



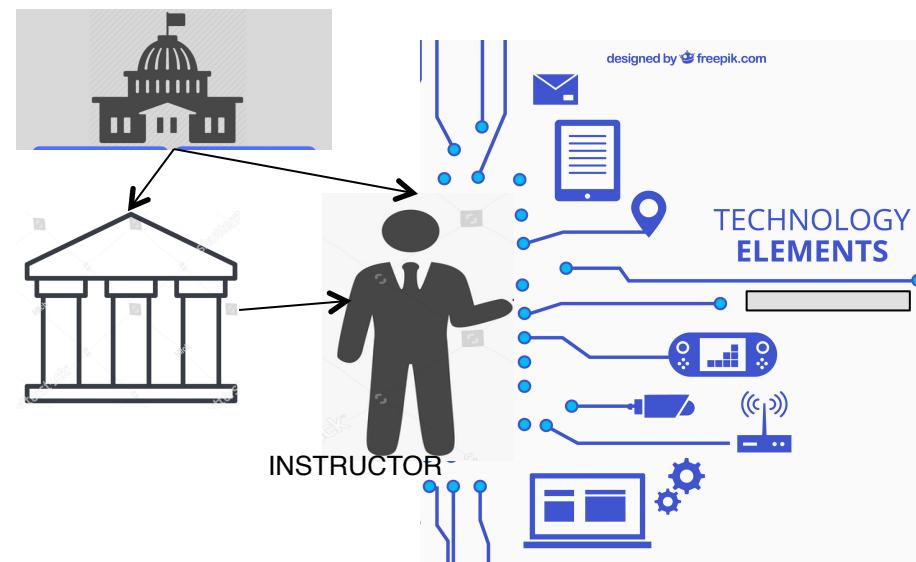
# A model for large-scale, in-service teacher training in effective technology integration in engineering education

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Under the supervision of  
Prof. Sahana Murthy and Prof. Sridhar Iyer

# Technology use in higher education

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

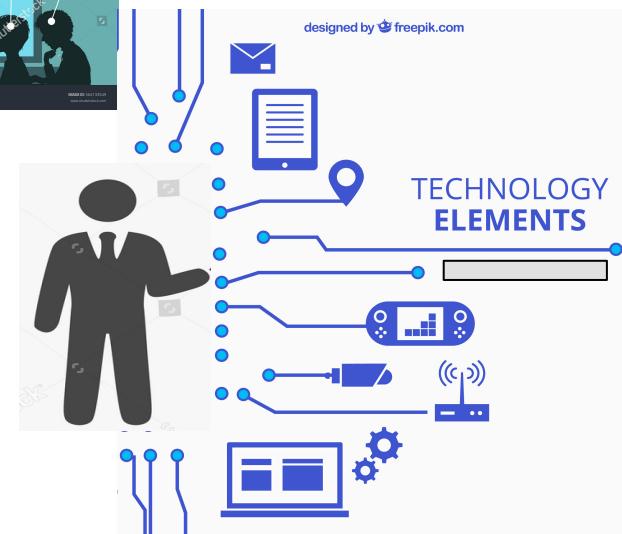


# Technology use in higher ed. classrooms

- Students as consumers of technology!!
- Research results on benefits of technology, if used effectively



RESEARCH



IDP in Educational Technology, IIT Bombay

# The Indian context

- INSTRUCTOR-MEDIATED  
Technology,MCA"UG"
- SCALE
- IN-SERVICE TRAINING

AICTE Approved Institutes for the Academic Year: 2016-2017 - `Architecture and Town Planning,Architecture,Engineering and

Year: 2016-2017

Select Program: 4 of 9 selected

Select Level: UG

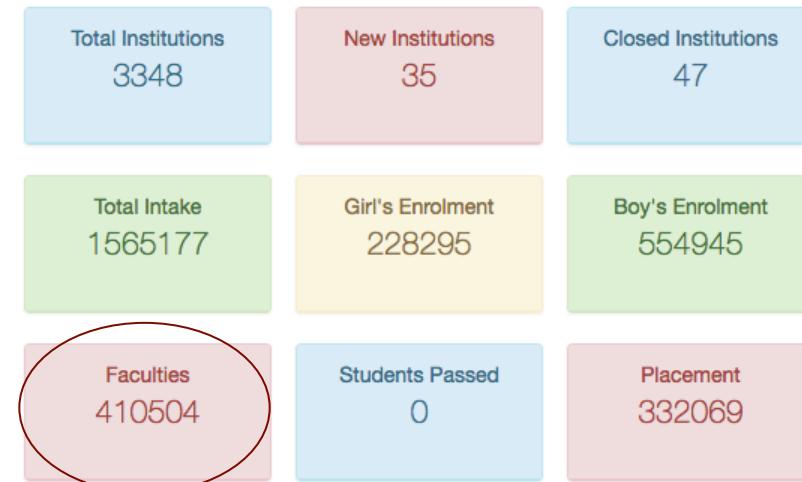
Institution Type: --All--

Select State: --All--

Minority: --All--

Women: --All--

Submit



# Existing initiatives

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- 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

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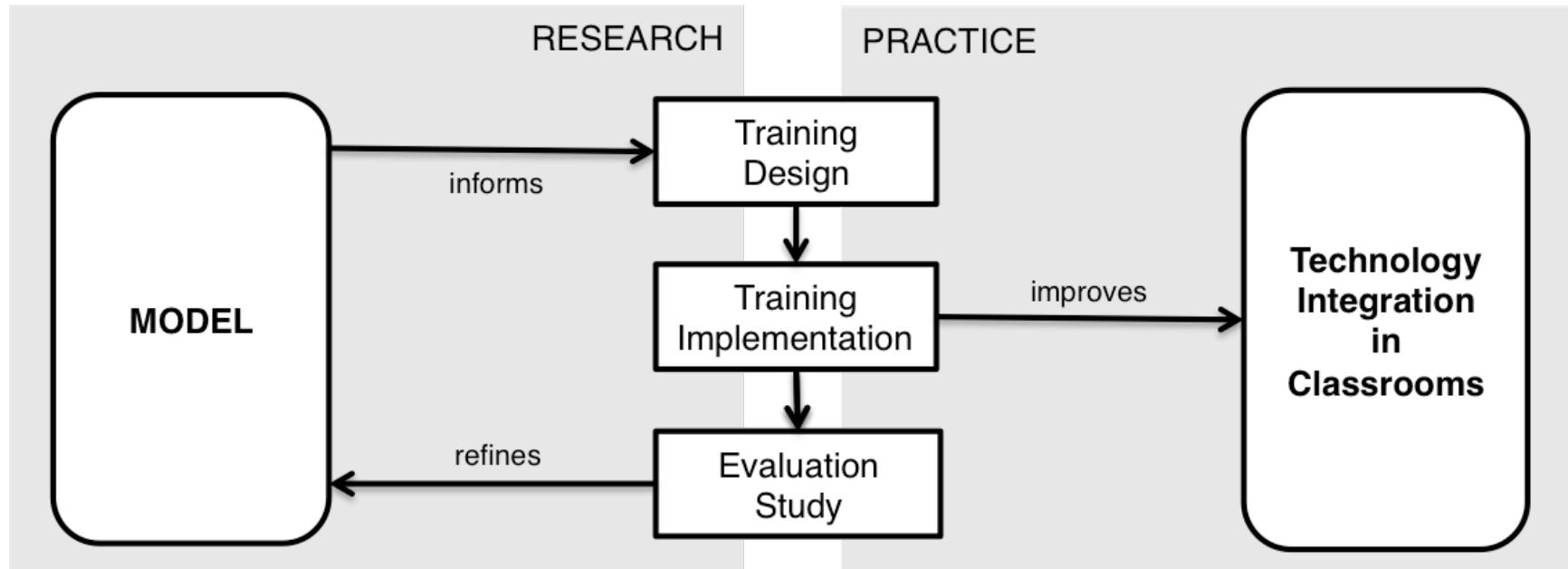
- How to **improve the design and delivery of large-scale training programs to in-service faculty in engineering education within India** to enable them in **effectively integrating Information and Communication Technology (ICT) tools** within their teaching-learning context?

