Chapter 4

Technology Integration for Student-Centered Learning: A Model for Teacher Professional Development Programs

Sahana Murthy*, Jayakrishnan M., Warriem, and Sridhar Iyer

Indian Institute of Technology Bombay
Email: sahanamurthy@iitb.ac.in; mail.2.jkmadathil@gmail.com; sri@iitb.ac.in

Abstract The use of digital technology for the improvement of teaching and learning has been the focus of many educational reform efforts in recent years. Access to digital technology and the reported frequency of its use in classrooms have increased. However, several studies have shown that meaningful integration of the technologies with effective pedagogical strategies has not happened. While the affordances of digital technologies can enable student-centered learning and promote higher level learning outcomes, teaching practices with digital technology have largely followed the information transmission model. In higher education settings, there is less research on effective integration of educational technology as compared to K-12 setting, and most decisions related to the use of educational technology are left to the instructor. This leads to problems such as ineffective use of technology and lack of dissemination of good practices at a systemic level. In line with the goals of the scholarship of teaching and learning, we describe a model for a teacher professional development program for effective technology integration into student-centered learning. We apply the model to design and deploy a large-scale (4000 participants) teacher professional development program in a higher education engineering context in India. We present evidence of teachers using educational technology for effective teaching and learning.

4.1 Introduction

The use of information and communication technologies in teaching and learning provides several benefits due to their affordances and should be used to promote student-centered

* Corresponding Author Address: Indian Institute of Technology Bombay, Powai, Mumbai 400 076, Maharashtra, India. Email: sahanamurthy@iitb.ac.in

learning (Howland, Jonassen & Marra, 2012). Access to digital technologies and the reported frequency of use in classrooms have increased (Greenhow, Robelia, & Hughes, 2009). Yet, challenges related to technology-supported student-centered teaching, such as inadequate preparation of teachers to use technology and implement new instructional strategies (Brown & Warschauer, 2006) and teachers' beliefs and attitudes towards technology (Ertmer, 2005) have prevented meaningful integration of technology with effective pedagogical strategies. Despite its known benefits, student-centered learning approaches with technology are still not common, and the use of technologies is often limited to information transmission (Lim & Chai, 2008).

Teacher professional development programs at the K-12 level have emphasized the integration of technology with constructivist pedagogical practices (Howland, et. al, 2012). However, at the tertiary level of education, there is an increasing need for professional development programs to focus on the alignment between domain content with assessment and instructional activities to help teachers engage in scholarly teaching (Streveler, Smith & Pilotte, 2012). The Course Design and Teaching Workshop at McGill University (Saroyan, et al., 2004) and National Effective Teaching Institute Program (NETI) (Brent and Felder, 2009) at North Carolina University are two short-term training programs that specifically target this alignment. A similar alignment process is discussed in the MARCH^{ET} training program (Rienties et. al, 2012) to train faculty in redesigning their own course by integrating technology. Yet, these programs may be difficult to adapt under different contexts and there is an absence of validated teacher training models that allow adaptations into a short-term teacher professional development programs (Felder, Brent & Prince, 2011).

To address this gap, we developed the Align-Attain-Integrate-Investigate (A2I2) model to design teacher professional development programs targeting the goal of effective technology integration for student-centered learning. The model informs the choice and organization of the content of such professional development programs, as well as the format of activities to be conducted in the program. Based on the concept of constructive alignment (Biggs, 1996), the model prescribes that the content of such programs include modules of learning objective, instructional strategy, assessment and technology, situated within the teaching-learning problems pertinent to the participants. The model contains four phases - Attain-Align-Integrate-Investigate (A2I2), over which modules are distributed in accordance with a spiral curriculum (Bruner, 1977). The model recommends the format of activities to follow the basis of immersivity (Howland et. al., 2012) and active learning (Prince, 2004).

The A2I2 model combines both scholarly teaching practices and action research (in its Investigate phase), thus elevating the practice of teaching towards the Scholarship of Learning and Teaching (SoLT). Based on the A2I2 model, we designed and implemented ET4ET (Educational technology for Engineering Teachers) - a large-scale blended mode program for engineering college instructors in India. This training program empowers teachers with critical

skills required for effective technology integration. By ensuring that the teachers get trained in constructive alignment practices with technology, teachers broaden their conceptualization of teaching-learning, which is a pre-requisite to conduct inquiry on their own practices (Strevler, Borrego and Smith, 2007). The ET4ET program further advances evidence-based inquiry practices by mentoring teachers to conduct classroom action research. The evaluation of the program included teachers' beliefs, competence and practices of technology integration as well as their implementation of student-centered practices. In line with the goals of SoLT, the ET4ET program provides participants with a platform to report their practices and action research findings among a larger community of teachers in the country.

