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
Technology use in higher ed. classrooms

- Students as consumers of technology!!

- Research results on benefits of technology, if used effectively
The Indian context

- INSTRUCTOR-MEDIATED
- SCALE
- IN-SERVICE TRAINING
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

Problem of Technology Integration in classrooms

Explored in

Literature

Exploratory Study

Created and Refined through DBIR across 5 iterations

Model

Training

for design and implementation

evaluated using

leads to

Improved Technology Integration in Classrooms

Refines

Evaluation Study

IDP in Educational Technology, IIT Bombay
POSITIONING THE RESEARCH
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)

- 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**

- **Existing programmes in higher ed**
  - Course Design Workshop at McGill University (Saroyan et. al., 2004), National Effective Teaching Institute – NETI (Brent & Felder, 2009), MarchET (Reinties et. al., 2013)
Lit. Review

- Barriers in effective technology integration
- Improving Teaching-Learning in Engg. Education
- Existing work on TPD: best practices & recommendation, Models
- Need for focusing on 2nd and 3rd order barriers
- Aiming for scholarship of teaching-learning through constructive alignment and action research
- 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
A2I2 MODEL

IMMERSIVITY  PERTINENCY

Attain
Introduction to Student-centeredness

Align
Alignment with Student Learning Goal

Integrate
Technology Integration Design

Investigate
Evaluating effectiveness

FOCUS

LEVEL OF IMMERSION
Exploration of technology features as a student
Exploration of technology features as a teacher
Selective use of technology features as a teacher
Identifying metrics for evaluation of selected features

PERTINENT OUTPUT
Independent Learning Artifacts
Artifacts designed for a teaching-learning goal
Integrated artifact for a Lesson Design
Ideas for evaluating effectiveness

Individual Work  Group Work  Transfer of Ownership
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Day 1
Sync. Mode
- P1
- Introduction
  - LO-What and Why
    - (Attain)
  - LAB
    - Attain

Day 2
- P1
- Concept Mapping as a tool for course planning
  - Attain
- Digital Blooms (A-VIEW)
  - Attain

Day 3
- P1
- Assessment for HOTS, Rubrics
  - (Attain-Align)
- LAB - Wiki
  - Attain
- Flipped Classroom
  - (Attain-Align)

Day 4
Sync. Mode
- P2
- Feedback
  - Peer Review
    - (Align)
  - LAB
    - (Align)
- Collaboration through Wiki Align
  - LAB
    - (Align)
- LAB
  - Wiki Activities
    - (Align)

Day 5
- P2
- Effective Integration of Technology
  - (Integrate)
- Lesson Plan
  - (Integrate)
- LAB
  - Course Portfolio
    - (Integrate)

Day 6
- P2
- Planning an Educational Research
  - (Investigate)
- From Idea Proposal to Study Planning
  - (Investigate)
- Consolidation – ET4ET
  - (Integrate)

CLOSURE

Online 1: Wiki Tasks (Attain-Align)
Online 2: Assessment (Align)
Online 3: Flipped Classroom (Align-Integrate)
IDP in Educational Technology, IIT Bombay
DBIR: IMPLEMENTATION AND EVALUATION CYCLES
DBIR: Single Iteration

- **RESEARCH**
  - Training Design
  - Training Implementation
  - Evaluation Study

- **PRACTICE**
  - Technology Integration in Classrooms

**MODEL**
- informs
- refines

IDP in Educational Technology, IIT Bombay
30
The five iterations of Educational Technology for Engineering Teachers (ET4ET)

IDP in Educational Technology, IIT Bombay
Overview of Research in each iteration

<table>
<thead>
<tr>
<th>Iteration (Training)</th>
<th>Iteration 1 (ET4ET₀)</th>
<th>Iteration 2 (ET4ET₁)</th>
<th>Iteration 3 (ET4ET₂)</th>
<th>Iteration 4 (ET4ET₃)</th>
<th>Iteration 5 (ET4ET₄)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mode</td>
<td>Face-to-Face</td>
<td>Blended Online</td>
<td>Massive Open Online</td>
<td></td>
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<tr>
<td>Number of Participants</td>
<td>23</td>
<td>1138</td>
<td>4358</td>
<td>51</td>
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<tr>
<td>Evaluation</td>
<td>Perception</td>
<td>Learning</td>
<td>Behaviour</td>
<td>Persistence</td>
<td>Sustainability</td>
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</table>
### Model evolution with each iteration

<table>
<thead>
<tr>
<th>Iteration (Training)</th>
<th>Iteration 1 (ET4ET₀)</th>
<th>Iteration 2 (ET4ET₁)</th>
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<td>Face-to-Face</td>
<td>Blended Online</td>
<td>Massive Open Online</td>
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<td><strong>Research Study</strong></td>
<td>Study 1</td>
<td>Study 2</td>
<td>Study 3</td>
<td>Study 4</td>
<td>Study 5</td>
</tr>
<tr>
<td><strong>A2I2 Model Version</strong></td>
<td>Model₁</td>
<td>Model₂</td>
<td>Model₃</td>
<td>Model₄</td>
<td>Model₅</td>
</tr>
<tr>
<td><strong>Evaluation</strong></td>
<td>EQ I: Persistence</td>
<td>EQ II: Reaction</td>
<td>EQ III: Learning</td>
<td>EQ IV: Behaviour</td>
<td>EQ V: Sustainability</td>
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<tr>
<td></td>
<td>-</td>
<td>RQ 1.1</td>
<td>RQ 1.2</td>
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<tr>
<td></td>
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<td>RQ 2.1</td>
<td>RQ 2.2, 2.3</td>
<td>RQ 3.1, 3.2</td>
<td>RQ 5.1</td>
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<td>RQ 5.2</td>
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<td>RQ 3.5, 3.6</td>
<td>RQ 4.1</td>
</tr>
<tr>
<td><strong>Impact of evaluation on Model</strong></td>
<td>Validated A2I2</td>
<td>Scaled A2I2</td>
<td>Design Principles of Immersivity and Pertinency in A2I2</td>
<td>Refined Design principle of Transfer of ownership for sustainability</td>
<td>Scaled A2I2 for fully online</td>
</tr>
</tbody>
</table>
ITERATIONS