# Solution

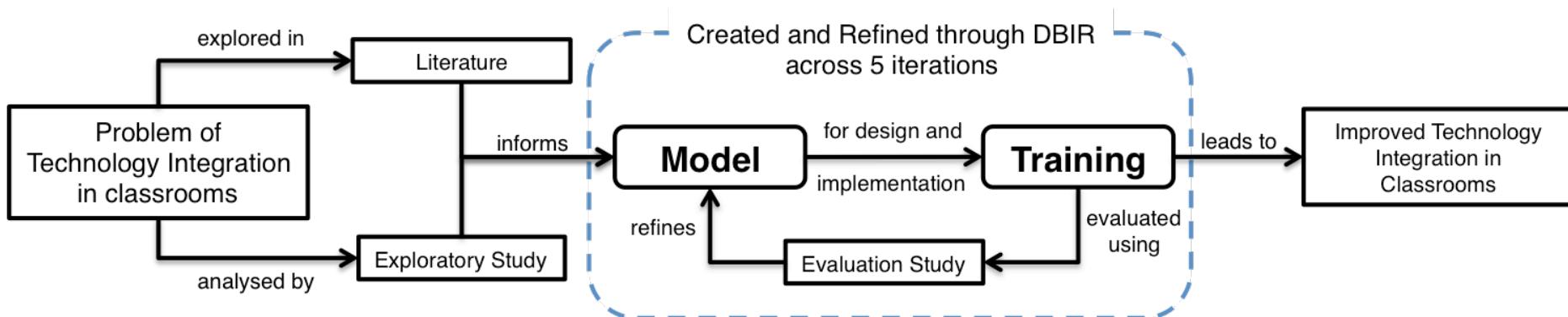
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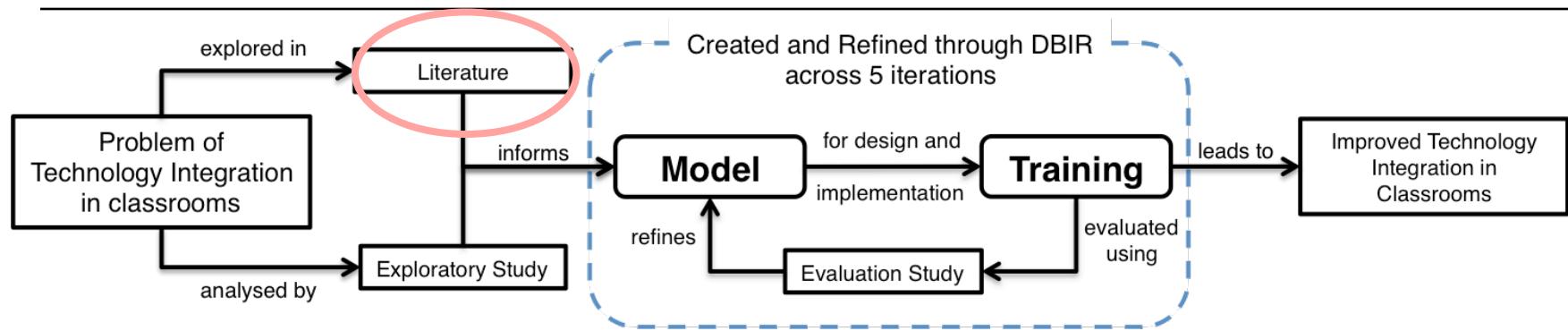
- Development of Attain-Align-Integrate-Investigate (A2I2) Model
- Implementation of Training based on A2I2
  - 1 face-to-face
  - 3 blended-online
  - 1 massive open online
- Evaluation of model via 5 studies

# 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 )

1<sup>st</sup> Order  
barrier

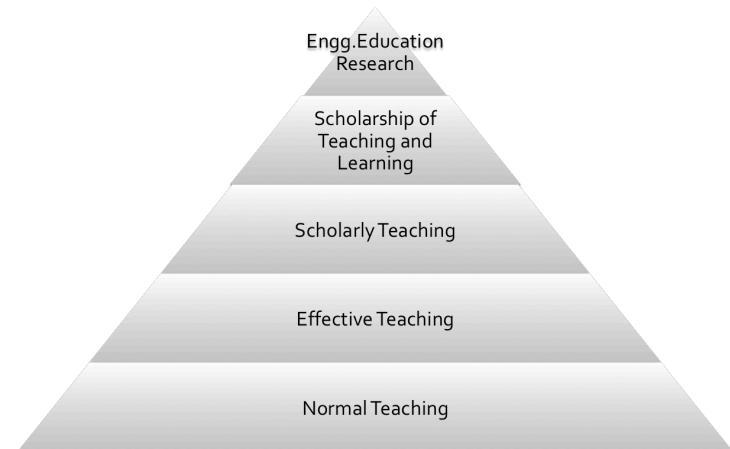
2<sup>nd</sup> Order  
barrier

3<sup>rd</sup> 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

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- 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<sup>ET</sup> (Reinties et. al., 2013)

# Lit. Review

Barriers in effective technology integration

Need for focusing on 2<sup>nd</sup> and 3<sup>rd</sup> 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

