INTERDISCIPLINARY PROGRAMME IN EDUCATIONAL TECHNOLOGY
Annual Report 2018-19

Introduction

The Interdisciplinary Programme in Educational Technology (IDP-ET) started in the Institute in the Autumn semester of the academic year 2010-11. The IDP-ET conducts research in areas of pedagogies and tools for technology-enhanced learning. In addition to Institute courses at a Ph.D. level, the IDP-ET organizes short-term intensive courses and MOOCs on effective teaching-learning and educational research methods through CEP, TEQIP, Train 10000 Teachers project, IITBombayX and NPTEL. Faculty members of the IDP-ET carry out sponsored projects for government organizations, and provide consultancy to educational technology industries. Faculty members, post-doctoral research scholars and Ph.D. students of the IDP-ET play a significant role in the organization of international conferences.

Noteworthy highlights:
- MTech program in Educational Technology to begin in 2019-20
- 3 Diamond Jubilee events: Open House, Research Showcase, Technology enhanced learning symposium

People

Convener: Prof Sridhar Iyer

Faculty members: The IDP-ET has 5 core faculty members, 1 adjunct faculty and 19 associate faculty members from academic units across the Institute.

Academic staff: The IDP-ET has 2 post-doctoral research associates and a number of project research staff and interns.

PhD alumni: The IDP-ET has 12 PhD alumni, who are currently pursuing various careers: post-doctoral researchers in India and abroad, college faculty, e-learning industry, independent consultants and start-ups.

Academic Programme

The IDP-ET offers a Ph.D. programme in Educational Technology. Starting from the coming academic year 2019-20, an M.Tech program will be offered. The expected intake of students in the 1st incoming M.Tech batch is ~10.

Ph.D students

Currently enrolled: 18
Degrees awarded in 2018-19: 4

Courses

The IDP-ET continues to offer core courses and electives in educational technology content and methods. These courses have had enrolment from B.Tech, M.Tech and Ph.D students in other academic programmes within the Institute. Several new courses were designed and included in the MTech curriculum.

R & D Activities

The main research areas of focus of the IDP-ET are:
- Technology-enhanced learning of thinking skills (TELoTS) focuses on developing students' cognitive skills such as problem-posing, estimation, algorithmic thinking, modeling, data representation and analysis, divergent-convergent thinking, and design thinking. We design, develop and evaluate technology enhanced learning environments for various thinking skills in different domains.
- Teacher Use of Educational Technology (TUET) focuses on the research-informed development and outreach of innovations for empowering teachers in effective use of educational technology. The key TUET

goals are to:
- Develop and evaluate models for: i) large-scale teacher training in different modes such as MOOCs and blended learning, ii) development of teachers' design thinking for effective learning designs.
- Develop innovative tools and strategies to assist teachers in effective technology integration and analytics.
- Conduct theory-informed capacity building activities to develop teachers' proficiency in effective integration of ICT in their practice.

- Educational data analytics (EDA) is an emerging field of study where data pertaining to student behaviour in a computer mediated environment are used to analyse cognitive and affective states of student. Some key EDA objectives are:
  - Use multimodal data such as mouse clicks, MOOC navigation data, eye gaze information, facial emotion recognition, galvanic skin conductance and brain waves to understand learner behaviour.
  - Use machine learning and big data analytics to model and predict learner behavior.
  - Design the next generation of learning products such as intelligent tutoring systems in which the learning content is personalized based on student's prior knowledge, cognition and emotion

- Emerge: Identify potential benefits that emerging technologies might afford in the teaching-learning process and design appropriate learning activities.

Areas of development focus for the IDP-ET are:
- Learning resources and tools for students – technology-enhanced learning environments for concepts and problem solving
- Tools for educational data analytics for teachers.
- Creation of multimedia e-books.
- Design and development of online courses for students and teachers.
- Guidelines and templates for teachers - effective teaching strategies, large classes, incorporation of ICT tools, teaching in new contexts such as online education and flipped classrooms.

