Volume 9, No. 2
June 2011
ISSN: 1545-679X

INFORMATION SYSTEMS EDUCATION JOURNAL

In this issue:

4. **Are Password Management Applications Viable? An Analysis of User Training and Reactions**
Mark Ciampa, Western Kentucky University

14 **A 'Rainmaker' Process for Developing Internet-based Retail Businesses**
Alan S. Abrahams, Virginia Tech
Tirna Singh, Virginia Tech

27 **Texting and the Efficacy of Mnemonics: Is Too Much Texting Detrimental?**
Randy Ryker, Nicholls State University
Chuck Viosca, Nicholls State University
Shari Lawrence, Nicholls State University
Betty Kleen, Nicholls State University

34 **Cloud Computing in the Curricula of Schools of Computer Science and Information Systems**
James P. Lawler, Pace University

55 **IS/IT Education vs. Business Education: The Plight of Social Collapse in Technical Business Environments**
Brian Hall, Champlain College

65 **Incorporating Capstone Courses in Programs Based upon IS2010 Model Curriculum**
Ken Surendran, Southeast Missouri State University
Dana Schwieger, Southeast Missouri State University

75 **Predicting Success in the Introduction to Computers Course: GPA vs. Student's Self-Efficacy Scores**
Joseph T. Baxter, Dalton State College
Bruce Hungerford, Dalton State College
Marilyn M. Helms, Dalton State College

95 **Impact of Pre-Grading / Resubmission of Projects on Test Grades in an Introductory Computer Literacy Course**
Thomas N. Janicki, University of North Carolina Wilmington
Judith Gebauer, University of North Carolina Wilmington
Ulku Yaylacicegi, University of North Carolina Wilmington

101 **Design, The "Straw" Missing From the "Bricks" of IS Curricula**
Leslie J. Waguespack, Bentley University

EDSIG
Serving Information Systems Educators

The **Information Systems Education Journal** (ISEDJ) is a double-blind peer-reviewed academic journal published by **EDSIG**, the Education Special Interest Group of AITP, the Association of Information Technology Professionals (Chicago, Illinois). Publishing frequency is quarterly. The first year of publication is 2003.

ISEDJ is published online (http://isedjorg) in connection with ISECON, the Information Systems Education Conference, which is also double-blind peer reviewed. Our sister publication, the Proceedings of ISECON (http://isecon.org) features all papers, panels, workshops, and presentations from the conference.

The journal acceptance review process involves a minimum of three double-blind peer reviews, where both the reviewer is not aware of the identities of the authors and the authors are not aware of the identities of the reviewers. The initial reviews happen before the conference. At that point papers are divided into award papers (top 15%), other journal papers (top 30%), unsettled papers, and non-journal papers. The unsettled papers are subjected to a second round of blind peer review to establish whether they will be accepted to the journal or not. Those papers that are deemed of sufficient quality are accepted for publication in the ISEDJ journal. Currently the target acceptance rate for the journal is about 45%.

Information Systems Education Journal is pleased to be listed in the 1st Edition of Cabell's Directory of Publishing Opportunities in Educational Technology and Library Science, in both the electronic and printed editions. Questions should be addressed to the editor at editor@isedj.org or the publisher at publisher@isedj.org.

Information Systems Education Journal

Cloud Computing in the Curricula of Schools of Computer Science and Information Systems

James P. Lawler
lawlerj@aol.com
Pace University
New York, New York 10038, USA

Abstract

The cloud continues to be a developing area of information systems. Evangelistic literature in the practitioner field indicates benefit for business firms but disruption for technology departments of the firms. Though the cloud currently is immature in methodology, this study defines a model program by which computer science and information systems students can learn needed skills in cloud computing strategy and technology. The study emphasizes problem-solving skills relative to elements of performance, process and security of cloud computing systems that are limiting investment in the cloud computing paradigm. This study benefits educators in schools of computer science and information systems considering curricula enhancement for the cloud and will also benefit technology departments of firms that will be needing skilled students once cloud computing becomes mainstream in industry.

Keywords: business process management (BPM), cloud, cloud computing, cloud service provider (CSP), computer science and information systems curricula, infrastructure-as-a-service (IaaS), platform-as-a-service (PaaS), program management methodology, service-oriented architecture (SOA), software-as-a-service (SaaS)

1. INTRODUCTION

Cloud computing is defined as:

> "Model of computing for enabling convenient, on-demand network access to a shared pool of configurable computing resources, [including] networks, servers, services, storage and [systems] that can be provisioned rapidly and released with minimal management effort or [cloud] service provider [CSP] interaction" (National Institute of Standards and Technology [NIST], 2009); or

> "Style of computing where elastic and scalable [technology] enabled [resources] are delivered as a service to external [clients through] Internet technologies (Smith et.al., 2009, p. 22)."

Cloud computing is delivered in high level models of the following:

> Infrastructure-as-a-Service (IaaS), furnishing on-demand services, such as CPU, networking and storage (e.g. Amazon – Elastic Compute Cloud / EC2 [hardware]);

> Platform-as-a-Service (PaaS), furnishing services, such as application framework and development tools to deploy, host and maintain systems (e.g. Google – App Engine or Microsoft Azure [software and tools]); and

> Software-as-a-Service (SaaS), furnishing pay-as-you-go remote services to deploy, host and manage network systems accessible to clients on the Internet (e.g. Cisco WebEx, Google

Mail, or salesforce.com [systems]) (Yachin and Patterson, 2009).