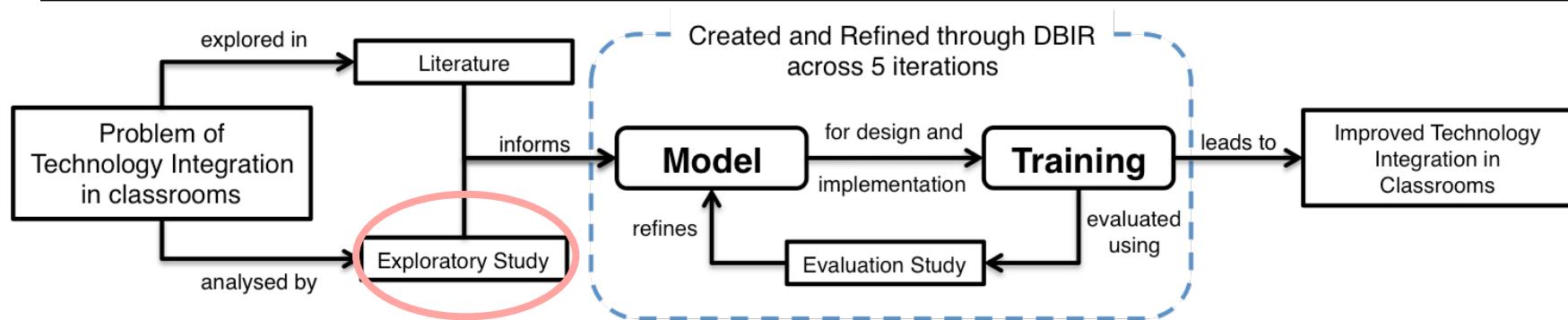
Use of constructivist practices and ensuring collaboration

# Positioning the current research

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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

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- 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

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- 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

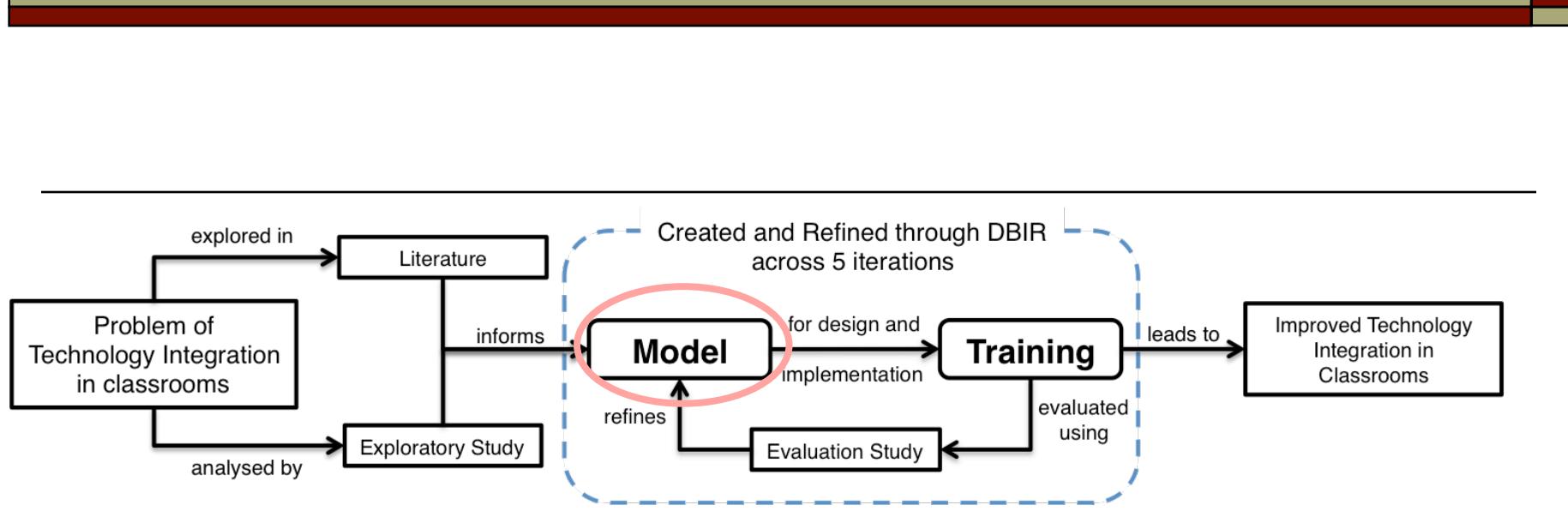
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## □ Research

- 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

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- 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

