A model for large-scale, in-service teacher training in effective technology integration in engineering education

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Under the supervision of

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Technology use in higher education

- Technology is ubiquitous.
- Top-down push to increase access

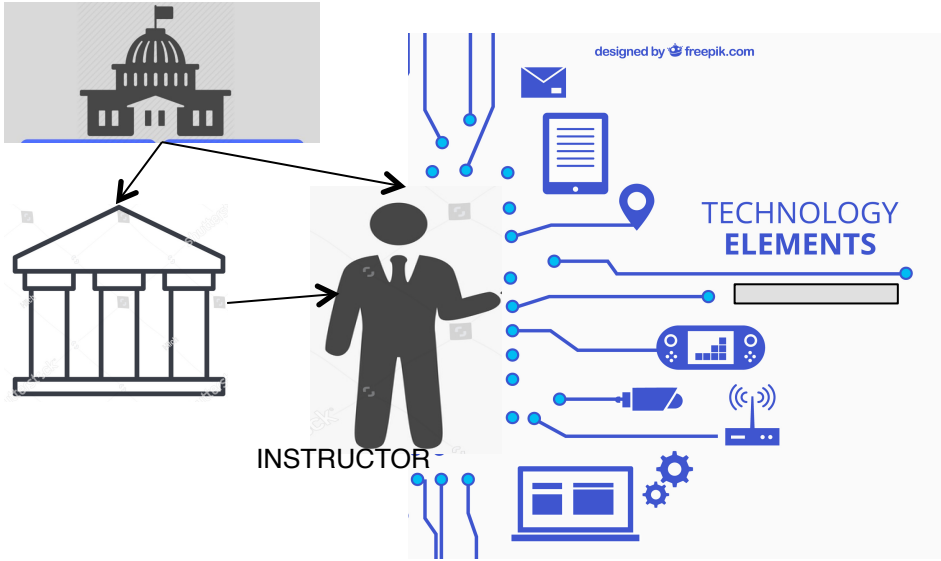


Image Credits:Shutterstock-Teacher-icon, Shutterstock-building, Top Differences, Freepik

Technology use in higher ed. classrooms

- Students as consumers of technology!!

- Research results on benefits of technology, if used effectively

RESEARCH

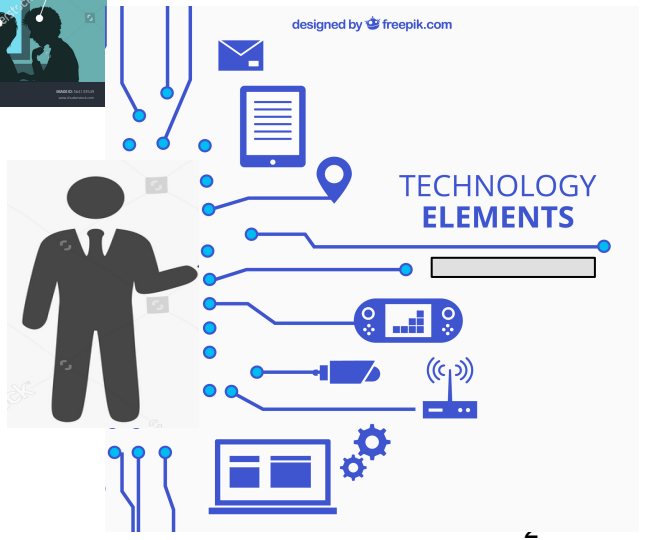
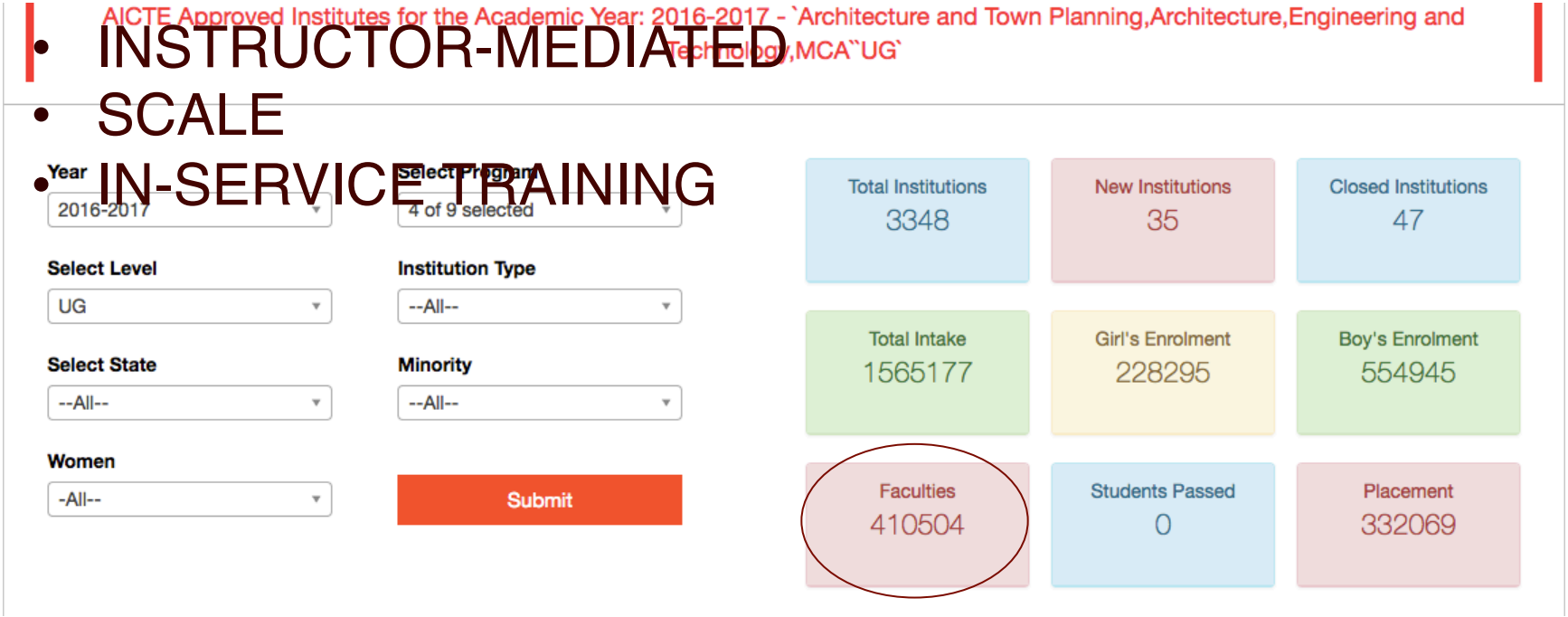


Image Created by:Shutterstock-students,

The Indian context

- INSTRUCTOR-MEDIATED
- SCALE
- IN-SERVICE TRAINING



Source: https://www.facilities.aicte-india.org/dashboard/pages/dashboardaicte.php

Existing initiatives

- National Missions
  - NMEICT (T10KT, AAQ, Spoken Tutorials,..), NPTEL, PMMMNMTT, TEQIP
- Institutional
  - National Institute of Technical Teachers Training & Research (NITTTR), CEP, QIP
- Local/individual efforts (STTPs, TLCs)

Operating Context

- Train 10000 Teachers (T10KT)
- Goal: Empowerment of teachers
- Hub (IITB) and Spoke (Remote Centre) model
- Synchronous Workshops through A-VIEW and MOODLE
- Blended courses using IITBX

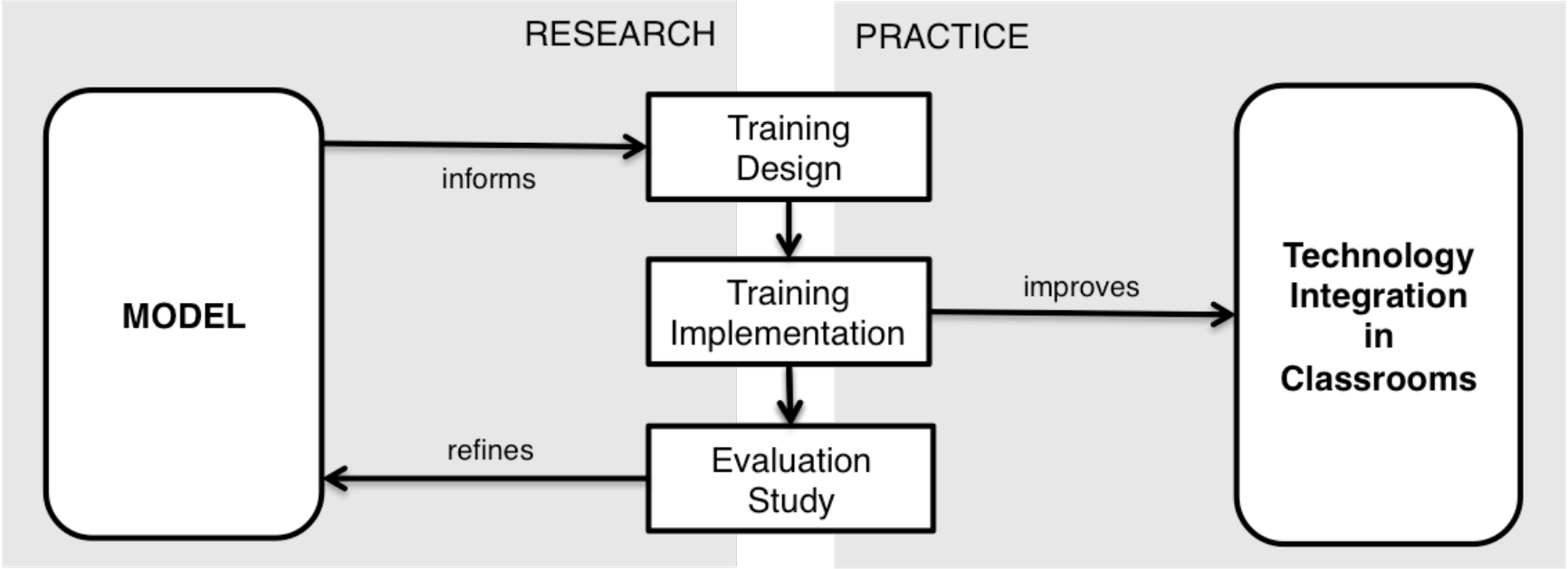
Problem Statement

- How to **improve the design and delivery** of large-scale training programs to in-service faculty in engineering education within India to enable them in effectively integrating Information and Communication Technology (ICT) tools within their teaching-learning context?