Cloud computing might be concurrently considered as delivered in models of application-as-a-service, database-as-a-service, information-as-a-service, infrastructure-as-a-service, integration-as-a-service, management-as-a-service, platform-as-a-service, process-as-a-service, security-as-a-service, storage-as-a-service and testing-as-a-service (Linthicum, 2010, p. 11).

Cloud computing is deployed either as a public (CSP) cloud, a private (business firm behind firewall of firm) cloud, or a hybrid of public and private clouds (National Institute of Standards and Technology, 2009). Features of the cloud are effectively in fast elasticity for faster resource scalability, increasingly on-demand resource self-service, location-independent pooling of resources in a multi-tenant or single tenant plan, pay-as-you-go for resource subscription, and ubiquitous network access of the resources. Cloud is essentially an evolution of autonomic computing, clustering, grid computing, utility computing and virtualization that includes connectivity to resources and services hosted on the cloud of the Internet instead of on local technology (CIO, 2009). Literature indicates the cloud to be the latest major phase in information technology (Neal, Moschella, Masterson and O'Shea, 2009, p. 4), though it is not a new technology (Conry-Murray, 2009).

Cost efficiency is a cited benefit of cloud computing because business firms may not have to buy further hardware and software (McMillan, 2009) or further invest in generic systems if not internal staffing – a capital expense model vs. a operational expense model, especially in data center server virtualization and in the public cloud (Babcock, August, 2009). Effectiveness in faster deployment of features of current or new systems for frameworks in the cloud – cloud-as-service (CaaS) – might improve the business operations platforms or business processes of firms (Fingar, 2009) as they respond to customers in the marketplace (Neal, Moschella, Masterson and O'Shea, 2009, p. 40). Firms may not have to further invest in flexible infrastructure if resource scalability of systems is managed in the cloud in minutes during peak periods (Hurwitz, Bloor, Kaufman and Halper, 2010), and they may not have to invest in over-provisioning of systems in non-peak periods (Reese, 2009), furnishing processing responding to the market. Functionality of the infrastructure if not innovation of leading edge technology might be a benefit to business firms leveraging services of the cloud (Akamai, 2009). Literature indicates the cloud to be beneficial especially for medium and small-sized firms (i.e. <$500 million in revenue) that do not have funds for investing in large-sized infrastructures or innovative methods (Gage, 2009).

Estimates indicate that 31% of business firms considered cloud computing in 2008 (Babcock, November, 2009, p. 2), but 52% of firms considered if not dedicated funds to the cloud in 2009 (Korzeniowski and Jander, 2009, p. HB14). Deployments of firms are expected to be increasing 66% in IaaS, 63% in SaaS and 59% in PaaS in 2010 (Greengard, 2009), and 31% of firms indicated SaaS to be the highest investment in the cloud since 2008 (Dubey, Mohiuddin, Rangaswami and Baijal, 2009). Deployments are higher on private clouds instead of public clouds (Babcock, April, 2009) and are expected to be higher into 2012 (Burt, 2009). Deployments of cloud computing are expected to be a $160 billion market in 2012 (Crossman, 2009) in a growth of 25% of all incremental investment in technology in 2012 – a growth indicated to be the largest since the Internet (Hamm, 2009). Cloud computing is clearly considered to be developing as an enabling model for improving the processes of firms, such that schools of computer science and information systems might include it in curricula.

2. BACKGROUND

Despite the bullish estimates on cloud computing, 48% of business firms in the earlier forecasts have not considered nor dedicated funds to the cloud (Korzeniowski and Jander, 2009, HB14) as of the first quarter of 2010. Exclusive of cloud service provider (CSP) technology firms, business firms are hesitant in investing in cloud computing, due to concern on governance and maturity (Kontzer, November, 2009). Frequently indicated in the literature are problems of integration of non-cloud services and systems, performance of cloud systems, privacy of proprietary information in cloud infrastructures and systems, and risk and security of cloud technology (Korzeniowski and Jander, 2009, p. HB5). 63% of business firms indicated performance, and 75% indicated security, as major problems in migrating systems to the cloud (Waxer, 2009), and firms further indicated hesitancy in forecasting cost savings from cloud computing systems

(Johnson, 2009). Cloud essentially is in its infancy, as indicated in Figure 1 of the Appendix.

Governance of cloud computing services is in its infancy (Linthicum, August 31, 2009). Integration of cloud delivered services and non-cloud on-premise services and systems, in an effective mix of processes, is a concern for business firms in the management of processes serviced by non-cloud and cloud systems (Smith et.al., 2009, p. 10). Performance of the cloud continues to be a concern for firms, as indicated in non-reliability of systems of CSP IaaS and PaaS technology firms (Linthicum, August 21, 2009). Portability of systems resident with CSPs is an issue (Linthicum, November, 2009). Protection and security of cloud information and infrastructure of systems, in conformance with firm controls, metrics, governmental regulations and industry standards defined on non-cloud systems, are especially indicated to be a problem of CSP systems (Rash, 2009). Neither performance nor security of public cloud systems is managed by internal technology departments of the business firms, a further problem. Though governance might furnish standards in the management of integration and interoperability of non-cloud and cloud systems, the performance of cloud systems and the security of cloud technology, standards are not currently established for the cloud (Korzeniowski, 2009). This immaturity of the cloud is limiting investment in cloud computing systems, except for certain SaaS systems (CIO Insight, 2009).