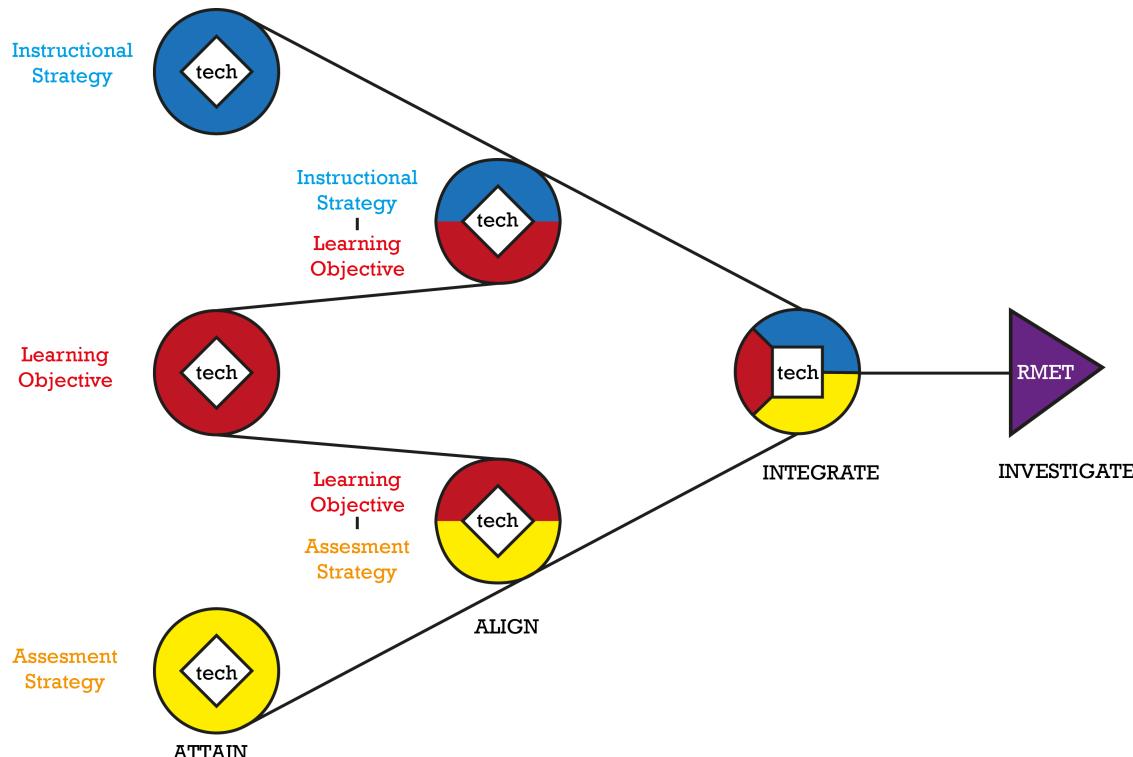
## □ Pertinency

- Helps in designing training content
- Immediate relevance of training content

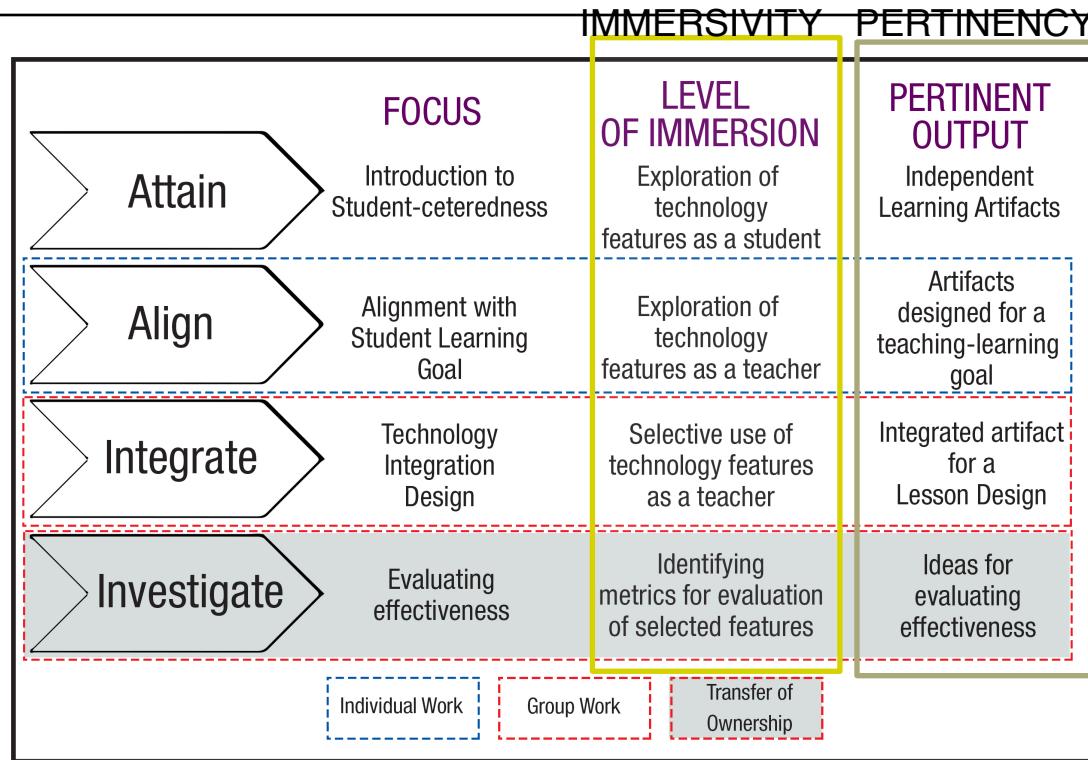
## □ Transfer of Ownership

- Helps in sustaining training benefits
- Promoting ownership of the change needed in practice