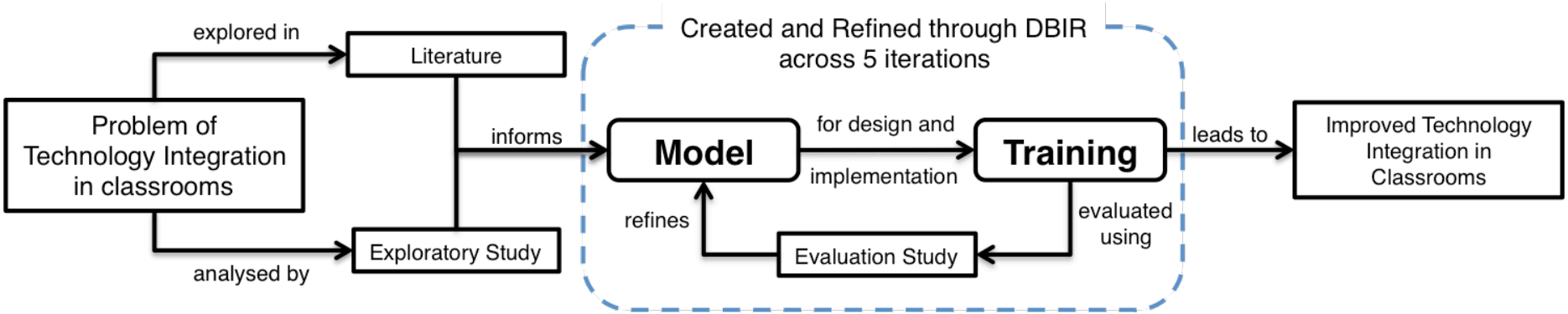
Solution

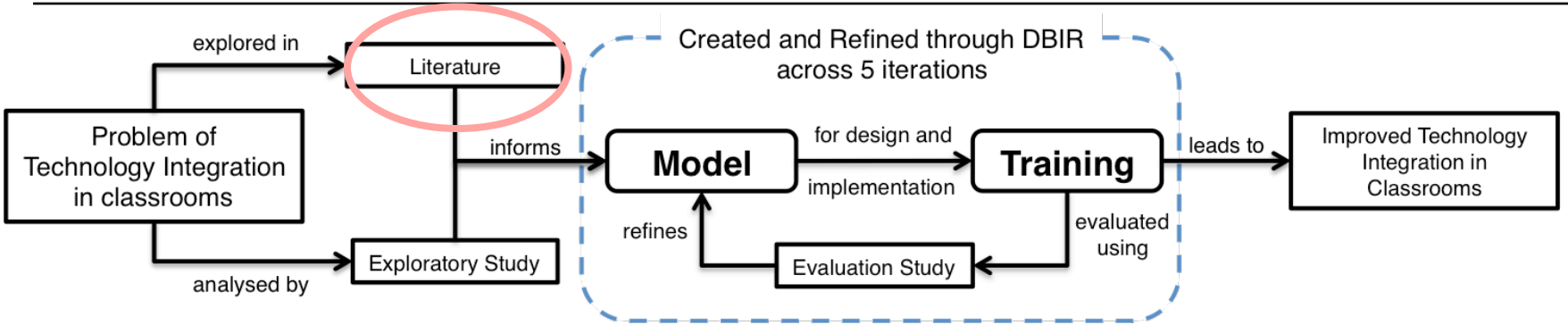
- Development of Attain-Align-Integrate-Investigate (A2I2) Model
- Implementation of Training based on A2I2
  - 1 face-to-face
  - 3 blended-online
  - 1 massive open online
- Evaluation of model via 5 studies

Overview of Research

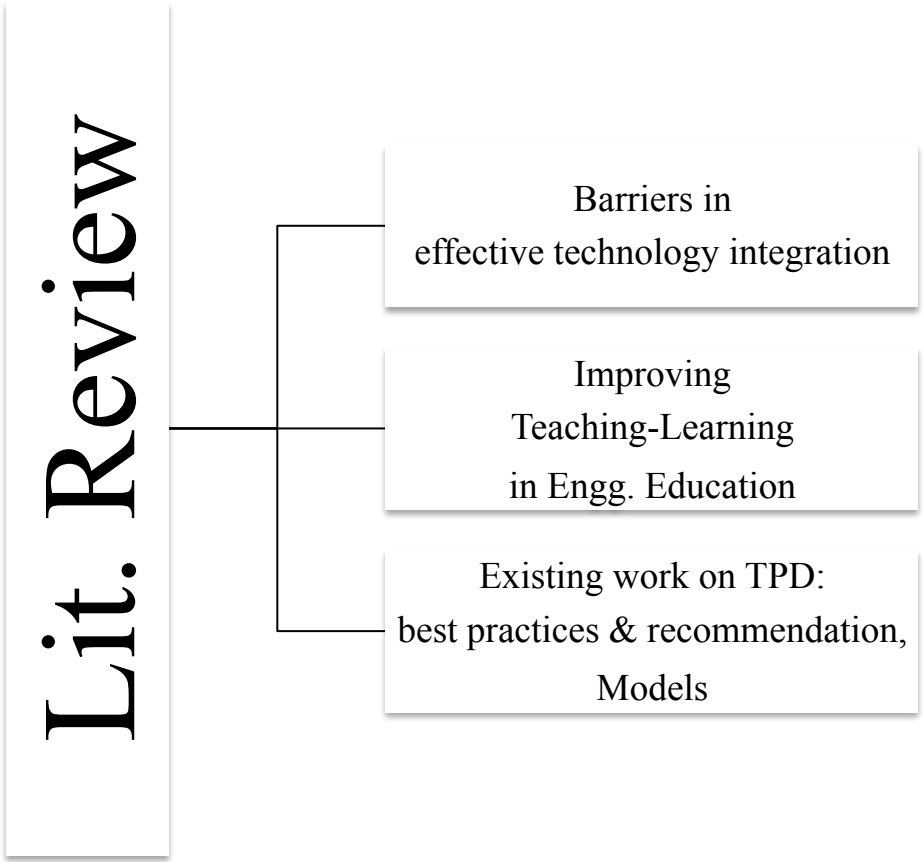


Flow of Research





POSITIONING THE RESEARCH


Lit. Review
Barriers in
effective technology integration
Improving
Teaching-Learning
in Engg. Education
Existing work on TPD:
best practices & recommendation,
Models

Barriers to effective ICT integration

Effectively integrating ICT tools is challenging because:

- Access to ICT tools (Ertmer, 2005)

- Teachers feel inadequately prepared for:
  - Using new technology (Mumtaz, 2000)
  - Teachers belief and attitude towards technology (Ertmer, 2005)
  - Design of lessons using Student-centric strategies (Brown & Warschauer, 2006; Gao, Choy, Wang, & Wu, 2009; Lim & Chai, 2008)