Though the cloud is in its infancy, business firms, especially large-sized firms, might experiment in cloud computing services if circumstances fit for them. Firms might explore the cloud if information, processes and services are independent of other information, processes and services and if they are new systems; if information, processes and services in the cloud are easy in integrating with non-cloud on-premise information, processes and systems and with cloud systems; if infrastructure is fully functional for non-cloud systems; if platform is Internet with a browser non-native interface to the Web; and if security is not a high requirement (Linthicum, 2010, p. 33). Inevitably firms might explore a hybrid of public and private cloud systems (Babcock, September, 2009), as competitive firms explore the cloud and as CSP technology firms improve maturity of standards and the offerings of the technology. Literature is indicating the cloud to be a "potentially game-changing technology" (Kontzer, August, 2009) for technology departments of business firms. In order to invest in a cloud computing plan, the technology departments of the firms might have to further invest in the skills of its staff (Babcock, November, 2009, p. 1) – skills in cloud computing strategy and in technology. This study introduces a model program of skills that might be integrated into the curricula of schools of computer science and information systems that will be furnishing the future staff of technology departments in the firms.

3. FOCUS

The focus of this study is to define a model program by which educators in computer science and information systems might instruct students in the skills needed in cloud computing strategy and in the technology.

The model program is an enhancement to an earlier model on business process management (BPM), program management methodology and service-oriented architecture (SOA) published by the author (Lawler, Benedict, Howell-Barber and Joseph, 2009), and is founded on this earlier model, inasmuch as SOA facilitates a foundation for cloud computing systems (Krill, 2009). The program is also an enhancement to the IS Curriculum Model, furnishing business, analytical, inter-personal and technical skills. The model program of this study is especially focused on interactions of internal technology departments and business departments of business firms in initiatives of cloud computing. It is focused on potential problem-solving skills relative to performance and reliability, and privacy, risk and security, of infrastructure-as-a-service (IaaS), platform-as-a- service (PaaS) and software-as-a-service (SaaS) public, private and hybrid cloud computing systems. It is further focused on regulatory requirements on the systems. Few publications have focused on an integrated model program for learning skills needed in a cloud computing strategy (Beard, 2009) - often publications have focused on problematic technology (Silverstone, 2010).

This study will benefit instructors in schools of computer science and information systems considering curricula enhancement for cloud computing strategy and technology, and it will benefit indirectly technology departments of firms that will need skilled students as the departments brace for the disruption of their organizations envisioned by cloud pundits (Carr, 2009).

4. METHODOLOGY

From July 2009 to March 2010, the author of this study, who is of the Seidenberg School of Computer Science and Information Systems of Pace University in New York City, conducted a literature survey of practitioner publications (e.g. Computerworld) on experimental projects of business firms relative to cloud computing. The projects were indicated to be infrastructure-as-a-service (IaaS), platform-as-a-service (PaaS) or software-as-a-service (SaaS) public, private or hybrid systems in small and medium-sized firms (i.e. <$500 million in revenue in 2008) and large-sized firms (i.e. >$500 million in revenue in 2008). The features of the projects were indicated to be those of cloud computing systems: fast elasticity for faster resource scalability, location-independent pooling of resources in a multi-tenant or single tenant plan, on-demand resource self-service, pay-as-you-go for resource subscription and / or ubiquitous network access of the resources (National Institute of Standards and Technology, 2009), as was feasible to learn from the publications. The author concurrently conducted a survey of publications of cloud computing provider (CSP) technology firms on recommendations relative to cloud computing, but filtered the findings for hype and bias by including technology-agnostic recommendations relative to the cloud from publications of leading technology consulting organizations (e.g. Gartner Group). All information and recommendations from all of the publications of the survey were further filtered for creditability and feasibility by a colleague of the author who is a technology-agnostic industry practitioner.

The cloud computing projects of the business firms and the technology firms, including the recommendations of the technology firms and the technology consulting organizations, discerned from the practitioner publication survey were evaluated by the author for apparent skills applied, or not applied but needed, by the firms on the systems. The author identified business, analytical, inter-personal and technical skills to the systems from his earlier model on business process management (BPM), program management methodology and service-oriented architecture (SOA) (Lawler, Benedict, Howell-Barber and Joseph, 2009), which was founded on the IS Curriculum Model. He included courses from the earlier model and other courses or modules relative to cloud computing to the applied or needed skills, as to the scope of skills technology departments of business firms might need in computer science and information systems students studying cloud strategy and the technology. He further evaluated the curricula of the Seidenberg School, and other schools of computer science and information systems in the northeast corridor of the country, as to the scope of teaching cloud topics. Most of the other schools have however limited programs in cloud topics.

The model program on cloud computing is presented in the next section of this study.

MODEL PROGRAM FOR CLOUD COMPUTING

The model program for cloud computing proposed for the curricula of computer science and information systems consists of business, culture, methodology, research and technology course modules, whose contents correspond to the domain fundamentals, foundational knowledge and skills, and information specific knowledge and skills of the IS 2009 Curriculum Model. The contents of a number of the modules correspond moreover to the contents of the earlier 2008 service-oriented architecture (SOA) model (Lawler, Benedict, Howell-Barber and Joseph, 2009). The program may begin with a mix of modules for freshman students in year 1 and continue with a further mix of modules for sophomore, junior and senior students in years 2, 3 and 4, dependent on other non-cloud computing modules of the established curricula.