Sponsored Projects

Ongoing
- Pedagogy for effective use of ICT by School teachers. Sponsored by Next Education India Pvt Ltd. 2017-20.
- Next Education Research Lab. Endowed lab sponsored by Next Education India Pvt. Ltd. 2017-22.
- Teaching Learning Centre for Information and Communication Technologies (TLC), sponsored by PMMMNMTT, MHRD. 2017-21.
- Educational Services for Outreach at Scale (ESOS) sponsored by MHRD. 2017-22.
- Leveraging eye tracking and allied bio-sensing for education research. IIT Bombay IRCC Seed Grant project.
- Reasoning about uncertainty and efficient decision-making in engineering design. IIT Bombay IRCC Seed Grant project.
- Interface development and pilot-testing of a novel classroom feedback system. IIT Bombay IRCC research internship grant.
- Modeling user's self-regulated learning behaviour using multimodal learning analytics. IIT Bombay IRCC research internship grant. (2018 - 21)

Completed
- Benchmarking digital content. sponsored by Next Education India Pvt Ltd. 2016-18

Consultancy Projects

Ongoing

- Advice on R&D of current and future education projects. Next Education India Pvt Ltd. 2016-19.

Papers published

Journals

- Dasgupta, C. (in press). Improvable Models as Scaffolds for Promoting Productive Disciplinary Engagement in an Engineering Design Activity. *Journal of Engineering Education*
- Rathod, B. B., Murthy, S., & Bandyopadhyay, S. (2019). Is this Solution Pink Enough? A Smartphone Tutor to Resolve the Eternal Question in Phenolphthalein-Based Titration. *Journal of Chemical Education*. *96* (3), 486-494. DOI: 10.1021/acs.jchemed.8b00708
- Magana, A. J., Elluri, S., Dasgupta, C., Seah, Y. Y., Madamanchi, A. & Boutin, M. (2019). The Role of Simulation-Enabled Design Learning Experiences on Middle School Students' Self-generated Inherence Heuristics. *Journal of Science Education and Technology*. https://doi.org/10.1007/s10956-019-09775-x
- Dasgupta, C., Magana, A. J., & Vieira, C. (2019). Investigating the affordances of a CAD enabled learning environment for promoting integrated STEM learning. *Computers & Education*, *129*, 122-142. https://doi.org/10.1016/j.compedu.2018.10.014
- Kothiyal, A. & Murthy, S. (2018) MEttLE: A Modelling-based Learning Environment for Undergraduate Engineering Estimation Problem Solving. *Research and Practice in Technology Enhanced Learning,* 13:17.

Peer-reviewed conference proceedings

- Kadam, K., Deep, A., Prasad, P., and Mishra, S., "Quantitative Evaluation of Concept Maps: An Evidence-Based Approach" In TEEL Workshop Track of the 9th International Conference on Learning Analytics and Knowledge (LAK19), Tempe, Arizona, USA, March 4-8, 2019.
- Mitra, R., & Chavan, P. (2019). DEBE feedback for large lecture classroom analytics. In Proceedings of the 9th International Conference on Learning Analytics & Knowledge (pp. 426-430). ACM.
- Negi, S., & Mitra, R. (2018). EEG Metrics to Determine Cognitive Load and Affective States: A Pilot Study. In Proceedings of the 2018 ACM International Joint Conference and 2018 International Symposium on Pervasive and Ubiquitous Computing and Wearable Computers (pp. 182-185). ACM.
- Joshi, A., Shah V. & Murthy S., "Speak Up: VR-based training system for improving oral presentation skills", The Future of Learning Conference (FOL 2019) Bangalore, India, January 4-5, 2019.
- Murthy, S., Warriem, J., Sahasrabudhe, S. & Iyer, S. LCM: A model for planning, designing and conducting Learner-Centric MOOCs. IEEE 9th International Conference on Technology for Education (T4E 2018) Chennai, India, December 10-13, 2018.
- Reddy, Deepti, Sridhar Iyer, and M. Sasikumar. "Technology Enhanced Learning (TEL) Environment to Develop Expansionist-Reductionist (ER) Thinking Skills through Software Design Problem Solving." IEEE 9th International Conference on Technology for Education (T4E 2018) Chennai, India, December 10-13, 2018.
- N. Swamy K L and C. Dasgupta. Investigating the Nature of Students' Reasoning in Connecting Molecular Structures of Stereoisomers with their Physical Properties Using an AR App. IEEE 9th International Conference on Technology for Education (T4E 2018) Chennai, India, December 10-13, 2018.
- Kaur, N., Pathan, R., Khwaja, U., Sarkar, P., Rathod, B., & Murthy, S. (2018, December). GeoSolvAR: Augmented Reality Based Application for Mental Rotation. IEEE 9th International Conference on Technology for Education (T4E 2018) Chennai, India, December 10-13, 2018.
- Shah V., Banerjee G., Murthy S. & Iyer S. (2018), Learner-centric MOOC for teachers on effective ICT integration: Perceptions and experiences. IEEE 9th International Conference on Technology for Education (T4E 2018) Chennai, India, December 10-13, 2018.