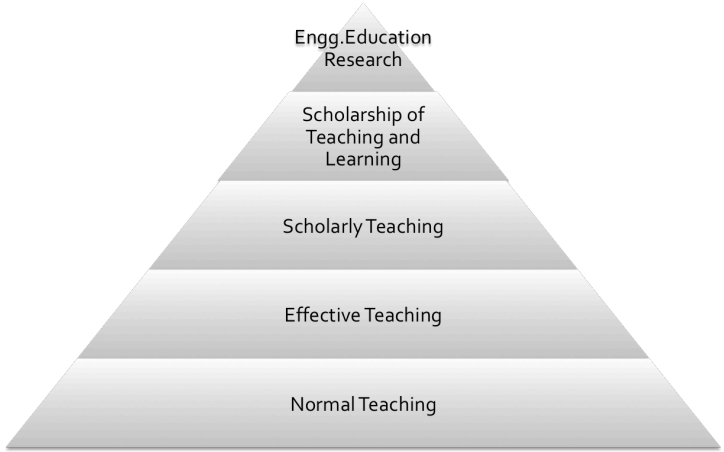
1st Order barrier

2nd Order barrier

3rd Order barrier

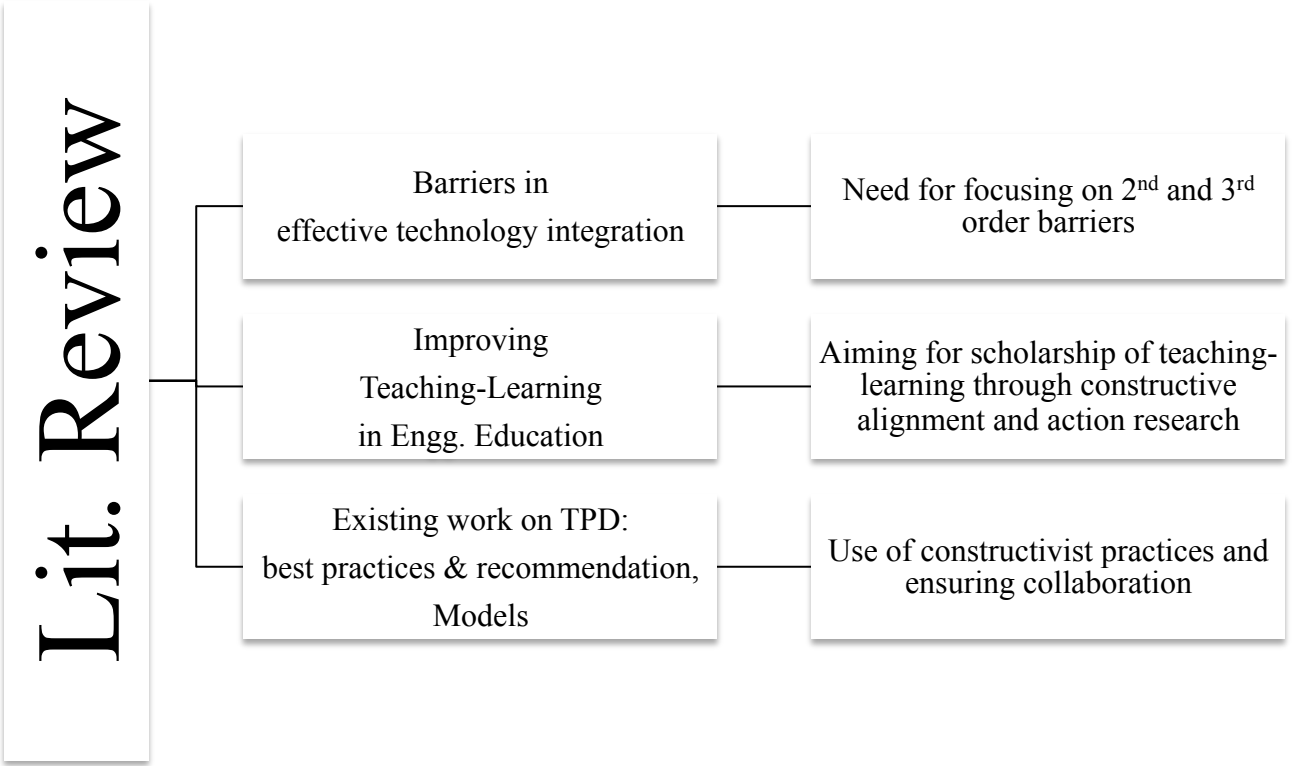
Improving Teaching-Learning in Engg. Edu.

- Levels of T-L practice in engg. education (Streveler et. al., 2012)
- Recommendation to operate above "scholarly teaching"
- Assess own teaching and make improvements



Existing work

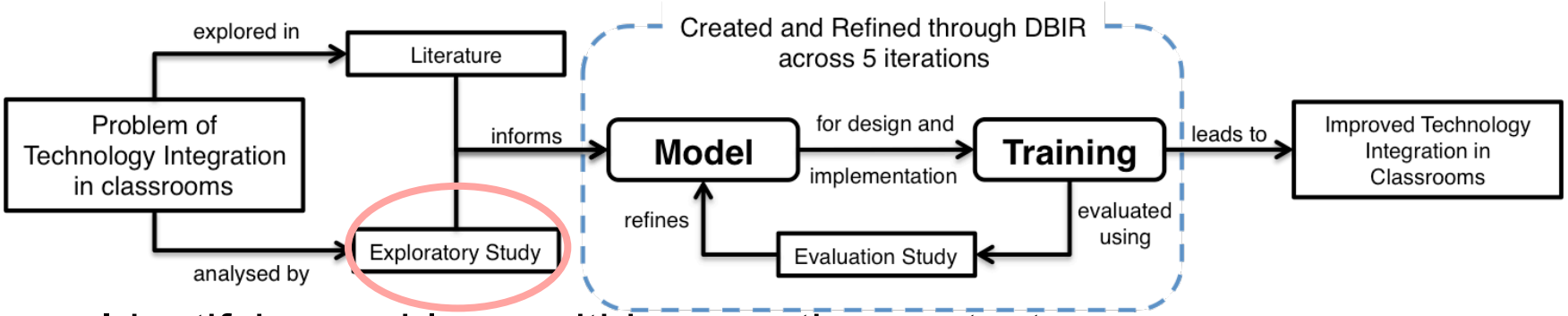
- Best practices and recommendations
  - Constructivist use (Jung, 2005; Jonassen et. al., 2008), Need for collaboration (Tseng & Kuo, 2014)
- Available Models
  - Reflective Practice (Avalos, 2011; Gibbs, 1988; Schon, 1987), Communities of Practice (Wenger, 1998), Action Research (Rock & Levin,2002; Zeichner, 1987), TPACK (Mishra & Koehler, 2009)
- Existing programmes in higher ed
  - Course Design Workshop at McGill University (Saroyan et. al., 2004), National Effective Teaching Institute – NETI (Brent & Felder, 2009), March^{ET} (Reinties et. al., 2013)


Lit. Review
Barriers in effective technology integration
Need for focusing on 2nd and 3rd order barriers
Improving Teaching-Learning in Engg. Education
Aiming for scholarship of teaching-learning through constructive alignment and action research
Existing work on TPD: best practices & recommendation, Models
Use of constructivist practices and ensuring collaboration

Positioning the current research

A model for:

- Going beyond best practices and recommendations
- Tackling second and third order barriers
- Scaling and Sustaining the training



Identifying problems within operating context

EXPLORATORY PHASE

Summary of studies

- Two research studies to:
  - What is the perception of instructors, in Indian engineering education, towards active learning strategies?
  - How effective are the instructors in reflecting on their own technology integration practice?
- Operating context – T10KT

Details of exploratory studies

Research Study 1

- Goal: Training CS instructors in active learning for teaching programming (2014, 7633 registered)
- Mixed-method research
  - Quant (6 Ques Survey, Likert scale; N=3688)
  - Qual (Content analysis of open-ended question; N=1802)
- High perception of usefulness of Active Learning (AL) strategies; Need support in AL
- Misconceptions about AL

Research Study 2

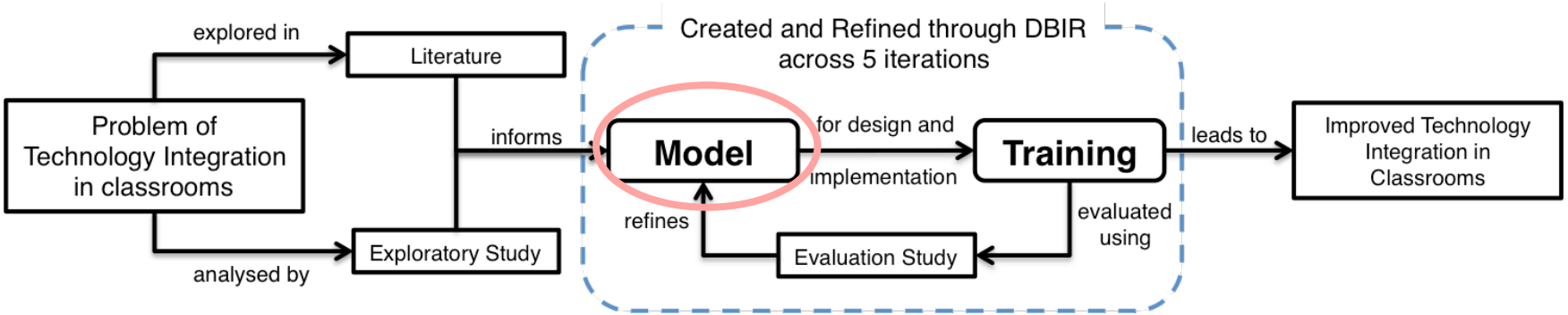
- Goal: Training instructors in Research Methods in ET (2013, 5675 registered)
- Mixed-method research
  - Quant (18 Ques Survey, Likert scale; N= 3688, Evaluation of participant submissions; N=1287)
  - Qual (Content Analysis of participant submissions; N=242)
- Improvement of teacher reflection
- Dominance of teacher-centered ideas
- (Warriem, Murthy & Iyer, 2013a; 2013b)

Need for a new metric for evaluation

- Not all registered participants participate
- Common phenomena in large-scale efforts
- Completion rate is insufficient
- “Persistence Rate” as a new metric
- Persistence Rate – Number of people completed/Number of active participants

Goals

- Research
  - Design and development of a scalable model that will assist in implementation of TPD programmes for technology integration
  - Evaluate the effectiveness of training programmes developed from the model
- Practice
  - Scaffolds for assisting in implementation
  - Promote higher persistence



