Shitanshu Mishra, PhD

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RESEARCH INTERESTS

- Open-ended computer-based learning environments
- Complex decision making and problem-solving
- Computational thinking
- Collaborative problem solving
- Student question-posing
- Knowledge integration
- Multimodal learning analytics

CURRENT POSITION

Research Scientist
IDP in Educational Technology, IIT Bombay, Mumbai, India.
July 2020 - present

EDUCATION

PhD, Educational Technology, 2012 – 2018
Inter-Disciplinary Program in Educational Technology, Indian Institute of Technology Bombay, Mumbai
Doctoral Thesis: Improving Students Cognitive Processes of Knowledge Integration using Exploratory Question Posing.
Committee: Prof. Sridhar Iyer (Advisor), Prof. Sahana Murthy, Prof. Supratim Biswas

MTech, Information Technology, 2010 – 2012
Department of Intelligent Systems, Indian Institute of Information Technology Allahabad, Uttar Pradesh
Master Thesis: EEG Signal Classification for Cognition.
Advisor: Prof. Sudip Sanyal

BTech, Computer Science and Engineering, 2006 – 2010
Dr. A.P.J. Abdul Kalam Technical University, Lucknow, Uttar Pradesh
Advisor: Prof. Ashwani Gupta

PROFESSIONAL EXPERIENCE

Total professional experience after PhD: 2 years, 6 months

- **Research Scientist at IDP in Educational Technology, IIT Bombay**
  February 2018 – present (1 month)

- **Postdoctoral Research Fellow, Department of Electrical Engg. And Computer Science, Vanderbilt University**
  August 2018 – June 2020 (23 months)
  (Postdoc Advisor: Prof. Gautam Biswas)

- **Research Associate at IDP in Educational Technology, IIT Bombay**
  February 2018 – July 2018 (5 months)

- **Institute Teaching Assistant for IDP in Educational Technology, IIT Bombay**
  July 2012 – February 2018 (5 years +)
  Assisted in research projects and mentored first and second-year PhD research students, interns and external workshop participants. As a teaching assistant, I conducted interactive lectures for graduate students in the Introduction to Qualitative Analysis and Introduction to Educational Technology course. Covered topics on content analysis, thematic analysis, grounded theory methodology, qualitative interviewing, etc. Contributed to academic services of reviewing academic articles and being in the local organizing committee of international conferences and workshops.

- **Institute Teaching Assistant for Department of Intelligent Systems, IIIT Allahabad**
  July 2010 - July 2012 (2 years)
  Engaged in conducting undergraduate level lectures, tutorials, lab sessions and evaluated performance of students in courses related to Introduction to Programming (CS1) and Data Structures (CS2). Also actively worked in the organization of conferences and science conclaves.

FEATURED SKILLS

- Multimodal Learning Analytics (focus on eye-tracking and facial data)
- Qualitative Methods (Grounded Theory, Thematic Analysis, Content Analysis, Cognitive ethnography)
- Design Based Research
- Technology Enhanced Learning of Thinking Skills (TELoTS) Framework
- Programming Proficiency (Java, Python, C#, Web 2.0)

KEY RESEARCH PROJECTS

1. **Representative Postdoctoral Project – 1**
   Betty's Brain: Study Learner's problem-solving Strategies in a TEL environment using Eye Tracking and Behavioral Data.
   Abstract: Researchers have highlighted how tracking learners' gaze in technology-enhanced learning (TEL) environments can reveal their learning and problem-solving behaviors and provide a framework for developing personalized scaffolds to foster strategic learning. In this project, I use eye-gaze data and action logs from middle school students to study their cognitive strategies while they perform ill-structured problem-solving in Betty's Brain, an agent-based open-ended science learning environment. I employ computational techniques such as sequence mining on the action logs to extract differentially frequent behavioral patterns among different levels of performers and then zoom into their cognitive strategies using their gaze patterns. The findings from this research will inform the designs of cognitive and affective scaffolds in Betty's Brain.