In this chapter, we describe the A2I2 model and its application to the design and implementation of the ET4ET professional development program for engineering instructors. The intended audience for this chapter are designers of teacher professional development programs, administrators, policy makers and educational researchers involved in scaling up implementations. Teacher professional development program designers can use the A2I2 model described in Section 4.3 and the implementation of the ET4ET training program in Section 4.4 to design their own training programs. Administrators and policy makers will find the overview diagram (Figure 4.1) in Section 4.3 and the results in Section 4.5 useful while formulating teacher professional development programs in their own context and benchmarking results. Educational researchers involved in scaling up implementations may find the Section 4.2 useful for understanding Design Based Implementation Research approach that we followed to develop the model. Based on our experience and the evaluation of the ET4ET program, we share recommendations (Section 4.6) for others who may wish to design such programs.

4.2 Research Basis for A2I2 Model

Within the context of engineering education, the *levels of inquiry* (Streveler, Borrego & Smith, 2007) has placed the scholarship of learning and teaching (SoLT) at the transition between scholarly teaching and educational research. A barrier in targeting the SoLT in the context of Indian engineering education is the lack of pre-service training to engage teachers even at the level of scholarly teaching practices. The A2I2 model addresses this gap by engaging engineering college teachers first to scholarly teaching practices, followed by a guided transition into SoLT via action research.

4.2.1 Theoretical Underpinnings of the Model

The goal of the A2I2 model is to provide a framework to design teacher professional development programs focused on effective technology integration for student-centered learning. The underlying theoretical basis of the A2I2 model consists of constructive alignment, spiral curriculum, immersivity and pertinency. These principles provide the foundation for A2I2-based training programs to address the above primary goal.

For teachers to engage in scholarly practices, they need to be able to align the content (or curriculum), assessment, and instruction (or pedagogy) for their regular teaching-learning transactions. This is captured by the concept of *constructive alignment* (Biggs, 1996), and it enables students to achieve higher cognitive levels in their learning practices. Constructive alignment is known to promote deep learning among students (Wang, Su, Cheung, Wong, & Kwong, 2013).

The A2I2 model prescribes the application of *spiral curriculum* to organize and sequence the content of training programs based on it. Spiral curriculum is characterized by an iterative process of revisiting the contents, with successive iterations looking at the topic in a greater depth for the learner to build on his initial understanding (Harden and Stamper, 1999). The aim of the A2I2 model is to enable teachers to solve their own complex, teaching-learning problems. The spiral approach used in the training provides them with not only the relevant techniques of technology integration and student-centered learning, but also the repeated experience of solving real-life problems at increasing levels of depth.

Immersivity is defined as the feature of the learning environment that drives participants to be involved in a set of meaningful activities (Howland et. al., 2012) and to get cognitively engaged in the content (Sherman & Craig, 2003). *Pertinency* of teacher training content is defined as the training participants' perception of degree to which the given content is applicable for his/her teaching immediately after the training. This idea builds upon the element of job relevance (Venkatesh & Davis, 2000) by adding the constraint of immediate practice.

4.2.2 Evolution of A2I2: Design Based Implementation Research

The A2I2 model discussed in this chapter evolved from three iterations of design, implementation and evaluation of training programs (Warriem, Murthy & Iyer, 2014; Murthy, Iyer & Warriem, 2015). To cater to the need of both design and implementation, we used the Design Based Implementation Research method (DBIR). The DBIR philosophy belongs to the broader umbrella of educational design research methods that operate within the intersection of research and practice and helps in bringing interventions to scale (Fishman, Penuel, Allen, Cheng, & Sabelli, 2013). The core principles that characterize DBIR are:

- *Focus on persistent problems of practice from multiple stakeholders' perspectives*. The problem being tackled in our context was that of providing teachers with training in

effective technology integration for student-centered learning. The stakeholders within each iteration included the training program designers (who are also the researchers), organizers of the T10KT project, participant institutions and teachers.

