# Research Statement

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At SMU, I have been actively involved in pedagogy and practice research. I have established a synergistic relationship between pedagogy focused and practice focused research. The following diagram shows the key areas of my work and the concerns that I have been addressing the last five years.
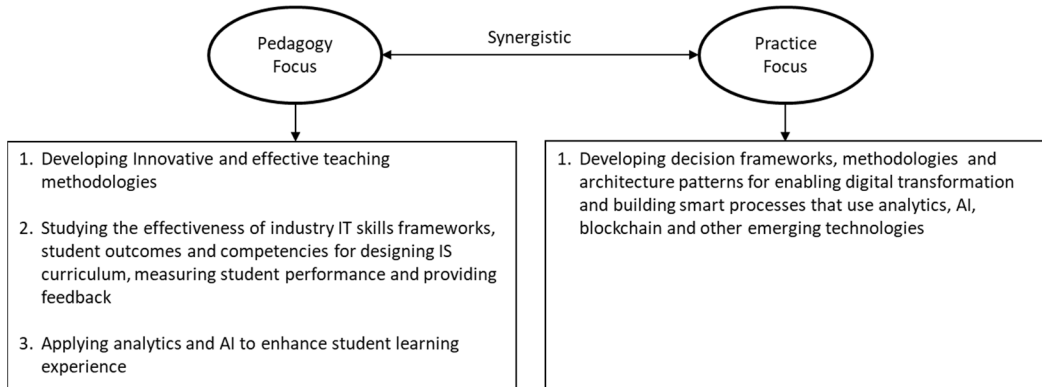
Pedagogy Focused Work

1. Developing innovative and effective teaching methodologies.

In the past, I have been experimenting with various approaches to develop both the content and methodologies for delivering courses that are focused on enterprise technology. For example, using mini-case pedagogy where mini-cases are integrated with the concepts and labs; using integrated industry relevant projects where students use enterprise technology to solve industry partner problems; incorporating emerging topics such as analytics into enterprise process design.

With my transition to the current role as Vice Provost (Education), I shifted some of my focus to university wide pedagogy issues, following are some example research projects.

Project-Based Experiential Learning

SMU effectively expanded its Industry Project Based Experiential Learning (INDEX) approach by introducing SMU-X and SMU-XO (Overseas) courses. Understanding the efficient delivery of project-based learning pedagogy was pivotal for enhancing student learning quality through project experiences. Collaborating with the SMU-X team, I spearheaded various research themes. For instance, one study delved into delineating the roles assumed by both educators and students in project-based learning courses. Findings indicated that educators function as designers, champions, facilitators, and managers within such courses. Meanwhile, for effective learning outcomes, students must embody the roles of self-directed learners and proactive participants in their projects. Furthermore, our research unveiled the presence of role ambiguity and conflict among participants in project-based learning settings, highlighting potential challenges to student learning effectiveness.

Online Learning

Amidst the COVID-19 pandemic, universities faced the daunting task of shifting their teaching methodologies to an online format, and SMU encountered similar challenges. Throughout this period, I was particularly interested in exploring the obstacles and potential solutions associated with this transition, for both regular and project-based learning (SMU-X) courses. Together with Prof Swapna Gottipati, we scrutinized the hurdles encountered, implemented practical remedies, and gained valuable insights while swiftly adapting a face-to-face master's degree course to a virtual format.

Additionally, in collaboration with the SMU-X team, we delved into understanding the dynamics of local student consulting courses conducted virtually. The aim was to examine the influence of digital literacy—specifically, proficiency in leveraging digital tools supporting virtual learning. This study also shed light on students' significant learnings within the virtual Project-Based Learning (PBL) framework.

Following are most recent selected outputs related to the above areas of research work.