2. **Representative Postdoctoral Project - 2**
   Learner Modeling of Cognitive and Psychomotor Processes for Dismounted Battle Drills.
   Abstract: Operations such as "Enter and Clear a Room" and "React to Direct Fire Contact" are essential dismounted battle drills (DBD) for urban warfare conducted by the armed forces. These operations require the soldiers to develop effective psychomotor and cognitive skills and cognitive strategies along with the ability to work in teams. This project aims at developing intelligent tutors that support team training for DBDs in virtual and augmented reality environments. In the initial steps towards developing tutors, we have specifically focused on "Enter and Clear Room (ECR)" DBD that relies heavily on a combination of psychomotor skills, cognitive skills, and team skills. For example, soldiers are required to identify and differentiate enemy combatants from noncombatants inside the threat area, and at the same time, they have to provide cover for the other team members. In addition to the skills at a tactical level, soldiers also need to develop strategic reasoning and decision making skills that are derived from situation awareness and planning to assure superior firepower inside and outside the threat area. Since the operations are performed as a team, it is crucial that the trainees also acquire team skills in addition to the task skills. The need to evaluate psychomotor, cognitive, strategic, and affective processes implies the need for multiple monitoring modalities, such as computer logs of individual and team performance, video analysis for analyzing psychomotor and cognitive skills, eye tracking for monitoring situation awareness, and physiological sensors to capture affect. We are designing multi-modal data collection and analysis

frameworks to monitor and analyze such complex tasks. In particular, the project proposes several performance and effectiveness measures and metrics for the *Squad Advanced Marksmanship Trainer (SAM-T)*, a virtual battle drill practice environment for soldiers. We propose to compute these metrics within the *Generalized Intelligent Framework for Tutoring (GIFT)* framework and develop integrated performance and effectiveness measures to support After Action Review by human instructors.

3. **Representative Postdoctoral Project - 3**

   Affective proxies for learners' gaze behavior

   Multimodal data provides opportunities to study the learner behavior and states in a richer manner than before. However, the current studies have a common limitation of not being able to scale up the implications since the apparatus used is not scalable. In this project, we attempt to identify measurements from modalities such as facial data that have the capacity to be scaled up; and examine which measures they correspond closely from the modes that have richer and more granular data such as eye-tracking. In other words, we aim at identifying pervasive-ubiquitous proxies to the measurements that have been reported to be obtrusive and detrimental for the ecological validity of the studies/experiments. We are exemplifying these approaches using eye-tracking and facial data from different studies. Recently, we found our first set of facial proxies to gaze-based measurements. The findings suggest that there exists a close connection between the facial-features and the gaze-variables.

4. **Doctoral Thesis**

   Improving Students' Cognitive Processes of Knowledge Integration through Exploratory Question Posing. July 2012 – January 2018
   Abstract: When students encounter new knowledge, it is often fragmented and not well connected to their existing knowledge. It is known that students need to integrate knowledge pieces effectively to develop a deep and cohesive understanding of any topic. My doctoral work focused on using student's question-posing as a cognitive tool to foster the cognitive processes associated with knowledge integration (KI). These cognitive processes include eliciting prior knowledge, focusing on new knowledge, and distinguishing among knowledge. In the initial phase of our research, we found that exploratory question-posing can be used as a cognitive-tool to trigger these cognitive processes. Thereafter, we designed a learning environment named Inquiry-based Knowledge Integration Trainer (IKnowIT). To investigate the effect of IKnowIT on KI, we chose concepts of Data Structures and carried out a series of exploratory qualitative and quantitative studies with sophomore CS engineering students.

   Thesis Link: https://www.it.iitb.ac.in/~sri/students/shitanshu-thesis.pdf
   IKnowIT url: www.et.iitb.ac.in/iknowit

5. "**Exploring Indian Computer Science (CS) Undergraduate Student's Conception about the CS major."** June 2015 - September 2016.
   Abstract: In the year 2016, in the International Computing Education Research (ICER) 2016 conference, Dr. Mike Hewner and I co-published a research report on Indian CS students' conceptions about computer science major. Applying grounded theory methods, we unfolded how the Indian educational system and the widespread perception about careers in CS-related fields in India, lead to student's decision to choose CS as their major for undergraduate studies.
   My Role: I co-designed the study, collected data (interviewed), co-performed the grounded theory analysis, co-authored the research report, presented at ICER 2016, Melbourne, Australia.

