems analysts serve as a liaison between business needs and technology utilization. This career will also serve as proof of concept for the methodology.

Every time ACM publishes a recommended curriculum, academic analyze the curriculum to determine if the new recommendation is preparing students for various careers in Information Systems. College has one job, and that's to prepare students for their anticipated careers. My research will be the first to analyze the 2020 MIS curriculum. However, that is only half of what this research sets out to accomplish. This only serves as proof of concept that the methodology works, and can be utilized for other careers.

The other half of this research is to create a methodology that can be used to automate the recommendation process and ensure a more up to date curriculum. This will be done by utilizing an artificial intelligence technique called natural language processing, through SPSS-text mining. SPSS-text mining finds common trends in text documents, including words or phrases. Systems analyst job advertisements are captured from Indeed.com, and then placed into SPSS to find common skills and knowledge needed for the job. If the information is accurate, the only variable that will need to be changed is what job ads are pulled from Indeed.com and placed into SPSS.

The two main questions are:

- How well does the curriculum recommended by the Association for Computing Machinery prepare MIS graduates with sufficient skills to be systems analysts? The assessment will be based on the level of coverage of specific topics requested in job ads - what areas are overfocused, under focused, and not focused on at all?

- How well can curriculum recommendations be automated utilizing artificial intelligence, to ensure up-to-date education?

Chapter two will cover the literature review. The literature review is extensive and tells the history of ACM information system curriculum recommendations. It looks at every curriculum, and analysis from those in academia. It also finds common trends in the curriculum, and what material has been taught for a long time. Another thing it shows is the methods of how curriculums were designed, and the inefficiencies with the methodology. Additionally, it looks to prove that there has always been a gap between what graduates learn, and what knowledge is actually. Finally, it looks to understand the 2020 ACM recommendation and the methodology used to create it; along with how the methodology is similar to past curriculums that led to a skills gap.

Chapter three covers the methodology that will be used to analyze the MIS curriculum; along with how the methodology can be used for other curriculums. It will

talk about the two workbooks, and how SPSS-text mining was used. It shows exactly what I did to analyze the 2020 ACM information systems curriculum.

Chapter four will cover the findings of the study. This chapter analyzes every course in the 2020 ACM information systems recommended curriculum. Additionally, skills not taught in the curriculum were discussed and if they may fit in a particular course. Every course will also conclude with whether its necessary or not for the systems analyst career, and how much of the course is necessary. Skills that were being taught in multiple courses were also identified. Additionally, some fun statistics like what type of degree, experience, education, and other things were pointed out. The chapter concludes with a brief summary of what knowledge is missing, what knowledge is taught too much, and what knowledge is not taught enough.

Chapter five will cover the conclusion of the study. It speaks to why in my opinion the recommended curriculum is not properly preparing information systems graduates for a systems analyst career. It also talks about my solution to the problem, which is including various concentrations in the curriculum. Additionally, it talks about how the methodology can be used for other curricula, possible employer use, problem(s) with the methodology, and an ideal solution to the problem(s) with the methodology.

# Chapter 2 - Review of Related Literature

I reviewed all recommended MIS curricula from 1973-2020 and journal articles relating to those curricula. I also reviewed journal articles that explored the skills required to be a systems analyst. Lastly, I reviewed the country's top MIS programs' curricula and compared them to unranked MIS programs. I used Google Scholars to conduct a search for relevant peered reviewed journal articles and used the University of Tampa online library to read them. When reviewing these articles, I attempted to understand the technical climate and how it correlated with the skills necessary for a systems analyst. I find that the skills required for systems analysts have evolved drastically over the last 50 years, but skills being taught based on the recommended curriculum have not.

Management Information Systems (MIS) is defined as, "A computer system that provides an organization's employees, especially its managers, with helpful information for their work (Cambridge Dictionary[4], 2020). The MIS concept is said to go back to 1801 when punch cards were introduced (bizfluent.com, 2020[5]). Any time a business used technology to improve their work processes' efficiency, an MIS concept was being used.

The forefather and "birthplace of MIS" (carlsonschool.umn.edu[6], 2020) was the University of Minnesota (U.M.) when they founded the Management Information Systems Research Center (MISRC) in 1968. U.M. professors Gordon Davis, Gary Dickson, and Tom Hoffmann worked with 21 international companies known for investing in IS research from the Minnesota area. Since then, MISRC has been the world's number one contributor to the MIS field. They are ranked first for publications in top information systems journals as per the AIS Research Rankings 2017-2019. As I was doing research, they consistently appeared as the most frequently cited articles over the last 20 years. Gordon Davis of MISRC contributed in a significant way to the first ACM recommended curriculum.

[4] MANAGEMENT INFORMATION SYSTEM: Definition in the Cambridge English Dictionary. (n.d.). Retrieved December 16, 2020, from https://dictionary.cambridge.org/us/dictionary/english/management-information-system?q=management+information+systems.

[5] Weedmark, D. (2019, March 31). The History of Management Information Systems. Retrieved December 16, 2020, from https://bizfluent.com/about-5444925-history-management-information-systems.html.

[6] MIS Research Center. (2020). Retrieved December 16, 2020, from https://carlsonschool.umn.edu/faculty-research/mis-research-center.

The first ACM curriculum was recommended in 1973[7]. This curriculum focused more on technical skills than business skills. The only core course that dealt with interpersonal and soft skills was Human and Organizational behavior. There were ten other core courses: Operations Analysis and Modeling, Information Structures, Programming Structures and Techniques, System Concept and Implications, Computer Systems, Computerware, Information Systems Analysis, File and Communication Systems, Systems and Implementation, and Software Design. The required electives included humanities, social sciences, math, and business, which still hold today for business schools. This was the first curriculum I read, and it is very interesting because several of the core courses are still being taught today. Systems Analysis and Design is the updated version of Information Systems Analysis. Application Development is the updated version of Software Design; Data and Information Management is the updated version of File and Communication Systems. It is also important to note that they had a whole course on computer hardware which is no longer included in the ACMs model curriculum today. My findings later will show that hardware is undertaught. There were also many more recommended courses back then. ACM only recommends seven courses with two electives for the 2010 version.

COBOL was taught through Software Design and Information Structures. A more recent report that surveyed CIS alumni to assess curriculum found that COBOL was still being used today and was one of their most critical learned skills (Mahaney[8], 2019). An IT Specialist and alumnus said, "Believe it or not, COBOL. I am still using COBOL over 30+ years after graduation…COBOL is still the number one language used in many applications."

The first MIS degree was created in 1974 by the University of Arizona, in partnership with ACM, a year after the first recommended curriculum (eller.arizona.edu, 2020[9]). After that, MIS degrees started popping up around the country's colleges like wildfire.

Personal computers were coming out, but they were costly. When the first personal computer came out is disputed, but it's some time between 1971-1973. Only large businesses could afford to implement them in their work processes, and there were few systems analyst jobs. However, it was clear that the potential benefits of technology

[7] Couger, J. D. (1973). Curriculum recommendations for undergraduate programs in information systems. *Communications of the ACM, 16*(12), 727-749. doi:10.1145/362552.362554

[8] Mahaney, R. C., & Fisher, J. H. (2019). A Survey of CIS Alumni to Assess Curriculum: Findings, Implications, and Future Directions. *Journal of Information Technology Education: Research, 18*, 571-587. doi:10.28945/4464

[9] MIS Department History. (2019, April 12). Retrieved December 16, 2020, from https://eller.arizona.edu/departments-research/schools-departments/mis/history.

were extraordinary. The idea of a tedious task being automated for all industries sounded like a fantasy. It is similar to the belief today that Elon Musk will never inhabit Mars.

A year after the recommended curriculum was published, Robert M. Henry reviewed it to see how the skills possessed matched up with the skills most useful for MIS graduates through the Management Information Systems Research Center at the University of Minnesota (Henry, 1974[10]). The study's goal was to project the demand for MIS graduates, specify the skills required, and develop an improved curriculum.

They surveyed 981 employees at 17 organizations in the Minnesota area. The respondents were asked to rank 111 skills on a 1-4 scale based on skills possessed and the value of each. These skills were then put into seven different skill clusters and ranked. The five top skill clusters from most important to least were performance, people, systems, organization, and computer. The first four skill clusters were soft skills and business skills, and the last skills cluster was technical. This conflicted with the ACM's proposed curriculum for 1973. The most critical skills for a systems analyst in 1974 were soft skills, but 10 of the 11 courses were technical. Despite the gap between skills being taught and those necessary, this report did at least validate the need and anticipated growth for a systems analyst.

A journal article was put out by Paul Cheney and Norman Lyons from the MISRC surveyed to find the most critical information systems skill requirements in 1980 (Cheney and Lyons, [11]1980). It was published when personal computers were cheap enough for businesses around the country to use for work. They were becoming so inexpensive that many individuals could afford them. Cheney and Lyons wrote, "The new machines and languages that are coming into existence will allow the user to be his own systems analyst and programmer." Today, applications like Excel, Tableau, and thousands of others allow all users, despite their knowledge level, to automate and make work processes more efficient. These forefathers did not foresee how powerful technology would become and how complex its problems could be. Systems analysts are well paid to fix these problems today. Cheney and Lyon's research objectives were to find out about information skills inventory and personal projections, hardware configurations and characteristics, software characteristics, and information systems' department characteristics. The methodology was through personal interviews and questionnaires. They only received 45 replies, but they – and their peers – believed the response was adequate. The survey had 26 questions. They hypothesized that there would be less of a need for systems analysts, but their research revealed that there would be a 50% increase

[10] Henry, R. M. (1974). Skills possessed and skills useful for MIS practitioners. *Proceedings of the May 6-10, 1974, National Computer Conference and Exposition on - AFIPS '74*. doi:10.1145/1500175.1500341

[11] Cheney, P. H., & Lyons, N. R. (1980). Information Systems Skill Requirements: A Survey. *MIS Quarterly, 4*(1), 35. doi:10.2307/248866

in the need for systems analysts. The top five skill areas ranked in order from most important to least were introductory computer and information, system design topics and information gathering techniques, file design, human relations in systems development, and application programming languages. This survey found that systems analysts should have more technical skills than soft or business skills than in the 1974 study (Henry, 1974). However, they still recognized that business skills like systems design topics and information gathering were necessary as were soft skills like human relations. Particularly noteworthy was how drastically the most critical skills changed in only six years.

Taking journal articles like these and others into account, ACM recommended an updated curriculum, ten years later, in 1983 (Nunamaker[12], 1983). Eight of the eleven courses were kept, and five new ones were introduced. There were 13 recommended core courses, two more than 1973s recommended curriculum. The classes that stayed in the curriculum from 1973 were human and organizational behavior, software design, file and communication systems, systems design, information analysis, information structures, computer systems, and operational analysis and modeling. The courses that were dropped were computerware, systems concepts and implications, and programming structures and techniques. The added courses were an introduction to systems concepts, organizational functions, informational systems for operations and management, social implications of information systems, and systems development projects.

This is one of the few times we see a hardware course in the MIS curriculum as ACM recommends is used more frequently in business schools, than engineering schools. Although programming structures and techniques were dropped, programming languages are still being taught through software design and computer systems. Systems concepts and implications got dropped, but the concepts are still being taught in the introduction to systems concepts. So, all core concepts were still being taught in the 1983 curriculum in addition to new courses. ACM recognized the need for systems analysts to have strong interpersonal skills and business knowledge. They added organizational functions, social implications of information analysis, and information systems for operations and management. This shows that they were reading the journals and listening to fact-proven research when recommending their curriculum.

In 1986, T.D. Crossman, a professor at the University of Witwatersrand in South Africa, published a report that predicted the skills required by systems analysts of the

[12] Nunamaker, J. F., Couger, J. D., & Davis, G. B. (1982). Information systems curriculum recommendations for the 80s. *Communications of the ACM, 25*(11), 781-805. doi:10.1145/358690.358698

future (Crossman[13], 1986). There was not a single MIS degree in the world in 1973; just 13 years later, there was a South African department for Management Informaiton systems. The systems analyst was becoming an essential job around the globe.

The introduction to this report by Crossman starts by stating, "the role of the systems analyst may be likely to undergo significant changes." This is a trend that journals have recognized since 1970. The systems analyst job is continually changing, and if you want IS graduates to be prepared, the curriculum must be continuously updated. However, it is difficult for a national governing body to update the curriculum regularly. It takes a ton of work, and there are hundreds of different factors. Perhaps ACM recommended such a broad curriculum, so colleges teach the core foundation and rely on the graduate's job to teach them specific skills. This is something that I predict still holds to this day. The IS degree allows graduates to pursue an enormous scope of careers, and it is nearly impossible to teach specific skills for all these careers. I will be diving into this in Chapter 5.