- Deep, A., Pathan, R., & Mitra, R. (2018). Comparing Experts' Systems Thinking Skill Across Contexts. IEEE 9th International Conference on Technology for Education (T4E 2018) Chennai, India, December 10-13, 2018.
- Padhi, D. R., Chavan, P., & Mitra, R. (2018). Understanding systems thinking from the perspectives of experience and diversity. IEEE 9th International Conference on Technology for Education (T4E 2018) Chennai, India, December 10-13, 2018.
- Nettikadan, D., Ngeze, L.V., Sukhathankar, S., and Warriem, J. M. (2018). iLTI-QAT: A Model to Orchestrate Interaction Sessions in Hybrid MOOCs. IEEE 9th International Conference on Technology for Education (T4E 2018) Chennai, India, December 10-13, 2018.
- A. S. Diwakar and S. Noronha, Usability and Usefulness of ADVIcE Tool Experiment Design Guidelines for Virtual Laboratories. IEEE 9th International Conference on Technology for Education (T4E 2018) Chennai, India, December 10-13, 2018.
- Rajendran, R., Munshi, A., Emara, M., and Biswas, G., A Temporal Model of Learner Behaviors in OELEs using Process Mining. Proceedings of the 26th International Conference on Computers in Education (ICCE 2018), Manila, Philippines, Nov. 26-30, 2018.
- Banerjee G., Warriem J., and Mishra S. (2018). Learning experience interaction (LxI): Pedagogy for peer-connect in MOOCs. Proceedings of the 26th International Conference on Computers in Education (ICCE 2018), Manila, Philippines, Nov. 26-30, 2018.
- Chavan, P., Gupta, S. and Mitra, R.(2018) A Novel Feedback System for Pedagogy Refinement in Large Lecture Classroom. Proceedings of the 26th International Conference on Computers in Education (ICCE 2018), Manila, Philippines, Nov. 26-30, 2018.
- Kaur, N., & Dasgupta, C. (2018). Types of uncertainty and collaborative uncertainty management strategies evidenced during the engineering design process. Proceedings of the 26th International Conference on Computers in Education 2018, Manila, Philippines. November 26 - 30.
- Ngeze, L.V., Khwaja, U and Iyer, S. (2018). Cascade Model of Teacher Professional Development: Qualitative Study of the Desirable Characteristics of Secondary Trainers and Role of Primary Trainer. Proceedings of the 26th International Conference on Computers in Education 2018, Manila, Philippines. November 26 - 30.
- Mahajan, S., Diwakar,A., Patel,K., Gawde,A., and Jadhav, R. (2018). Improvisation of Circuit Design and Analysis Skills of students for Analog Electronics Course Using Virtual labs. Proceedings of the 26th International Conference on Computers in Education 2018, Manila, Philippines. November 26 - 30.
- A. S. Diwakar and S. Noronha. (2018). Effectiveness of Experiment Design Guidelines for Virtual Laboratories in the ADVIcE tool. Proceedings of the 26th International Conference on Computers in Education 2018, Manila, Philippines. November 26 - 30.
- Lakshmi, T. G. (2018, August). Developing Students' Conceptual Design Skills for Software Engineering. In *Proceedings of the 2018 ACM Conference on International Computing Education Research* (pp. 278-279). ACM.
- Emara, M., Rajendran, R., and Biswas, G., Do Students Learning Behaviors Differ when they Collaborate in Open-Ended Learning Environments? *21st ACM Conference on Computer-Supported Cooperative Work and Social Computing (CSCW)* 2018.
- Kothiyal, A. & Murthy, S. (2018). "Exploring How Students Learn Estimation Using a Modelling-based Learning Environment". In Rethinking Learning in the Digital Age: Making the Learning Sciences Count, Proceedings of the 13th International Conference of the Learning Sciences (ICLS 2018), Vol. 3 (pp. 1543-1545). London: The International Society of the Learning Sciences.
- Lakshmi, T. G., & Iyer, S. (2018). Exploring Novice Approach to Conceptual Design of Software. In Rethinking Learning in the Digital Age: Making the Learning Sciences Count, Proceedings of the 13th International Conference of the Learning Sciences (ICLS 2018), Vol. 3 (pp. 1399-1400). London: The International Society of the Learning Sciences.