6. **International Working group on "New Horizons in the Assessment of Computer Science at School and Beyond."** Vilnius, Lithuania, Feb - September 2015
   Abstract: A working group, comprised of Computing Education researchers from multiple countries, collaborated, and published a research report in the Innovation and Technologies in Computer Science Education (ITiCSE) 2015. As a working group, we reviewed the state of the CSEd field and made concrete, achievable proposals for developing shared, high-quality assessments for computer science. Central to this proposal was the collaborative platform *VIVA (the Vilnius collaboratively coded and Validated computer science questions/tasks for Assessment)*. Two requirements were key to VIVA**:** 1) support for multiple competency frameworks so that the contributors can meta-tag assessment resources with respect to the framework they are most familiar with, and 2) support for crowdsourcing the validation

of each question/task and its mapping to competencies. The use of a taxonomy of questions/tasks type that has been mapped to computational thinking concepts and competency framework was proposed.
My Role: I was one of the working group members and my role was to develop the VIVA platform.

7. **Institute - level project: Incorporating Educational Technology in CS1 and CS2.** Mumbai, India, 2012 - 2015.
   Abstract: My department (IDP in EdTech) at IIT Bombay had carried out several efforts to incorporate innovative pedagogies and technologies for improving the teaching-learning of undergraduate learners from other departments within IIT Bombay, especially Computer Science. These projects include: (i) Using problem-posing activities in CS1 class; (ii) Using Scratch (a visual programming language) based introduction to programming (CS1) for novice learners; (iii) using "think-pair-share" pedagogy in CS2 (data structures) class, etc.
   My Role: I administered the research and conducted the evaluation studies. The empirical studies and findings have been published in peer-reviewed conference proceedings.

8. **SQDL: Student Question Driven Learning.** Mumbai, India, 2013 – 2015
   Under the guidance of Prof. Sridhar Iyer, I designed a pedagogy that uses student question-posing to enable student-directed learning. The pedagogy proposes to use the questions posed by the students to decide which content has to be taught in the next instruction. The pedagogy has been empirically tested primarily on two factors: (i) How much course-coverage is achieved in an SQDL-based classroom; (ii) What are its effects on students' affective dimensions such as their interests, motivation, and belongingness to the instructions.
   My Role: I designed the pedagogy, implemented the study, and collected-analyzed the data, under the guidance of Prof. Sridhar Iyer.

9. **International Working group on "Exploring Link between Early Developmental Activities and Computing Proficiency."** Feb 2017 - Present
   Abstract: As countries adopt computing education for all pupils from primary school upwards, there are challenging indicators: significant proportions of students who choose to study computing at universities fail the introductory courses, and the evidence for links between formal education outcomes and success in CS is limited. We hypothesized that early childhood activities can have effects on the development of an individual's computational skills. A working group comprised of Computing Education researchers from multiple countries was formed to study this link between early childhood activities and computing proficiency in adulthood. In this study, we collected and analyzed over 1300 responses to a multi-institutional and multi-national survey that we developed. The survey captured the enjoyment of early developmental activities such as childhood toys, games, and pastimes between the ages 0 — 8 as well as later life experiences with computing. We identified unifying features of the computing experiences in later life and attempted to link these computing experiences to childhood activities. This research is still under progress, and it is hoped that it will feed into early years and primary education, and thereby improve computing education for all.
   My Role: Initially, I volunteered as a non-official member, actively participated in deliberations, administered the data collection from the Indian population, and assisted the data analyses in Bologna. Currently, I am one of the official collaborators and conducting the analysis and related research work.

RELEVANT COURSEWORK

Fundamentals of Educational Technology, Research Methodology in Educational Technology, Educational Technology Tools, Educational Game Designs, Intelligent Tutoring Systems, Learning Analytics, Machine Learning, Cognitive Science, Computational Intelligence, Natural Language Processing, Soft Computing, Computer Vision.

ACADEMIC PUBLICATIONS

Journal

- **Shitanshu Mishra** and Sridhar Iyer. An Exploration of Problem Posing Based Activities as an Assessment Tool, and as an Instructional Strategy. Research and Practice in Technology Enhanced Learning (RPTEL), June 2015.