- *Commitments to iterative, collaborative design.* All training materials were initially developed through collaboration between the researchers and a few teachers from the participating colleges. These were then refined based on the feedback and evaluation at the end of each iteration.
- *A concern with developing theory and knowledge related to classroom learning and implementation through systematic inquiry*. A major theoretical input provided by the iterations, apart from the A2I2 model, were the principles of immersivity and pertinency (Warriem, Murthy & Iyer, 2015) in training design.
- *A concern with developing capacity for sustaining change in systems*. Sustainability is an important driver of training programs developed on the basis of the A2I2 model. The underlying theoretical principles of immersivity and pertinency, and the final Investigate phase of the A2I2 model help address the goal of sustainability.

The first and second iterations of the model contained only three phases: Attain, Align, Integrate. In the first iteration, we found that a face-to-face training program based on the model was beneficial for shifting the attitude of teachers towards student-centric learning. However, the technologies used were unfamiliar to teachers, and insufficient exposure led to poor technology integration in their lesson plans. This led to the second iteration where a larger emphasis was given to immersion into the technology. Teachers were immersed in meaningful activities with technology in their own contexts, for example, they created a wiki page for use in group projects for their own course. In addition, the model was used to scale up the training program to larger numbers and different modes (blended mode with synchronous and asynchronous online modules). Participant responses once again showed a conscious shift towards learner-centered approaches, and an effective integration of technology in their lesson plans. The third iteration of the model (Section 4.3), includes an additional Investigate phase at the end that allows teacher participants to systematically examine the effectiveness of their lesson plans, thus guiding them into the practice of action research.

4.3 A2I2: The Model

Figure 4.1 shows the broad outline of the content and flow of A2I2 model, with each of Attain, Align, Integrate and Investigate phases. The model contains three core modules of learning objectives (red), instructional strategies (blue) and assessment strategies (blue), and pertinent technology (white parallelogram inscribed in circle).

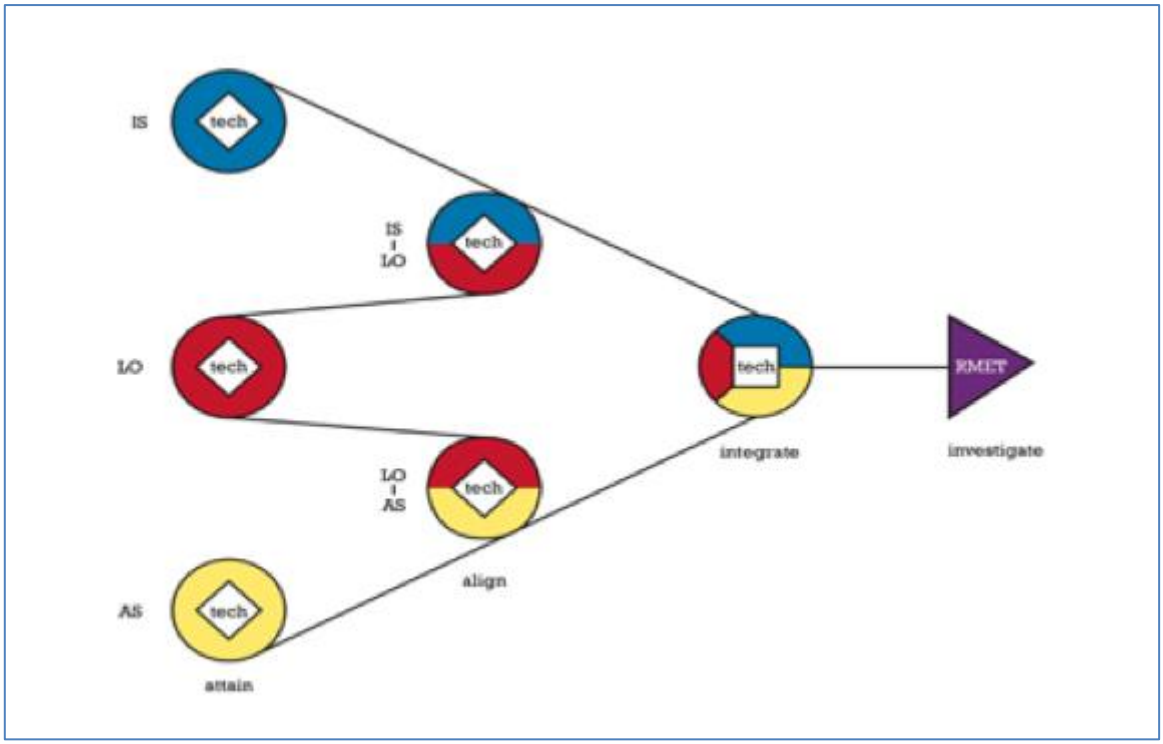

Fig. 4.1 The Align-Attain-Integrate-Investigate (A2I2) model

The main design features of the A2I2 model are: Phase, focus, module, format of activities, technology immersion and expected output (Table 4.1). The model provides recommendations to teacher professional development designers to make decisions for each of these components, and suggests the role of the participants of the professional development program at each phase. The underlying theoretical bases of the A2I2 model, viz., constructive alignment, spiral curriculum, immersivity and pertinency inform the design of these training programs.