Two surveys were sent out by Crossman. Survey one was open-ended, and survey two used a 1-5 scale—survey one received responses from 16 practitioners and 6 in academia. Survey two received 23 practitioners and 9 in academia. Survey one asked three open-ended questions: "What methods/development tools will be used; what job responsibilities will be given to the systems analyst; and what skills will be required from the systems analyst?" Survey one identified 61 different skills and was used to make the questionnaire for survey two. Survey two had 32 respondents rate each skill's predicted importance in 5-8 years on a 1-5 scale. The top five collective skill clusters predicted in order from most important to least were social/communication, development tools/methods, analysis, management/project management, and finance. Another important note is that there were significant differences in the perceived importance of skills between academia and working practitioners.

Communication and soft interpersonal skills have consistently been among the more critical skill clusters, but do not have specific courses. Today, these skills are taught through various group projects over four years. It is not easy to see how they were being taught back in the ‘70s and '80s.  It was also interesting to see that finance was rated so highly. My hypothesis for this was due to new management techniques and the transition from waterfall approaches to agile. Working with the user was becoming increasingly important; it was recognized that this was the way to deliver the highest quality product. The age-old concept to give the customer what they want was being ignored until then for IS concepts. The predictions ended up being correct, with the first scrum project being

[13] Crossman, T. D. (1986). Predictions of the skills required by the systems analyst of the future. *ACM SIGCPR Computer Personnel, 10*(4), 12-15. doi:10.1145/15467.15469

used in 1993 (Lynch[14], 2019). Agile methodologies became increasingly popular after that.

More importantly, this report did a great job of showing the disconnect between practitioners and those in academia. Crossman said there was "unexpected inconstancy of opinion," coming from academia and not a practitioner. Practitioners believed that more traditional skills would still be necessary for the future. I hypothesize that this is common. When those in technology development work with something every day, they may not want to transition to something new. It is a common problem; it is hard-to-get people to change the way they work, and it is easy for practitioners to not see the changing future because of this bias. Overall, the report found that academia focused on systems analysis breeding innovation, identifying competitive advantages, and taking risks to make the business process more efficient. In contrast, practitioners believed that systems analysts were there to control and lead small teams. Academics saw systems analysts evolving into a more technical role.

The journal article titled Requisite Skills for New MIS Hired (Watson[15], 1990) does a great job analyzing DPMA and ACM curriculum. They say, "Both the ACM and DPMA curriculums identify specific courses and their contents:

> "These courses are the means of providing the necessary skills for those going into the field. While each of these curriculums is useful, most schools do not follow either completely. Schools want to respond to the unique needs of the market they serve." Even in 1990, schools were not following the curriculum of both prominent national bodies because it did not best prepare their graduates for their intended market."

They also go on to say, "As IS technology changes, so do the requisite skills for IS personnel. Most IS personnel first acquire the skills necessary to perform their job(s) in colleges and universities". This is not something that ACM follows today. ACM focuses on teaching a broad, more generalized, and less in-depth curriculum that prepares graduates with a core foundation and then relies on their careers to teach specific skills.

Another quote that stuck out to me was, "The core curriculum for CIS programs must remain flexible, in light of the changing environment it serves. Academics must

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[14] Lynch, W. (2019, January 09). The Brief of History of Scrum. Retrieved December 18, 2020, from https://warren2lynch.medium.com/the-brief-of-history-of-scrum-15efb73b4701.

[15] Watson, H. J., Young, D., Miranda, S., Robichaux, B., & Seerley, R. (1990). Requisite skills for new MIS hires. *ACM SIGMIS Database: The DATABASE for Advances in Information Systems, 21*(1), 20-29. doi:10.1145/95367.95374

keep abreast of changing needs and respond quickly in an appropriate manner." I agree with this statement, and the best schools do as well. It is not up to ACM and other national curriculum bodies, it is the responsibility of the schools to remain flexible. Top schools[16] like Carnegie Mellon[17] offer concentrations and many electives for students to choose from to prepare them for their field. Many schools cannot afford to offer many classes for their MIS curriculum, so they must rely on ACMs generalized curriculum to build a foundation. Therefore, ACM should offer the best curriculum possible based on employers preferred knowledge for graduates, something I will explore later in the thesis.

Watson sent out a survey to 20 MIS industry leaders with diverse expertise and ranked skills based on 20 knowledge categories. The skills ranked in importance from most to least are systems analysis and design, business communication and interpersonal skills, business knowledge and skills, applications programming languages, and database concepts and structures. Non-technical skills involving business, interpersonal, and management skills have been more critical to systems analysts than technical skills. This report is vital because it is the first to focus on industry leaders. It shows that the people at the top see the systems analyst role as someone who should be a tech-savvy businessperson. They want systems analysts to develop user requests into a working product.

The following curriculum was proposed by DPMA in 1990 and published in 1991. ACM did not recommend another curriculum until 1997 that was in a joint effort with other national bodies. However, "material from the unpublished work of the ACM-IS curriculum committee that met in the late 1980s was incorporated into the model" (Gorgone[18], 2002). I was not able to find the 1990 DPMA curriculum, but the 2002 ACM curriculum summarized it. The classes were not offered in the summarization, but they clarified that this report was instrumental in developing future curriculum. It led to significant dialogue and many journal articles in IS academia. It eventually led to creating a joint task force between ACM, AIS, and AITP (DPMA updated its name to AITP) to create the curriculum in 1997.

One such report that came after the DPMA proposed curriculum called Critical Skills and Knowledge Requirements of IS Professionals: A joint Academic/Industry Investigation reviewed the divide in preferred skills for graduates between the two parties

[16] The Best Colleges for Management Information Systems. (2020). Retrieved December 16, 2020, from https://www.usnews.com/best-colleges/rankings/business-management-information-systems.

[17] Undergraduate Catalog. (2020). Retrieved December 16, 2020, from http://coursecatalog.web.cmu.edu/schools-colleges/dietrichcollegeofhumanitiesandsocialsciences/informationsystems/.

[18] Gorgone, J. T., Davis, G. B., Valacich, J. S., Topi, H., Feinstein, D. L., & Longenecker, H. E., Jr. (2002). Model Curriculum and Guidelines for Undergraduate Degree Programs in Informaiton Systems.

(Lee[19], 1995). All businesses will have different responsibilities and ideals for their systems analysts. They may serve the same core responsibility but require different skills because of differences in organizational philosophy. This naturally leads to differences in what skills industry leaders want for entry-level IS professionals. Simultaneously, many in academia can easily get left behind in what skills are being used today if they are not working with them. Some outdated skills like COBOL end up not being taught anymore, even though reports at this time found it was still a much-needed skill. Furthermore, I am sure we will identify many required skills through the data gathering that are not even being glossed over in the 2020 ACM curriculum. The reality is that academia's one job is to provide prepared graduates that can make an impact and improve businesses, so they should be catering to business as much as they can.

The article by Lee starts by saying, "low-level IS jobs are disappearing" and failed to explain why. Looking back 25 years later, low-level jobs were being automated through beneficial applications. Nevertheless, they were not being lost, but were transforming into more technical jobs. A multivariate analysis that they conducted predicted the need for programmers, operators, and data entry clerks would decline. The analysis also indicated end-user support and business/systems analyst would increase.

Lee, Trauth, and Farwell surveyed a diverse group of 98 IS professionals, and the professionals ranked the importance of specific jobs and skills. These skills were then placed into four broad categories. The skills ranked for IS managers from most important to least important are interpersonal and management skills, business functional knowledge, knowledge of technology management, and technical specialties knowledge. Again, technical skills are perceived to be less crucial to business than management and interpersonal skills.

The study also said, "the challenge for educators and educational institutions is to parallel this diversity of career paths into curriculum design" and "the current IS curricula in many universities are not well aligned with business needs." The article acknowledges a broad scope of career paths for IS graduates, and it is not easy to create a curriculum that best prepares for all paths. Accounting degrees face a similar problem.

Accounting can offer just as broad of a career scope as any major. Accounting is known to be the language of business and allows graduates to pursue a wide variety of careers. They can pursue various types of accounting, including tax, audit, and assurance. They can also pursue external careers involving risk, finance, economics, and others across all industries. Accounting handles the internal careers by offering a broad

[19] Lee, D. M., Trauth, E. M., & Farwell, D. (1995). Critical Skills and Knowledge Requirements of IS Professionals: A Joint Academic/Industry Investigation. *MIS Quarterly, 19*(3), 313. doi:10.2307/249598

curriculum, just like information systems, and then relying on their jobs to go more in-depth in specific skills.

The accounting governing body audits the preparedness of graduates by offering the CPA exam. The CPA requirements are different for every state. However, most states require 150 credit hours, including various accounting courses at an accredited university, a year of experience under a CPA, and passing four different exams in 18 months. These exams cover a lot of material, and the pass rate is only about 50%. One idea to audit MIS graduates is by offering a similar certification covering a broad scope of IS skills. The CPA is not a mandate to get, but it opens doors and provides opportunity. The MIS cert should not be mandated but required for those in charge of IS decisions.

Lee, Trauth, and Farwell says it best, "Given the many resources and academic accreditation constraints, universities must be more innovative in designing their IS programs in order to add breadth, depth, and relevance to their curriculum." However, this statement is contradictory to what ACM recommends. Schools are required to follow ACM to be ABET certified. ACM naturally leaves little room for innovation. Our country's top MIS program, Carnegie Mellon University, is not even ABET-accredited. Neither are other top MIS programs like University of Illinois at Urbana- Champaign. It says something if the top-ranked MIS programs in our country are not ABET-accredited because of following the ACM curriculum loosely.

From 1992-1997, our countries top MIS curriculum recommenders had a joint task force to propose the best curriculum and build upon it going forward. This task force was made up of ACM, AIS, and AITP. They proposed a curriculum based on all research and analysis to provide students with a general foundation to pursue any IS field (Davis[20], 1997). This curriculum included knowledge work software tool kit, fundamentals of IS, personal productivity with IS technology, information systems theory and practice, information technology hardware and software, programming data file and object structures, networks and telecommunications, analysis, and logical design of IS, physical design and implementation with DBMS, physical design and implementation with a programming environment, and project management and practice. These 11 courses were a dramatic change from previous curricula, and they did not match up with findings from the research in academia. This was the most technical-oriented curriculum yet.

All of the courses were new. Out of the 11 courses, all were technical-oriented. There were a few updated courses from the 1983 curriculum. The 1990 DPMA

[20] Davis, G. B., Gorgone, J. T., Couger, J. D., Feinstein, D. L., & Longenecker, H. E. (1997). Is '97. *Guidelines for Undergraduate Degree Programs on Model Curriculum and Guidelines for Undergraduate Degree Programs in Information Systems - IS '97*. doi:10.1145/512249.512222

curriculum was not found, so I am relying on the 1983 curriculum for comparison. Physical Design and Implementation with DBMS was an updated database course from File and Communications Systems. The capstone in Project Management and Practice was an update from Systems Development Projects. Fundamentals of IS was an updated version of the introduction to systems concepts. Information Technology Hardware and Software was an updated version of Computer Systems. Physical Design and Implementation with a programming environment was an updated version of system design. Programming, data, and object structures was an updated version of software design. Analysis and Logical Design of an IS is an updated version of Operating Analysis and Modeling. The four completely new courses were knowledge work software tool kit, personal productivity with IS Technology, information systems theory and practice, and networks and telecommunications.

Shortly after, in 2002, ACM made a minor adjustment to the 1997 curriculum (Gorgone,[21] 2002). There were 11 courses in total. The eight courses that stayed the same from 1997 were personal productivity with IS technology, Fundamentals of IS, Information Systems Theory and Practice, Information Technology Hardware and Software, Network and Telecommunications, Analysis and logical Design, Physical Design and Implementation with DBMS, and Project Management and Practice which was the capstone. Programming, Data, File, and Object Structures was a minor update from Programing, Data, and Object Structures. Physical Design and Implementation in Emerging Environments was an update of Physical Design and Implementation with a Programming Environment. Electronic Business Strategy, Architecture, and Design was a new course.