Conference

- Bernard Yett, Caitlin Snyder, Ningyu Zhang, Nicole Hutchins, **Shitanshu Mishra** and Gautam Biswas. Using Log and Discourse Analysis to Improve Understanding of Collaborative Programming. International Conference on Computers in Education (ICCE), Darwin, Australia, November 2020.

- Anabil Munshi, **Shitanshu Mishra**, Ningyu Zhang, Luc Paquette, Jaclyn Ocumpaugh, Ryan Baker and Gautam Biswas. Modeling the relationships between basic & academic emotions during learning in a CBLE. 21th International Conference on Artificial Intelligence in Education (AIED), 2020, in press.

- Bernard Yett, Nicole Hutchins, Caitlin Snyder, Ningyu Zhang, **Shitanshu Mishra** and Gautam Biswas. Student Learning in a Synchronous, Collaborative Programming Environment through Log-Based Analysis of Projects. 21th International Conference on Artificial Intelligence in Education (AIED), 2020, in press.

- Caitlin Snyder, Nicole Hutchins, Gautam Biswas, **Shitanshu Mishra**, Bernard Yett and Mona Emara. Understanding Collaborative Question Posing During Computational Modeling in Science. 21th International Conference on Artificial Intelligence in Education (AIED), 2020, in press.

- Caitlin Snyder, Nicole Hutchins, Gautam Biswas, **Shitanshu Mishra** and Mona Emara. Exploring Synergistic Learning Processes through Collaborative Learner-to-Learner Questioning. In Proceedings of the International Conference of the Learning Sciences (ICLS), Nashville, TN, USA, 2020, in press.

- Kshitij Sharma, **Shitanshu Mishra**, Zacharoula Papamitsiou, Anabil Munshi, Bikram Kumar De, Gautam Biswas and Michail Giannakos. Towards obtaining affect-based proxies for attentional behaviour in TEL. In Proceedings of the International Conference of the Learning Sciences (ICLS), Nashville, TN, USA, 2020, in press.

- **Shitanshu Mishra,** Gautam Biswas, Naveeduddin Mohammed, Benjamin S. Goldberg. Learner Modeling of Cognitive and Psychomotor Processes for Dismounted Battle Drills. In Proceedings of the 7th Annual Generalized Intelligent Framework for Tutoring (GIFT) Users Symposium (GIFTSym7), Orlando, Memphis, May 2019.

- **Shitanshu Mishra**, Anabil Munshi, Marian Rushdy, Gautam Biswas. LASAT: Learning Activity Sequence Analysis Tool. In Technology-Enhanced & Evidence-Based Education & Learning (TEEL) Workshop at the 9th International Learning Analytics and Knowledge (LAK) Conference, Tempe, Arizona, March 2019.

- Gargi Banerjee, Jayakrishnan Madathil, **Shitanshu Mishra**. Learning experience interaction (LXI): Pedagogy for peer connect and engagement in MOOCs. International Conference on Computers in Education (ICCE), Manila, Philippines, November 2018.

- **Shitanshu Mishra**, Sridhar Iyer. Promoting Cognitive Processes of Knowledge Integration. 13th International Conference of the Learning Sciences (ICLS), London, June 2018.

- Michael Hewner, **Shitanshu Mishra**. When Everyone Knows CS is the Best Major. Decisions about CS in an Indian context. ACM International Computing Education Research (ICER) Conference, Melbourne, Australia, September 2016.

- **Shitanshu Mishra**, Sridhar Iyer. Exploratory question posing: Towards improving students' knowledge integration performance. Learning Environments for Deep Learning in Inquiry and Problem-Solving Contexts, the pre-Conference workshop at the 12th International Conference of the Learning Sciences (ICLS), Singapore, June 2016.

- **Shitanshu Mishra**, Sridhar Iyer. Question-Posing Strategies used by Students for Exploring Data Structures. ACM International Conference on Innovation and Technology in Computer Science Education (ITiCSE), Vilnius, Lithuania, June 2015.

- Daniela Giordano, Andrew Paul Csizmadia, Simon Marsden, Charles Riedesel, **Shitanshu Mishra**, Lina Vinikienė. New Horizons in the Assessment of Computer Science at School and Beyond: Leveraging on the ViVA Platform. Proceedings of the 2015 ITiCSE on Working Group Reports, ACM, 2015.