Table 4.1 Features of A2I2 model

Phase	**Focus**	**Module**		**Format of activities**	**Technology immersion**	**Output**
		Topic	**Knowledge level**			
Attain	Attaining an introduction to concepts	Contains one of the three core modules: 1) Learning objective (LO) 2) Instructional strategy (IS) 3) Assessment strategy (AS)	Targets *recall* or *understand* type of knowledge related to one of the three core modules. For ex., how to write a correct learning objective, or how to execute	Most activities are instructor-led, such as introduction to concepts, summary of duration 5-15 min. each.	First, instructor guided activities on using the technology, followed by explanation on the	Identification of learning objective (LO), Instructional strategy (IS) and assessment strategy (AS) relevant to their own course and

			the steps of a particular instructional strategy.	Some activities are participant-driven individual activities of duration 5-10 min. each.	affordances of technology.	use of technology to display them.
Align	Aligning modules pairwise along with deeper knowledge.	Involves the alignment of two of the three core modules: - LO and IS - LO and AS - IS and As	Targets *apply* level of knowledge related to use of an instructional or assessment strategy for achieving a learning objective, or choice of a technology with an instructional strategy for a particular learning objective.	Majority are participant-driven individual activities such as constructing material for own course, such as micro-teaching.	More *evaluate* level activities followed by instructor-guided activities so as to align the affordances of technology with its intended use.	Examples of pairwise aligned modules within their own course with use of technology: a) LO - AS b) LO – IS c) IS - AS
Integrate	Integrating the knowledge gained.	Address the integration of all three core modules – LO, IS and AS.	Targets integrate phase target *create* level of knowledge for combining the three core modules. For example, creation of a lesson plan with the use of a specific technology.	Most activities are participant-driven and collaborative in nature. For ex., writing a lesson plan in a group, with participants of the same domain.	Integrating technology within the lesson plan	An integrated lesson plan for one lecture within their course which integrates technology.
Investigate	Investigating the effects of practice.	Research methods in educational technology	Targets investigate target basic research methods knowledge of the participants	A mix of instructor guided and participant driven	Identifying innovative ways of using technology and its	A proposal for a research study investigating effectiveness of a

				activities.	evaluation strategies.	teaching-learning strategy using technology.

- *Phases and focus* - There are four phases viz., Attain, Align, Integrate and Investigate. In the Attain stage, the model prescribes a focus on an introduction to concepts, so that participants attain preliminary knowledge on the three core modules of learning objectives, instructional strategies and assessment strategies, and on the affordances provided by the technology. The instructional strategies are student-centered as recommended by constructive alignment. The Align phase looks at pairwise alignment between the modules. At the same time, there is an increasing depth in the coverage of module. Participants are expected to have some mastery on the content at the end of the phase as the designed activities increase in complexity. In the Integrate phase, all the three modules get integrated along with effective use of technology. The complexity and depth of each of the module is largest in this phase. Thus, guided by the spiral curriculum, the three core modules are revisited as we move forward in the A2I2 phases, but each time at greater depths that involve overall integration. Finally, the Investigate phase helps in providing introduction to the basic idea of educational research so that participants get motivated to move towards action research within their own practice.
- *Module* - This deals with content and level within each phase.
  - *Topics* - This specifies the various topics and sub-topics under the main modules of learning objective, assessment strategy, instructional strategy and technology.
  - *Level of Knowledge* - This specifies the cognitive level of the learning outcomes, as per revised Bloom's taxonomy, (Anderson and Krathwohl, 2001) corresponding to each topic.
- *Format* – This specifies the format of activities in each phase. Overall, the A2I2 model prescribes the use of active learning strategies. There are three main types of activities viz., instructor-driven, participant-driven individual, participant-driven collaborative. The role of participant varies from a learner to that of a teacher across the various activities. Instructor-driven activities are recommended to be of a shorter duration, as studies show that the average attention span of an adult learner is ~20 minutes (Dukette & Cornish, 2009). More time is recommended for participant-driven collaborative activities, most of which employ active learning strategies.
  - *Instructor Driven* - These are activities in which the instructor plays the major role, e.g., lecture, demonstration, summary. The A2I2 model recommends that the activities be designed so that the role of the participant within these is that of an active learner. Instructor driven activities are recommended in the Attain phase.