In 2004, an article published by Mark M. Misic and David K. Graf called Systems Analyst Activities and skills in the new millennium was published (Misic[22], 2004). This was published when the internet was in full swing, and a majority of homes had personal computers. They start by saying, "The environment in which systems analyst perform their jobs is characterized by constant change," which is something academia has appeared to agree upon throughout my literature review. They also had a good definition of systems analyst, "a problem-solving specialist who works with users and management to gather and analyze information on current and future computer-based programs." In other words, they serve as a liaison between users and developers to create a product that automates or makes work processes more efficient. They also define a systems analyst as someone who "identifies and evaluates alternative solutions, makes formal presentations,

[21] Gorgone, J. T., Davis, G. B., Valacich, J. S., Topi, H., Feinstein, D. L., & Longenecker, H. E., Jr. (2002). Model Curriculum and Guidelines for Undergraduate Degree Programs in Informaiton Systems.

[22] Misic, M. M., & Graf, D. K. (2004). Systems analyst activities and skills in the new millennium. *Journal of Systems and Software, 71*(1-2), 31-36. doi:10.1016/s0164-1212(02)00124-3

and assists in directing the coding, testing, training, conversion, and maintenance of the proposed system." Most of those qualities just listed are non-technical and focus more on their business and leadership skills.

The report by Miric and Graf sent out a survey to analyze the skills necessary for a systems analyst. The survey was sent to 819 organizations that appeared on the report in the Directory of Top Computer Executives of 2001; they received 158 responses. The survey listed 35 tasks, and the respondent had to rank the importance of each task on a 1-5 scale. The respondent had to rank the four skill categories for each task and how necessary they are for each task. The five most important tasks for a systems analyst in order from most important to least were defining scope and objects of systems/projects, defining new system requirements, reviewing MIS plans and scope, determining the impact of new system requirements, and evaluating new systems against user requirements. These five tasks were all technical but could be done without a degree in the information systems field. They rely more on business, precisely management, skills. However, having more technical knowledge would make sense. With just general business knowledge, you will not properlu comprehend the limitations and scope of technology.

The four skill categories ranked in order of most essential to least were analytical skills, technical skills, communication skills, and interpersonal skills. Even though the most crucial task was not overly technical, the respondents indicated that having technical knowledge would make for a more successful analysis. The communication and interpersonal skills were ranked lower on importance despite the top task being oriented around these two skill groups. Furthermore, I think technical skills and communication skills are like yin and yang. You can have the technical skills to create a fantastic product, but it will not happen unless you have the communication skills to pitch the product. To get backing and funding, you need to properly communicate what the product will do and why it will benefit the user.

Choong Kwon Lee published an article called Analysis of Skill Requirements for Systems Analysts in Fortune 500 Organizations in 2005 (Lee[23], 2005). Out of all the journals I read, this one had the best data collection to analyze what skills are necessary for a systems analyst. They gathered data directly from 902 job ads on 230 Fortune 500 websites over three years from 2001-2003. The job ad titles were systems analyst, business systems analyst, and information systems analyst, which are similar jobs prepared for by the MIS degree. I will be basing my methodology on this, but instead, I'll be scraping data from Indeed.com, which we will discuss in Chapter 3. A flaw in this

[23] Lee, C. K. (2005). Analysis of Skill Requirements for Systems Analysts in Fortune 500 Organizations. *The Journal of Computer Information Systems, 45*(4), summer 2005, 84-92.

research is that it only looked at Fortune 500 companies, not small companies or governmental systems analysts. MIS degrees are designed to prepare graduates to pursue careers in all industries, so this should have been included in the research. It's possible they only included Fortune 500 companies because they believed the most successful organizations' skills may trickle down and determine systems analysts' responsibilities.

There was a diverse scope of industries, but the dominant ones were manufacturing (251 job ads) and telecom/finance/real estate/technical services (377 job ads). The jobs were also in many states. Owing to the vast scope of skills that various companies wanted, Lee grouped each skill into 1 of 8 clusters. 691 job ads required a bachelor's degree, 53 a masters, 16 an MBA, four a Ph.D., six an associate, and 16 only a high school diploma. Most entry-level systems analyst jobs required that the applicant learn the skills necessary from their bachelor's degree.

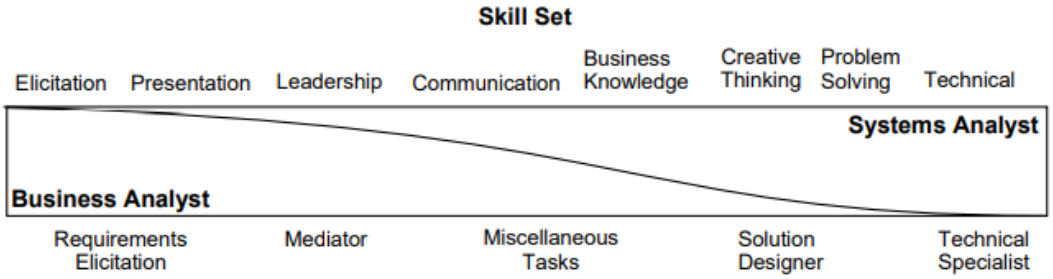
The skill clusters ranked in order from most listed to least were development, software, business, social, problem-solving, management, architecture/network, and hardware. The curriculum recommended in 2002 by ACM taught courses in hardware and architecture/network even though they were the bottom two in terms of necessity. The last curriculum did not have any specific business and social courses even though they ranked third and fourth. This study goes to show that the recommended ACM curriculum at the time was not preparing graduates sufficiently for Fortune 500 companies. Another important note from this journal was that 47.2% of job ads wanted graduates to have programming skills. At the time, programming was being taught through multiple courses. However, today's recommended curriculum only teaches an elementary level of one programming language.

The MIS degree prepares graduates to pursue various careers, and two big ones are a business analyst and a systems analyst. Sometimes these two go by different names like information analysis, but they are all variations of the same core job. Bruce Campbell published an informative study on it that shows how the roles differ (Campbell[24], 2008). It was published in Australia and gave insight into international companies. It also reinforces the idea that "the number of positions for systems analyst and business analyst is predicted to increase in the future as low-level information technology development roles continue to be outsourced overseas." As low-level jobs get outsourced, systems analysts become increasingly important. There could be cultural barriers, along with language barriers. Systems and business analysts are responsible for communicating user

[24] Campbell, B. (2008). The Roles and Skill Sets of Systems vs Business Analyst. *Australian Conference of Information Systems*.

needs to developers to create a working product. These skills will become increasingly crucial as IS continues to be outsourced.

They used an interview approach with semi-structured hour-long interviews with two systems analysts, two business analysts, and four managers. The sample size is small, but the report had an in-depth literature review, and there are excellent takeaways. The main difference between the two roles is minimal. The difference lies in the emphasis placed on specific responsibilities. Below is the visual they created that represents the differences. Mainly, systems analyst is more technical and analytical. In comparison, business analyst focuses more on interpersonal leadership, and general management skills. Both parties still need to know all the skills below, just to different extents.




The next IS curriculum was recommended in 2010 and has been used until today by ACM and AIS (Topi[25], 2010). There were seven recommended core courses and seven recommended electives. Students only had to take two electives. The seven core courses are Foundations of Information systems, Data and Information Management, Enterprise Architecture, IS Project Management, IT Infrastructure, Systems Analysis and Design, and IS Strategy Management and Acquisition. The seven recommended electives are Application Development, Business Process Management, Enterprise Systems, Introduction to Human-Computer Interaction, IT Audit and Controls, IS Innovation and New Technologies, and IT Security and Risk Management.

Foundations of Information Systems was an updated version of Fundamentals of Information Systems. Data and Information Management was an updated version of Physical Design and Implementation with DBMS. IS Project Management was an updated version of Project Management and Practice, which was the capstone. IT Infrastructure was an updated version of IT Hardware and Software. Systems Analysis and Design is an updated version of Analysis and Logical Design. IS Strategy, Management, and Design is an updated version of Electronic Business Strategy,

[25] Topi, H., Valacich, J. S., Wright, R. T., Nunamaker, J. F., Jr., Sipior, J. C., & De Vredde, G. J. (2010). Curriculum Guidelines for Undergraduate Degree Programs in Information Systems. *IS 2010*.

Architecture, and Design. The new core course was Enterprise Architecture, so seven of the eight core courses were just updated.

Research in 2011 looked to assess MIS graduates' critical skills and revise the curriculum (Stevens[26], 2011). They surveyed two groups, MIS faculty and IT professionals. There were 111 responses from IT professionals and 37 from MIS faculty. They ranked 42 skill areas and knowledge. The top 5 most essential skills for MIS graduates from most important to least were problem-solving, critical thinking, communication, creative thinking, and teaming. All of these skills are non-technical soft skills.

My favorite research was published by the Journal of Computer Information Systems and authored by Kiku Jones, Lori N. K. Leonard, and Guido Lang. It was a 3-part study that looked to analyze if AACSB schools were preparing MIS graduated sufficiently.

The first part of the study looked to identify the skills necessary for entry-level IS positions (Jones[27], 2015). They had ten telephone interviews with various IS professionals that lasted 30-60 minutes based on an interview guide of 5 general questions. They focused on asking questions that did not ask about skills directly. The most important soft skills they found were breaking a complex problem into smaller steps, thinking things through, working in teams, facilitating workshops meetings and conference calls, conducting interviews, influencing people who do not report to them, and communicating with different audiences. The most important hard skills were project management, systems development methodologies, development estimation techniques, database design, enterprise architecture, extract data from databases using SQL, use of all Microsoft Office products with an emphasis on Visio and Project.

I do not think this part of the methodology is an accurate representation of entry-level systems analyst skills. The sample size is too small. The sample was from their alumni network and connections they already knew. The five questions were too generalized.

The second part of the study was a questionnaire based on the phone calls in part 1 (Jones[28], 2016). The questionnaire consisted of 26 different interpersonal skills, 16

[26] Stevens, D., Totaro, M., & Zhu, Z. (2011). Assessing IT Critical Skills and Revising the MIS Curriculum. *The Journal of Computer Information Systems, 51*(3), spring 2011, 85-95.

[27] Jones, K., Leonard, L. N., & Lang, G. (2015). In the Know: Desired Skills for Entry-Level Systems Analyst Positions. *Journal of Computer Information Systems, 16*(1), 142-148.

[28] Jones, K., Leonard, L. N., & Lang, G. (2016). Desired Skills for Entry Level IS Positions: Identification and Assessment. *Journal of Computer Information Systems, 58*(3), 214-220. doi:10.1080/08874417.2016.1229144

different knowledge areas, and eight technical skills were ranked by 73 respondents. The top 5 knowledge areas in order from most important to least were security, programming, systems development methodologies, database design, and project management. The five most critical interpersonal skills were learning, critical thinking, attitude, honesty, integrity, ethics, and analytical skills. The five most important technical skills were Microsoft Office, Database/Data warehouse, Programming, enterprise system software, and web development software. Again, I do not think their data collection method was appropriately done, which may have resulted in the sample being inaccurate.

The best part of their study was the third part published in 2019 (Jones[29], 2019). They compared the curriculum from all AACSB accredited schools to the skills identified, and analyzed if the skills being taught to MIS students were sufficient. They collected the curriculum for 517 AACSB accredited schools through their website. I would have loved to have access to this dataset, but they were unable to share. This would have helped my comparison in Chapter 4.

They state, "In reviewing the results of the study, it is clear that there are gaps between what industry professionals rank as important entry-level skills and where the current IS curriculum stands." This was said just last year to academic leaders, a conclusion based on a three-year study. I agree and hypothesize that this conclusion is correct but disagree with their data collection methodology.

They found that security was one of the most critical skills through their methodology, but only 14% of schools offer it in their curriculum. The research I completed, discussed in Chapter 3, disagrees with this. They also found that project management was a top skill, but only 45% of schools offered it. Microsoft Office was the #1 technical skill, but only 8% of schools offered the course.

Network/Telecommunications ranked #11 and was being taught in 62% of schools. Web development was a top-ranked skill, but only 2% of schools offered it. Enterprise Architecture was a top skill, but only 19.5% of schools offered it. Although I cannot entirely agree with the skillsets, they believe are most important; the AACSB-accredited schools' data collection is outstanding.

After ten years, a new curriculum is finally being recommended by a collaboration from ACM and AIS (ACM/AIS[30], 2020). The recommended core courses can be seen below on page 23.

[29] Leonard, L., Jones, K., & Lang, G. (2019). Information System Curriculum versus Employer Needs: A Gap Analysis. *Information Systems Education Journal, 17*(5), 32-38.

[30] IS2020 Competency Model for Undergraduate Degree Programs in Information Systems. (August 2020).

The courses that stayed the same from the 2010 curriculum were systems analysis and design, IT Infrastructure, data/information management, and IS Project Management. Four of the seven core courses stayed the same from 2010. The new courses were secure computing, practicum, ethics use and implications for society, and IS management and strategy. Application development was recommended as an elective in 2010 but not recommended as a core course. All five recommended electives are new. The new courses were all skills the Jones report believed were not being taught adequately.