- Abhinav Anand, **Shitanshu Mishra**, Anurag Deep, Kavya Alse. Generation of Educational Technology Research Problems using Design Thinking Framework. IEEE conference on Technology for Education (T4E), Warangal, India, December 2015.

- Deepti Reddy, **Shitanshu Mishra**, Ganesh Ramakrishnan, Sahana Murthy. Thinking, Pairing, and Sharing to Improve Learning and Engagement in a Data Structures and Algorithms (DSA) Class. IEE Conference on Teaching and Learning in Computing and Engineering (LaTiCE), Taipei, Taiwan, April 2015.

- **Shitanshu Mishra**, Mukulika Maity. A Software Solution to Conduct Inquiry Based Student Directed Learning. IEEE International conference on Technology for Education (T4E), Amritapuri, India, December 2014.

- Rekha Ramesh, **Shitanshu Mishra**, M Sasikumar, Sridhar Iyer. Semi-Automatic Generation of Metadata for Items in a Question Repository. IEEE conference on Technology for Education (T4E), Amritapuri, India, December 2014.

- Abhinav Anand, Aditi Kothiyal, Anita Diwakar, Anura Kenkre, Anurag Deep, Depti Reddy, Jayakrishnan Warriem, Kapil Kadam, Kavya Alse, Kiran Eranki, Rekha Ramesh, Rwitajit Majumdar, **Shitanshu Mishra**, Vasanta Akondy, Yogendra Pal, Neena Thota. Designing Engineering Curricula Based on Phenomenographic Results: Relating Theory to Practice. IEEE conference on Technology for Education (T4E), Amritapuri, Indi, December 2014.

- **Shitanshu Mishra**, Sudish Balan, Sridhar Iyer, Sahana Murthy. Effect of a 2-week Scratch Intervention in CS1 on Learners with Varying Prior Knowledge. ACM conference on Innovation Technology in Computer Science Education (ITiCSE), Uppsala, Sweden, June 2014.

- **Shitanshu Mishra** and Sridhar Iyer. Problem Posing Exercises (PPE): An Instructional Strategy for Learning of Complex Material in Introductory Programming Courses. IEEE Conference on Technology for Education (T4E 2013), Kharagpur, India, December 2013.

- **Shitanshu Mishra** and Rekha Ramesh. A Software Solution to Facilitate Moderation, Observation and Analysis in a Focused Group Interview. IEEE Conference on Technology for Education (T4E 2013), Kharagpur, India, December 2013.

Panel Report (s)

- Francesco Maiorana, Miles Berry, Mark Nelson, Chery Lucarelli, Margot Phillipps, **Shitanshu Mishra**, & Andrea Benassi. International Perspectives on CS Teacher Formation and Professional Development. In Proceedings of the 2017 ACM Conference on Innovation and Technology in Computer Science Education (pp. 236-237). ACM, Bologna, Italy, July 2017.

Abstracts

- **Shitanshu Mishra**. Improving Students' Knowledge Integration in Data Structures. ACM conference on International Computing Education Research, Melbourne, Australia, September 2016.

- **Shitanshu Mishra**. Developing Students' Problem-Posing Skills. ACM conference on International Computing Education Research, Glasgow, Scotland, August 2014.

Manuscripts submitted for publication or in preparation

- **Shitanshu Mishra** and Sridhar Iyer. Questioning is the Answer: Fostering Knowledge Integration Process Skills. Manuscript in preparation.

- **Shitanshu Mishra,** Anabil Munshi, Naveeduddin Mohammed, Gautam Biswas, Daniel T Levin. Using gaze analysis and pattern mining to study problem-solving strategies in a technology-enhanced learning environment. Manuscript in preparation.

- Daniel T Levin, **Shitanshu Mishra,** Anna Write, Xiarui Xue, Shiwei Xie, Gautam Biswas.What Causes eye-tracking data loss in a middle-school classroom. Manuscript Submitted for review.