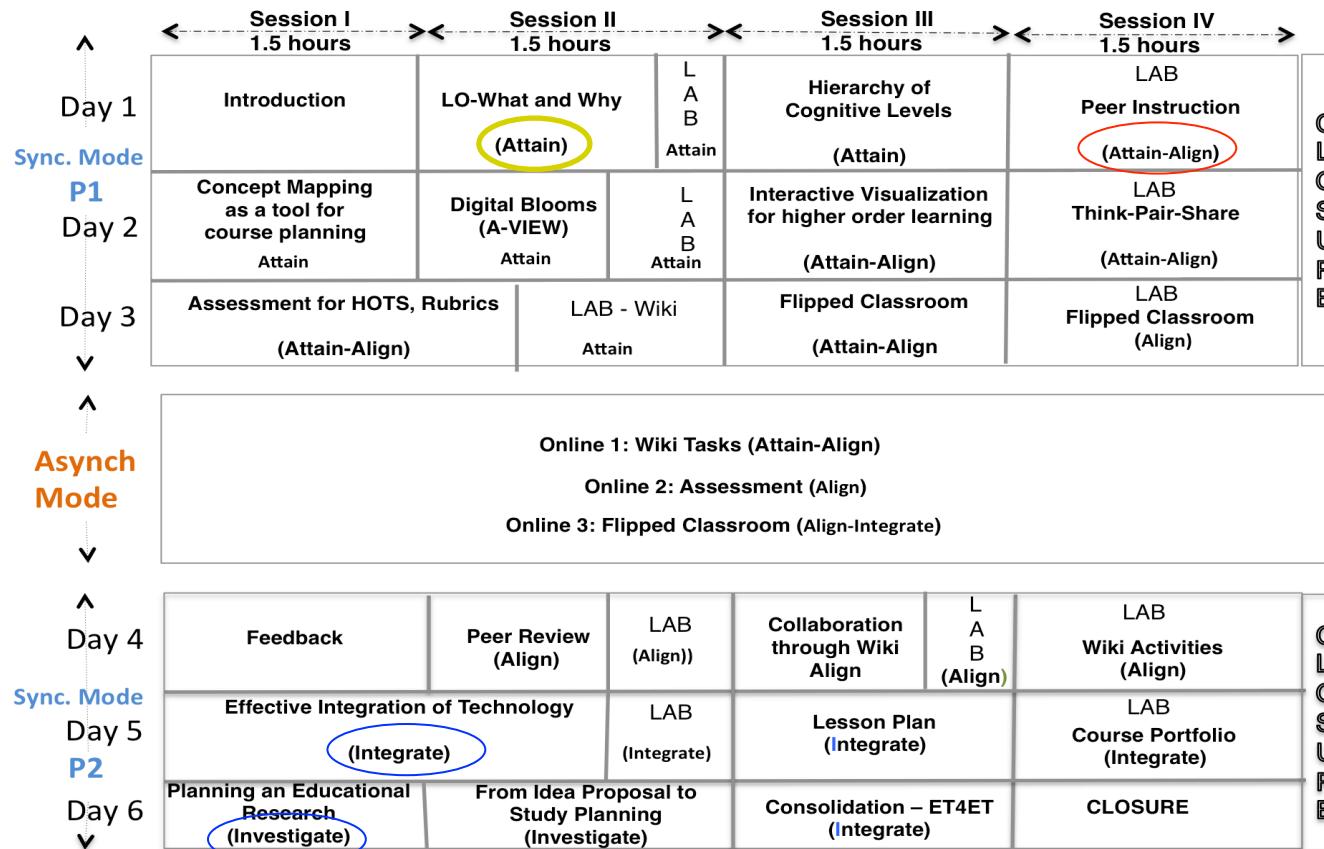
# A2I2 MODEL

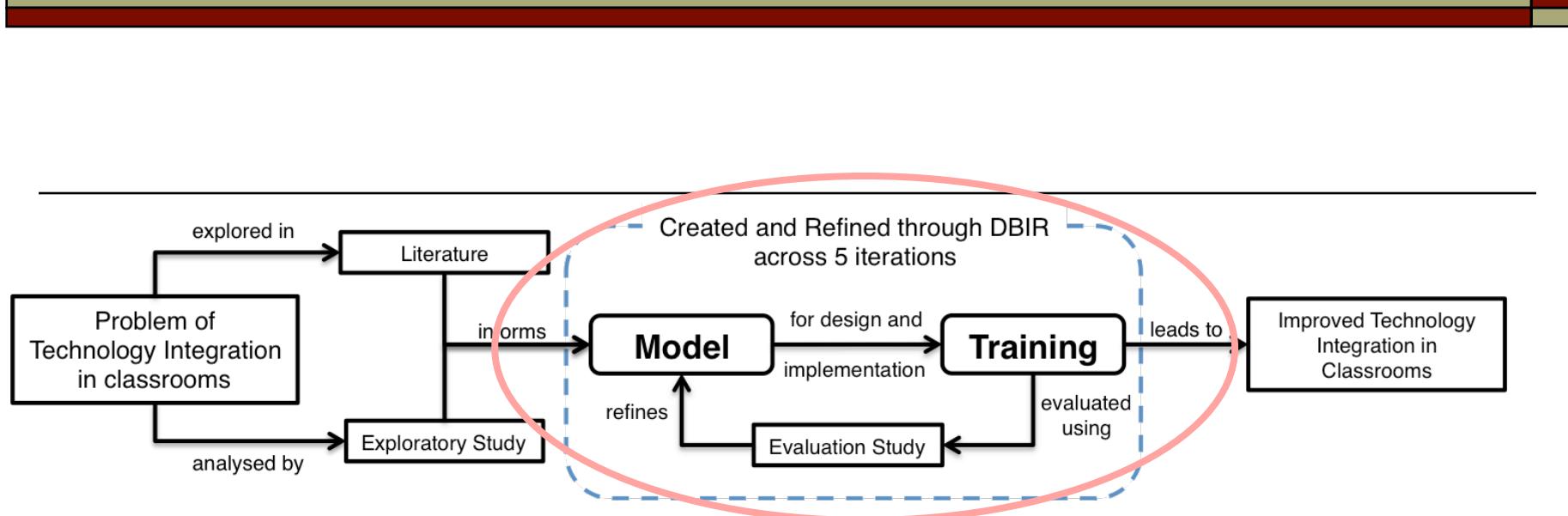


# A2I2 MODEL



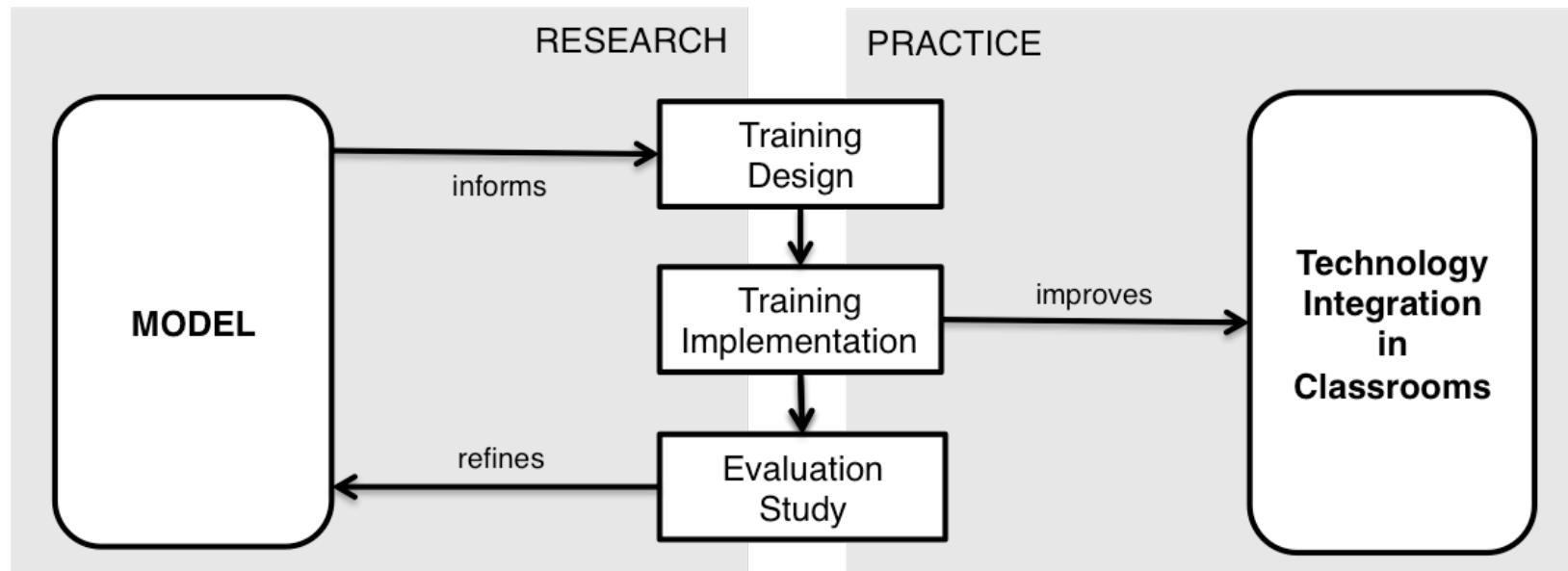
A2I2 Model Iterations Overview							CLOSURE		
		Session I 1.5 hours		Session II 1.5 hours		Session III 1.5 hours		Session IV 1.5 hours	
Sync. Mode	P1	Introduction	LO-What and Why (Attain)		L A B Attain	Hierarchy of Cognitive Levels (Attain)	LAB Peer Instruction (Attain-Align)		CLOSURE
		Concept Mapping as a tool for course planning Attain	Digital Blooms (A-VIEW) Attain		L A B Attain	Interactive Visualization for higher order learning (Attain-Align)	LAB Think-Pair-Share (Attain-Align)		
Day 3	Assessment for HOTS, Rubrics (Attain-Align)		LAB - Wiki Attain		Flipped Classroom (Attain-Align)		LAB Flipped Classroom (Align)		CLOSURE
		Online 1: Wiki Tasks (Attain-Align) Online 2: Assessment (Align) Online 3: Flipped Classroom (Align-Integrate)							
Sync. Mode	P2	Feedback	Peer Review (Align)		LAB (Align))	Collaboration through Wiki Align	L A B (Align)	LAB Wiki Activities (Align)	CLOSURE
		Effective Integration of Technology (Integrate)		LAB (Integrate)	Lesson Plan (Integrate)		LAB Course Portfolio (Integrate)	CLOSURE	
Day 6	Planning an Educational Research (Investigate)		From Idea Proposal to Study Planning (Investigate)		Consolidation – ET4ET (Integrate)		CLOSURE		