Refereed Journals
- **"University-industry collaboration in project-based learning: Perspective and motivation of industry partners",** by PAN, Gary; SEOW, Poh-Sun; SHANKARARAMAN, Venky; KOH, Kevin. (2023). International Journal of Education, 15 (3), 18-32.
- **"Making virtual project-based learning work during the COVID-19 pandemic"**, by KUSNADI, Yuanto; PAN, Gary; SHANKARARAMAN, Venky. (2022). International Journal of Education, 10 (2), 1-13.
- **"Students' evaluation of teaching in the project-based learning programme: An instrument and a development process"**, by PAN, Gary; SHANKARARAMAN, Venky; KOH, Kevin; GAN, Sandy. (2021). International Journal of Management Education, 19 (2), 1-11.
- **"An exploration into key roles in making project-based learning happen Insights from a case study of a university"**, by PAN, Gary; SEOW, Poh-Sun; SHANKARARAMAN, Venky; KOH, Kevin. (2021). Journal of International Education in Business, 14 (1), 109.
- **"Essence of partnership management in project-based learning: insights from a university's global project programme"**, by PAN, Gary; SEOW, Poh Sun; SHANKARARAMAN, Venky; KOH, Kevin. (2021). Journal of International Education in Business, 14 (2), 297-319.
- **"Rapid Transition of a Technical Course from Face-to-Face to Online"**, by GOTTIPATI, Swapna; SHANKARARAMAN, Venky. (2021). Communications of the Association for Information Systems, 48, 7-14.

2. Studying the effectiveness of industry IT skills frameworks, student outcomes and competencies for designing IS curriculum, measuring student performance and providing feedback.

IT Skills and Competencies

My interest in this area of work deepened when I started to further explore ways to improve student learning and provide better feedback to the students in my course. In my earlier role as the Deputy Dean (Practice & Education), it was also my responsibility to drive continuous improvement and renewal of the SCIS BSc (IS) curriculum. In this context, I collaborated with SCIS faculty Prof Ilse Baumgartner, Prof Swapna Gottipati, SCIS Senior Instructor Ms Joelle Elmaleh along with external collaborators namely Prof Emanuel Grant, Department of Computer Science, University of North Dakota, USA, and Dr Mehdi Asgarkhani, CPIT, Christchurch, NZ. I was also a member of the ACM-AIS IS2020 Curriculum Task force that involved professors from

across the globe to help design a competency-based curriculum for IS Programs. Currently my research work in this area is directed towards exploring existing IT skills frameworks such as National Infocomm Competency Framework (NICF) developed by the Singapore Workforce Development Agency, Skills Framework for the Information Age (SFIA), etc., and applying them to curriculum design for tertiary IS/IT education.

Graduate Learning Outcomes
At SMU we had developed the Graduate Learning Outcomes (GLOs), and in my role as the Vice Provost (Education) I was keen to explore approaches to measuring the student outcomes beyond disciplinary attainment, culminating in feedback to help students grow in a spectrum of personal competencies such as critical thinking or collaboration. Working with Centre for Teaching Excellence (CTE) an action research study was conducted to analyse a proposed institution-wide assessment and feedback system that measures student attainment on a set of university-level GLOs and present this information to students as feedback for their learning. The study indicated that students were generally appreciative of the insights gained regarding their attainment of the learning outcomes and thought they could use the information for self-improvement. Similarly, the instructors who used the system found that it provided a systematic way of delivering meaningful and consistent feedback to students. The study also revealed areas for improving the students' learning experience in terms of learning outcomes measurement.

Following are most recent selected outputs related to the above areas of research work.

Refereed Conferences
- **"Information systems business analytics curriculum: Competencies from National Infocomm skills model and job listings"**, by GOTTIPATI, Swapna; SHANKARARAMAN, Venky; SHIM, Kyong Jin; YIP, Chan Yuen. Proceedings of AMCIS 2021: Digital Innovation and Entrepreneurship, Virtual Conference, August 9-13, Virtual: AMCIS.
- **"Renewal of an information systems curriculum to support career-based tracks: A case study"**, by GOTTIPATI, Swapna; SHANKARARAMAN, Venky; SHIM, Kyong Jin. (2020.0). Proceedings of 2020 SIGED International Conference on Information Systems Education and Research, Virtual, December 12-13, (pp. 1-13) Virtual: Association for Information Systems.
- **"A visual analytics tool for personalized competency feedback"**, by ELMALEH, Joelle; SHANKARARAMAN, Venky. Proceedings of the Americas Conference of Information Systems: 26th AMCIS 2020, Salt Lake City, UT, August 10-14, (pp. 1-10) Atlanta: Association for Information Systems.