The business modules displayed in Table 1 in the Appendix are essentially focused on business process management (BPM) and cloud computing inter-dependency.

The culture modules in Table 2 are focused on the impact of cloud computing on the culture of business firm organizational staff, including the internal technology department staff.

The methodology modules in Table 3 are focused on cloud computing and service-oriented architecture (SOA), and on frameworks of program management methodology, for managing cloud computing projects with organizations teams.

The research modules in Table 4 furnish industry practices on the projects, as learned from practitioner publications and if feasible from industry project internships.

The technology modules in Table 5 furnish a sampling of technologies, tools and utilities and a sampling of standards that might be applied on pseudo projects by students.

Several of the technologies, tools and utilities might be granted by the technology firms to the schools through partnerships with the universities (National Science Foundation, 2009 and Yahoo!, 2009).

Finally, the program might be enhanced for inclusion of cloud architect, cloud developer, cloud engineer, cloud project manager and cloud strategist career tracks in business client firms, as furnished in Table 6 of the Appendix, inasmuch as the literature of practitioner publications indicates a demand for professionals if not students in the tracks in Table 6.

5. IMPLICATIONS

"Cloud Computing is more of an opportunity than a threat. Ignore an opportunity long enough, it becomes a threat." (Boreel, 2008)

The model program defined for educating on cloud is designed on the foundation that cloud computing is currently a durable initiative. Firms in industry continue evolving on incremental methods and projects on the cloud on the implication that cloud computing is the future, but firms have to begin learning cloud computing skills in order for the cloud to be the future (Erlanger, 2009, p. 3). The model program is formulated on the implication that the curricula of computer science and information systems might be current with experimental if not holistic projects of the firms in the inclusion of cloud computing strategy and technologies, so that students might learn marketable skills in tandem with industry.

The model program is founded on the implication that business process management (BPM) is essential in a cloud initiative. Firms have to include particular process requirements in cloudification initiatives (Vizard, 2009), so that innovation investment is maximized on the cloud (Mitchell, 2009). Literature indicates a movement of the profession from the technical requirements to business process requirements (Erlanger, 2009, p. 2). Technologists have to learn more business skills than technical skills. The model program is formulated on the implication that students might learn more business skills, along with the nuts and bolts the technologies.

The model program is further founded on the implication that governance is important in the management of a cloud computing initiative. Governance in the cloud is not distinct from governance in service-oriented architecture (SOA) except for the increased risk management of cloud projects, services and systems, especially public systems, relative to performance, process and security on the cloud. Governance does the ownership and provisioning of services on cloud and non-cloud external and internal systems (Worthington, 2009). Firms might formalize governance in a program management methodology. The program in the study is formulated on the implication that students might learn program management methodology skills that integrate project management techniques.

The model program is formulated moreover on the implication that service orientation is important in the initiative of a cloud computing strategy. SOA might have furnished a foundation of a platform of "on demand" services for a cloud computing strategy (Krill, 2009) that includes non-cloud and cloud systems. The program is formulated on the implication that students might learn service orientation skills and SOA as a prerequisite to studying cloud computing topics.

Lastly, *the model program for cloud computing is flexibly formulated on the implication that the courses and modules of study might have to be improved for the manner in which firms in industry migrate to the cloud*. Small-sized firms might move into the cloud with their own practices and systems as early as 2010, but large-sized firms might move noticeably into the cloud with their strategies and systems as late as 2011 – 2012 (Smith et.al., 2009, p. 10). Technology firms will move into the field with next-generation technologies that ostensibly suit cloud computing themes (Global Services, 2009). Standards will be new too. The proposal of this study is formulated on the implication that cloud will be a journey, with numerous paths that will require the flexibility of instructors in schools of computer science and information systems that pioneer in programs for improving the cloud computing skills of students, inasmuch as cloud computing is considered now one of the top technologies of 2010 (Currier, 2009).

6. LIMITATIONS AND OPPORTUNITIES IN RESEARCH

This study is constrained by the current immaturity of initiatives in the cloud. Most of the documented projects are software-as-a-service (SaaS) systems, are not public but private systems, and are of small and medium-sized firms not large-sized firms, and if in large-sized firms are not perceived to be strategic systems; and most schools of computer science and information systems do not have a model program for cloud computing strategy and technology. The publication survey of firms in the 2009 – 2010 study might be followed up by a case study of a firm or firms in a new 2011 – 2012 study, once firms further invest in initiatives in cloud computing of higher complexity, as in hybrid or public systems, or in strategic systems. The evolving field of cloud computing is ideal for a planned research study, from which results will be even more helpful to schools of computer science and information systems and to technology departments of firms.

7. CONCLUSION

This study of the cloud can be beneficial to instructors considering enhancement of the curricula of computer science and information systems. The model program defined for cloud computing in the study is founded on a model of business process management (BPM), program management methodology and service-oriented architecture (SOA) that can improve the IS Curriculum Model. Though cloud computing systems and standards are currently in an immature stage, students might learn problem-solving skills relative to performance, process and security that might be eventually helpful to technology departments of firms that will need the skills once cloud computing becomes mainstream in the market. Further planned research on initiatives in the cloud will be helpful in improving the model program of the study. This study furnishes a framework for the further research.

8. REFERENCES

Babcock, C. (2009). Why 'private cloud' computing is real – And worth considering. *Information Week*, April 11,1,5.