Created and Refined through DBIR across 5 iterations

Problem of Technology Integration in classrooms

Literature

Exploratory Study

Model

Training

Evaluation Study

Improved Technology Integration in Classrooms
ITERATION 3

- Jan 5 – Jan 31, 2015
- 4358 Teachers from 148 institutions (remote centres)
ITERATION 3

### DAY 1
- **Sync. Mode**
  - **P1**
  - Introduction (Attain)
  - LO - What and Why (Attain)
  - Concept Mapping as a tool for course planning (Attain-Align)

### DAY 2
- **Asynch Mode**
  - **Day 2**
  - Digital Blooms (A-VIEW) (Attain)
  - Interactive Visualization for higher order learning (Attain-Align)
  - Assessment for HOTS, Rubrics (Attain-Align)
  - LAB - Wiki (Attain-Align)

### DAY 3
- **Sync. Mode**
  - **P2**
  - LAB Peer Instruction (Attain-Align)
  - Think-Pair-Share (Attain-Align)
  - Flipped Classroom (Align)

### DAY 4
- **Sync. Mode**
  - **Day 4**
  - Feedback (Align)
  - Peer Review (Align)
  - LAB (Align)
  - Effective Integration of Technology (Integrate)

### DAY 5
- **Sync. Mode**
  - **Day 5**
  - Collaboration through Wiki Align
  - Lesson Plan (Integrate)
  - LAB Wiki Activities (Align)
  - Planning an Educational Research (Investigate)

### DAY 6
- **Asynch Mode**
  - **Day 6**
  - Consolidation – ET4ET (Integrate)
  - From Idea Proposal to Study Planning (Investigate)
  - LAB Course Portfolio (Integrate)

**Online Sessions**
- Online 1: Wiki Tasks (Attain-Align)
- Online 2: Assessment (Align)
- Online 3: Flipped Classroom (Align-Integrate)
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?
<table>
<thead>
<tr>
<th>RQ Answered</th>
<th>Time of data collection</th>
<th>Data Source/Instrument</th>
<th>Metric</th>
</tr>
</thead>
<tbody>
<tr>
<td>RQ 3.1, 3.2</td>
<td>End of Training</td>
<td>MOODLE Assignment submission logs Registration logs</td>
<td>Completion rate, Persistence rate</td>
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<tr>
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<td></td>
<td>Technology Competency Survey, adapted from Technology Self Proficiency Survey (Milman, Nortecamp &amp; Peters, 2007)</td>
<td>Perception of competence in “Selection of Technology”, “Use of Technology to design lessons” and “Evaluation of artefacts generated by students using technology”.</td>
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<tr>
<td>RQ 3.3</td>
<td>Before and After the training</td>
<td>Lesson Plan for integrating wiki</td>
<td>Evaluated using a “Technology integration evaluation rubric” that has 3 criteria</td>
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<tr>
<td>RQ 3.4</td>
<td>End of training</td>
<td>Video Sessions and slides Program schedule</td>
<td>Time spent during the program on active learning activities</td>
</tr>
<tr>
<td>RQ 3.5</td>
<td>Before Training</td>
<td>A-View Chat logs</td>
<td>No of chat interactions to Active Learning strategies.</td>
</tr>
<tr>
<td></td>
<td>During Training</td>
<td>Moodle Submissions</td>
<td>Active learners based on assignment submissions</td>
</tr>
<tr>
<td></td>
<td>End of Training</td>
<td>Wiki pages</td>
<td>Number of page views, edits and user statistics</td>
</tr>
<tr>
<td>RQ 3.6</td>
<td>End of Training</td>
<td>End of program survey</td>
<td>Responses to questions related to relevance and intention to apply</td>
</tr>
<tr>
<td>RQ 3.7</td>
<td>One semester after end of training</td>
<td>Open ended response to survey after a semester</td>
<td>Levels of Changes observed</td>
</tr>
</tbody>
</table>
RESULTS

- ET4ET\textsubscript{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
- 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

- 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


CURRENT WORK

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

• Prof. Sahana Murthy and Prof. Sridhar Iyer
• Prof. Kannan Moudgalya and Prof. Chetan Solanki
• Prof. Deepak B Phatak
• T10KT, IITBOMBAYX Team, Participating instructors
• Dr. Madhuri Mavinkurve, Dr. Mrinal Patwardhan, Dr. Rekha Ramesh and Ms. Anita Diwakar, Dr. Gargi Banerjee
• 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
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

Training in Student-centered Practices

[Teach 10k Teachers (T10KT)]
Blended Online
Large-Scale
Introductory CS
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
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)
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
• 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* = 6.2% (N=3896)
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
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
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 their teaching-learning context?
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
Majority are Instructor-driven
(Type of T-L Interaction)
(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
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
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
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