Book Chapters
- **"Developing and evidencing attainment of graduate learning outcomes through an institution-wide feedback system"**, by LEW, Duan Ning Magdeleine; DEMEESTER, Lieven; SHANKARARAMAN, Venky; ZHUO, Yuehan. (2022). In AUER, Michael E.; PESTER, Andreas; MAY, Dominik (Ed.), Learning with technologies and technologies in learning: Experience, trends, and challenges in higher education (pp. 629-654) Switzerland: Springer.

3. Applying analytics and AI to enhance student learning experience

There are two themes in this area of research work: One is focused on enhancing student learning experience in IS courses through support tools. The other is focused on using text mining techniques to help instructors analyse forum discussions and generate a learner's profile based on the contributions the learner makes to the discussion topic.

Following are examples of work in this area.

Generative AI Tools for Supporting Learning
As computing projects increasingly become a core component of undergraduate courses, effective mentorship is crucial for supporting students' learning and development. Our study examined the adoption of ChatGPT as a mentor for undergraduate computing projects. It explored the impact of ChatGPT mentorship, specifically, skills development, and mentor responsiveness, i.e., ChatGPT's responsiveness to students' needs and requests. We utilized PLS-SEM to investigate the interrelationships between different factors and developed a model that captured their contribution to the effectiveness of ChatGPT as a mentor. The findings suggested that mentor responsiveness and technical/design support are key factors for the adoption of AI tools like ChatGPT. The study provided practical implications for educators seeking to incorporate AI as a mentor to support students doing computing projects and contributed to the broader understanding of the use of AI in education.

Programming Coach
Effective teaching and learning of programming play an important role in developing a future-ready workforce. An essential element of learning programming is that students must practice on their own frequently. In this research project, we developed AP-Coach, an Automatic Programming Coaching system based on a combination of AI and software engineering techniques to support students practice coding via formative feedback generation. AP-Coach implements a pedagogical strategy derived from the well-known constructionism and deconstructionism learning theories. An innovative component of AP-Coach is that, beyond source code, it also emphasizes the analysis of textual content in the form of natural language-like pseudo-code, which is common in learning activities such as code reading, tracing and algorithm designing.

This research is funded by Ministry of Education, Singapore: AP-Coach: AI-based formative feedback generation to improve student learning outcomes in introductory programming courses, Tertiary Education Research Fund (TRF), Ministry of Education (MOE) , PI (Project Level): Don TA, Co-PI (Project Level): SHAR Lwin Khin, Venky SHANKARARAMAN, 2022, S$200,741.6.

Learning from Classroom Discussion
A large body of research has been dedicated to building frameworks to better understand collaboration and interactions amongst students along the different dimensions of behaviour. Examples of these frameworks include Walsh's Classroom Interactional Competence (CIC), Hyland's interpersonal aspects of written discourse, Aijmer's interpersonal aspects of spoken discourse, and Soller's Collaborative Learning Conversation Skill Taxonomy. Our research was directed at discourse analysis of classroom discussions. It used Soller's framework and the Penn Discourse Treebank 2.0 (PDTB 2.0) data set from the University of Pennsylvania with the aim of understanding interactions at the discourse and semantics level. We developed an Integrated Discourse Analysis and Collaborative Learning Skills (IDALS) framework based on class discussions. Further, we used unsupervised automated techniques to implement the framework. The outcome of the implementation was the generation of a learning profile based on an individual student's contributions to in-class discussions that was made available to both instructors and students.

Following are most recent selected outputs related to the above areas of research work.