ATTAIN-ALIGN-INTEGRATE-INVESTIGATE (A2I2) MODEL

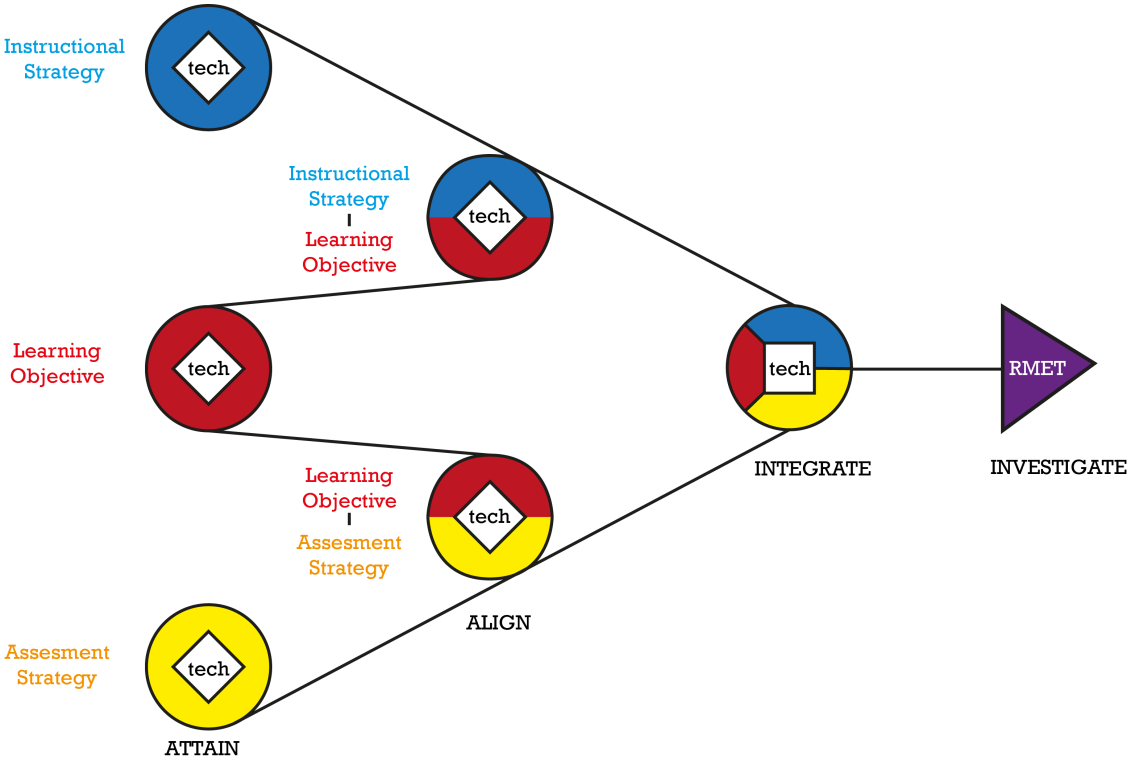
Theoretical Basis

- Constructive Alignment (Biggs, 1996)
- Spiral Curriculum (Bruner, 1977)
- Active Learning (Meltzer & Thornton, 2012)

Design Principles (Warriem, Murthy & Iyer, 2015; 2017)

- Immersivity
  - Helps in designing learning environment
  - Experience as learner first, teacher next
- Pertinency
  - Helps in designing training content
  - Immediate relevance of training content
- Transfer of Ownership
  - Helps in sustaining training benefits
  - Promoting ownership of the change needed in practice

A2I2 MODEL


Instructional Strategy
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Instructional Strategy
Learning Objective
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Learning Objective
tech
Learning Objective
Assesment Strategy
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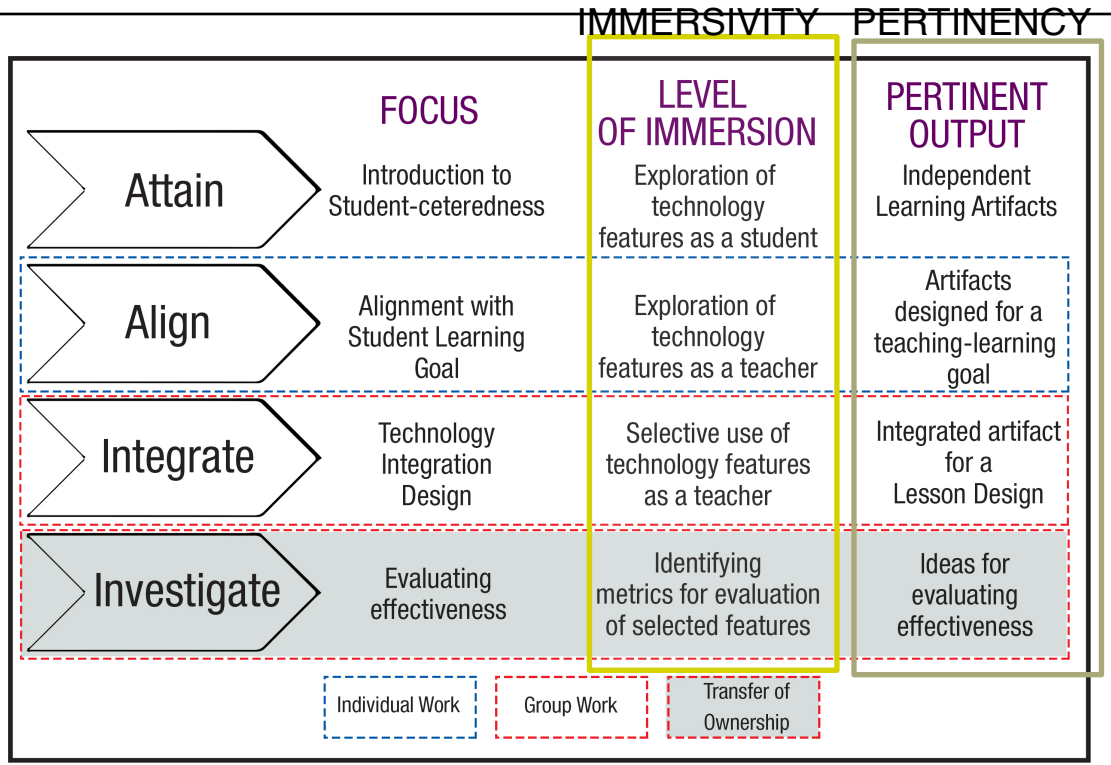
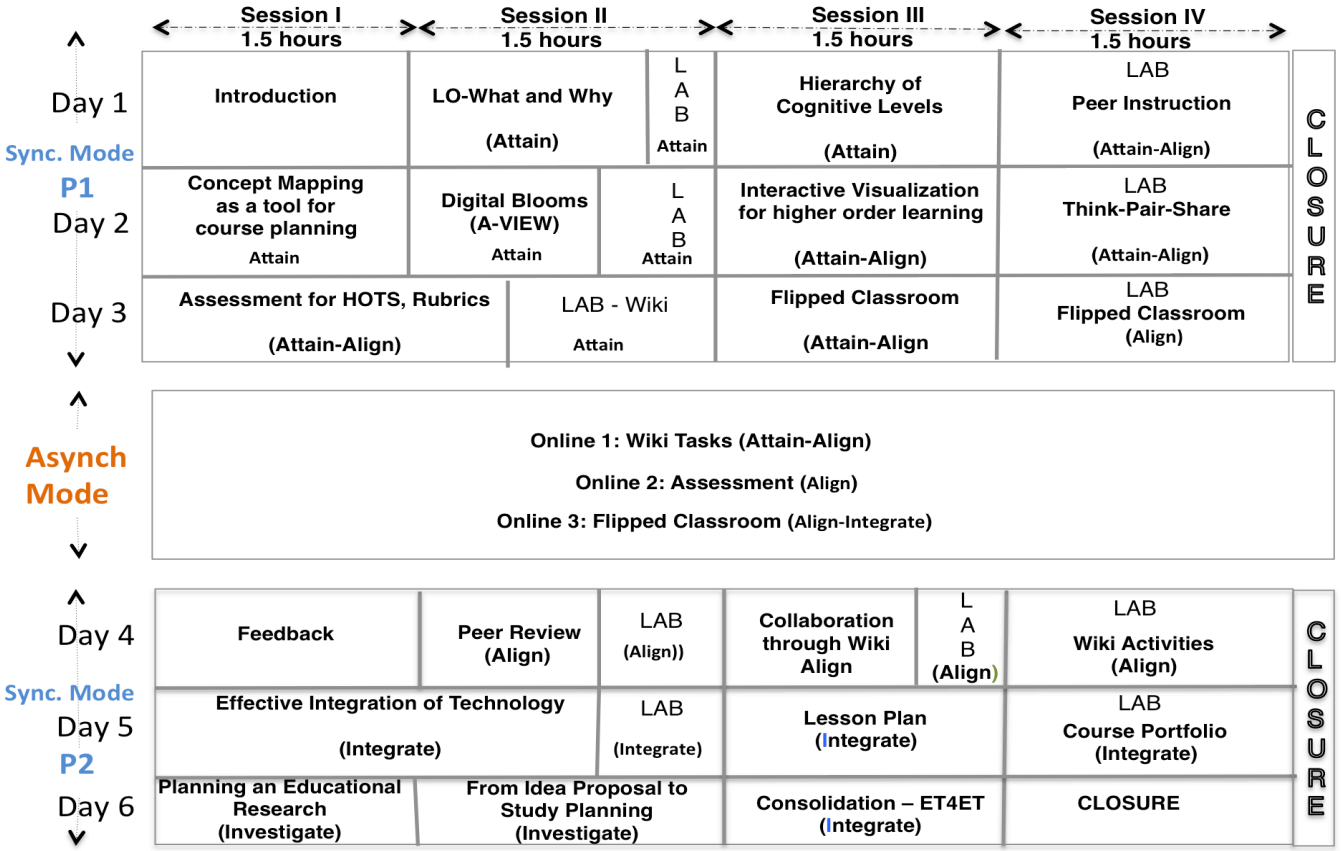
ATTAIN
ALIGN
tech
INTEGRATE
RMET
INVESTIGATE