- Deep, A. (2018). "Supporting undergraduate bioscience learners in problem-solving process skills using a technology-enhanced learning environment". In Doctoral Students Consortia, Proceedings of the 13th International Conferences of the Learning Sciences (ICLS 2018), Vol. 3 (pp. 1880). London: The International Society of the Learning Sciences.
- Bywater, J. P., Floryan, M., Chiu, J., Chao, J., Schimpf, C., Xie, C., Vieira, C., Magana, A. J., & Dasgupta, C. (2018). Using Machine Learning Techniques to Capture Engineering Design Behaviors. Proceedings of the 13th International Conference of the Learning Sciences, 2018 (pp. 1359 - 1360). London, UK.
- Dasgupta, C. (2018). Investigating the use of Anchoring for Promoting Design Thinking. Proceedings of the 13th International Conference of the Learning Sciences, 2018. (pp. 1529 - 1530). London, UK.
- Dasgupta, C. (2018). Reasoning About Uncertainty and Efficient Decision-making in Engineering Design. ICLS 2018 Early Career Workshop. Proceedings of the 13th International Conference of the Learning Sciences, 2018. (pp. 1852 - 1853). London, UK.
- Kaur, N., Pathan, R., Khwaja, U., & Murthy, S. (2018, July). GeoSolvAR: Augmented reality based solution for visualizing 3d solids. In 2018 IEEE 18th International Conference on Advanced Learning Technologies (ICALT) (pp. 372-376). IEEE.
- A. Raina, S. Murthy and S. Iyer, ""Help Me Build": Making as an Enabler for Problem Solving in Engineering Design," 2018 IEEE 18th International Conference on Advanced Learning Technologies (ICALT), Mumbai, 2018, pp. 455-457.

Conferences/Symposia/Workshops/Seminars (Participated/ Papers presented)
- Biswas, G., Rajendran, R., & Munshi, A. Multi-Modal Data Analysis of Students' SRL Behaviors in Open-Ended Learning Environments. *In Proceedings of the American Educational Research Association* 2019. Symposium on Multimodal Data during Learning with Advanced Learning Technologies. Toronto, Canada from April 5-9, 2019.
- Navneet Kaur: Presentation on 'Improving uncertainty management skills of the learners in the context of engineering design' in Annual Research Meet (ARM 2019) held in HBCSE, Mumbai, India from March 13-15, 2019.
- Herold PC: Presentation on 'Investigating concreteness and abstraction in the context of mathematics education' in Annual Research Meet (ARM 2019) held in HBCSE, Mumbai, India from March 13-15, 2019.

Invited Talks
- Sahana Murthy. Improving learning and learner engagement in f2f and blended settings. Invited talk in 'Training and Development in RBI – Bridging the Gaps' - conclave organized by Reserve Bank of India. March 30, 2019.
- Sahana Murthy. Active learning strategies for improving student learning and engagement. Somaiya College of Science and Commerce. February 21, 2019.
- Sridhar Iyer and Jayakrishnan Warriem. Designing learner-centric MOOCs. NPTEL, IIT Madras. November 2018.
- Sridhar Iyer. Technology enhanced learning of thinking skills. Invited talk at TCS Innovation Labs, Pune. October 2018.
- Sridhar Iyer. Active learning: Improving student learning and engagement. Invited talk at K J Somaiya College of Engineering. July 14, 2018.

Conferences chaired
- Sahana Murthy. General Program co-chair. 18th IEEE International Conference on Advanced Learning Technologies (ICALT 2018), Mumbai. July 9-13, 2018.
- Sridhar Iyer, Chandan Dasgupta, and Ramkumar Rajendran. Track Program Chairs of TELoTS track in IEEE ICALT 2018 conference, Mumbai. July 9-13, 2018.

- Chandan Dasgupta. Doctoral Consortium Chair. 18th IEEE International Conference on Advanced Learning Technologies (ICALT 2018), Mumbai. July 9-13, 2018.
- Sahana Murthy. Doctoral Consortium Chair. 26th International Conference on Computers in Education (ICCE 2018), Manila, Phillipines. Nov. 26-30, 2018.

Conferences and Workshops organized
- Technology-Enhanced Learning Research Symposium (Diamond Jubilee event). Organized at IIT Bombay, Nov. 19 & 20, 2018.
- 18th IEEE International Conference in Advanced Learning Technologies, ICALT 2018, organized at IIT Bombay from July 9-13, 2018.

Continuing Education Programs (CEP)
- Sessions in TEQIP-III KIT Faculty Induction Program, June 2018. Sridhar Iyer, Sahana Murthy.