Below is a chart of the ACM/DPMA recommendations:

| ACM/DPMA Recommended Curriculum for Information System Degrees | Courses | Electives |
|---|---|---|
| 1973 ACM | 1. Human and Organizational Behavior<br>2. Operations Analysis and modeling<br>3. Information Structures<br>4. Programming Structures and techniques<br>5. Systems Concepts and Implications<br>6. Computer Systems<br>7. Computerware<br>8. Information Systems Analysis<br>9. File and Communication Systems<br>10. System and Design implementation<br>11. Software Design | |
| 1983 ACM | 1. Introduction to Systems Concepts<br>2. Organizational Functions<br>3. Information Systems for Operations and Management<br>4. Social Implications of Information Systems<br>5. Operations Analysis and Modeling<br>6. Human and Organizational Behavior<br>7. Information Structures<br>8. Computer Systems<br>9. File and Communications Systems<br>10. Software Design<br>11. Information Analysis<br>12. System Design<br>13. Systems Development Projects | |

| | | |
|---|---|---|
| 1990 DPMA | Not found (believed to be from a conference) | |
| 1997 ACM, AIS, AITP | 1. Knowledge Work Software Tool Kit-Prerequisite<br>2. Fundamentals of IS<br>3. Personal Productivity with IS Technology<br>4. Information Systems Theory and Practice<br>5. Information Technology Hardware and Software<br>6. Programming, Data, and Object Structures<br>7. Networks and telecommunications<br>8. Analysis and Logical Design of an IS<br>9. Physical Design and Implementations with DBMS<br>10. Physical Design and Implementation with a programming Environment<br>11. Project Management and Practice- Capstone | |
| 2002 ACM | 1. Personal Productivity with IS Technology<br>2. Fundamentals of Information Systems<br>3. Electronic Business Strategy, Architecture, and Design<br>4. Information Systems Theory and Practice<br>5. Information Technology Hardware and Software<br>6. Programming, Data, File, and Object Structures<br>7. Networks and Telecommunications<br>8. Analysis and Logical Design<br>9. Physical Design and Implementation with DBMS | |

| | | |
|---|---|---|
| | 10. Physical Design and Implementation in Emerging Environments<br>11. Project Management and Practice- Capstone | |
| 2010 ACM | 1. Foundations of Information Systems<br>2. Data and Information Management<br>3. Enterprise Architecture<br>4. IS Project Management<br>5. IT Infrastructure<br>6. Systems Analysis and Design<br>7. IS Strategy, Management, and Acquisition | 1. Application Development<br>2. Business Process Management<br>3. Enterprise Systems<br>4. Introduction to Human-Computer Interaction<br>5. IT Audit and Controls<br>6. IS Innovation and New Technologies<br>7. IT Security and Risk Management |
| 2020 ACM/AIS Draft | 1. Data/Info. Management<br>2. IT Infrastructure<br>3. Secure Computing<br>4. Systems Analysis and Design<br>5. Application development/programming<br>6. IS Management & Strategy<br>7. Ethics, use, and implications for society.<br>8. IS Project Management<br>9. Practicum<br>10. Foundations of Informaiton Systems | 1. Object-oriented paradigm<br>2. Web programming<br>3. User Interface design<br>4. Business Process Management<br>5. Digital Innovation<br>6. Mobile programming<br>7. Emerging Technologies (IoT, blockchain, etc.)<br>8. Data/Business Analytics (Data Mining, AI, B.I.).<br>9. Data/Information visualization |

# MIS 2020 Curriculum:

It will probably be the recommended curriculum until 2030 based on past trends.

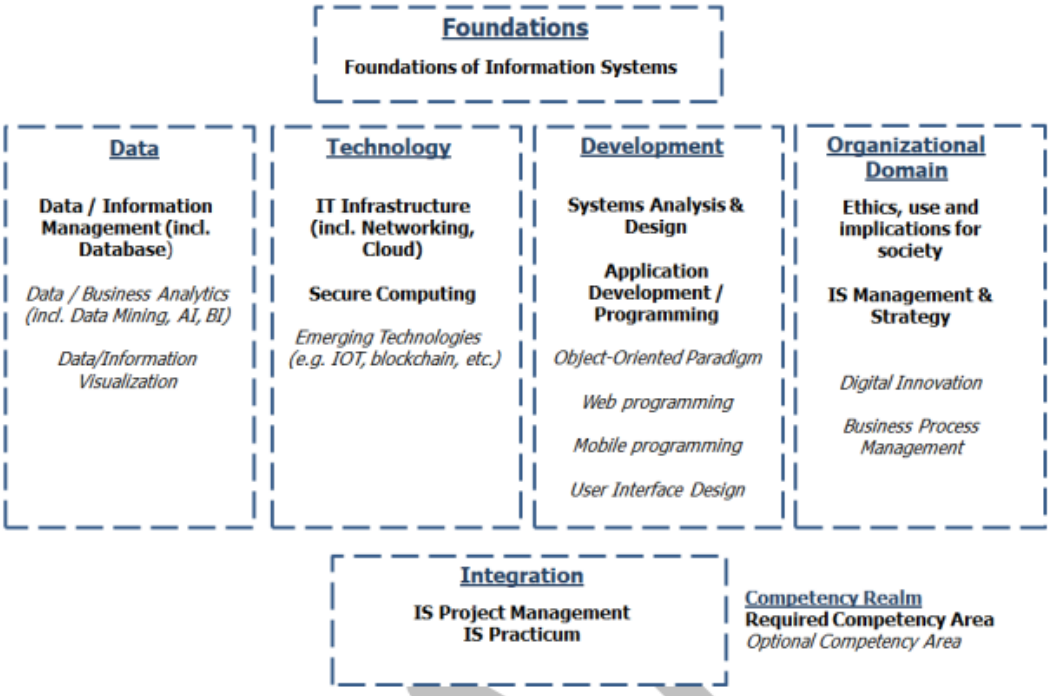
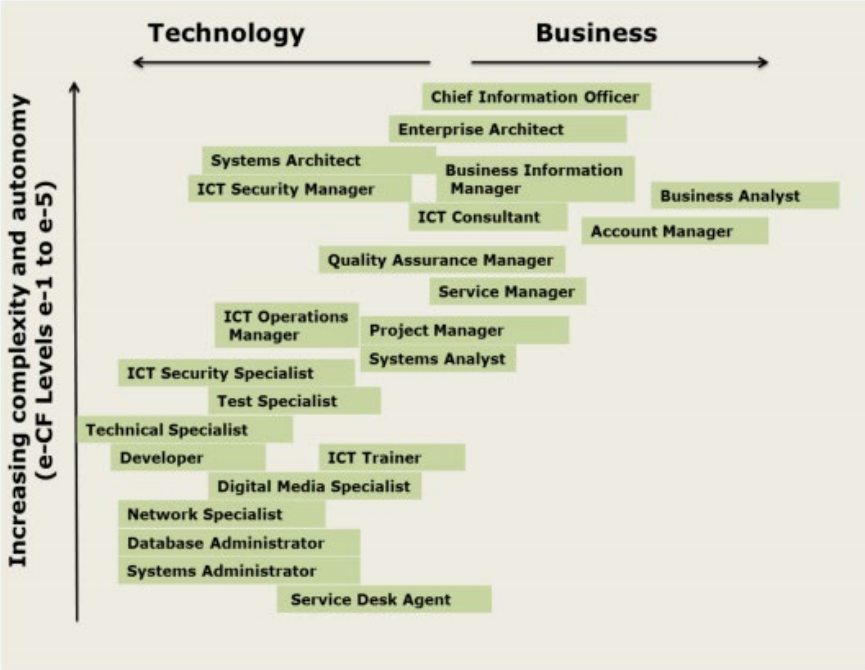



***Figure 4-2 Competency Based IS2020 Curriculum Guidelines***

The curriculum was made using the Skills Framework for the Information Age (SFIA), which was developed by leading industry firms and the British computer society (SFIA, 2020). The current version of SFIA is SFIA and focuses on 7 themes – software engineering, cybersecurity, digital transformation, Agile and DevOps, big data and informatics, and knowledge. It focuses on preparing MIS majors for a career as a data administrator, data analyst, data scientist, cloud analyst, network executive, security executive, system admin, systems analyst, developer, UI/UX designer, solution design, systems architect, sales consultant, business analyst, and IT/digital consult (15 careers).

Additionally, the European e-competency framework (eCF) was used to discern what careers can be considered IS jobs. This framework identified over 30 jobs that an information systems degree would prepare students for, that belonged to the 7 themes used in SFIA. Below is an image of some of the various careers that an IS degree provides for students. Its wide in scope, which results in the curriculum requiring to be wide in scope.




Text mining for curriculum recommendations hasn't received too much research. A research study published by Cornell University titled "Curriculum Vitae Recommendation Based on Text Mining[31]" was one study that I have identified. The methodology used a text mining model with more than 20,000 job ads in Spanish, specific job titles weren't mentioned. They came to the conclusion that research should be continued on "recommendation systems", which may help improve the employability of graduates.

What has been explored were recommendation systems based on ontology, which text mining could help with. Since my thesis expanded to utilizing artificial intelligence for all degrees from just analyzing the ACM curriculum, there wasn't time to complete a literature review on this. When exploring publishable work after the semester, a thorough investigation will be done.

[31] Chire Saire, J. E., Alanoca, H. A., & Rubin de Celis Vidal, A. A. (2020). Curriculum Vitae Recommendation Based on Text Mining. doi: https://arxiv.org/abs/2007.11053

**Summing up the Literature Review:**

The literature was extensive and focused on analyzing the ACM curriculum. Here are some of the key takeaways:

- Those in academia analyzing curriculum have identified that there has always been a skills gap between what employers want and what the curriculum provides.
- Courses have not changed that much since the first recommendation. The same core foundation is being taught, which may not be applicable to the technology industry.
- Those analyzing the curriculum were mostly forced to rely on small qualitative studies.
- Systems analysts serve as the middle of technology of business, it is a good middle point for potential careers that graduates can pursue.
- MIS is too large of a basket and should be broken up.
- Top ranked schools are not accredited, and they follow the curriculum recommendation extremely loosely.
- Communication, soft skills, and business skills have always been more preferred than technical skills. However, a significant majority of the recommended courses are technical.
- Schools focus on creating a foundation and relying on employers to teach the specifics. However, the foundation is too wide as there are so many possible careers and MIS graduate can pursue. Graduates lack the knowledge for an entry level positions.
- Technology is rapidly changing, and curriculum can not keep up.
- Not much research has been put into text mining and automating curriculum, but ontology is a hot topic. Artificial Intelligence may be able automate recommending utilizing ontology.

# Chapter 3 - Methodology

The student's objective was to figure out what skills employers wanted from system analysts. Two Microsoft Excel workbooks were created along with the utilization of SPSS.

**First Excel Workbook (created with the help of Dr. Farkas):**

This workbook was made to identify common trends in knowledge from the job postings and count how many times each piece of knowledge showed up. The workbook was labor intensive to produce and took significant computing power to execute, it was essentially doing what SPSS does to a less accurate extent. This workbook was used to verify the data in SPSS and the other Excel workbook, ultimately raising the quality of the research.

The first step was to compile a technology and general skills dataset. I identified a dataset from *data.world*, which had 28,935 unique skills. The dataset was made to read candidate resumes, then identify and group similar skills. The authors apply a word embedding method using skills from job ads. They "treat skills as terms, job posts as documents and find the relatedness of these skills" (Van-Duyet, 2019).[32] This serves as a large dataset of skills words/phrases.

The second step was to scrape Indeed.com for all systems analyst job postings. Indeed was chosen because they are consistently ranked a top job ad site for recruiters across various sites. A user on apify.com [33]created an Indeed scraping tool, and I had to input the criteria below. We only wanted to work with a sample of 20 job postings to make sure it was accurate.

1. Position = Systems Analyst
2. Country = United States
3. MaxItems = 20

Each pull contained the company, description, ID, location, position name, and URL. I then checked the sample on Indeed.com, and the information was accurate for all of them.

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[32] Van-Duyet, L., Quan, V. M., & An, D. Q. (n.d.). Skill2vec: Machine Learning Approach for Determining the Relevant Skills from Job Description.

[33] Apify Indeed scraping tool. (n.d.). Retrieved March 04, 2021, from https://my.apify.com/tasks/PIA5ABOTw8FbgQV0W#/runs/SVY8jnIKEZApdqhNC.