A2I2 MODEL


IMMERSIVITY
PERTINENCY
FOCUS
LEVEL OF IMMERSION
PERTINENT OUTPUT
Attain
Introduction to Student-ceteredness
Exploration of technology features as a student
Independent Learning Artifacts
Align
Alignment with Student Learning Goal
Exploration of technology features as a teacher
Artifacts designed for a teaching-learning goal
Integrate
Technology Integration Design
Selective use of technology features as a teacher
Integrated artifact for a Lesson Design
Investigate
Evaluating effectiveness
Identifying metrics for evaluation of selected features
Ideas for evaluating effectiveness
Individual Work
Group Work
Transfer of Ownership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Session II 1.5 hours
Session III 1.5 hours
Session IV 1.5 hours
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LO-What and Why (Attain)
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Hierarchy of Cognitive Levels (Attain)
LAB Peer Instruction (Attain-Align)
Sync. Mode
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Digital Blooms (A-VIEW) Attain
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LAB Think-Pair-Share (Attain-Align)
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LAB - Wiki Attain
Flipped Classroom (Attain-Align
LAB Flipped Classroom (Align)
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Online 2: Assessment (Align)
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LAB Wiki Activities (Align)
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Lesson Plan (Integrate)
LAB Course Portfolio (Integrate)
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From Idea Proposal to Study Planning (Investigate)
Consolidation – ET4ET (Integrate)
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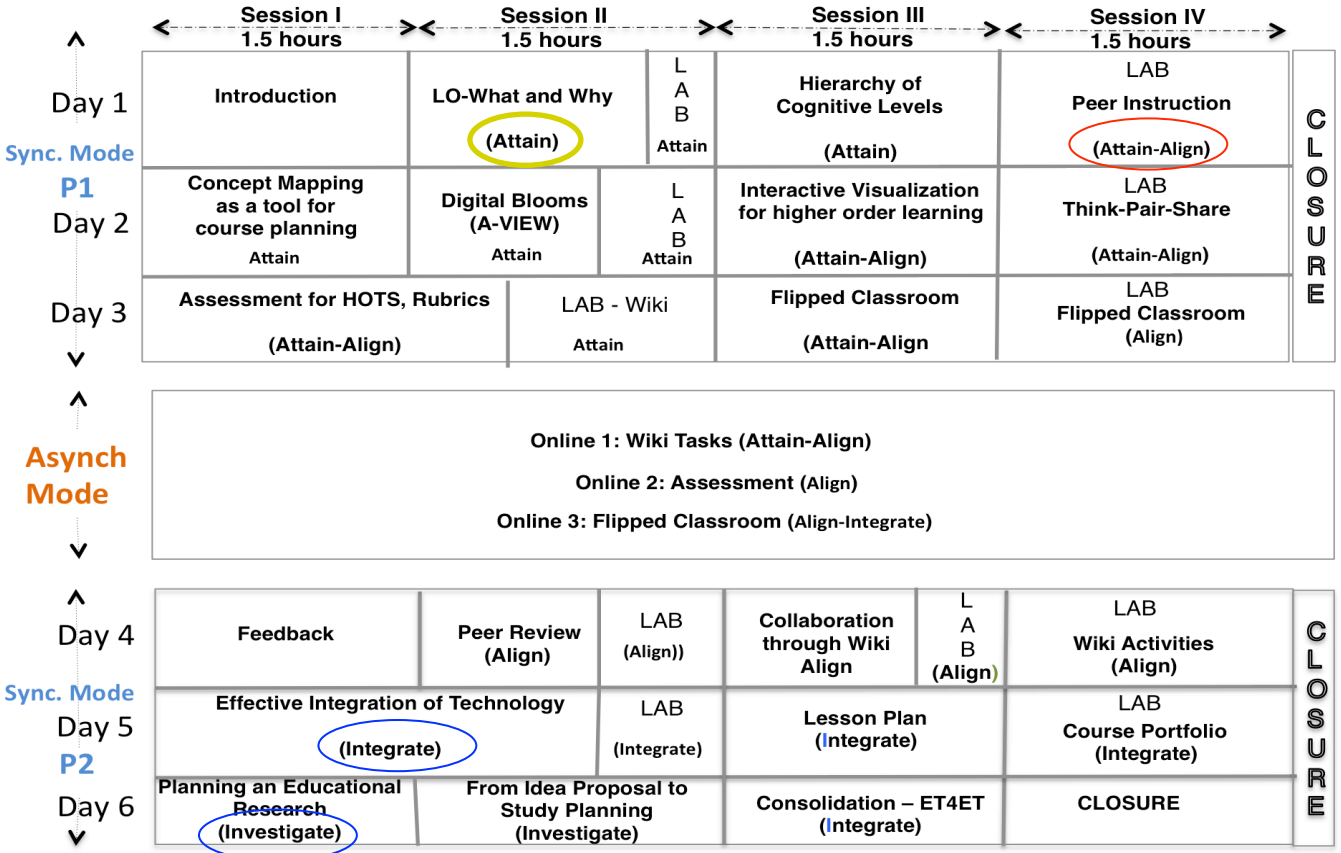
CLOSURE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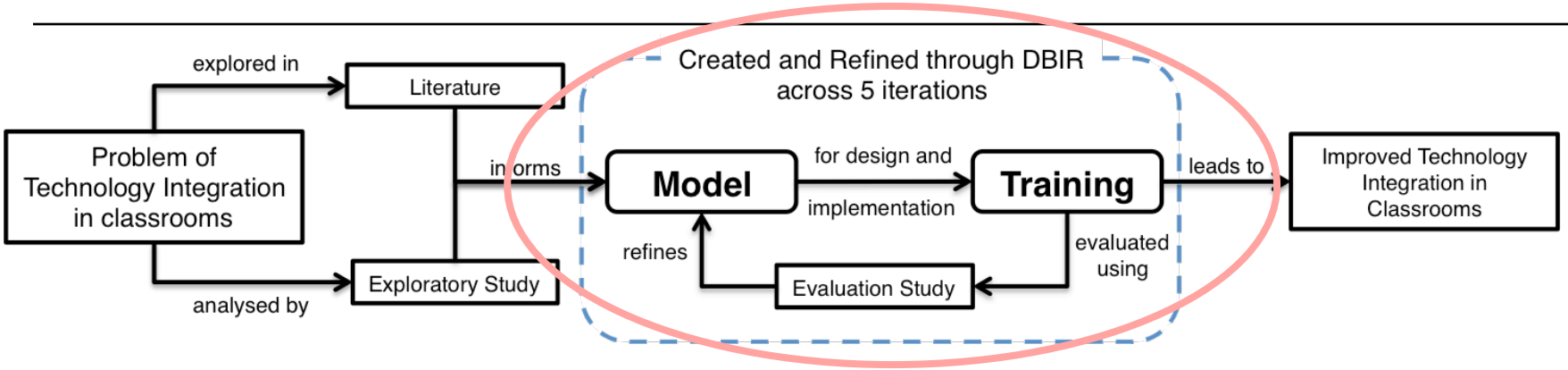
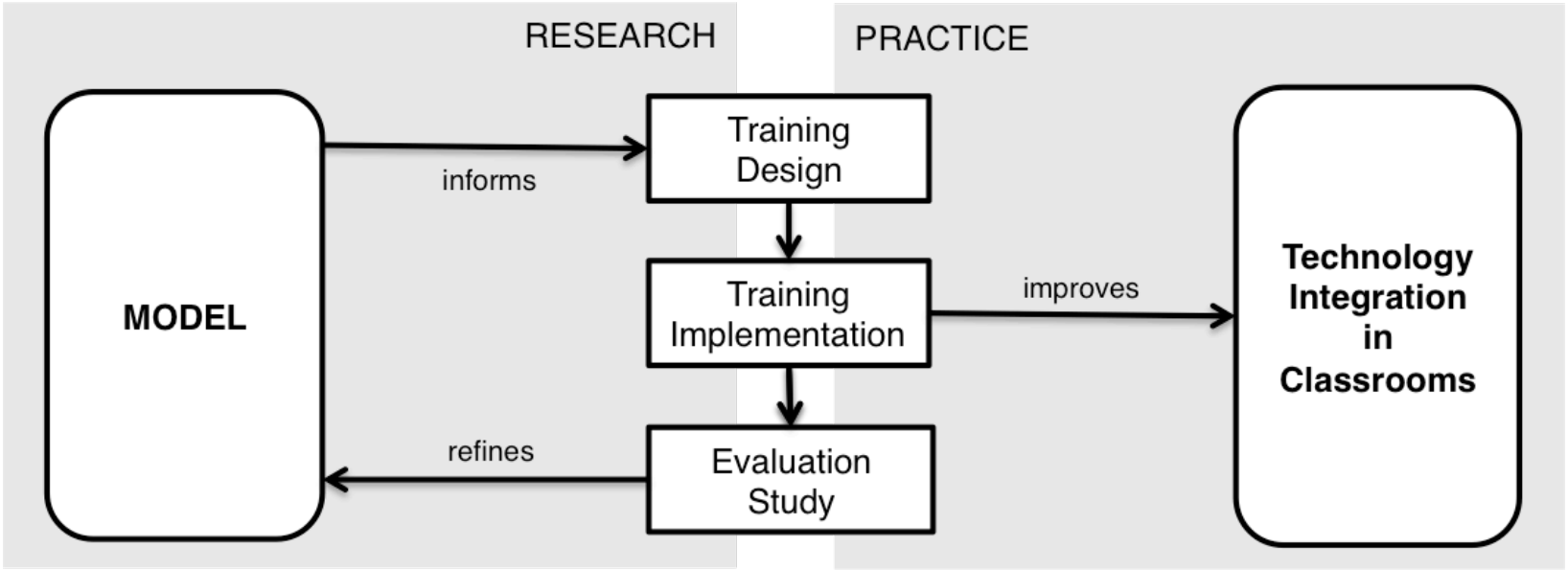
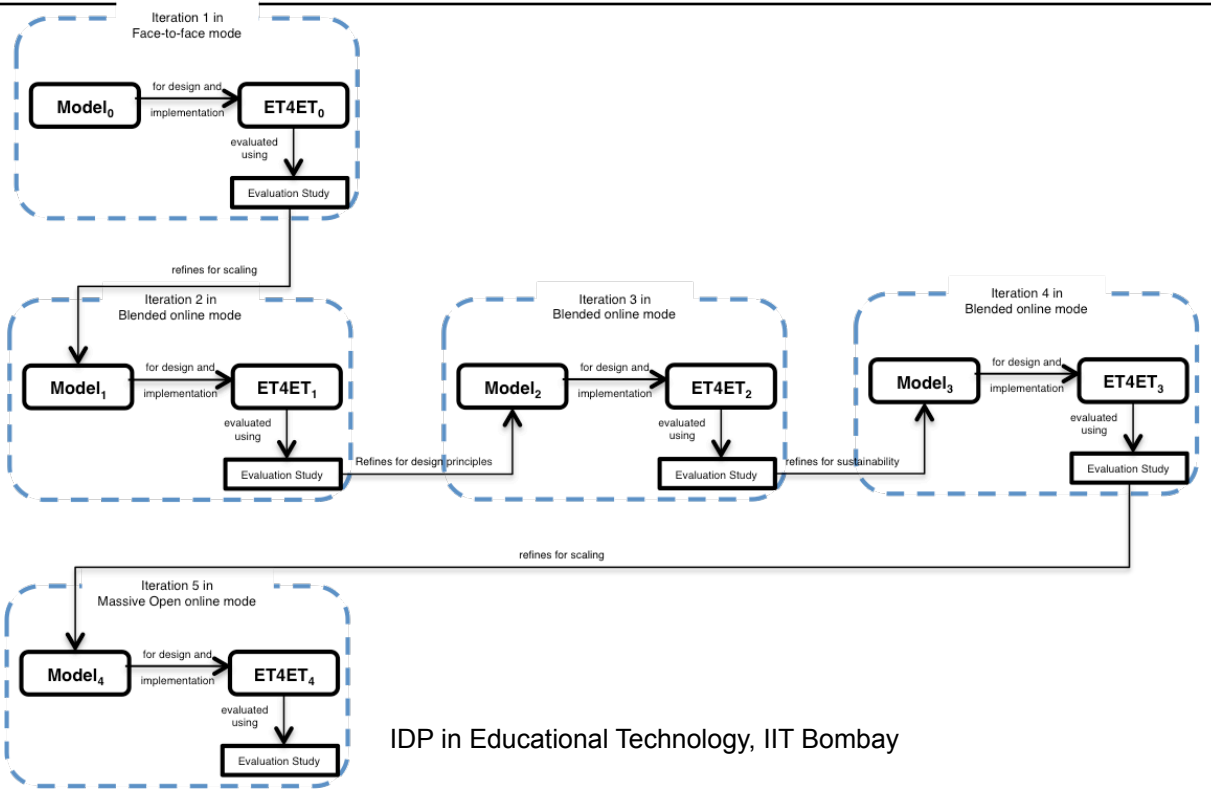