Refereed Conferences

- **"Exploring students' adoption of ChatGPT as a mentor for undergraduate computing projects: PLS-SEM analysis"**, by GOTTIPATI, Swapna; SHIM, Kyong Jin; SHANKARARAMAN, Venky. Proceedings of the 31st International Conference on Computers in Education Conference, Matsue, Shimane, 2023 December 4-8, (pp. 40-45) Japan: Asia-Pacific Society for Computers in Education.
- **"AI for connectivism learning - Undergraduate students' experiences of ChatGPT in advanced programming courses"**, by GOTTIPATI, Swapna; SHIM, Kyong Jin; SHANKARARAMAN, Venky. Proceedings of AMCIS 2023, Atlanta, Georgia, USA: Association of Information Systems.
- **"AP-coach: Formative feedback generation for learning introductory programming concepts"**, by TA, Duong; SHAR, Lwin Khin; SHANKARARAMAN, Venky. 2022 IEEE International Conference on Teaching, Assessment and Learning for Engineering, Hong Kong, December 4-7: Proceedings, (pp. 323-330) Piscataway, NJ: IEEE.
- **"Coders Assembly: Peer assisted learning model for freshman programming courses"**, by SHIM, Kyong Jin; GOTTIPATI, Swapna; SHANKARARAMAN, Venky. 2022 IEEE Global Engineering Education Conference (EDUCON): Tunisia, March 28-31: Proceedings, (pp. 1128-1134) Piscataway, NJ: IEEE.
- **"Mining informal and short student self-reflections for detecting challenging topics: A learning outcomes insight dashboard"**, by LIN, Ong De; GOTTIPATI, Swapna; LO, Siaw Ling; SHANKARARAMAN, Venky. 2021 IEEE Frontiers in Education Conference (FIE): Lincoln, Nebraska, October 13-16: Proceedings, (pp.1-9) Piscataway, NJ: IEEE.
- **"Integrated discourse analysis & learning skills framework for class conversations"**, by TAN, Devyn Wei Hung; GOTTIPATI, Swapna; SHIM, Kyong Jin; SHANKARARAMAN, Venky. Proceedings of 2021 Frontiers in Education (FIE), Lincoln, Nebraska, October 13-16, (pp. 1-9) Lincoln, NE, USA: IEEE.
- **"Automated discussion analysis: Framework for knowledge analysis from class discussions"**, by GOTTIPATI, Swapna; SHANKARARAMAN, Venky; GOKARN, Mallika Nitin. 2020 50th Frontiers in Education Conference (FIE): October 21-24, Uppsala, Sweden: Proceedings, (pp. 1-8) Piscataway, NJ: IEEE.
- **"Clustering models for topic analysis in graduate discussion forums"**, by NITIN, Mallika Gokarn; GOTTIPATI, Swapna; SHANKARARAMAN, Venky. (2019). Proceedings of the 27th International Conference on Computers in Education, Taiwan: Asia-Pacific Society for Computers in Education, Kenting, Taiwan: APSCE.
- **"TopicSummary: A tool for analyzing class discussion forums using topic based summarizations"**, by GOTTIPATI, Swapna; SHANKARARAMAN, Venky; RAMESH, Renjini. 2019 IEEE Frontiers in Education Conference 49th FIE: Covington, KY, October 16-19: Proceedings, (pp. 1-10) Piscataway, NJ: IEEE.
- **"Cognitive and social interaction analysis in graduate discussion forums"**, by NITIN, Mallika Gokran; GOTTIPATI, Swapna; SHANKARARAMAN, Venky. 2019 49th Frontiers in Education Conference: Cincinnati, OH, October 16-19: Proceedings, (pp. 1-8) Piscataway, NJ: IEEE.

Practice Focused Work

1. Developing decision frameworks, methodologies and architecture patterns for enabling digital transformation and building smart processes that use analytics, AI, blockchain and other emerging technologies.

Organizations can develop competitive edge through exploitation of digital technologies namely cloud computing, big data and analytics, mobile networks, social media, artificial intelligence, blockchain and the Internet of Things. By effectively leveraging these technologies they can go beyond boosting efficiency and drive new business models, develop new revenue streams, or

drive other material changes that lead to an increase in the top or bottom lines. However, to do this effectively, organizations must redesign their existing enterprise architecture and enterprise systems to make them more agile and develop smart processes that leverage the emerging technologies. The next generation of enterprise solution focus is on developing process platforms where parts of business processes are available as "services" and organizations can compose their processes by using the "services" as building blocks. Instead of having to write low-level code, the composition of services is achieved through a graphical user interface with drag-and-drop mechanism.

Following are examples of work in this area.