- *Participant Driven Individual* - These are activities in which the participant performs the task individually and turns to instructor only for feedback. E.g., working out an example individually, solving a question. Since participants are solving real-life teaching-learning problems, the model demands that the role of participant becomes that of a teacher during these activities. Most activities in the Align phase are recommended to be participant driven individual activities.
- *Participant Driven Collaborative* - These are activities in which participants work in a group to solve a teaching-learning problem faced by them in class or perform an activity posed by instructor. E.g. Think-Pair-Share or Peer Instruction. The model prescribes that the majority of activities participants be primarily engaged in the Integrate phase are participant driven collaborative activities.

- *Immersion of Technology* – This explains how to what extent participants get exposed to the technology. . The principle of immersivity recommends that training program activities should be designed such that the participant engage with the content first as a learner and then as a teacher. Since participant is mostly in the learner mode in Attain phase, the immersion of technology as suggested by A2I2 model requires participant to perform teacher guided activity in the Attain phase. In the align phase, participants are in the role of teachers and hence evaluate the affordances of technology to achieve the intended learning objectives.
- *Output* - This specifies the tangible output at the end of each phase, which provides the participant with flexibility in application and the needed reflection on outcomes. The pertinency principle of A2I2 demands that these outputs be of immediate relevance to the participant in their own practice.

Overall, immersivity and pertinency help in the selection and design of activities, selection of technology, and examples within each module.

4.3.1 Using the A2I2 Model

The A2I2 model is primarily useful for a designers of teacher professional development programs as an instructional design model to develop short-term training programs for effective technology integration. At the broad level, the phases within A2I2 will help the training program designer to select and organize the contents of the program. Going a level deeper, Table 4.1 can help the trainer to design various activities within individual phases of the training program. The focus of each phase will help the trainer to identify the target levels of content and activities required at each phase. The format and immersion level specified by the A2I2 model will help the trainer to design instructional strategies across each phase to achieve the intended learning outcomes. The output at the end of each phase helps the training designer evaluate the intended learning outcomes of the program based on a tangible product

created by the training program participants. Finally the guidelines in the Investigate phase will help the trainer to introduce educational technology research methods to scaffold the participants in performing action research.

4.4 Application of A2I2 Model: The ET4ET Program

The A2I2 model was implemented in the design and development of a large scale teacher professional development program: Educational Technology for Engineering Teachers (ET4ET). The ET4ET program was conducted under the Teach 10000 Teachers project (T10KT, 2015), a part of a national initiative by the Indian government, the National Mission of Education through ICT (NMEICT, 2015). The goal of the T10KT project is to enhance the teaching skills of engineering college faculty. For this, 2-4 week professional development programs in the form of workshops are conducted on the teaching of various engineering topics. The T10KT project provides the infrastructure for conducting such programs via a blended learning approach involving synchronous remote classrooms and asynchronous online modules. Engineering college teachers attend the workshop at one of the 200+ remote centres across the country, where they participate in the synchronous sessions that include live two-way audio-visual interaction. In addition, Moodle is used for asynchronous interaction, such as for assignments and quizzes.

The main objective of ET4ET is to train engineering college teachers across the country to implement ICT supported student-centric teaching practices. The ET4ET program was conducted in January 2015. Participants were 4358 engineering college teachers who attended this program from 148 different colleges across India. The participants were from diverse domains of engineering and basic sciences. The training program spanned 4 weeks and was split into four parts:

Part 1: Face to Face Synchronous Sessions - 3 days

Part 2: Asynchronous Online Sessions - 12 days

Part 3: Face to Face Synchronous Sessions - 3 days

Part 4: Asynchronous Online Sessions - 10 days

The schedule for the ET4ET program is shown below in Figure 4.2.