DBIR: IMPLEMENTATION AND EVALUATION CYCLES

DBIR: Single Iteration



The five iterations of Educational Technology for Engineering Teachers (ET4ET)



Face-to-face

Blended-online

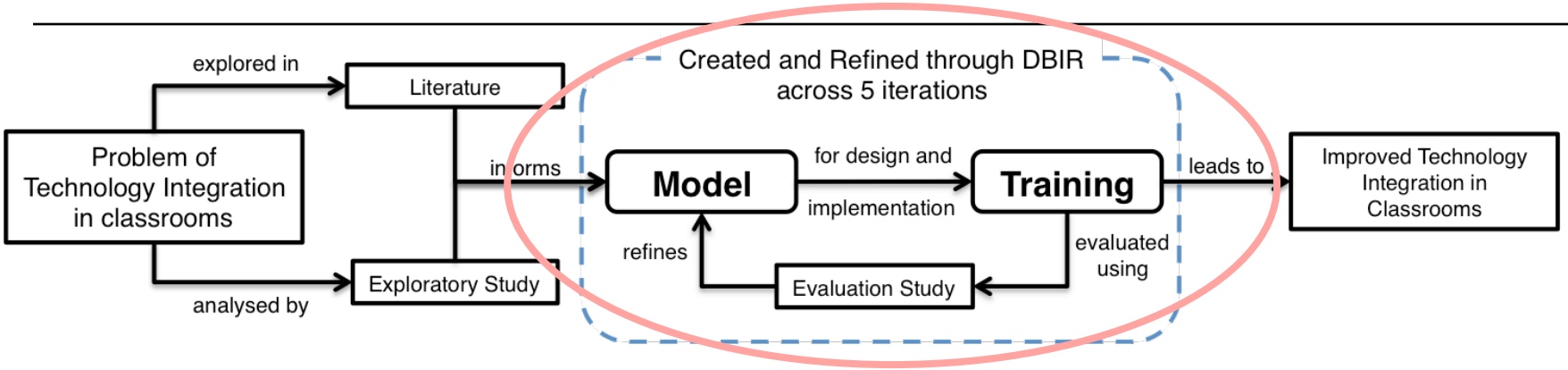
Massive Open Online

Overview of Research in each iteration

Iteration (Training)		Iteration 1 ($ET4ET_0$)	Iteration 2 ($ET4ET_1$)	Iteration 3 ($ET4ET_2$)	Iteration 4 ($ET4ET_3$)	Iteration 5 ($ET4ET_4$)
Mode		Face-to-Face	Blended Online			Massive Open Online
Number of Participants		23	1138	4358	51	5105
Evaluation	Perception	✓	✓	✓	-	✓
	Learning	✓	-	✓	-	-
	Behaviour	-	-	✓	-	-
	Persistence	-	✓	✓	-	✓
	Sustainability	-	-	✓	✓	-

Model evolution with each iteration

Iteration (Training)		Iteration 1 ($ET4ET_0$)	Iteration 2 ($ET4ET_1$)	Iteration 3 ($ET4ET_2$)	Iteration 4 ($ET4ET_3$)	Iteration 5 ($ET4ET_4$)
Mode		Face-to-Face	Blended Online			Massive Open Online
Research Study		Study 1	Study 2	Study 3	Study 4	Study 5
A2I2 Model Version		$Model_1$	$Model_2$	$Model_3$	$Model_4$	$Model_5$
Evaluation	EQ I: Persistence	-	RQ 2.1	RQ 3.1, 3.2	-	RQ 5.1
	EQ II: Reaction	RQ 1.1	RQ 2.2, 2.3	RQ 3.3	-	RQ 5.2
	EQIII: Learning	RQ 1.2	-	RQ 3.4	-	-
	EQIV: Behaviour	-	-	RQ 3.7	-	-
	EQV: Sustainability	-	-	RQ 3.5, 3.6	RQ 4.1	-
Impact of evaluation on Model		Validated A2I2	Scaled A2I2	Design Principles of Immersivity and Pertinency in A2I2	Refined Design principle of Transfer of ownership for sustainability	Scaled A2I2 for fully online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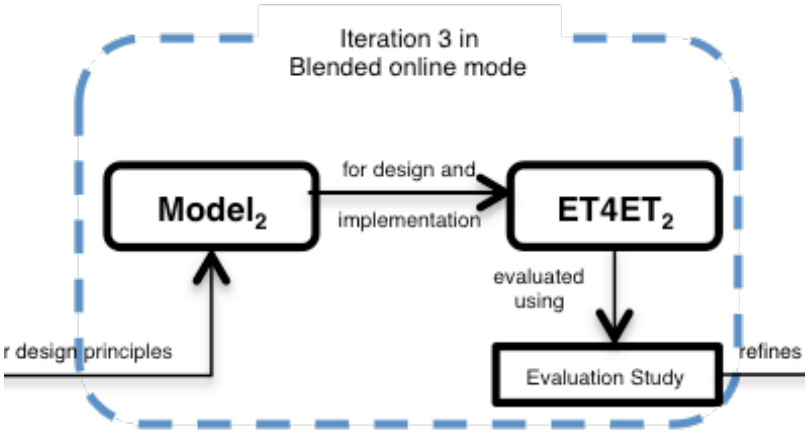
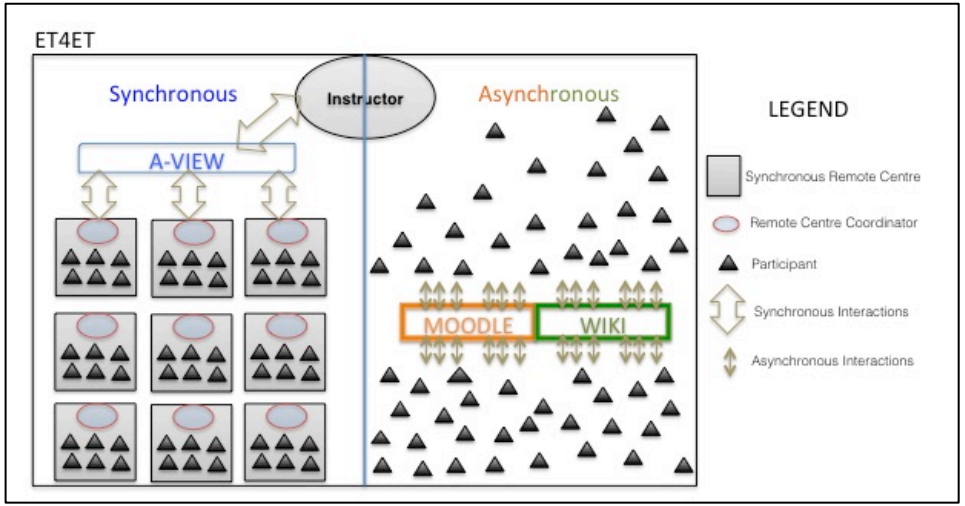
informs
Created and Refined through DBIR across 5 iterations
Model
for design and implementation
Training
leads to
Improved Technology Integration in Classrooms
refines
Evaluation Study
evaluated using
analysed by
Exploratory Study