Microservices Decision Framework for Architects
Microservices-based applications consist of loosely coupled, independently deployable services that encapsulate units of functionality. To implement larger application processes, these microservices must communicate and collaborate. Typically, this follows one of two patterns: (1) choreography, in which communication is done via asynchronous message-passing; or (2) orchestration, in which a controller is used to synchronously manage the process flow. Choosing the right pattern requires the resolution of some trade-offs concerning coupling, chattiness, visibility, and design. To address this problem, we developed a decision framework for microservices collaboration patterns that helps solution architects to crystallize their goals, compare the key factors, and then choose a pattern using a weighted scoring mechanism. The work is quite unique in the sense that currently there are no other existing decision frameworks to guide solution architects in choosing a microservices collaboration pattern.

Citizen Service Management using Data Analytics and AI
A government provides various services to its citizens. Often this leads to citizens requiring clarifications regarding the details of the services offered. Traditionally, this problem has been addressed through call centres that help answer citizens' queries. The utilization of data analytics and AI for citizen service management represents a transformative approach in modern governance. By harnessing the power of data, governments can gain valuable insights into citizens' behaviours, preferences, and needs, enabling them to deliver more targeted and efficient services. Through sophisticated techniques, such as predictive modelling and sentiment analysis, authorities can anticipate and address potential issues before they arise, enhancing overall service quality and responsiveness. Our work is focused on providing an AI-driven methodology for extracting recommended answers from publicly available frequently asked questions (FAQs). Additionally, we employ an established ontology (consisting of predefined categories) as the foundation for our question-answering (QA) system, specifically addressing inquiries regarding government initiatives related to adult training.

Following are most recent selected outputs related to the above areas of research work.

Refereed Journals
- **"Digital Banking Accelerator: A Service-Oriented Architecture Starter Kit for Banks"**, by MEGARGEL, Alan; SHANKARARAMAN, Venky. (2021). IEEE Software, 38 (3), 106-112.

Book Chapters
- **"Enhancing Citizen Service Management through AI Enabled Systems: a proposed AI readiness framework for public sector"**, by SHAN, Alvina Lee Hui; SHANKARARAMAN, Venky; OUH, Eng Lieh. (2024). In Yannis Charalabidis, Rony

Medaglia and Colin van Noordt, (Ed.), Research Handbook on Public Management and Artificial Intelligence (pp. 79-97), Edward Elgar Publishing

- **"Accelerating business transformation in the digital age",** by PAN, Gary; SHANKARARAMAN, Venky. (2023). In Clarence Goh, Yuanto Kusnadi, Benjamin Lee, Gary Pan, & Seow Poh Sun (Ed.), Accelerating digital transformation of SMEs (pp. 1-10) Singapore: World Scientific.
- **"AI for financial services: An Asian perspective"**, by MEGARGEL, Alan; SHANKARARAMAN, Venky. (2022). Will AI dictate our future? In Will AI Dictate the Future? authored by Dr Anton Ravindran. Singapore: Marshall Cavendish.
- **"Digital innovation: A catalyst and enabler of achieving business sustainability"**, by GOH, Clarence; PAN, Gary; SEOW, Poh Sun; SHANKARARAMAN, Venky. (2021). In SEOW, Poh Sun; GOH, Clarence; PAN, Gary; YONG, Melvin; CHEK, Joanna (Ed.), Embracing Digital Transformation in Accounting and Finance (pp. 1-8) Singapore: CPA Australia.
- **"Migrating from monoliths to cloud-based microservices: A banking industry example"**, by MEGARGEL, Alan; SHANKARARAMAN, Venky; WALKER, David K. (2020). In M. Ramachandran, & Z. Mahmood (Ed.), Software engineering in the era of cloud computing (pp. 85-108). Springer.
- **"A decision framework for decentralised control of distributed processes: Is blockchain the only solution?"** by GRIFFIN, Paul; MEGARGEL, Alan; SHANKARARAMAN, Venky. (2019). In Shi, Nansi (Ed.), Architectures and Frameworks for Developing and Applying Blockchain Technology (pp. 1-27) IGI Global.