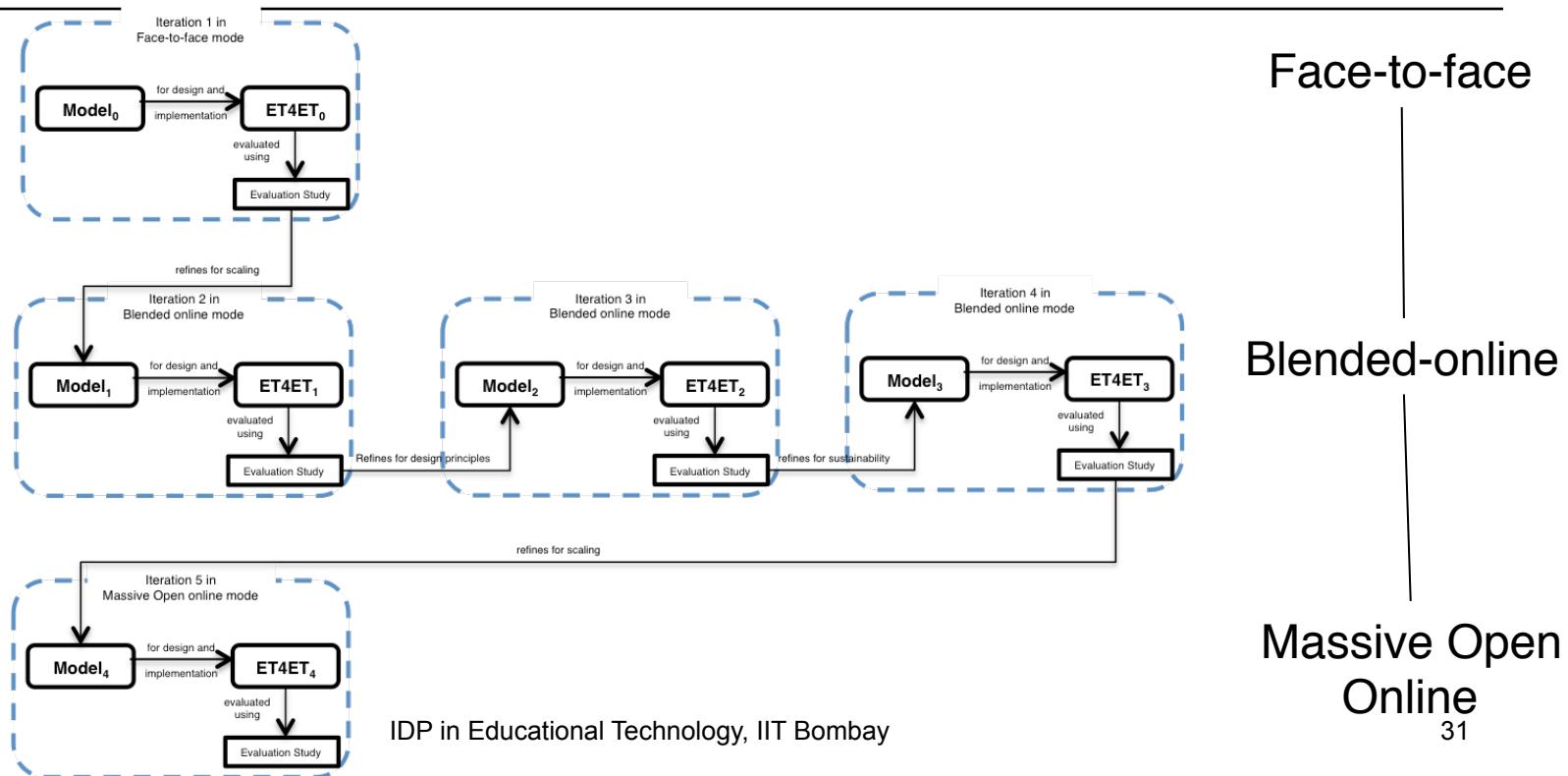


# DBIR: IMPLEMENTATION AND EVALUATION CYCLES

# DBIR: Single Iteration



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

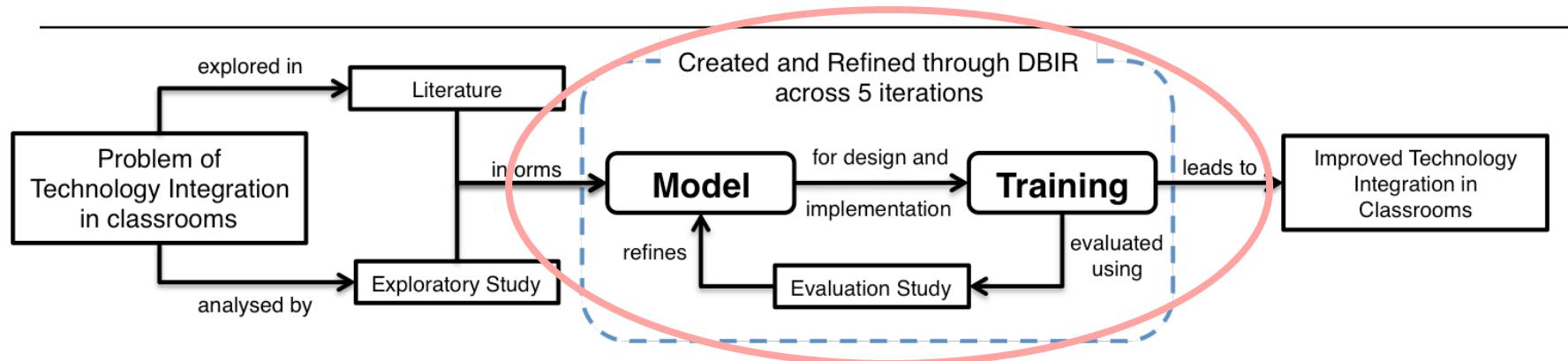


# Overview of Research in each iteration

Iteration (Training)	Iteration 1 (ET4ET <sub>0</sub> )	Iteration 2 (ET4ET <sub>1</sub> )	Iteration 3 (ET4ET <sub>2</sub> )	Iteration 4 (ET4ET <sub>3</sub> )	Iteration 5 (ET4ET <sub>4</sub> )
Mode	Face-to-Face	Blended Online			Massive Open Online
Number of Participants	23	1138	4358	51	5105
Evaluation	Perception	✓	✓	✓	-
	Learning	✓	-	✓	-
	Behaviour	-	-	✓	-
	Persistence	-	✓	✓	-
	Sustainability	-	-	✓	-

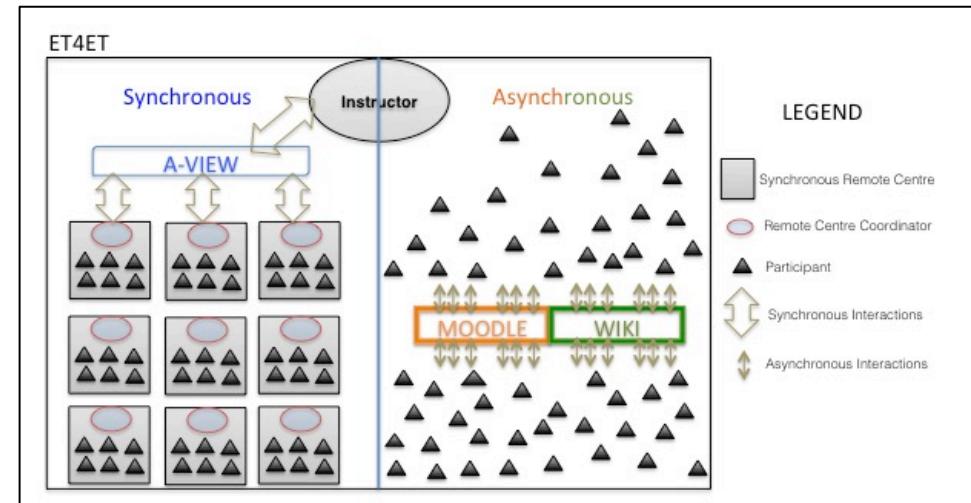
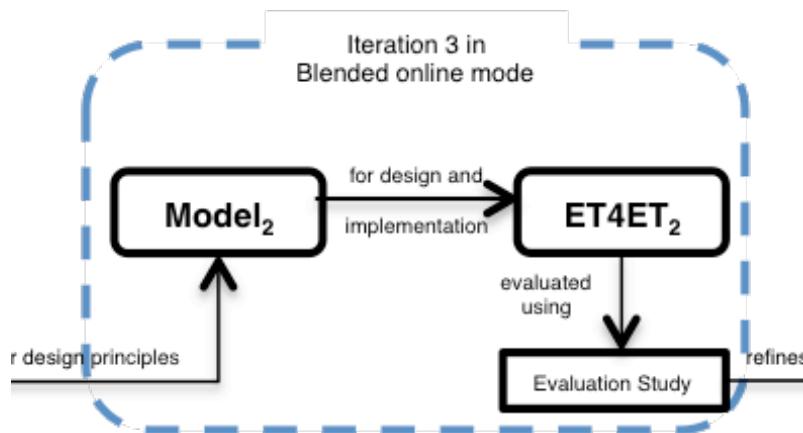