Babcock, C. (2009). 2 in 3 information technology (it) managers have cloud funding. *Information Week*, August 25, 1-2

Babcock, C. (2009). Hybrid clouds: No easy concoction. *Information Week*, September 5, 1.

Babcock, C. (2009). How cloud computing changes information technology organizations. *Information Week*, November 28, 1-2.

Beard, H. (2009). Cloud Computing Best Practices for Managing and Measuring Processes for On-Demand Computing, Applications and Data Centers in the Cloud with Service Level Agreements (SLAs). Office of Government Commerce, London, United Kingdom.

Akamai and cloud computing: A perspective from the edge of the cloud", (2009). *Akamai White Paper*, 1.

Boreel, M. (2008). Our collaboration platform Sogeti. *Sogeti Group*, April.

Burt, J. (2009). Enterprises will invest in private clouds first: Gartner. *eWeek*, December 1, 1.

Cameron, B., & Purao, S. (2009). Enterprise integration: An experiential learning model. *Proceedings of the Information Systems Education Conference (ISECON)*, Washington, D.C., November, 1,5.

Carr, N. (2009). The many ways cloud computing will disrupt information technology (it). *Infoworld*, March 26, 3.

Cloud, defined, (2009). *National Institute of Standards and Technology (NIST), Information Technology Laboratory*, Draft Definition, Version 14.

Conry-Murray, A. (2009). From Amazon to IBM, what 12 cloud computing vendors deliver. *Information Week*, September 5, 1.

Crosman, P. (2009). Securing the clouds. *Wall Street and Technology*, December, 23.

Currier, G. (2009). On the rebound: Cloud computing and new mobility technologies gain focus as information technology (it) executives look beyond cost-cutting to new productivity and growth opportunities. *CIO Insight*, December, 29.

Dubey, A., Mohiuddin, J., Rangaswami, MR., & Baijal, A. (2009). Enterprise software survey 2008. *McKinsey and Company and Sandhill Enterprise Software*, February 18.

Erlanger, L. (2009). The tech[nical] jobs that the cloud will eliminate. *Infoworld*, July 22, 2,3.

Fingar, P. (2009). Dot.Cloud: The 21st Century Business Platform. Meghan-Kiffer Press, Tampa, Florida, 27.

Forecast: Cloud computing looms big on the horizon, (2009). *CIO*, CIO Focus, White Paper.

Gage, D. (2009). Big software: Finally dead?. *CIO Insight*, October, 15.

Greengard, S. (2009). Trends for 2010: Piecing together a strategy. *Baseline*, December, 18.

Hamm, S. (2009). Cloud computing: Big bang for business. *Business Week*, June 15, 044.

Hurwitz, J., Bloor, R., Kaufman, M., & Halper, F. (2010). Cloud Computing for Dummies. Wiley Publishing, Indianapolis, Indiana, 15.

Johnson, C. (2009). Hazy prospects for cloud services: Information technology (it) buyers uncertain about benefits, more worried about security. *CIO*, September 1, 28.

Kontzer, T. (2009). The cloud steps up to the plate: Cloud-enabled services emerge as a replay of the internet's rise as a business tool. Anything as a service (xaas) is a potentially game-changing technology that could reshape information technology (it). *CIO Insight*, August, 45,48.

Kontzer, T. (2009). The cloud's sky-high hype: The buzz around cloud computing is alive and well. But chief information officers (cios) need to proceed carefully – and make sure they have the right understanding of what the 'cloud' actually is'. *CIO Trends*, November, 22.

Korzeniowski, P. (2009). Cloud standards are a work in progress. *Information Week*, November 9, HB8.

Korzeniowski, P., & Jander, M. (2009). Cloud security: Business users see cost savings from cloud computing, so they are finding ways to get past this number 1 concern. *Information Week*, November 9, HB5,14.

Krill, P. (2009). SOA gets an obituary. *Infoworld,* January 5, 2.

Lawler, J.P., & Howell-Barber, H. (2008). Service-Oriented Architecture: SOA Strategy, Methodology and Technology. Taylor & Francis Group, Boca Raton, Florida, 27-59.

Lawler, J.P., Raggad, B., & Howell-Barber, H. (2008). Methodology for educating information systems students on the new paradigm of service-oriented architecture (soa) Technology. *Information Systems Education Journal*, 6(52), 3-10.

Lawler, J.P., Benedict, V., Howell-Barber, H., & Joseph, A. (2009). Critical success factors in the planning of a service-oriented architecture strategy for educators and managers. *Information Systems Education Journal*, 7(94), 26-30.

Linthicum, D. (2009). Which cloud platforms deliver reliable service?. *Infoworld*, August 21, 1.

Linthicum, D. (2009). Service governance for the cloud: Ignore at your peril. *Infoworld*, August 31, 1-2.

Linthicum, D.S. (2009). Application design guidelines for cloud computing. *Infoworld*, November 17, 2.

Linthicum, D.S. (2010). Cloud Computing and SOA Convergence in Your Enterprise: A Step-by-Step Guide. Pearson Education, Boston, Massachusetts, 11,33.

McMillan, R. (2009). Researchers find a new way to attack the cloud. *Infoworld*, September 3, 1.

Mitchell, R.L. (2009). Wrapped in complexity: One-off integrations lead to trouble as saas use multiplies. But information technology (it) will get help this time. *Computerworld*, March 23, 23.

Moore, G. (2002). Crossing the Chasm: Marketing and Selling Disruptive Products to Mainstream Customers. HarperCollins Publishers, New York, New York.