The third step was to create a function that counted any time a unique skill (from Step 1) matched to a word in the description portion (from Step 2). We then had to clean the skills dataset and make a few formulas in excel. See the workbook attached for details.

The final step was to increase the MaxItems in the second step to 15,000. Seven hundred eighty-four job postings ended up being pulled. I then audited 15 random postings to make sure it was pulling accurate information and concluded it was. Finally, we added the job postings to the workbook and ran the function.

**SPSS- text mining:**

Some words or phrases were missing from excel, and it didn't work as I expected it would. Thus, it was used to audit the words that were included by SPSS. SPSS finds common words and phrases, then counts how many documents (job descriptions) it appears in.

Below is the stream used for SPSS- text mining. It is an artificial intelligence tool that found common words or phrases through all the job postings. It is such a powerful and easy-to-use tool that should be used for all curriculum creations. The only thing I had to do was put in the pulled job descriptions from Apify into the source node, then configure few settings. Specifically - Text field= Job_Description, document type=Full Text, and Textual unity= Document mode. See below.


**Second Excel Workbook:**

This workbook was made to analyze knowledge included in ACM's recommended curriculum. By reading ACMs 2020 Information Systems curriculum, I analyzed all 21 of the courses' core competencies to understand exactly what was being taught, I then put the knowledge identified next to each course. The core competencies included every piece of knowledge that a course should include. This would allow me to see what courses are more relevant, along with what specific knowledge is necessary or unnecessary. It would also provide insight into what is taught too much or not enough, and what's not included. See workbook attached.

More importantly, it would verify that the SPSS data was correct. SPSS was much easier and quicker to set up then the workbook above, it can also be used for all

curriculums. It automated the curriculum creation process. The SPSS data was within 1.66% of the Excel, which is within a reasonabl margin of error and proved to be accurate. The only difference is what job descriptions was put in.

First step: Put knowledge being taught in workbook.

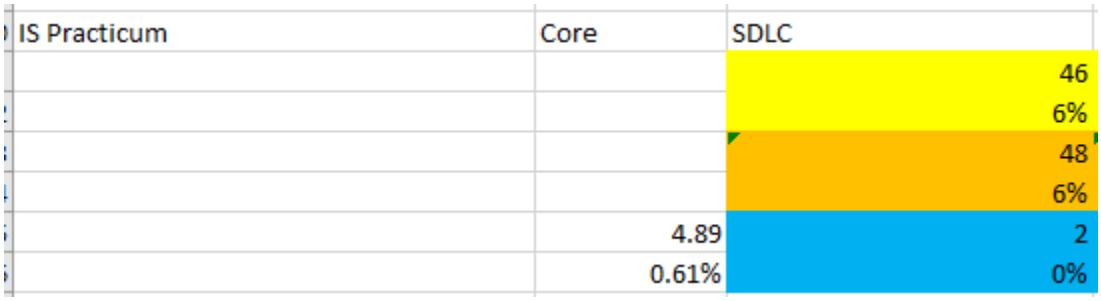
Second step: Put scraped job data on one sheet.

Third step: Create count function to count how many times a word appears in the job descriptions from second step. Function was =COUNTIF(jobpulls!$A:$A,"*"&C6&"*"). jobpulls!$A:$A was the range of what was being checked and included all job descriptions,"*"&C6&"*" was the specific knowledge being checked, then matched with how many times it appeared in the range. It would only count one word per job. So, if one job post included Microsoft Excel 5 times, it would only count once. This methodology would ensure one word wasn't counted multiple times for only a few employers, leading to more consensus.

Additionally, =AVERAGE(IF(C11:BS11<>0,C11:BS11)), was used to calculate the average difference between total and total percent. <> means that it will not include numbers that are 0, so it doesn't bring down the average if there is no difference.

Fourth step: Manually check two courses' specific knowledge in SPSS to ensure that the Excel count function was accurate.

Below is a snippet of what this workbook looked like. There was the course, in this case, IS Practicum. Next was whether it was core or elective. Below that was the average difference among all the skills, and the average percent difference below that. Next to core/elective, was the knowledge areas. Each cell had a name of a piece of knowledge going down the row, there was about 70-130 skills per row. The yellow highlight indicates what SPSS showed, while orange indicated the accurate data from excel, and blue was the difference. This workbook will be given at request.



| IS Practicum | Core | SDLC |
|---|---|---|
| | | 46 |
| | | 6% |
| | | 48 |
| | | 6% |
| | 4.89 | 2 |
| | 0.61% | 0% |

**Limitations**:

This employer's skill workbooks counts how many times a skill word or phrase is used. So, it would count "excel" from a posting. However, it will not count "working with workbooks." To get over this hurdle, I used natural language processing (SPSS).

The ACM curriculum is not too specific about technologies because they leave some academic freedom to the professor. An example is one professor preferring Python, while another prefers teaching Java for application development. These skills are typically transferable. Someone who knows how to use python well, can typically teach themselves how to use another coding language. Or, another example, one Professor prefers Visio while another prefers Lucidchart. Both tools are extremely similar and won't be difficult to learn the other.

Employers don't include all the minor details in their job specifications all the time. For example, they may include a coding language like Python, but not the skills learned like library, Boolean, algorithmic, and more. Or they might say excel, but not VLOOKUP, pivot tables, or specific function.

**Positives**:

Although I only pulled systems analyst jobs, which is only one career that the MIS degree prepares students for, the first workbook can be utilized for all technology-related careers. The methodology could be used to see the skills that employers want for database administrators, you would need to replace "systems analyst' with "database administrator" in the second step.

The systems analyst postings serve as a proof of concept. The methodology could also analyze various careers like police office, nursing, finance, accounting, and any other career.

The only variable for SPSS is what job descriptions you pull and include in the source node.

# Chapter 4 - Findings

Disclaimer: These findings are just analyzing skills from systems analyst job postings. Skills that are not relevant are possibly relevant for another career. Additionally, some phrases did not pop up exactly, so they may be missing. For example, the skill "build a database" may show up as "database creation" or "create a database."

The Excel workbook will be provided upon request.

The average difference between Excel and SPSS was 1.64%. The Excel numbers were used below as they were completely accurate. Half of this study is to analyze the ACM curriculum; the other half is to prove that SPSS works. A 1.64% average difference is within margin of error, which was established at 3%. Because of the low margin of error, it still proves that SPSS works accurately. Excel was time consuming and labor intensive, while SPSS found the common words automatically.

More specific knowledge like business problem, python, Tableau, and PowerBi were always exactly the same. Words that never appeared in excel also never appeared in SPSS. The difference between the two were in larger and broader words like data, communication, people, and software.

**Core Course 1- Foundations of Information Systems:**

This course was comprehensive. It is a mile wide and an inch deep, so there were a significant number of hits.

IS components were mentioned 48 times. Specifically, "hardware" was mentioned 152 times, "software" 471 times, "communication" 47 times, "data" 537 times, "people" 207 times, "procedures" 320 times, and "processes" 431 times. These seven terms serve as the core of information systems, and everything falls under at least one of them. Systems analysts serve as a liaison between management and the technical employees, and these statistics prove that. Processes and procedures are most emphasized, as at least one of them shows up in 60% of postings.

"Operations" were mentioned 241 times, "information" 543 times, and "functions" 234 times. IS professional roles, responsibilities, and characteristics are also taught in this course. It is a solid introductory course because it allows students to determine what career they want to pursue, as considered in chapter 5. There, I will discuss why universities should offer MIS students concentrations. However, all MIS students should take this course.

IT issues were returned 364 times, almost half of job ads. Moreover, IT "trends" popped up 65 times, or 8% of ads. This shows that systems analysts are there to lead

initiatives to solve problems and keep up on trends. IS "solutions" showed up on 454 postings, or 58%. Interestingly, “solutions” popped up more than “issues.” Maybe that indicates systems analysts are problem solvers rather than problem finders. Problem solving hit 107 times, 14% of postings. Things like "ERP" (53 postings) and "power-bi" (21 postings) popped up a good amount but are being taught in other courses. ERP is briefly taught in IT infrastructure, and they used to have a complete course for it, Enterprise Architecture and Governance. They assumed that this material was not necessary anymore and took it out. The reality is, at least for system analyst job postings, the knowledge is still required.

The network is also taught in cloud development, which is an elective, and IS Project Management. Networking is taught in cloud development, and if someone wanted to pursue being a system analyst, this elective would be a good one to take.

SDLC was mentioned 48 times, but specific methodologies were mentioned more. Agile was mentioned 131 times, waterfall 21 times, scrum 48 times, and DevOps 19 times. This indicates that companies are utilizing Agile methodologies significantly more than waterfall.

This course also introduces students to innovation. Innovation showed up in 179 of postings (23%) which was surprising, as I thought it would be much greater. Innovation techniques were also not being returned in the search.

This course did not include much that might be unnecessary for a systems analyst. The only things that did not pop up at any time were information privacy-related skills, security skills, crowdsourcing, emerging technologies, and value identification skills.

**Core Course 2- Data and Information Management:**

In 235 job ads, 30%, mentioned SQL, showing that database creation is essential for a systems analyst. Eighty-two ads mentioned Oracle, while 66 mentioned MS SQL server. No other specific DBMS was mentioned more than five times. Design and manage a database were not mentioned much, but I think we can assume those are necessary when a posting mentions SQL as a requirement.

Twenty-five postings mentioned relational models, while zero mentioned non-relational. A new point of emphasis for this course is data security. However, there were no pulls for that or other database security terms in the systems analyst job postings. Forty-seven job postings mentioned user stories. Visio was mentioned 12 times, while Lucidchart was mentioned four times.

Seventy-one job postings mentioned data analytics, but is not emphasized in this course. If a student wants to pursue a career in data analytics, they can take an elective for it.

Database was mentioned 221 times, more than a quarter of job postings. If there are 11 core courses that an MIS student needs to take to graduate, each course should teach roughly 8% of the material. Database was mentioned in a quarter of job ads but is only being taught in one course. For systems analysts, the database as a whole is undertaught. It is mentioned in other courses but does not go into advanced detail. A career like a database architect, which is another career MIS graduates pursue, sounds like it may be significantly undertaught. There are many recommended electives, but none of them allow students to pursue advanced database material.

Material not mentioned for systems analysts included data security terms. Lack of security terminology in systems analyst job postings is a trend.

**Core Course 3- IT Infrastructure:**

This course has many skills that it attempts to teach that stretch very broad. Moreover, despite this extensive list, the count was small. "Infrastructure" popped up on 108 postings or 14%. Installation popped up 77, configuration was 198 times, and maintenance was 227 times. This showed that jobs are placing the most emphasis on maintenance for a systems analyst. None of the network topologies or security measures received hits. ITIL popped up five times. Network security popped up eight times.

Architecture design, architecture development, server design, server development, cloud design, and cloud development all had zero hits. Network hit 124 times, 16%, but specific terminology was rarely mentioned. Network software, network configuration, network protocols, network security, network topologies, OSI, Mesh, Bus, Star, Ring, UDP, pop, TCP, I.P., SMTP, and FTP never popped up. This may indicate that systems analyst recruiters prefer a network foundation, but nothing specific.

AWS popped up 8 times, Azure 27 times, Google Cloud five times, Oracle 82 times, Salesforce 39 times, and SAP 37 times. This shows that companies prefer that systems analysts know various cloud technologies. Network competencies are half of the course, security 1/8, architecture a quarter, and cloud 1/8. For systems analysts, almost half (3/8) of the course is unnecessary. This course would be better if architecture and security were taken out as they are taught in many other courses (see below), and if cloud was half of the course with network being the other half. There is a lot of wasted education for a core course if a student plans to pursue a systems analyst career.

**Core Course 4- Secure Computing:**

As the other courses have shown, cybersecurity is not crucial for a systems analyst. Secure computing is a new course that came to be because prior research showed that cybersecurity is becoming increasingly important. It may be, but not for a systems analyst.

Specific cybersecurity skills like cryptography (0), authentication (6), authorization (25), access control (2), cyberattack (1), malware (5), phishing (2), man in the middle (0), DoS (3), DDoS (0), SQL injection (0), zero-day exploit (0), and DNS tunneling (0) were mentioned infrequently. "Cybersecurity" was only mentioned 20 times out of 784 job postings. This includes three quarters of the competencies for the course. The remaining competencies are risk management and security laws. Risk hit 121 times or 15% of postings. Risk management only hit 24 times. The risk competency should be included for about half of a core course. These searches would indicate that cybersecurity is not necessary for a systems analyst to know. If a student wanted a backup career, this may be an excellent course to have. However, it should be an elective.