# Model evolution with each iteration

Iteration (Training)	Iteration 1 (ET4ET <sub>0</sub> )	Iteration 2 (ET4ET <sub>1</sub> )	Iteration 3 (ET4ET <sub>2</sub> )	Iteration 4 (ET4ET <sub>3</sub> )	Iteration 5 (ET4ET <sub>4</sub> )
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 <sub>1</sub>	Model <sub>2</sub>	Model <sub>3</sub>	Model <sub>4</sub>	Model <sub>5</sub>
Evaluation	EQ I: Persistence	-	RQ 2.1	RQ 3.1, 3.2	-
	EQ II: Reaction	RQ 1.1	RQ 2.2, 2.3	RQ 3.3	-
	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



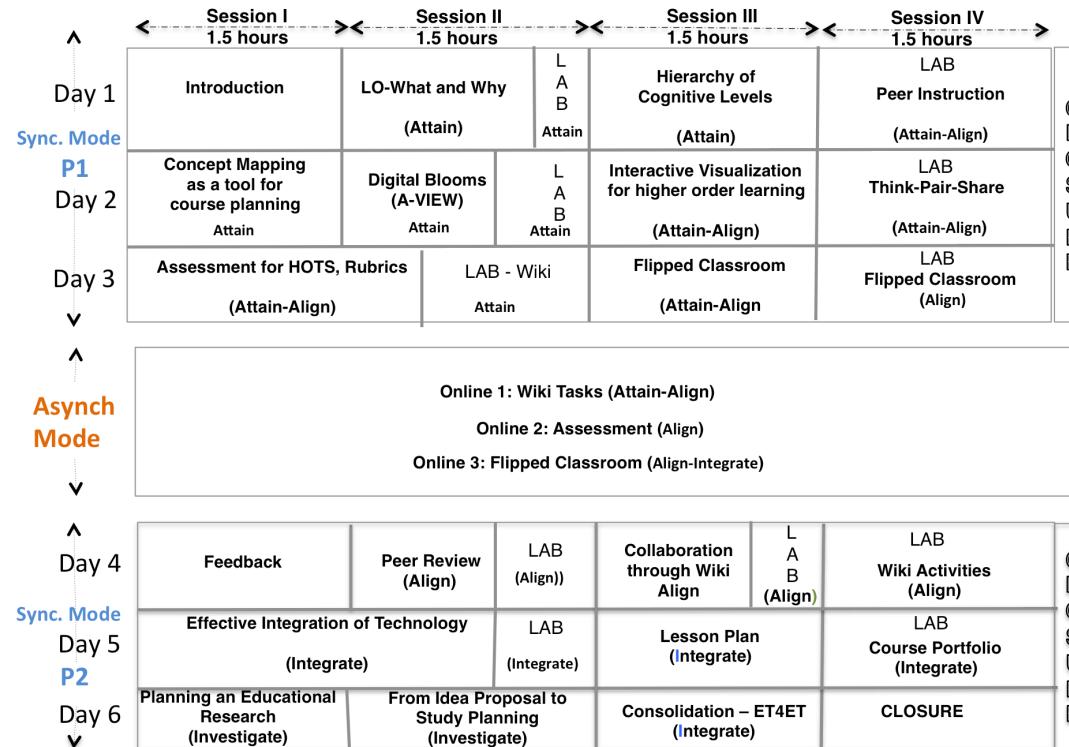
# ITERATIONS

# ITERATION 3



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

# ITERATION 3



# 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<sub>2</sub> programme?
  - How immersive is the ET4ET<sub>2</sub> 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