SERVICE EXPERIENCE

- **PC co-chair**, ICCE 2020 Sub-Conference on Practice-driven Research, Teacher Professional Development and Policy of ICT in Education (PTP)
- **Local Organizing Committee Member** for International conferences: LaTiCE 2016, ICCE 2016, T4E 2016, COLING 2012
- **International Committee Member**, SIGCSE 2018
- **Reviewer** for:
  - Journal of Leanring and individual differences (2020)
  - IEEE Transactions on Learning Technologies (IEEE TLT 2019-20)
  - Journal of Educational Technology & Society (ET&S in 2018)
  - International Conference on Innovations and Technology in Computer Science Education (ITiCSE 2017, 2018, 2019)
  - International Conference on Special Interest Group in CS Education (SIGCSE 2018)
  - International Conference on Technology for Education (T4E 2015, 2016, 2017, 2018, 2019)
- **Sub-reviewer** for: AIED (2013, 2015), epiSTEME (2015), ICALT (2013), ICCE (2014, 2015), ICSLE (2015), ITiCSE (2014), LaTiCE (2014, 2015, 2016), SIGCSE (2015), T4E (2013, 2014)
- Administered an online course, ET612Tx: Pedagogy for effective teaching and learning of Computer Science in schools, on IITBombayX, as a chief teaching assistant (May 18th - June 14th, 2017)
- Headed the Research Scholars' Forum, IIT Bombay, as the Overall Coordinator for the tenure 2014-2015
- Coordinator, Research Scholars' Confluence (ReSCon) 2015.

TALKS & WORKSHOPS

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1. Online webinar for Mumbai University College Teachers on “Student-Centric Design Thinking for Educational Problem Solving.” TBD on 20th June 2020. ***Role: Instructor***
2. Invited talk on “Analyzing Problem Solving and Decision Making Processes in Open Ended Learning Environments.” ML4ED lab at Swiss Federal Institute of Technology Lausanne (EPFL), Switzerland. May 5th, 2020. ***Role: Speaker***
3. Invited talk on “An EdTech Researcher needs both Learning Analytics and Qualitative Research Skills.” IITB Alumni Interaction Series, IIT Bombay, Mumbai, April 29th, 2020. ***Role: Speaker***
4. Panel Talk on “International Perspectives on CS Teacher Formation and Professional Development.” July 4th, 2017, ITiCSE 2017, Bologna, Italy. ***Role: Panelist.***
5. Workshop on “Using Exploratory Questioning to foster cognitive skills of Knowledge Integration.” August 5th, 2017, Fr. Conceicao Rodrigues College of Engineering, Mumbai. ***Role: Instructor.***
6. Workshop on “Exploratory Questioning and Knowledge Integration Skills.” February 19th, 2017, IIT Bombay, Mumbai. ***Role: Instructor.***

7. Workshop on “Exploratory Questioning and Knowledge Integration Skills.” April 4th, 2017, MPSTME, Vile Parle West, Mumbai. ***Role: Instructor.***
8. Workshop on “Knowledge Integration Skills.” August 1st - 15th, 2016, IIT Bombay, Mumbai. **Role: Instructor.**
9. A three-day workshop on “Exploratory Questioning skills.” October 27th - 30th, 2015, DIT University, Dehradun. ***Role: Instructor.***
10. Design Thinking workshop on “Creative Problem Solving in the context of MOOC platform.” April 11th - 12th, 2015 IIT Bombay. ***Role: Instructor.***
11. Workshop on “Technology Integration in Education (TIE).” March 22nd, 2015, IIT Bombay. **Role: Instructor.**
12. Workshop on data structures using question posing and online collaboration strategy. January 25th, 2015, IIT Bombay. ***Role: Instructor.***
13. A three-day workshop on “Introduction to Data Structures using Question Posing based Active Learning Strategy. 4th-6th July 2014, IIT Bombay. ***Role: Instructor.***
14. Instructional Design Workshop. October 6, 2013, BITS Pilani. ***Role: Instructor.***
15. Technology Enabled Quality Improvement Program (TEQIP) workshop on “Effective Teaching Strategies for Quality Engineering Education teachers on Educational Technology.” 24th - 28th January 2013, IIT Bombay. ***Role: Content Creator and Organizer.***
16. Workshop on “Improvement of Spatial Thinking Skills using Blender.” 29th - 30th September 2012, Goa University. ***Role: Instructor.***

AWARDS

- Mashruwala Award for Educational Innovation, 2017
- MHRD Postgraduate Assistantship, 2012-2017
- Google India travel funding, 2015

Resume updated on 18th Aug 2020