**Core course 5- Systems Analysis and Design:**

This course is crucial for a systems analyst, but its scope is too large. There are too many competencies included (49). Thirty of those are from competency realm 2- demonstrate the SDLC phases and activities. This course needs to be broken up into two courses, not just for a systems analyst career but for all students.

Systems analysis was mentioned 78 times, 10% of postings. This is a bit low considering the job name is a systems analyst. This course focuses on what systems are and how they are developed. The word design was mentioned 470 times (60%), and system was mentioned 772 times (98%).

This course walks students through a system/software development life cycle (SDLC). SDLC was mentioned 48 times, and the development life cycle was mentioned another 48 times (6%). There are different types of SDLCs. Agile was mentioned 131 times, Waterfall 21, V-shaped 0, Iterative 8, Spiral 0, DevOps 19, and Scrum 48. This indicates that companies are more interested in leaner methodologies with less upfront planning and figuring it out as they go rather than more planning and research. This course focuses on teaching the SDLC, but there is no single SDLC. There are many different types, and a different type may be best for each unique project. It is a controversial topic on what is best, but this course teaches one SDLC and briefly mentions the different models. The data indicate that for systems analysts, a more agile education should be taught.

There are four steps throughout the SDLC being taught- planning (193 times, 25%), analysis (448 times, 57%), design (470 times, 60%), and implementation (360 times, 46%). Each covers various topics to achieve their step’s goals. However, most of

the course included planning skills even though data showed companies want more agile systems analysts. Specific planning skills were rarely mentioned. Planning was mentioned the least out of the four steps but was the primary focus in this course.

Planning included- requirements specification eight times, technical feasibility three times, cost-benefit three, economic feasibility zero, business requirements document zero, organizational feasibility zero, project management plan zero, responsibility assignment matrix zero, functional requirements 78 (10%), non-functional requirements 3, root cause analysis 34, use case 45, work breakdown structure 1, pert chart zero, Gantt chart zero, work schedule 24, critical path, zero. Many of these requirements were not mentioned even once. Use cases and the requirements documents should have a higher point of emphasis. Most of the course falls within the planning realm. It would be better to call the course Systems Planning rather than Systems Analysis and Design. The planning section should focus on identifying functional requirements, performing a root cause analysis, and developing use cases.

TOGAF (1) and ITIL (14) are included in another competency, and other courses are barely mentioned. These two are also taught in IS Management and Strategy, as well as IT Infrastructure. A lot of the things taught in this course are reinforced in later courses. This is not necessarily a bad thing as important material should be reinforced, but the problem is that it is not information crucial for a systems analyst. Many database skills are being taught that are also explicitly taught in Data and Information management, Data/Business Analytics, Data/Information Visualization, Object-Oriented Paradigm, User Interface Design, and Foundations of Information Systems. Data is essential for a systems analyst. The problem is that surface level and introductory material is being taught many times over. It should be incremental and focus on eventually teaching students advanced material.

In this course, risk is taught again (121, 15%). Risk is also covered in IS project management (core), IS practicum (core), and secure computing (elective). Risk is overcovered for a systems analyst.

**Core course 6- Application Development/Programming:**

Specific coding lingo like primitive data type, numeric, string, Boolean, derivative data type, binary, library, hashing, or any other words weren't mentioned at all. However, specific languages were mentioned: PHP (11), C++ (18), C# (18), Java (18), Python (34), Git (3), Visual Basic (7), JavaScript (21), SQL (235), and code (55). This is a significant number of mentions and is deserving of a class. However, only 7% of postings mentioned code. This indicates that it's not important for a systems analyst to know, and one language is enough. The Professor should have the discretion to cover either Java or Python. SQL will be covered in data and information management.

Test was mentioned 471 times, 60%. Black-box was mentioned zero, white-box zero, acceptance testing 49, unit testing 6, automated testing 7, regression testing 7, functional testing 14, exploratory testing zero, load testing 2, performance testing 3, recovery testing zero, security testing zero, stress testing zero, and usability testing 2. Despite the test importance, only one in fifteen competencies involve testing for this course. Unit testing concepts will be taught throughout the curriculum, but there is room to cover more material on all testing. For a systems analyst, it would be preferable to take a full course on testing, which isn't included in the recommended curriculum.

**Core course 7- Ethics, use and implications for society:**

This is a new course from the ACM recommendations that is long overdue. Technology is becoming increasingly governed as it becomes a larger and larger part of our lives. Governmental regulation bodies are beginning to issue huge fines for failure of compliance. Some examples are Facebook being in a constant legal battle concerning privacy and facing a $5 billion fine by FTC; Citibank was fined $400 million by the OCC for failure to comply with technology risk standards; Google and Amazon got hit by CNIL (a French regulating body) for $163 million for failure to comply with data privacy regulations. There are local, state, national, and international laws that companies have to adhere to.

International law/regulation was mentioned zero times, state law (11), stage regulation (0), federal law (12), and federal regulation (1). Despite governing bodies hammering down, systems analyst recruiters aren't mentioning it. Regulating bodies like SOX (5), OCC (0), GDPR (0), SEC (0), OCR (0), and CFPB (1) were rarely, if at all, mentioned as well.

"Law" was mentioned 136 times (17%), regulation was mentioned 57 times (7%), and compliance was mentioned 13 times (14%). The word "ethic" (6) was only mentioned 36 times total. I used "ethic" so as to include the plural "ethics" as well. This may indicate that recruiters are more concerned with systems analyst knowing the law, and less so with having ethical behavior.

Words correlating with ethics were mentioned- best practices 104 times (13%), integrity 99 times (13%), honest 8 times, respect 84 times (11%), accountable 20 times (3%), fair 42 times (5%), and honor 7 times. For integrity- data integrity was mentioned 23 times and systems integrity was mentioned 12 times.

**Core course 8- IS Management & Strategy:**

This course focuses more on general management skills rather than specific project management skills. This course appears to be the updated version of Enterprise Governance and Architecture, focusing on organizational alignment and vision.

The first competency involved interpersonal, conceptual, and leadership education. "Interpersonal skills" was mentioned 128 times (16%), leadership 120 times (15%), lead 374 times (48%), communication 472 times (60%), and plan 456 times (58%). This may indicate that soft skills are more important to employers than technical skills for the systems analyst.

The recommendation didn't mention any particular interpersonal skills, but I found an article that included some buzz words to determine what is most important for systems analyst.[34] Interpersonal skills included several types- Communication, conflict management, empathy, leadership, listening, negotiation, positive attitude, and teamwork. Each type includes several skills within it.

For communication- nonverbal hit zero, public speaking 2, verbal 209 (27%), presentation 106 times (14%).

For conflict management- conflict resolution hit 6, constructive criticism once, counseling twice, mediating 76 (10%), conflict management once, and problem solving 107 (14%).

For empathy- caring hit 13, compassion 15, diplomacy 7, diversity 84 (11%), help 267 (34%), kindness 16, inclusion 46 (6%), patience 5, respect 84 (5%), sensitivity 38 (5%), and sympathy zero.

For leadership- encouraging hit 91 (12%), inspiring 36 (5%), instruct 90 (11%), mentor 61 (8%), self-motivated, positive reinforcement 0, delegate 2, self-reliant 0, strategic 99 (13%), charismatic 0, optimistic 1, pessimistic 0, supportive 29 (4%), disciplined 88 (11%), diligent 5, visionary 2, pioneer 7, organized 95, resilient 4, level-headed 0, impartial 0, and humble 3.

For listening- active listening hit 4, curiosity 9, focus 208 (27%), listen 41 (5%), and inquiry 1.

For negotiation- negotiation hit 16 times, persuasion 3, and research 199 (25%).

For positive attitude- behavior skills hit 35, developing rapport 5, friendliness 33 (4%), humor none, networking 44 (6%), and social skills 95 (12%).

For teamwork- collaboration hit 100 times (13%), in contrast independent hit 192 times. Group facilitating hit 0 times, team building 4, and teamwork 42 (5%).

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[34] Doyle, A. (2020, November 18). Important Interpersonal Skills That Employers Value. Retrieved March 17, 2021, from https://www.thebalancecareers.com/interpersonal-skills-list-2063724.

Additionally, detail-oriented hit 64 times (8%), while big picture hit 10 times. Out of all of the different skill types, the curriculum should build a strong pillar in teamwork, leadership, empathy, and communication. This course should be taught at the beginning of the curriculum so students can apply the knowledge through other courses and internships. This is only one competency out of eleven for a single course. This indicates that soft skill development is up to the student to learn; it should be of higher emphasis in ACMs recommendation.

This course mainly covers organizational goals, management skills is only one of the 11 competencies. This should be of significantly more emphasis. Most of the other areas of the course are already taught in other places, as you see below.

Efficient was mentioned 132 times (17%), while effective was mentioned 358 times (46%). Cost efficient was mentioned 0 times, high quality 32 times, and quality 260 times (33%). Strategic goals hit 10, milestones 31, information management 10, long range plan 0, competitive advantage 2, align 78, organizational plan 2, and oversight 17. This may indicate that enterprise long-term vision and sustainability aren't important for systems analyst recruiters.

This course also goes over business compliance, but that would be better in the ethics course. ISO was mentioned 7, SOX 5, COBIT 0, HIPAA 7, PCI-DSS 1, and GDPR 2. Again, this may be assumed knowledge for employers.

This course also goes over risk again which is covered in Secure Computing, Systems Analysis and Design, and IS Project Management. Risk hit 121 times (15%), threat 18 times, vulnerabilities 17 times, risk management 24 times, risk transfer 0, risk acceptance 0, and risk mitigation 0.

This course also goes over talent acquisition (9), talent retention (0), and training (362, 46%). This may also mean training for the job, rather than training other employees. Specific training techniques like in-house workshops, bootcamp, employee education also never hit.

ITIL (14) and TOGAF (3) are taught again. Both of these skills are also covered in IT Infrastructure and Systems Analysis and Design. CMMI and COBIT is also taught which received no hits. This further proves that there is much waste and repetition in the curriculum. It's good to reinforce skills, but three times for two skills that are irrelevant for systems analyst may be a waste of time for students.

**Core course 9- IS Project Management:**

Similar to Systems Analysis and Design, this course focuses more on the planning stage of the systems development life cycle (SDLC) rather than the other three steps-

analysis, design, and implementation. One course should be planning and analysis, and the other design and implementation. The two courses are extremely similar. Project management hits 150 times, 19% of postings.

The first competency realm includes software/system project life cycle and hits 48 times, organizational structure 10, and project management processes (2). It also goes over project management terms like agile which hit 131 times (17%), waterfall 21, baseline 4, contingency plan 3, deliverable 89 (11%) dependencies 241 (31%), Gantt chart 0, iteration 3, milestones 31, PMBOK 1, Prince2 1, project portfolio 1, requirements 637 (81%), scope creep 0, and triple constraint 0. By now, all of these terms are taught through other classes.

The second competency realm includes project charter which hit 4 times, project management plan once, and statement of work zero. It also goes over the process of making changes, changes hit 222 times, 28% of postings and deserves more focus. Project management plan and change request are also taught in Systems Analysis and Design. The third competency realm covers scope management plan which hit 0 times, requirements management plan 9, and work breakdown structure 0. Requirements management plan and work breakdown structure are also taught in systems analysis and design.

The fourth competency realm includes schedule management plan which hit 0 times, sequence activities 0, network diagrams 0, critical path 0, schedule compression 0, critical chain method 0, and modeling techniques 0, like Monte Carlo which was also 0. Schedule techniques, modeling techniques, and critical path are also taught in Systems Analysis and Design.

The firth competency realm includes estimates which hit 50 times (6%), three point 0, analogous 0, bottom up 0, earned value management 0, and plan cost management 0.The sixth competency realm includes quality tool which hit 0, continuous improvement 37 (5%), quality management 5, quality assurance 52 (7%), quality control 8, and cause and effect diagram 0.

The seventh competency realm includes human resource plan which hit 0 times, roles and responsibilities of team members, and acquiring the team. The last two were difficult to measure given the tool but are important as every project will require a team. The eighth competency realm dealt with communication which should be a foundational pillar for a systems analyst concentration, as determined in IS Management and Strategy.

Risk is covered again in the 9$^{th}$ competency realm and hit 121 times (15%). Risk is also taught in other courses including Secure Computing, Systems Analysis and Design, and IS Management & Strategy. This section also teaches SWOT analysis which hit 1 time.

The 10th competency realm includes procurement management which isn't mentioned in job descriptions but is important for all students because it is involved in their hiring process.

This course also teaches about stakeholder identification and other relations, stakeholder hit 192 times (25% of postings). Specific skills like stakeholder analysis, engagement, and assessment matrix didn't hit at all. Additionally, this course teaches project management tools like MS Project which hit 19 times, Hive 6, and Wrike 0.