	Day 1	Day 2	Day 3
Session 1	D1AM1: Setting Expectation	D2AM1: Concept mapping as a tool for course planning	D3AM1: Assessments for Higher Order Thinking Skills
		Break	Break
Session 2	D1AM2: Learning Objectives - What and Why?	D2AM2: Digital Blooms Taxonomy	D3AM2: Rubrics - Assessing Open Ended Tasks
Session 3	D1AM3: Lab	D2AM3: Lab - Exploration of Technology Tools	Lab
	Break	Break	Break
Session 4	D1PM1: Hierarchy of cognitive levels	D2PM1: Interactive Visualization for Higher Order Learning	D3PM1: Flipped Classroom
	Break	Break	Break
Session 5	D1PM2: Lab - Active Learning Using Peer Instruction	D2PM2: Lab - Active Learning Using Think-Pair-Share	D3PM1: Lab - Create video for Flipped Classroom
Session 6	Q & A		
	ONLINE PHASE-1 (Flipped Classroom, Interactive Visualizations)		
	Day 4	Day 5	Day 6
Session 1	D4AM1: Feedback on Online Assignments	D5AM1: Effective integration of technology followed by live Q&A	D6AM1: Converting your Idea to a Research Study
	Break	Break	Break
Session 2	D4AM2: Peer Review of Question Paper followed by live	D5AM2: Lab Assignment - Lab Assignment - Exploring Visualizations, Creating in-class activity with Visualizations	D6AM2: From Idea Planning -> Idea Proposal -> Study Planning
Session 3	D4AM3: Lab - Revise assignments		
1:00 - 1:30 1:30 - 2:00	Break	Break	Break
Session 4	D4PM1: Bringing in Collaboration through Technology - Wiki, Forums	D5PM1: Creating your Lesson Plan for 1 hour topic(Integrate Lesson Plan).	D6PM1: Consolidation - ET4ET followed by live Q&A
	Break	Break	Break
Session 5	D4PM2: Reviewing AL Strategies (Sorting of TPS, PI) Lab	D5AM2: Portfolios for your course Lab Assignment - Portfolio	Valedictory Session
Session 6	Q & A		
	ONLINE PHASE-2 (Wikis, Final Lesson Planning and Reflection)		

Fig. 4.2 Schedule of ET4ET training program

4.4.1 Immersivity and Active Learning in ET4ET Program

The immersivity principle is key in creation of an engaging session to the participants. As training designers, we followed the A2I2 model to adapt active learning strategies within the program to ensure engagement of participants. Table 4.2 shows engagement data related to these active learning strategies. The evidence for engagement comes from the chat messages received during the synchronous remote sessions during implementation of the strategies. From Table 4.2, we see that 37 active learning strategies were used across 7 sessions that totaled to 3.5 hours of active engagement (or 51% of instructional time). In terms of participation by individual colleges (i.e remote centres), we see that the average interaction per strategy is 130, i.e. 87.8% participation.

Table 4.2 Active-learning strategies and resulting engagement

	Day I		**Day II**	**Day III**		**Day IV**		**TOTAL**
Session	2	4	2	1	4	1	4	
Time in min for active learning (% of session time)	31 (34%)	30 (33%)	29 (32%)	47 (52%)	30 (33%)	44 (49%)	5 (17%)	216 (51%)
No of active learning activities	4	4	7	11	3	6	2	37
No of participant interactions	347	427	1336	1090	492	874	227	4793

The participants were provided with 8 Wiki tasks that required them to create 4 different Wiki pages per person and 1 page per college (remote center) and perform at least 10 edit operations. It was seen that over the course of the program, 1009 different participants had generated 6279 pages and performed 21487 edits. In terms of activity presence within the Wiki we can see that participants have created an average of 6 pages per person and performed 21 edits per person.

4.5 Evaluation of ET4ET Program

We evaluated the ET4ET program by investigating how teachers' belief, competence and practice have changed within the context of student-centered practices and technology integration. Our research questions are:

RQ1: To what extent have the teachers moved to student-centered practices?

RQ2: To what extent have teachers become competent in use of technology?

RQ3: How effective are the teachers in integrating technology in their own practice?

4.5.1 Teachers' Belief about Student-centered Practices

We answer first research question (RQ1) by analyzing teachers' perception of learning and intention to apply these strategies in their own courses. We use the example of an active-learning strategy, Think-Pair-Share, that was extensively used in the ET4ET program sessions. A total of 8 Think-Pair-Share strategies were used within the ET4ET program. Think-Pair-Share was also one of the instructional strategies that was discussed in the Attain, Align, Integrate phases. Assignments were given in the ET4ET program on creating Think-Pair-Share activities for their own course. Participants had submitted a total of 3013 assignments on creation of Think-Pair-Share activities in their own course.