National Science Foundation awards millions to fourteen universities for cloud computing research, (2009). *National Science Foundation Press Release*, April 23, 1-6.

Neal, D., Moschella, D., Masterson, M., & O'Shea, D. (2009). Doing business in the cloud – Implications for cost, agility and innovation. *CSC*, White Paper, August, 4,11,40.

Providers look to refine value of their cloud services: Report, (2009). *Global Services*, August 5, 2.

Rash, W. (2009). Is cloud computing secure? Prove it: The cloud can be a secure place for meeting your information technology (it) needs, but proving it is another matter entirely. *eWeek*, September 21, 8.

Reese, G. (2009). Cloud Application Architectures: Building Applications and Infrastructure in the Cloud. O'Reilly Media, Sebastopol, California, 12.

Silverstone, A. (2010). Clearer definition, new metrics for cloud security. *CSO*, January / December, 30-31.

Smith, D.M. et.al. (2009). Hype cycle for cloud computing, 2009. *Gartner Research Note*, July 16, 10, 22.

Topi, H., Valacich, J.S., Kaiser, K., Nunamaker, J., Sipior, J.C., & de Vreede, G. et.al. (2009). IS 2009: Curriculum Guidelines for Undergraduate Degree Programs in Information Systems. Association for Computing Machinery (ACM) and Association for Information Systems, New York, New York and Atlanta, Georgia.

Vizard, M. (2009). How to build private clouds: The challenge is to determine how to recast internal information technology (it) operations into more of a service Model. *Baseline*, May, 16.

Waxer, C. (2009). Can you trust the cloud?: Outages at a cloud computing service could hurt your business. The question is whether your in-house systems can do better. *Computerworld*, May 25 / June 1, 24.

Where does hype end and reality begin with cloud computing? (2009). *CIO Insight*, October 23, 1.

Woodward, B., Sendall, P., & Ceccucci, W. (2009). Integrating soft skill competencies through project-based learning across the information systems curriculum. *Proceedings of the Information Systems Education Conference (ISECON)*, Washington, D.C., 2.

Worthington, D. (2009). Governance in the cloud less than hazy. *SD Times*, May 15, 22.

Yachin, D., & Patterson, R. (2009). Market & analysis overview: Cloud computing. *IDC White Paper*, September, 1.

Yahoo! partners with four top universities to advance cloud computing systems and applications research, (2009). *Yahoo! Finance Press Release*, April 9, 1.

APPENDIX

Figure 1: Adoption of Cloud Computing in 2010

Source: Neal, Moschella, Masterson and O'Shea, 2009 [Adapted from Moore, 2002]

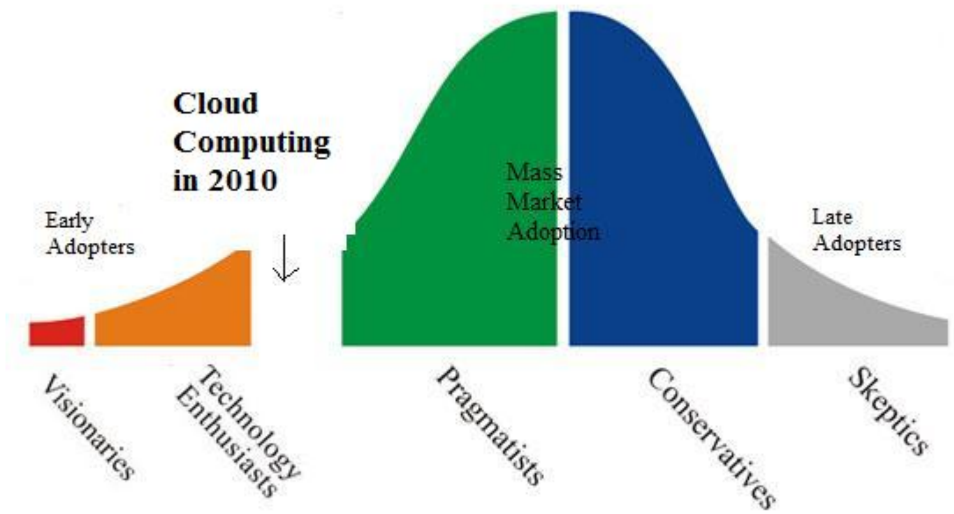

Table 1: Model Program for Cloud Computing – Business Module

Module (Topics)	Content (Examples)		IS 2009 Knowledge Areas *					Year
			General Computing	Domain	Foundational	Information Specific		
Business								
Business Process Management (BPM)	Business Objectives Critical Few Objectives (CFOs) Customer Centricity-Problems in Processes Competitive Differentiation of Core Processes Strategic Performance Management – Process Thinking			x		x		1
Business Process Management (BPM) and Cloud	Candidate Data, Processes and Services for Cloud Computing Cloud Computing Cost Model			x		x		1
Cloud Deployments of Processes	Private Cloud Public Cloud Hybrid Cloud					x		1
Cloud Models	Infrastructure-as-a-Service (IaaS) Platform-as-a-Service (PaaS) Software-as-a-Service (SaaS)					x		1
Industry Regulations	Gramm-Leach-Biley Act (GLBA) Health Insurance Portability and Accountability Act (HIPPA) Statement on Auditing Standard 70 (SAS-70)			x				4