ITERATIONS

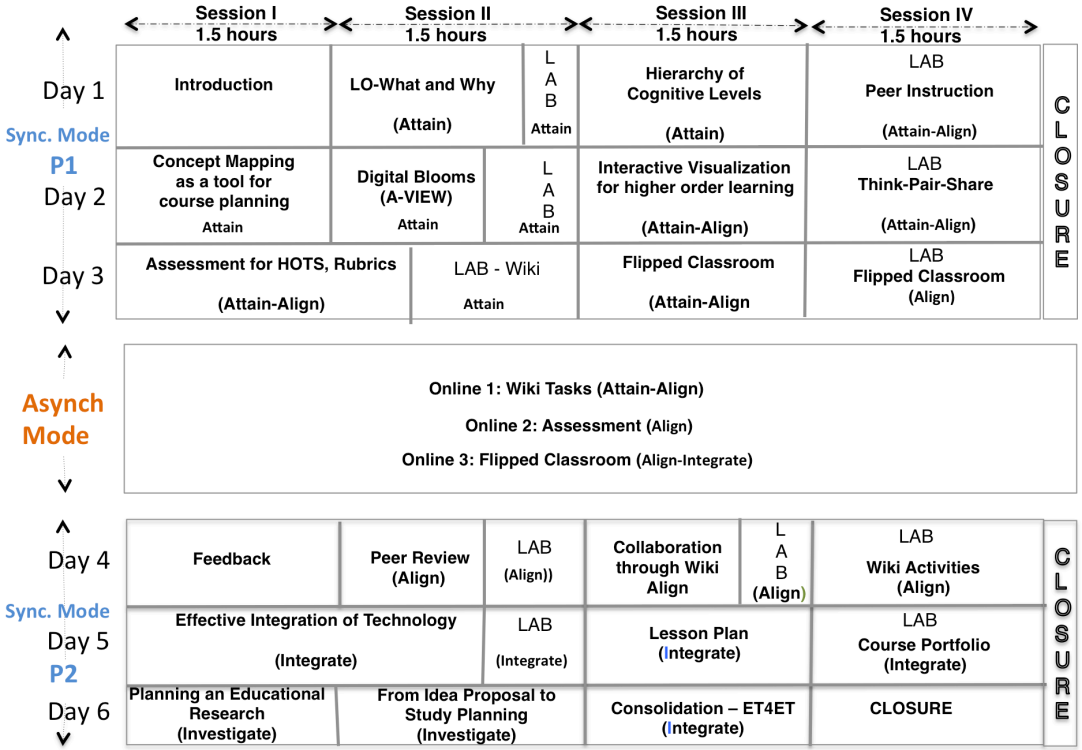
ITERATION 3





- Jan 5 – Jan 31, 2015
- 4358 Teachers from 148 institutions (remote centres)

ITERATION 3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CLOSURE
CLOSURE

Evaluation Questions

- Persistence Rate
  - What is the completion rate in the programme?
  - What is the persistence rate in the programme?
- Perception
  - Does participants' perceived competence in the use of technology, increase after the training programme?
- Learning
  - Do the participants produce effective wiki integration plans during the training programme?
- Behaviour
  - How has the participants' learning from the ET4ET program transferred into actual practice?
- Sustainability
  - How pertinent is the $ET4ET_2$ programme?
  - How immersive is the $ET4ET_2$ programme?

RQ Answered	Time of data collection	Data Source/Instrument	Metric
RQ 3.1, 3.2	End of Training	MOODLE Assignment submission logs Registration logs	Completion rate, Persistence rate
RQ 3.3	Before and After the training	Technology Competency Survey, adapted from Technology Self Proficiency Survey (Milman, Nortecamp & Peters, 2007)	Perception of competence in "Selection of Technology", "Use of Technology to design lessons" and "Evaluation of artefacts generated by students using technology".
RQ 3.4	End of training	Lesson Plan for integrating wiki	Evaluated using a "Technology integration evaluation rubric" that has 3 criteria
RQ 3.5	Before Training	Video Sessions and slides Program schedule	Time spent during the program on active learning activities
	During Training	A-View Chat logs	No of chat interactions to Active Learning strategies.
	End of Training	Moodle Submissions	Active learners based on assignment submissions
	End of Training	Wiki pages	Number of page views, edits and user statistics
RQ 3.6	End of Training	End of program survey	Responses to questions related to relevance and intention to apply
RQ 3.7	One semester after end of training	Open ended response to survey after a semester	Levels of Changes observed

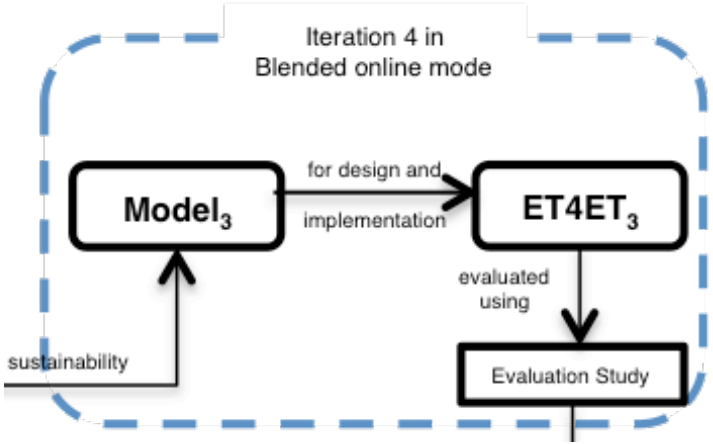
RESULTS

- ET4ET$_2$ has completion rate of 12.7% and persistence rate of 15.6%
- Statistically significant increase in the perception of competence of wiki and screencasts.
- Participants are able to align the technology affordances with the learning outcomes
- Participants find the training highly immersive and pertinent

RESULTS

- Changes in practice after training felt at three levels – At student level, At teacher level and At institution level
  - *“I was able to engage the backbenchers with the activities and that was reflected in their exam results.”*
  - *In each class I am successful in grabbing the attention of every student in the class by making them to involve in one or the other activity.*
  - *We also conducted a training program for about 120 faculty members out of 350 in our College and shared the important topics of this workshop.*

ITERATION 4



- 53 Participants
- Shortlisted from Iteration 2 and 3
- Asynchronous training (June to October)
- Face-to-Face training (3 days)

Research Design

- Research Question
  - What changes were observed in the ownership of problem from trainer to the teacher over the course of training?
- Qualitative method
- Data Analysis
  - Content analysis of participant submissions and focus group discussions

RESULTS

- Impact of immersivity
- Changes seen in student behaviour
- Out of 9 study plans submitted, 4 went on to implement and disseminate in peer reviewed international conferences (LaTiCE, ICCE; 2016)

IMPLICATIONS

- Immersivity and Pertinency required in Investigate phase
- Scaffolds needed for moving from practice to research

DISCUSSION

SUMMARY OF RESULTS

- Completion and Persistence rates
  - Completion rates similar to existing large-scale programmes
  - Best completion happening in final iteration
- Learner Reaction
  - High perception of relevance and application of training

SUMMARY OF RESULTS

- Participant Learning
  - Improved display of aligning strategies with outcome
- Participant Behaviour
  - Changes at Teacher level, Student-level, and Institution level
- Sustainability
  - High pertinence and immersivity indicator of sustainability
  - Classroom action research helps in transfer of ownership

CLAIMS AND EVIDENCE

- A2I2 is an effective model for TPD
- A2I2 is scalable
- Significance of design principles
- Evaluation research done in 5 iterations
- Operated in 3 modes
- Perception, Learning and Behaviour results

CLAIMS AND EVIDENCE

- A2I2 is an effective model for TPD
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- Operated in 3 modes
- Perception, Learning and Behaviour results

IMPLICATIONS

RESEARCH

- DBIR for scaled interventions
- Design principles of Immersivity and Pertinency for assisting diffusion of practice
- Pedagogic adaptations for various modes

PRACTICE

- Use of scaffolds for planning classroom practice
- Classroom action research as a thread for sustaining
- Developing communities of inquiry, beyond practice

RECOMMENDATIONS

- Blended approach worked better in scale
- Examples closer to participants' domain - Pertinency
- Student role first, teacher role next – Immersivity
- Ensuring collaboration to tackle complex task like lesson design, study plan
- Leveraging peer learning through peer review and discussion forums

LIMITATIONS

- Content mastery of participants has been assumed
- Self-reported data on practice
- Few secondary implementations

FUTURE WORK

- Extending A2I2 for synchronous collaboration tools
- Extending sustainability beyond medium term (i.e. more than 3 years)
- Incorporating content knowledge in A2I2

CONTRIBUTIONS

RESEARCH

- A2I2 Model for design and implementation of technology integration training programs
- Design principles of Immersivity and Pertinency
- Model for adaptation of active learning in blended mode

PRACTICE

- Activity constructors for scaffolding practice
- Training resource for other trainers
- Portals for building communities of practice

PUBLICATIONS FROM THE THESIS

Warriem, J, Murthy, S., & Iyer, S. (2013). *A model for active learning in synchronous remote classrooms: Evidence from a large-scale implementation*. In Proceedings of 21st International Conference on Computers in Education (ICCE 2013), Bali, Indonesia, Nov 18-22.