Refereed Conferences
- **"Vision paper: Advancing of AI explainability for the use of ChatGPT in government agencies: Proposal of a 4-step framework"**, by LEE, Alvina Hui Shan; SHANKARARAMAN, Venky; OUH, Eng Lieh. (2023. IEEE International Conference on Big Data (BigData): Sorrento, December 15-18: Proceedings, (pp. 5852-5856). Piscataway, NJ: IEEE.
- **"Extending the horizon by empowering government customer service officers with ACQAR for enhanced citizen service delivery"**, by LEE, Alvina Hui Shan; SHANKARARAMAN, Venky; OUH, Eng Lieh. (2023). IEEE International Conference on Big Data: Sorrento, Italy, December 15-18: Proceedings, (pp. 1952-1958) Piscataway, NJ: IEEE.
- **"Machine learning based financial aid management process"**, by GOTTIPATI, Swapna; SHANKARARAMAN, Venky; RAO, Komirisetti C.; VETRIVILLALAN, Vennila. (2023). Proceedings of AMCIS, Atlanta, Georgia, USA: Association of Information Systems.
- **"Implementation of Empath X SLA predictive tool for a government agency"**, by LEE, Alvina Hui Shan Lee; SHANKARARAMAN, Venky; OUH, Eng Lieh . 2022 International Conference on Big Data, Osaka, Japan; December 17-20, Osaka, Japan.
- **"Learnings from a pilot hybrid question answering system: CQAS: Case study based on a Singapore government agency's customer service centre",** by SHAN, Alvina Lee Hui; SHANKARARAMAN, Venky; OUH, Eng Lieh. (2022). Proceedings of the 23rd Annual International Conference on Digital Government Research, Virtual Conference, June 15-17, (pp. 437-439) New York: ACM.
- **"Microservices Orchestration vs. Choreography: A decision framework"**, by MEGARGEL, Alan; POSKITT, Christopher M.; SHANKARARAMAN, Venky. (2021). Proceedings of the 25th IEEE International Enterprise Distributed Object Computing Conference (EDOC 2021), Gold Coast, Australia, October 25-29, (pp. 134-141) New York: IEEE.

Pipeline
- (Book Chapter Under Review)- **"Transformation of Digital Banking Back-Office Operations Using AI".** MEGARGEL, Alan; SHANKARARAMAN, Venky; OBUCHETTIAR, Arun. (2024). In David Lee & Robert H. Deng (Ed.), Handbook of Blockchain, Digital Finance, and Inclusion.

Most Recent Research Grants (for earlier grants please refer to my CV)
1. <u>Awarded:</u> AP-Coach: AI-based formative feedback generation to improve student learning outcomes in introductory programming courses. Tertiary Education Research Fund (TRF), Ministry of Education (MOE) , PI (Project Level): Don TA, Co-PI (Project Level): SHAR Lwin Khin, Venky SHANKARARAMAN, 2022, S$200,741.6.
2. <u>Submitted:</u> A Mix-Methods Investigation of Learning Effectiveness, Assessment Quality, Credential Transferability and Graduate Employability in Stackable Postgraduate Degree Programme: A Case Study of Two Universities, The Workforce Development Applied Research Fund, SkillsFuture Singapore, 2023, S$133,120. PI: Gary Pan; CO-PI: Venky Shankararaman, Poh Sun, Clarence Goh, Calvin Chan, and Rebkah Lim.

Current Research Supervisions (for earlier supervisions please refer to my CV)
1. DEng (Doctor of Engineering) Alvina Lee Hui Shan, Research Topic: Implementation and Evaluation of a Question-and-Answer model in a CRM system for a Singapore Government Agency (2020).
2. DEng (Doctor of Engineering) Ng Kok Leong, Research Topic: Using Generative AI as a Coach for Cybersecurity Training (2021).
3. DEng (Doctor of Engineering) Hue Tse Leong Andy, Research Topic: Artificial Intelligence to help Transform Operations Work at Maritime Port Authority (2023).

1. Future Research Work

- Software development process for building AI solutions that incorporate humanity into consideration. This research focuses on taking a conscientious approach aimed at building artificial intelligence systems that align with human values, ethics, and well-being.