*Topi, Valacich, Kaiser, Nunamaker, Sipior and de Vreede et.al., 2009

Table 2: Model Program for Cloud Computing – Culture Module

Module	Content		IS 2009 Knowledge Areas					Year
			General Computing	Domain	Foundational	Information Specific		
Culture								
Change Management	Changing the Culture of Business Firm Organizations (e.g. Technology Department)				x			1
Organizational Sectors	Corporate Staff Business Staff Governance Staff Technology Staff				x			2
Planning for Cloud	Centers of Excellence in Cloud Computing					x		4

Table 3: Model Program for Cloud Computing – Methodology Module**

Module	Content		IS 2009 Knowledge Areas					Year
			General Computing	Domain	Foundational	Information Specific		
Methodology								
Cloud Computing, Service Orientation and Service-Oriented Architecture (SOA)	Design of Cloud Services Expansion of Cloud Services Governance of Cloud Services					x		1
Program Management Methodology***	**Framework of Governance** **Framework of Communication** **Framework of Product Realization** Analysis and Design Phases Development Phase Integration and Testing Phases Deployment and Implementation Phases Multiple Iterations **Framework of Project Management** **Framework of Architecture** **Framework of Data Management** **Framework of Service Management** **Framework of Human Resource Management** **Framework of Post Implementation**					x		2,3,4
Program Staff Team Playing	Corporate, Business, Governance and Technology Staff of Business Firm and Staff of Cloud Service Provider (CSP) Technology Firm				x	x		3

** Lawler, Benedict, Howell-Barber and Joseph 2009
*** Lawler and Howell-Barber, 2008 and Lawler, Raggad and Howell-Barber, 2008

Table 4: Model Program for Cloud Computing – Research Module

Module	Content		IS 2009 Knowledge Areas					Year
			General Computing	Domain	Foundational	Information Specific		
Research								
Independent Project Study of Cloud Systems			x	x	x	x		3,4
Best-of-Class Practices in Industry	IaaS, PaaS and SaaS Systems			x		x		3,4
Practitioner and Scholarly Publications				x		x		3,4
Instructor as Study Supervisor			x	x	x	x		3,4
Industry Project Internships ****	Experiential Learning Projects		x	x	x	x		4

**** Cameron and Purao, 2009

Table 5: Model Program for Cloud Computing – Technology Module

Module	**Content**	**IS 2009 Knowledge Areas**				**Year**
		General Computing	**Domain**	**Foundational**	**Information Specific**	
Technology						
Cloud Computing as Design Patterns					x	1
Infrastructure	**CPU** Network -Servers Storage **Platforms** **Services**	x				2,3
Cloud Computing and SOA	SOA and Service-Oriented Enterprise (SOE)				x	1
Cloud Computing Information Model	Clustering vs. Replication Metadata Privacy				x	2
Cloud Computing Infrastructure of Services	Grid Computing Transactional Computing	x			x	2.3
Languages	AJAX Force.Com APEX Google GQL Java Microsoft C# Microsoft Office Web Apps	x				2,3,4
Platforms of Cloud Technology Firms		x				2,3,4
Product Specific Cloud Technologies	Amazon Web Services Google Docs SalesForce.Com	x				3,4
Technology Process Management				x	x	4

Risk Management and Security of Cloud Systems	**Cloud Computing Security Strategy** Data Security Host Security Network Security **Cloud Computing Security Techniques** Detection and Forensics Encryption Identity Management **Disaster Recovery Planning**				x	x		3,4
Standards on Cloud	Cloud Camp Cloud Computing Interoperability Forum Cloud Computing Use Cases Group Cloud Security Alliance Distributed Management Task Force Object Management Group Open Cloud Manifesto Open Group Service Integration Maturity Model (OSIMM) Open Group SOA Work Group SOA Governance Framework (Sample)		x			x		3
Systems Management of Cloud	**Capacity Planning** Expected Demand Impact of Load					x		4
Cloud Scaling	Dynamic Scaling Proactive Scaling Reactive Scaling					x		4
Monitoring of Systems			x			x		3,4
Cloud Computing "Bill of Rights"	Business Firms (Data) Technology Firms (Interfaces) Business Firms and Technology Firms (Service Levels) **Contracts for Business Firms** Lock-In vs. Portability **Service Levels for Cloud Systems** Availability Performance Security			x		x		4
Utilities	Product-Specific Utilities		x					3,4
Trends	Careers for Cloud Computing Practitioners -Compensation and Employment Forecast for Practitioners Impact of "Everything as a Service on Cloud" on Information Technology Departments of Business Firms			x		x		4

Table 6: Model Program for Cloud Computing – Modules with Career Tracks

Module (Topics)	Content (Examples)	Skills				Career Tracks					Year
		Business Skills	Analytical Skills	Interpersonal Skills	Technical Skills	Cloud Architect	Cloud Developer	Cloud Engineer	Cloud Manager	Cloud Strategist	
Business											
Business Process Management (BPM)	Business Objectives Critical Few Objectives (CFOs) Customer Centricity-Problems in Processes Competitive Differentiation of Core Processes Strategic Performance Management – Process Thinking	x	x							x	1
Business Process Management (BPM) and Cloud	Candidate Data, Processes and Services for Cloud Computing Cloud Computing Cost Model	x	x			X				x	1
Cloud Deployments of Processes	Private Cloud Public Cloud Hybrid Cloud	x	x			X				x	1
Cloud Models	Infrastructure-as-a-Service (IaaS) Platform-as-a-Service (PaaS) Software-as-a-Service (SaaS)	x	x		x	X				x	1
Industry Regulations	Gramm-Leach-Biley Act (GLBA) Health Insurance Portability and Accountability Act (HIPPA) Statement on Auditing Standard 70 (SAS-70)	x								x	4