This course places heavy emphasis on Agile which hit multiple times as we previously saw (131, 17%), and should be an emphasis for the systems analyst concentration. Specifically, it utilized Scrum which hit 48 times (6%). Specific scrum/agile terminology like daily stand-up hit four times, sprint planning 15, product backlog 1, user stories 47, scrum master 9 times, sprint review 4, and sprint retrospective 2.

Even for specific terminology, this course didn't have too many hits. It also retaught a few topics like risk and general planning techniques. Systems Analysis and Design should change to Systems Planning and Analysis, while this course changes to Systems Design and Implementation. There is too much repetition with subject matter that is taught in other classes. By ACMs very nature, they are teaching a more waterfall approach by having so much focus on planning.

**Core course 10- IS Practicum:**

This course is the capstone that focuses on applying everything learned throughout the curriculum. There isn't much new knowledge. The course begins by understanding the SDLC. Every course taken up to this point applied at least one of the steps of the SDLC (mostly planning).

The second competency realm is applying various SDLCs including waterfall (21), iterative waterfall (0), spiral (0), rapid application development (0)/prototyping (8), and Agile (131, 7%). It's somewhat important to learn about waterfall and the other SDLCs that aren't agile because they build a foundation. Every project is different and may require a different SDLC, but it still appears to be overtaught. Project management tools are taught again through Jira (40, 5%), Azure Devops for Teams (6), and Team City (0). A systems analyst should choose Jira to learn rather than the others.

This course also teaches version control systems (1) like Subversion, GitHub, Gitlab, Beanstalk, Perforce, Apache Subversion, AWS Codecommit, Microsoft Team Foundation, Mercurial, CVS Version Control, and Bitbucket, which all hit only once or not at all. Knowledge of these tools must not be of much importance for a system analyst.

This course also covers acceptance testing which hit 49 times (6%), and other testing methods. Regression testing hit 10 times, unit testing 6, manual testing 4, and integration testing 0. Test did hit 471 times (60%) and is extremely important for systems analyst to know. The course also teaches UML structural diagrams, behavioral diagrams, solid principles, and O/RM which hit 0 times. RDBMS is also taught which hit 4 times. Finally, the course teaches security techniques, which are also taught in Foundation of Information Systems, Data and Information Management, IT Infrastructure, Secure Computing, and Application/Development Programming. Security techniques got very few hits. Cybersecurity only hit 8 times, less than 1%.

**Elective Course Option 1- Data / Business Analytics**

Data analytics appeared in 71 postings, 9% of job ads. Besides that, there were not any specific data analytic skills that matched enough to mention. This may be an excellent elective to take because automation matched in 78 postings, almost 10%.

Big data, which is a core competency, was only mentioned in three job postings. Hadoop (2), MapReduce (0), and Spark (3) were all recommended to be taught in this course and were mentioned rarely. However, Tableau (25 times), Excel (54 times), and PowerBI (30 times), which are more popular data analytic tools, were never mentioned in the course. Excel was explicitly mentioned in 7% of job postings but is only briefly taught in data/information visualization, another elective course. For systems analysts, a whole course devoted to Excel is necessary, even the option to continue in a second course should be available. If a systems analyst concentration was implemented, an Excel core course and elective course option should be included in the curriculum.

Volume (24), velocity (3), and variety (129), which are core terms in data analytics, were barely mentioned. Further investigation showed that variety wasn't referencing data. Data classification, data clustering, and data optimization, which are keywords, were also never mentioned.

**Elective Course Option 2- Data/Information Visualization:**

Investigation showed that data analytics tools were mentioned as preferred skills. Excel was mentioned 54 times or 7%. Tableau was mentioned 25 times, which is 2%. PowerBI was mentioned 30 times as well. Furthermore, Python was mentioned 34 times at 4%. Additionally, presentation skills showed up in 106 postings, 14%. Pivot tables showed up 12 times, just 1%. The other programming language that this course strives to teach is R, and I could not get an accurate count utilizing the workbook and SPSS. Lastly, PowerPoint showed up 60 times, 8% of postings. However, PowerPoint- is not explicitly mentioned in the curriculum.

This course may be necessary just for students to learn Excel skills. This elective would be suitable to take after application development/programming as it goes into greater detail about Python.

This course also taught soft skills revolving around understanding people, psychology, and marketing to that audience. PowerPoint was mentioned 60 times, 8% of postings but was not mentioned anywhere in the curriculum. The curriculum states, "oral and presentation competencies remain essential to the profession," but there is no specific course teaching the necessary skills to prepare or give presentations. Students present throughout the curriculum and are educated through trial and error. However, specific training on how to present effectively is necessary. This course would be an excellent elective to take for a systems analyst, even better if at least half of it included PowerPoint and possibly becoming certified using it.

Data story (7), data manipulation (8), and filtering (0) weren't mentioned much but are critical points of emphasis in this course. These three falls under the data analytics competency and would be better suited in that course. The data/business analytics course focuses on teaching students how to think and utilize data to solve problems critically. Simultaneously, the data/information visualization course focuses on presenting data so others can understand it. However, the material in the courses is repetitive and waste time. These two courses cover a lot of material that is unimportant for systems analysts and cover few essentials. Combining them to create a single course that covers Excel, Tableau, PowerBI, PowerPoint and focusing on soft skills surrounding presentation would be an important core course for a systems analyst.

**Elective course option 3- Emerging Technologies**

This course is an elective that teaches valuable soft skills through the use of emerging technologies and innovation. It focuses on teaching students to think about creative solutions to complex problems.

Emerging technologies were only mentioned 16 times. Specific emerging technologies such as cryptocurrency (0), bitcoin (0), blockchain (0), RPA (8), AI (8), 5G (1), IoT (0), robotics (0), biometrics (0), 3D (3), VR (0), AR (1), and drone (0) were barely mentioned.

Requirement analysis was mentioned twice, business needs 137 times, and business requirements were mentioned 207 times (26%). Recommendations were mentioned 126 times (17%), decision making 24 times (42%), solutions were mentioned 454 times (58%). This indicated that systems analysts are hired to solve problems and make recommendations; this is extremely important. This course uses emerging technologies to teach students how to think creatively. The course focuses on how to think creatively, and outside the box.

This course also teaches research skills: research popped up 199 times (25%) on job postings. Specific research skills like participant observation, nonparticipant observation, observational trials, Delphi method, cohort, case studies, experiment, and questionnaire never popped up. Survey popped up on eight postings, and interview could not be used because it could imply getting an interview for the job.

Prototyping is also taught, which was mentioned eight times. Throwaway prototyping, rapid prototyping, evolutionary prototyping, and incremental prototyping were never explicitly mentioned.

Another competency realm is teamwork; communication popped up 472 times (60%), teamwork 42 times (5%). Moreover, project management popped up 150 times (10%).

Ethics (36 times) and sustainability (18) are also a large part of this course. Although these two competencies did not pop up in job postings more than three times, it must have an unmentioned importance to an organization. These two are also taught through Ethics, Use, and Implications for Society, a new core course. It is essential to reinforce this knowledge and has a place in multiple courses.

This course teaches many vital skills for a systems analyst. Even though the course is called emerging technologies, it only uses them to teach students how to be creative when coming up with a solution. And then how to present and recommend those solutions. This is a must-take elective for systems analysts and should be a core course if a school implemented a systems analyst concentration.

**Elective course 4- Object Oriented Paradigm:**

"Object-Orientation is a paradigmatic perspective on how to organize data and routines into libraries or reusable code centered on organization of data and routines into containers called classes" (IS-2020). This course teaches code classification and organization skills. Core skills in this course such as polymorphism, abstraction, reuse, base class, parent class, inheritance, decouple, encapsulation, UML, OOP, and others were not mentioned once. This course is not an elective that a systems analyst should take, and a systems analyst concentration wouldn’t include the option to take it.

**Elective course 5- Web Development:**

This course teaches students application design and programming through the creation of a website. It re-teaches internet protocols that are taught in the core course, IT Infrastructure (weren’t mentioned much in job postings). It teaches back-end (4 hits) and front-end (7 hits) approaches. It also teaches algorithms (0 mentions).

The high note of this course is the documentation competencies, which is one of the 13 competencies. Documentation is mentioned 362 times, 46% of postings. It's an extremely important skill for systems analysts; they are responsible for communicating to non-technical minded people. This needs to be of higher importance.

Another important part of this course is the teamwork competencies realm, also one of 13 competencies. Teamwork (42), communication (472, 60%), and teaming (593, 76%) were mentioned an astonishingly high number of times in the job postings. These skills should be the takeaway soft skills for systems analysts through every course. This can be done through groupwork that simulates a real working world experience. However, all of the courses that encompass this skillset only do so as an afterthought. Its only one of the 13 competencies in this course. I wouldn't call it a competency; it should be a foundational skill for every course.

This course also teaches either CSS (14), HTML (38), or JavaScript (21). HTML or JavaScript should be taught, if anything. Specific terminology within these languages, again, weren't mentioned. They may be mentioned more in developer/coder jobs, but the data indicates that systems analyst recruiters only care about the foundational concept of these languages.

Server side (back-end) languages are also covered. Python (34, 4%), Django (0), Node Express (0) were specific languages mentioned. Python only needs to be covered in application development as it's only mentioned in 4% of postings.

CRUD matrix and other website/application design skills weren't mentioned. Web security skills like authorization (25), authentication (6), encryption (0), and others were rarely mentioned, reinforcing the lack of need of security skills for systems analysts. Even if they were needed, they are already taught in secure computing and other courses.

Debug (27), syntax error (0), and logic error (0) were mentioned very few times as well. However, test, as we saw previously was mentioned many times, and this material would be included in a testing course for systems analyst.

This course and mobile programming also include a competency realm on intellectual property and copyright laws, this material would be better included in the core course, Ethics- Use and Implications for Society.

**Elective course 6- Mobile Programming:**

This course teaches many of the same core competencies as the web development elective. The main difference, of course, being that it's for mobile applications rather than a website. Five of the 13 competencies are the same.

Words associated with mobile applications rarely popped up. IoT, smart home, mobile application never hit. They are also taught in emerging technologies. "Mobile" hit 31 times but referenced phone numbers. Also, "Android" only hit 4 times. Specific code terminology like algorithm never hit. Mobile development programing languages hit somewhat, Java 18 times (2%), JavaScript 21 times (3%), Dart (0), C# (18), C++ (18), Flutter (0), Ionic (4), and Xamarin (0). Java and JavaScript can be used for a wide variety of purposes, beyond mobile development. If application development teaches Python, it may be wise for a systems analyst to take this course to learn a Java foundation, but it's not necessary.

The only skills of importance were the same ones that were taught in web development-teamwork, documentation, and other soft skills. This course also teaches marketing skills, which hit 34 times (4%). These skills may be more important for a systems analyst at a start-up or smaller company. This information is somewhat relevant, but not enough for an entire course. This competency realm can be included in a system planning course, IS Practicum, or Business Process management courses.

If there was an MIS-Developer concentration, the two courses above would be good to include.

**Elective course 7- User Interface Design:**

This course includes five competency realms and is about creating a design that is most beneficial to the users.

"User centered design," "UCD," "user feedback," and "user involvement" never hit once, surprisingly. The word "users" hit 229 times (38%), and the synonym, "customers," hit 232 times (30%). Customer feedback hit twice; customer focus hit 18 times. Internal customer hit 26 times, while external customer hit 35 times. Customer service hit 109 times (4%), customer support (15), customer satisfaction (13). User support also hit 30 times, 4%.

Although user centered, user feedback, and user involvement were never mentioned- user was used frequently. End users were mentioned 124 times (16%), user stories 47 times (6%), user training 39 times (5%), and user acceptance testing 50 times (6%). This indicates that the users are always thought of when creating the deliverable, but they may not be consulted as much, at least by the systems analyst.

User interface was only mentioned 21 times, but interface was mentioned 148 times (19%). Everyone who sees an interface is a user, so the recruiters don't have to include user before interface. However, interface design was only mentioned nine times. Wire frame, an interface design technique, was only mentioned 11 times. Popular UI

tools like Invision, Zeplin, Balsamiq, Sketch, Figma, Flinto, Adobe XD, Axure RP, Fluid UI, and Framer X weren't mentioned once.

User interface design isn't important for a systems analyst but understanding the user/customer is. Understanding the user should be another core foundation for all IS courses.

**Elective course 8- Digital Innovation:**

This course teaches innovation or creating creative new solutions to complex problems. Its goal mirrors the emerging technologies elective. One competency realm even covers emerging technology areas. Emerging hit 11 times and isn't a huge focus for systems analyst employers.