The data source to identify teachers' beliefs included two questions from a 5-point Likert scale questionnaire. (In addition, the questionnaire contained other questions on various topics related to the workshop). The two questions used for this analysis were based on constructs of perceived learning and intention to apply, which are important constructs while investigating teachers' beliefs (Muijis et.al, 2004). The questions were asked in the context of TPS strategy that participants used extensively. The questions were: "I learnt how to set up a Think-Pair-Share activity in my class through Moodle activities and assignment on TPS." and "I intend to use Think-Pair-Share activities in my course in the coming semester." The survey questions had a Cronbach-alpha of 0.764 indicating good reliability.

The questionnaire received 1203 responses. The responses showed that 89% of participants had positive perceptions about learning and intention to apply Think-Pair-Share strategies in the workshop. Table 4.3 summarizes the results related to participants' perception of learning and intended use of Think-Pair-Share within the ET4ET program.

Table 4.3 Questionnaire responses on Think-Pair-Share strategy

Think-Pair-Share	**Perception**				
	SD	**D**	**N**	**A**	**SA**
Learning	18 (2%)	5 (0%)	106 (9%)	723 (60%)	350 (29%)
Intention to Apply	16(1%)	6 (0%)	122 (10%)	697 (58%)	362 (31%)

4.5.2 Teachers' Competence in Use of Technology

The training program used technologies such as Interactive Visualizations, Wiki and Screencasts. To answer the second research question (RQ2), we consider participants' perception of confidence in use of Wiki and Screencasts using responses to survey questionnaire and frequency of assignment submissions. Wikis and Screencasts have been

chosen primarily because more than 50% of participants had indicated lack of knowledge or use of these technologies within their current practice at the start of the workshop.

Teachers' competence in use of technology was analyzed using their responses to the Technology Competency Survey. We have used a questionnaire adapted from Technology Proficiency Self-Assessment Survey (Ropp, 1999) and administered it via Moodle pre- and post-program. The survey questions were asked on "Selection of Technology", "Use of Technology to design lessons" and "Evaluation of artifacts generated by students using technology". The survey utilized a five-scale approach - "I cannot do this", "I need training to this", "I can do this with support of resources like books/videos etc", "I can do this independently" and "I can teach this to others".

Cronbach's alpha of 0.83 showed that the survey was reliable. To check the validity of survey we did an Exploratory Factor Analysis using PCA with Varimax rotation. The factor analysis had resulted in 2 factors with four elements loading onto each with values greater than 0.6, which is sufficient to ensure validity. We then performed a Wilcoxon Signed-rank test on the pre- and post-survey data to test whether results are significant.

The results for perception survey and the assignment submissions for screencast and wiki are shown below in Table 4.4. As seen the median has increased from 1 (Need training) to 3 (can do individually) with a medium effect size in both use and evaluation within lesson. This shows that the ET4ET program training resulted in a statistically significant improvement in participants' perception of competence of integrating technology in their own lesson.

Table 4.4 Competence of teachers in using Screencast and Wikis

Parameter		**Screencasts** (number of submissions = 1899)		**Wiki** (number of submissions = 1074)	
		Use in lesson	Evaluate	Use in lesson	Evaluate
Median	Pre	1	1	1	1
	Post	3	3	3	3
Wilcoxon Signed Rank test		Z=-15.26 r=0.40 p<0.001	Z=-13.73 r=0.36 p<0.001	Z=-11.59 r=0.30 p<0.001	Z=-12.24 r=0.32 p<0.001

4.5.3 Teachers' Reported Practice

The third research question (RQ3) is answered using both post-workshop lesson planning activity and the self-reported practice by the participants at the end of a semester. We have taken the case of wiki as an example technology to explain the results. In an initial survey before the workshop 56% of the participants had indicated that they never used wiki in lesson planning.

The first data source was lesson plan submissions at the end of Wiki activity. There were a total of 1074 submissions, out of which we used purposive sampling to shortlist 554 submissions of participants who had submitted all the assignments during the workshop. A random sampling was done then to select 85 participants' (15%) wiki implementation plan for analysis. Each lesson plan was evaluated using a rubric containing three criteria for technology integration: C1 - Matching learning objective with Wiki affordances, C2 - Aligning use of Wiki affordances for instructional strategy, C3 - Appropriate assessment strategies based on Wiki affordances to measure learning objectives. Each criterion contained descriptions at four performance levels (scale of 0-3). The criteria of evaluation were the alignment of the use of technology with the intended learning objectives for the task, instructional strategy adopted and assessment strategy defined. The rubric was used by iteratively modified through discussions of two independent raters till it led to good agreement for all criteria. The reliability scores (Cohen's κ) for each of the criteria were found to be $\kappa = 0.85$ for C1, $\kappa = 0.85$ for C2 and $\kappa = 0.797$ for C3, indicating high reliability.