Module	Content	Skills				Career Tracks					Year
		Business Skills	Analytical Skills	Interpersonal Skills	Technical Skills	Cloud Architect	Cloud Developer	Cloud Engineer	Cloud Manager	Cloud Strategist	
Culture											
Change Management	Changing the Culture of Business Firm Organizations (e.g. Technology Department)		x	x		x			x	x	1
Organizational Sectors	Corporate Staff Business Staff Governance Staff Technology Staff	x	x	x					x		2
Planning for Cloud	Centers of Excellence in Cloud Computing	x	x	x	x	x			x	x	4

Module	Content	Skills				Career Tracks					Year
		Business Skills	Analytical Skills	Interpersonal Skills	Technical Skills	Cloud Architect	Cloud Developer	Cloud Engineer	Cloud Manager	Cloud Strategist	
Methodology											
Cloud Computing, Service Orientation and Service-Oriented Architecture (SOA)	Design of Cloud Services Expansion of Cloud Services Governance of Cloud Services		x			x	x		x		1

Program Management Methodology*	**Framework of Governance** **Framework of Communication** **Framework of Product Realization** Analysis and Design Phases Development Phase Integration and Testing Phases Deployment and Implementation Phases Multiple Iterations **Framework of Project Management** **Framework of Architecture** **Framework of Data Management** **Framework of Service Management** **Framework of Human Resource Management** **Framework of Post Implementation**		x	x	X	x		x	x	x	x	x		2,3,4
Program Staff Team Playing	Corporate, Business, Governance and Technology Staff of Business Firm and Staff of Cloud Service Provider (CSP) Technology Firm				X			x	x	x	x			3

Module	**Content**	**Skills**				**Career Tracks**					**Year**
		Business Skills	**Analytical Skills**	**Interpersonal Skills**	**Technical Skills**	**Cloud Architect**	**Cloud Developer**	**Cloud Engineer**	**Cloud Manager**	**Cloud Strategist**	
Research											
Independent Project Study of Cloud Systems		x	x	x	x	x	x	x	x	x	3,4
Best-of-Class Practices in Industry	IaaS, PaaS and SaaS Systems	x	x		x	x	x	x	x	x	3,4
Practitioner and Scholarly Publications		x	x		x	x	x	x	x	x	3,4
Instructor as Study Supervisor		x	x	x	x	x	x	x	x	x	3,4
Industry Project Interships****	Experiential Learning Projects	x	x	x	x	x	x	x	x	x	4

Module	**Content**	**Skills**				**Career Tracks**					**Year**
		Business Skills	**Analytical Skills**	**Interpersonal Skills**	**Technical Skills**	**Cloud Architect**	**Cloud Developer**	**Cloud Engineer**	**Cloud Manager**	**Cloud Strategist**	
Technology											
Cloud Computing as Design Patterns			x		x	x	x		x		1
Infrastructure	**CPU** Network -Servers Storage **Platforms** **Services**		x		x		x	x			2,3
Cloud Computing and SOA	SOA and Service-Oriented Enterprise (SOE)	x	x		x	x			x	x	1

Cloud Computing Information Model	Clustering vs. Replication Metadata Privacy		x	x		x		x	x		x			2
Cloud Computing Infrastructure of Services	Grid Computing Transactional Computing			x		x				x				2,3
Languages	AJAX Force.Com APEX Google GQL Java Microsoft C# Microsoft Office Web Apps			x		x			x					2,3,4
Platforms of Cloud Technology Firms				x		x			x	x	x			2,3,4
Product Specific Cloud Technologies	Amazon Web Services Google Docs SalesForce.Com			x		x			x	x	x			3,4
Technology Process Management			x	x	x	x					x	x		4
Risk Management and Security of Cloud Systems	**Cloud Computing Security Strategy** Data Security Host Security Network Security **Cloud Computing Security Techniques** Detection and Forensics Encryption Identity Management **Disaster Recovery Planning**			x		x		x	x	x	x	x		3,4
Standards on Cloud	Cloud Camp Cloud Computing Interoperability Forum Cloud Computing Use Cases Group Cloud Security Alliance Distributed Management Task Force Object Management Group					x		x	x	x	x	x		3

	Open Cloud Manifesto Open Group Service Integration Maturity Model (OSIMM) Open Group SOA Work Group SOA Governance Framework (Sample)													
Systems Management of Cloud	**Capacity Planning** Expected Demand Impact of Load		x	x		x				x				4
Cloud Scaling	Dynamic Scaling Proactive Scaling Reactive Scaling			x		x				x				4
Monitoring of Systems				x		x		x		x		x		3,4
Cloud Computing "Bill of Rights"	Business Firms (Data) Technology Firms (Interfaces) Business Firms and Technology Firms (Service Levels) **Contracts for Business Firms** Lock-In vs. Portability **Service Levels for Cloud Systems** Availability Performance Security		x	x	x	x					x	x		4
Utilities	Product-Specific Utilities			x		x			x					3,4
Trends	Careers for Cloud Computing Practitioners -Compensation and Employment Forecast for Practitioners Impact of "Everything as a Service on Cloud" on Information Technology Departments of Business Firms		x	x	x	x		x	x	x	x	x		4

Note: Cloud manager is cloud project manager.