Innovation was mentioned 179 times (23%). This is surprisingly low and may be because innovation is a part of an organization's culture. It also may be low because employers don't want new employees knowing they have creative freedom.

It also covers social (0), mobile (4), and business applications (41, 5%) of technology. But when it comes down to it, technology is used for one of these three things all the time. It seems like a broad competency realm that differentiates the three.

It also covers digital innovation which hit 4 times, digital business not at all, and business model 12 times. It teaches it via "Scrum or SDLC". Scrum hit 48 times, and SDLC appears 48 times. It's weird that it was titled this way in the recommendation considering Scrum is a type of SDLC, but it seems like this course focuses on teaching agile approaches. DevOps, which is a new SDLC, is extremely agile. It hit 19 times, but it's known to breed innovation so may be a good SDLC to cover.

Finally, this course values collaboration, negotiation, planning, and communication. All of these soft skills were found to be valuable in the previous course analysis, IS Management and Strategy. It's difficult to propose new ideas without getting shut down and looks to teach entrepreneurship and presentation skills. The soft skills in this course are extremely important and may be a good course to take after IS Management and Strategy to reinforce soft skill knowledge. However, the course is still repetitive and only a slight variation of the emerging technologies course.

**Elective course 9- Business Process Management**

This course teaches various business process management skills, which look to make organization practices more efficient. Considering how half of a systems analyst job deals with the business side, this would be an ideal elective for students pursuing a systems analyst career. An argument could be made that it should be a core course in a systems analyst concentration degree.

Process improvement hit 109 times (14%), business process analysis 15, and business processes 229 times (29%). However, business process management only hit 7 times out of 784 job postings, BPM 0, BPMN 0, process model 15, process 622 (79%), decision point 0, control flow 0, organization perspective 0, exclusive decisions 0, inclusive decisions 0, parallel execution 0, information artifacts 0, and information resources 0. However, process improvement hit 109 times (14%), and business process analysis 15.

It also teaches Visio (12 times, 2%) and ARIS which hit 0 times. with business scenario (1), process discovery (0), document analysis (8), process architect (0), process portfolio (0). Measuring skills like root cause analysis hit 34 times, pareto chart 0, cost benefit analysis 5, and return on investment 3, didn't hit much. Root cause analysis is taught in another course.

This course again goes over some emerging technology solutions like artificial intelligence (3 times), IoT (0), and blockchain (0) which didn't hit much. These skills are also taught in the Emerging Technologies and Digital Innovation. IoT is taught in Foundations of Information Systems, Emerging Technologies, Digital Innovation, Mobile Programming, and Business Process Management.

This course also teaches business process tools like XML (29 times, 4%), XPDL (0), and SOA (1). Along with robotic process automation (10), specifically UIPath which hit 0 times.

I think this course would be better suited for systems analyst if it included more general business skills like accounting which hit 84 times (11%), marketing 34 (4%), finance 82 (10%), healthcare 107 (14%), consulting 50 (6%), economics 8 (1%), government 92 (12%), business 630 (80%), management 525 (67%), supply chain 40 (5%), and business administration 35 (4%). All these skills are clearly important for systems analyst recruiters but aren't mentioned anywhere in the MIS core curriculum. They would be best suited to replace 75% of this course.

**Interesting statistics**

Job postings mentioned Master's degree 25 times, Ph.D. 0, Bachelor's 487 times (16%), high school 62 (8%), Associate's 44 times (6%), and certification 214 times (27%). No specific certification was mentioned more than twice.

Passion was mentioned in 14% of postings and integrity was mentioned 13%.

Solutions was mentioned 525 times (67%), while problems were mentioned 423 times (54%).

Liaison was mentioned 108 times, 14% of postings. A significant majority of times it requested serving as liaison between a technology aspect with business aspect.

Windows was mentioned 85 times (11%), Linux was mentioned 33 times (4%), and Apple 10 times.

Business was mentioned 630 times (80%), while technology was mentioned 435 times (55%). However, 19/21 courses are more technical than business.

Travel was mentioned in 17% of jobs, total of 130 times.

Information Systems was mentioned 193 times (25%), while computer science 245 times (31%), management information systems 40, and engineering 185 times (24%). This may indicate that employers would rather hire a more technical candidate. It could also indicate that employers are content with information systems majors for the systems analyst job. Considering the systems analyst career is the middle ground in terms of careers an information systems graduate can pursue, this is troubling.

| Skills | % of Postings | # of courses |
|---|---|---|
| Some skills that are missing: | | |
| Compliance | 14% | - |
| Customer Service | 14% | - |
| Healthcare | 14% | - |
| Microsoft Office | 13% | - |
| Government | 12% | - |
| Accounting | 11% | - |
| Finance | 10% | - |
| Oracle | 10% | - |
| Technical Support | 10% | - |
| PowerPoint | 8% | - |
| Test Plans | 8% | - |
| Cleaning Procedures | 7% | - |
| Detail-Oriented | 7% | - |
| Excel | 7% | - |
| SAP | 7% | - |
| Salesforce | 5% | - |
| Supply Chain | 5% | - |
| Workday | 5% | - |
| Business Admiration | 4% | - |
| Marketing | 4% | - |
| Word | 3% | - |
| Interviewing | Every job | - |
| Resume | Every job | - |
| Some skills that are taught too little: | | |

| | | |
|---|---|---|
| Many soft skills listed above | 100% | 1 |
| Requirements | 81% | 4 |
| Business | 80% | 6 |
| Application | 72% | 4 |
| Documentation | 67% | 3 |
| Testing | 60% | 4 |
| Communication | 60% | 3 |
| Operations | 48% | 3 |
| Training | 46% | 1 |
| Implementation | 46% | 2 |
| SQL | 30% | 3 |
| Database | 28% | 2 |
| Informaiton Technology | 27% | 2 |
| Research | 25% | 1 |
| Configuration | 25% | 2 |
| Troubleshooting | 21% | 2 |
| Business Processes | 20% | 1 |
| Hardware | 19% | 2 |
| Recommendations | 18% | 1 |
| Collaboration | 13% | 1 |
| Business Analysis | 10% | 1 |
| Functional Requirements | 10% | 1 |
| Systems Analysis | 10% | 1 |
| Data Analysis | 9% | 2 |
| ERP | 7% | 1 |
| System Integration | 4% | 1 |
| Some skills being taught too much | | |
| Software | 60% | 7 |
| Planning | 25% | 4 |
| Network | 23% | 3 |
| Agile | 17% | 4 |
| Risk | 15% | 4 |
| Architecture | 14% | 3 |
| Coding | 12% | 5 |
| Innovation | 10% | 2 |
| Java | 7% | 3 |
| Scrum | 6% | 4 |
| SDLC | 6% | All |
| Python | 4% | 4 |
| User Interface | 3% | 1 |
| Waterfall | 3% | 3 |
| Cybersecurity | 2% | 7 |
| Emerging Technologies | 1% | 2 |
| SOLID Principles | - | 3 |

Many small skills like data science, big data, decomposition, cloud, everything previously stated were mentioned 0%, but were still in the curriculum. I won't detail it again here, but each class analysis contains skills that weren’t mentioned at all. Ultimately, if a skill wasn’t mentioned once by employers but in the curriculum, its overtaught.

# Chapter 5 - Conclusion

**Systems Analyst and IS graduates anticipated careers:**

The systems analyst career is just one career considered by ACM when making their curriculum recommendation; there are at least 30 more potential career paths that MIS graduates can pursue. Management Information Systems (MIS) can be considered a basket, where any career that combines some technology and business gets thrown into. The nature of the degree makes it extremely difficult for ACM to create a recommendation that helps everyone.

College has one responsibility- to prepare graduate for their career. Students pay a large amount of money so they can achieve an education that prepares them for their career. It‘s not my intention to criticize ACMs efforts, but, it’s their responsibility to put forward the most efficient/effective curriculum.

A curriculum gets recommended once every 10 years, even though technology changes at a much more rapid pace. Tons of time, money, resources, and effort gets put into recommending a curriculum. For universities to stay up to date, the process must be automated. And I propose the answer to the problem is the methodology that has been laid out in the my research.  At the core of the methodology is the use of artificial intelligence, specifically SPSS-text mining, which would provide more current curriculum recommendations.

As my forty-five plus page report shows, this curriculum does not do an adequate job in preparing graduates for a systems analyst career. There is a material amount of information that is missing, information that is redundant, and a significant amount of information that is inadequately covered. It may prepare other careers adequately, but not the systems analyst, which is in the middle as the ACM-made graphic shows (Page 24).

**Recommended solution:**

It's appropriate for the MIS curriculum to be considered a basket, but I think it needs to be organized to achieve maximum efficiency. Compare it to going grocery shopping for a large BBQ. You can either bring someone and use two carts (2 different degrees), or you can organize the cart and use the space effectively. Its impossible to effectively recommend a curriculum that adequately prepared graduates for over 30 careers. So, I believe that ACM should begin to recommend concentrations for the MIS curriculum. Below is a concept of what the concentrations could include. I believe my

research serves as a strong proof of concept and the methodology is easy to replicate. Important skills can be identified through this methodology. Careers can be determined by eCF.

The concentrations can include:

**MIS-Business**: For graduates pursuing careers like business analyst, account manager, business information manager, chief information officer, digital media specialist and enterprise architect, ICT operations manager and more careers focused on business utilizing technology to improve processes.

**MIS-Database**: For graduates pursuing database administrator, systems analyst, network specialist, project manager and more database/query related careers.

**MIS-Developer**: For graduates pursuing more technical careers, including service desk assistant, technical specialist, developer, system administrator, web developer test specialist, and more technical-oriented careers.

**MIS-Data Analytics**: For graduates pursuing data analyst, digital marketer, big data engineer, logistician, market research analyst, operations research analyst, business intelligence analyst, data scientist, data engineer, and other data analytics careers.

**MIS-Cybersecurity**: For graduates who want to pursue careers like ICT security manager, ICT security specialist, risk consultant, security system administrator, penetration tester, information security associate, cryptographer, cryptanalyst, and more cybersecurity careers.

The MIS degree has evolved to a point where it is too expansive, and it has come time to split the degree as outlined above. There is too much to fit in a degree that is supposed to prepare graduates for over 30 careers. It needs to be broken up. There should be a few introduction courses that all of these concentrations require. These courses can be taken Freshman and Sophomore year and introduce them to various topics. After students determine what they're interested in, they can choose a concentration.

**Other curricula:**

This methodology can be used for understanding what all employers want, that goes beyond systems analyst, or even technology related jobs. There is only one variable, and that’s what job title is put into the Indeed.com job scraper. If someone wanted to figure out what skills, knowledge, or attributes police departments look for in their officers, to follow this methodology they would only need to change the job title from "systems analyst" to "police officer" and use the SPSS stream provided.

**Possible Job Seeker use:**

If a young person wanted to be a chemist when they got older, they could use this methodology as well. They would simply change the job title input from "systems analyst" to " chemist." This can show the person what skills, certification, degree, knowledge, experience, and other trends that employers are looking for in a chemist.

This tool can even be developed to figure out hot words that people had in their resumes, that allowed them to get hired.

**Possible Employer use:**

This tool can be used by employers to sort resumes. It can show common trends in the quality of people applying, and what skills they may have that's irrelevant or relevant. This could possibly allow employers to update their job descriptions to attract more appealing candidates. It can also serve as screening to only allow resumes with certain key words to get to their desk. For instance, if a recruiter wanted a candidate with an excel certification, they can filter out resumes that don't have it on there.

**Possible problem with this Methodology:**

Employers may be too general in their job descriptions and not list specific skills. This methodology is a quantitative study that shows words that appear the most. A qualitative study can be used after to break down the more generalized words into specific skills. This can be done through surveys, or properly sampled interviews and focus groups.

A second issue with this methodology is that it only looks at the current employer wants and past wants, it doesn't predict what will be needed in the future. When creating a curriculum recommendation, a qualitative study may be needed in addition to this methodology to predict future knowledge.

**An idealistic solution to the problem with this methodology:**

Preferably, Indeed.com or similar job search website should give a prompt for employers to be more specific on job descriptions. If the job descriptions were better written, AI could be more effectively used to filter resumes. It will give universities an opportunity to tailor to employers wants, it will produce a higher quality education, which would produce a higher quality workforce. It's a small and easy thing for employers to do, and the outcome would be tremendously positive. It would be interesting if employers were incentivised to be more specific in their wants. Maybe they can offer checkboxes that employers select with what skills they are looking for in the position.

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