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Warriem, J, Murthy, S., & Iyer, S. (2016). Shifting the focus from Learner Completion to Learner Perseverance: Evidences from a Teacher Professional Development MOOC. In Proceedings of 24th International Conference on Computers in Education (ICCE 2016), Mumbai, India.

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CURRENT WORK

- FDPs in IITBombayX
  - Separating Technology and Pedagogy
  - Faculty Mentor-Mentee

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- **RS.ET**
- **My better half, My family**

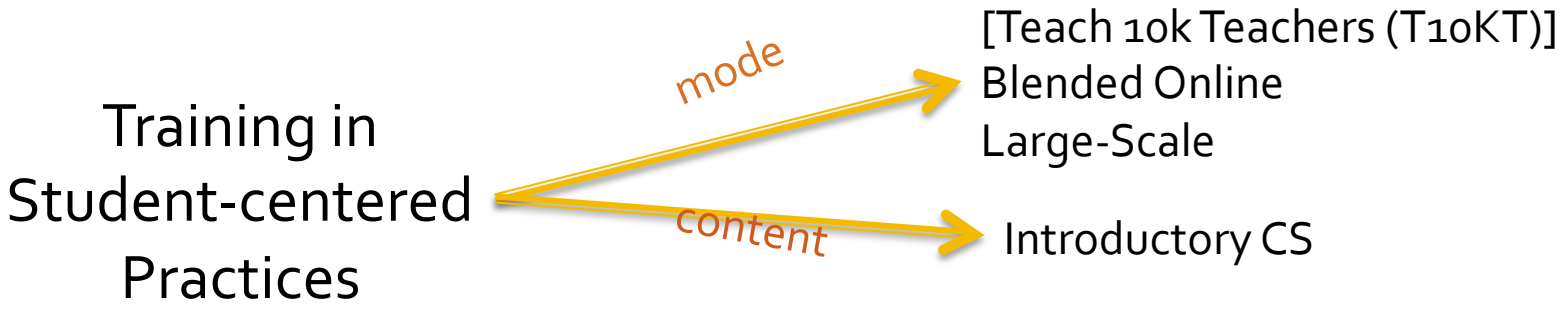
REFERENCE

THANK YOU!!!

EXTRA SLIDES

Exploratory Study - 1

- Training Computer Science instructors in student-centered practices with Visualizations for Introductory Computer Science Programming
- Goal: Identify beliefs and practices towards active learning strategies
- 3688 instructors responding to survey on beliefs and practices towards active learning at end of training



Research Design

Research Question

- What are instructors' perceptions of usefulness and need for support in active learning and ICT integration?
- What are instructors' understandings about meaning of active learning?

Mixed-method Research: Quantitative and Qualitative

Instruments: 6-question survey + Open-ended feedback

Data Analysis: Frequency Analysis, Correlation, Content Analysis of open-ended feedback

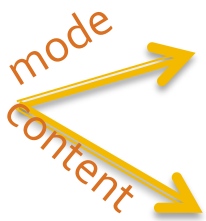
Results – Exploratory Study 1

- High perception of usefulness of active learning (88%)
- Significant correlation between perception of usefulness of ICT and usefulness of active learning ($\rho = 0.6573$, $p < 0.05$)
- 5 different categories of conceptions about understanding of active learning – Category A (Mere use of ICT), Category B (Use of in-class assessment), Category C (Providing home assignments), Category D (Instructor directed interactions with students), Category E (Identical Conceptions as active learning)
- Instructors lack confidence in implementing active learning with ICT in their teaching. They self-report requirement of scaffolds (nearly 70%) for effective ICT integration.

Exploratory Study 2

- Training engg. college instructors in systematic reflection on practice through "Research Methods in Educational Technology"
- Familiarize engineering college teachers with research methods in performing classroom action research while integrating technology.
- Out of 3896 active teachers only 241 did all assignments

Training in Action Research



[Teach 10k Teachers (T10KT)]
Blended Online
Large-Scale

Research Methods in Educational Technology (RMET)

Research Design

RQs

- What was the rate of participation in the workshop?
- What was the improvement in the participant's knowledge of research methods, both (a) measured and (b) perceived?
- How satisfied were the participants with the workshop?
- How do participants' perceptions of the usefulness of active learning strategies affect their overall satisfaction?

Mixed-Method Research

Instruments: Perception survey questionnaire with open-ended feedback, Idea and Study Planning Assignments

Results – Exploratory Study 2

- High perception of learning and satisfaction (>85%) in Blended Online Mode
- Statistically significant learning gains with large effect size ($Z=-12.4969$, $r=0.566$, $p<0.001$)
- Adaptation of Active Learning Strategies in Blended Online mode

Results – Exploratory Study 2

- Median of change was from 3 to 4 (out of 12), which was considered Low within the grading rubric
- Most ideas were teacher-centric (i.e. use of Technology for Presentation) and not involving students in meaningful activities in class
- Most teachers predominantly uses Presentation tools
- Persistence rate* = 6.2% (N=3869)

* Persistence Rate = (No of Completions / No of people who did at least 1 activity)

Reflection - 1

- Challenges in Technology Selection
  - Majority of Indian engineering teachers primarily rely on presentation tools in teacher-centric mode.

- Implication for training
  - Needs to consider challenges in introducing complex ICT tools along with use of student-centered practices

Reflection - 2

- Challenges for effective Teaching-Learning Practices
  - Teacher-centric Attitude
  - Alternate conception of active learning

- Implication for Training
  - Needs to bring in attitude shift towards learner-centeredness
  - Provide student experiences of active learning during training to avoid alternate conceptions

Reflection - 3

- Challenges for training practices
  - Lack of Constructive Alignment
  - Support during training
  - Participation and persistence in Large-Scale Training

- Implication for Training
  - Knowledge and Skill of Constructive Alignment
  - Need for Scaffolds during design
  - Adapting pedagogies for scaling up

How can we improve the design and delivery of large-scale training programs to the in-service faculty in engineering education within India to enable them in effectively integrating Information and Communication Technology (ICT) tools within

Training Need (Research Goals)

- In terms of design
  - To train the engineering educators in research-based student-centered practices while integrating technology.
  - To design scaffolds for these student-centered strategies that will assist participants during training as well as implementation in their classrooms
  - To train teachers in action research of teaching-learning practices in the use of technology tools to ensure sustainability

- In terms of implementation
  - Adaptable in multiple instructional modes, viz. face-to-face, Blended Online Mode, Online Mode, etc. to achieve scalability.
  - Promote higher persistence rates

PHASES IN A2I2 MODEL

Attain

FOCUS	Introduction to LO, IS, AS
FORMAT (Type of T-L Interaction)	Majority are Instructor-driven (Explanation, Summary etc.)
Role of Participant	Student Mode (Try to ensure activeness)
OUTPUT	Participant creates LO for own course Participant identifies possible IS and AS for own course

PHASES IN A2I2 MODEL

Align

FOCUS	Pairwise Alignment
Type of T-L Interaction	Majority are Participant-driven individual (Presentation, Practice etc.)
Role of Participant	Teacher Mode
OUTPUT	Participant creates IS aligned to LO for own course Participant creates AS aligned to LO for own course

PHASES IN A2I2 MODEL

Integrate

FOCUS	Integration of LO-IS-AS
Type of T-L Interaction	Majority are Participant-driven collaborative (Think-Pair-Share, Groupwork etc.)
Role of Participant	Shuttles between Teacher and Student Mode
OUTPUT	Participant creates IS aligned to Lesson plan for own course

PHASES IN A2I2 MODEL

Investigate

FOCUS	Evaluation of Own practice
Type of T-L Interaction	Majority are Participant-driven collaborative (Think-Pair-Share, Groupwork etc.)
Role of Participant	Shuttles between Teacher and Evaluator Mode
OUTPUT	Participant generates an idea to evaluate within their own practice.

Implications for stakeholders

- Researchers
  - Pedagogic adaptation while scaling
  - Increasing collaboration in discussion forum
- Trainers and Administrators
  - A2I2 Model
  - Existing workshop design and resources
  - Avenues for developing communities of practice

Implications for stakeholders

- Teachers
  - Scaffolds for student-centered practices
  - Participation in A2I2 based workshop helps in developing communities of practice
- Technology Developers
  - Immersivity principle to design and disseminate technology