Faculty Professional Development programs
- Content Delivery and Assessment Methods for CS/IT Curriculum. 2-day FDP at Thiagarajar college of Engineering, Madurai, Tamil Nadu. February 11-12, 2019. Kapil Kadam.
- Active Teaching Learning Strategies, 1-day FDP at Fr. Conceicao Rodrigues College of Engineering, Mumbai, February 1, 2019. Anita Diwakar
- Design virtual lab experiment, IEEE approved 1-day Workshop at Yeshwantrao Chavan College of Engineering, Nagpur, January 24, 2019. Anita Diwakar.
- Active Learning, and ICT Enabled Hybrid Learning (MOOCs). 1-day FDP at Shri Mata Vaishno Devi University (SMVDU), Katra, J&K. Jan 19, 2019. Sameer Sahasrabudhe and Kapil Kadam.
- AICTE-ISTE Approved STTP 'Pedagogy for Effective Integration of Information & Communication Technologies (ICT) in Engineering Education'. 1-week program at Shah and Anchor Kutchhi engineering college, Mumbai, May 3-8, 2018.
- Capacity development workshops for Engineering faculty, 1-day FDP at PSG College of Technology, Coimbatore, 8th June, 2018.
- Outcome based education, 2-day FDP at Deogiri Institute of Engineering & Management, Aurangabad, June 15-16, 2018.

MOOCs
Faculty, post-doctoral research scientists and PhD research scholars of the IDP-ET designed and taught the following MOOCs on NPTEL and IITBombayX platform:
- Designing Learner Centric MOOCs. 4-week MOOC for school teachers and e-learning curriculum designers. Instructors: Sridhar Iyer, Sahana Murthy, Sameer Sahasrabudhe, Jayakrishnan Warriem; Course management: Veenita Shah. Offered on NPTEL, January - March 2019. Enrolment 2454.
- Fundamentals of 3D Visualization (SKVIZ101x). 4-week MOOC. The course design was based on LCM pedagogy. Offered on IITBombayX, August-October, 2018. Enrolment 1904. Instructors: Sameer Sahasrabudhe, Kapil Kadam. Course Management: Pankaj Chavan.
- Pedagogy for effective use of ICT for school teachers. 4-week MOOC for school teachers from different domains and different countries. Offered on IITBombayX platform, July 26 - September 7, 2018. Enrolment 13603.
- Effective teaching-learning of CS in schools, 4-week MOOC for Computer Science school teachers from different countries. Offered on IITBombayX platform, September 6 - October 7, 2018. Enrolment 412.

Workshops conducted
- Basics of 3D Animation using Blender, 2day workshop, March 17-18, 2019, KIT's College of Engg. Kolhapur, Maharashtra. 50 participants from 2nd year CS engg. Kapil Kadam.
- Thinking Skill workshop on Problem-solving and process skills in genetics, 2 day workshop, February 14-15, 2019, VPM's B. N. Bandodkar College of Science, Thane, Maharashtra. 131 participants from Bio-Science Discipline, Anurag Deep.

Honorary Work
International professional societies:
- Executive Committee Member, Asia Pacific Society of Computers in Education (APSCE). Sahana Murthy, Sridhar Iyer. 2014-20.
- APSCE Practice driven research and teacher professional development SIG Chair. Sridhar Iyer. 2017-19.
- New Initiatives Chair, IEEE Technical Committee on Learning Technologies. Sridhar Iyer. 2015-18.
- Committee Member, Communications Committee, International Society of the Learning Sciences. Chandan Dasgupta. 2018-21.
- Committee Member, Membership Committee, International Society of the Learning Sciences. Chandan Dasgupta. 2018-21
- International Partner and Collaborator, Purdue University Cyberlearning Consortium. Chandan Dasgupta. 2018 onwards.

Reviewers and program committee members:
- Reviewer for journals: ACM Transactions on Computing Education (ToCE), IEEE Transactions on Education (ToE), Educational Technology, Research & Development (ETR&D), International Journal of Distance Education Technologies (IJDET), Research & Practice in TEL (RPTEL), Interactive Learning Environments (ILE), Journal of Computers in Education (JCE), Cognitive Research: Principles and Implications, IEEE Transactions on Learning Technology (TLT).
- International program committee member for various conferences: Artificial Intelligence in Education (AIED 2019), International Conference on Computers in Education (ICCE 2018), International Conference on Computational Thinking Education 2017 (CTE 2018), International Conference on Advanced Learning Technology (ICALT 2019).