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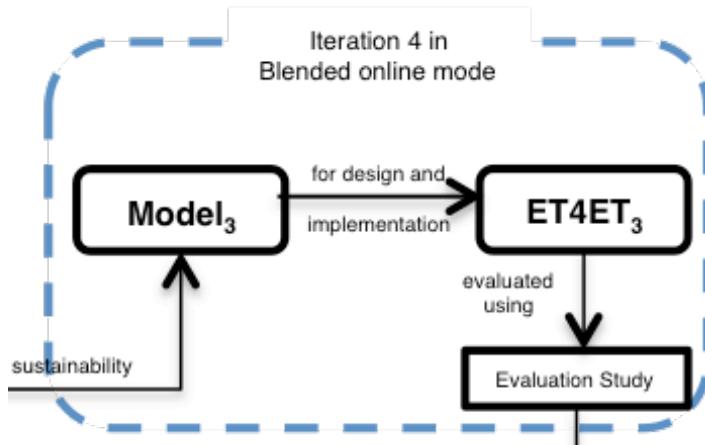
- ET4ET<sub>2</sub> has completion rate of 12.7% and persistence rate of 15.6%
- Statistically significant increase in the perception of competence of wiki and screencasts.
- Participants are able to align the technology affordances with the learning outcomes
- Participants find the training highly immersive and pertinent

# RESULTS

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- 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

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- 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

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- 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

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

# DISCUSSION

# SUMMARY OF RESULTS

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- 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

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- **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

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- 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

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- 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

# 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

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- 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

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

# FUTURE WORK

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- 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

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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.

Warriem, J, Murthy, S., & Iyer, S. (2013) *Training in-service teachers to do action research in educational technology*. In IEEE Fifth International Conference on Technology for Education (T4E 2013), Kharagpur, Dec. 18-20.

Warriem, J, Murthy, S., & Iyer, S. (2013). *A2I: A Model for Teacher Training in Constructive Alignment for Use of ICT in Engineering Education*. In Proceedings of 22nd International Conference on Computers in Education (ICCE 2014), Nara, Japan, Nov 30- Dec 4.

Murthy, S., Iyer, S., & Warriem, J. (2015). *ET4ET: A Large-Scale Faculty Professional Development Program on Effective Integration of Educational Technology*. Journal of Educational Technology & Society, 18(3), 16-28.

Warriem, J, Murthy, S., & Iyer, S. (2015). Sustainability at Scale: Evidence from a Large Scale Teacher Professional Development Program. In Proceedings of 23rd International Conference on Computers in Education (ICCE 2015), Hangzhou, China, pp. 651-660.

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.

Murthy, S., Warriem, J., & Iyer, S. (2017). *Technology Integration for Student-Centered Learning: A Model for Teacher Professional Development Programs*. in Kong, S.C., Wong, T.L., Yang, M., Chow, C.F., Tse, K.H. (Eds.) Emerging Practices in Scholarship of Learning and Teaching in a Digital Era, 55-74.

# CURRENT WORK

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

# ACKNOWLEDGEMENTS

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- **Prof. Sahana Murthy and Prof. Sridhar Iyer**
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- **Dr. Rwitajit Majumdar, Ms. Aditi Kothiyal, Mr. Shitanshu Mishra, Mr. Kapil Kadam, Dr. Yogendra Pal, Dr. Sameer Sahasrabudhe**
- **RS.ET**
- **My better half, My family**

# REFERENCE

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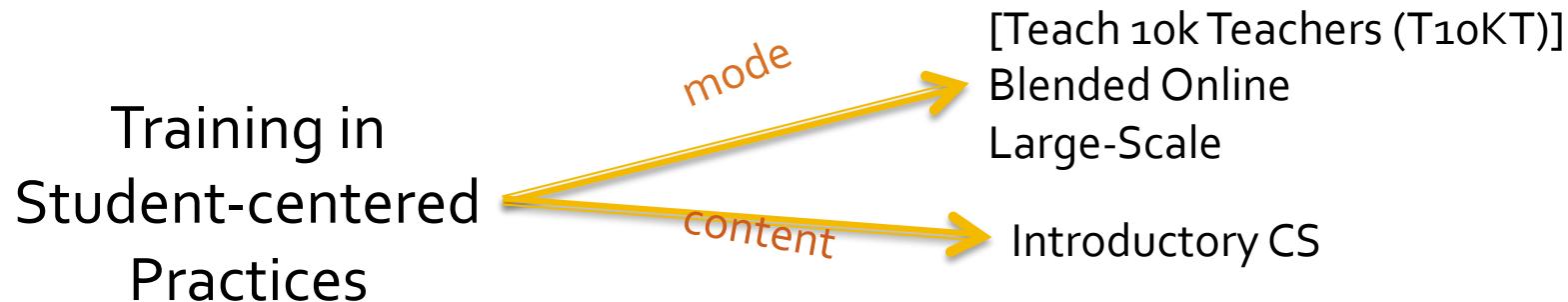
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# THANK YOU!!!

# 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

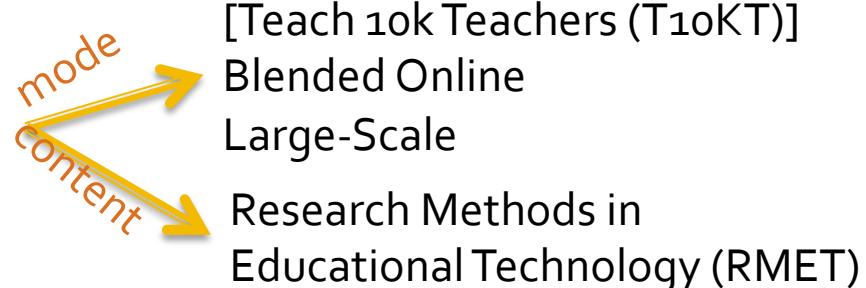
# Results – Exploratory Study 1

- 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



# 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 = (No of Completions / No of people who did at least 1 activity)

**Persistence rate\*** = 62% (N=896)  
How can we support 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

# 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

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## □ 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

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- 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