The second data source was a survey on reported practice which was administered using Moodle at the end of a semester of instruction (3 months after ET4ET workshop concluded). 71 participants had responded to this survey. There were four questions related to use of Wiki within their teaching-learning practice.

Additionally we solicited open ended responses by asking, "*Overall what changes do you feel in your teaching in this semester after attending the Pedagogy Workshop?"***.** A thematic analysis of the responses was performed (Braun and Clarke, 2008), wherein two researchers had used a deductive approach based on the existing literature on different levels of program effectiveness (Steinert et. al., 2006). Two rounds of coding by both the researchers generated common themes related to changes observed at Student Level, Teacher Level and Institution Level. The analysis of lesson plans using wikis showed the following results (Table 4.5).

Table 4.5 Evaluation of teachers' Wiki plan

Criteria	Mean Score (Out of 3)	SD
Matching learning objectives with Wiki affordances	2	0.85

Aligning use of Wiki affordances for instructional strategy	1.80	0.82
Appropriate assessment strategies based on Wiki affordances to measure learning objectives	1.17	0.72

The semester end responses on the survey showed that nearly 30% of the participants attempted to design wiki based activities for their course. The major purpose for which participants used Wikis were for: Uploading Course notes/resources (76%), Conducting and documenting classroom discussions (52.38%) and Conducting Project discussions (19%). Among the non-users a major reason cited for not using Wikis in their course was their own evaluation that wiki based activities are not suitable for their course (25%) and lack of internet access to their students (23%). Only a few (6%) had cited lack of knowledge as a reason for not applying wikis in own course.

In the thematic analysis of open ended responses on the levels of program effectiveness, the two researchers initially generated codes for each individual response and discussed these codes further to combine the codes to a set of relevant common themes. They subsequently did another round of discussion to refine and generate three broad common themes. The first theme of interest is the changes observed at student level. Most respondents felt increased engagement of the students and its effect on the student learning. This is best highlighted by the comment *"I was able to engage the backbenchers with the activities and that was reflected in their exam results."* The teachers also felt that applying workshop learning has facilitated better learning attitudes and beliefs from students, as seen from the comment *"students are more aware about what is being taught for what purpose."*

The second theme, changes at the teacher level, indicated shifts in beliefs and attitudes, and practice. The attitude shift from a teacher-centric or content oriented approach to a more a student centric or learning oriented approach was seen in comments like *"[I was] thinking from a student perspective rather than a teacher perspective"*. Some participants indicated improvement in self-belief: *"I feel I can handle the class with more confidence"* and *"... able to apply learnt practices"*. They also feel that their practices have improved to make classes more interactive: *"In each class I am successful in grabbing the attention of students by making them involved in one or the other activity."* There was a comment on the evaluation activity: *"[Question] Paper setting is improved after attending the workshop."* The comment *"... ICT enabled teaching methodology will be fruitful in future if we follow it regularly"* brings out the need to sustain these practices to bring about positive changes.

Within the third theme, changes at the institution level, two teachers clearly indicated the explicit effort made by them to disseminate the learning from workshop: *"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." This teacher indicated their plan to sustain this effort - "*We have also planned to conduct another phase of this workshop in the near future.*

From the lesson plan scores and reported practices, it is seen that participants have primarily used wikis as they had planned (i.e. for course repository or for classroom discussions). Participants fared better in identifying the learning objectives that wiki affordances provide, compared to the assessment strategies that will be used for evaluating these learning objectives. The low percentage of actual use can be primarily attributed to the self-evaluation of non-suitability and lack of internet access to students. This shows that teachers had positively thought about use of Wiki in their own course. The open ended responses from reported practice reiterates the finding that teachers have shifted towards student-centered practices (RQ1).

4.6 Discussion and Conclusion

The A2I2 model provides a framework to design teacher professional development programs on technology integration for student-centered learning. The model recommends both the choice and organization of the content of such professional development programs, as well as the format of activities to be conducted in the program. We designed a training program, ET4ET based on the A2I2 model. The evaluation of ET4ET indicates that teachers have learnt and intend to apply student-centered practices such as Think-Pair-Share (RQ1) in their teaching. Their lesson plans and reported practice show that they have become competent in use and integration of technology (RQ3). Further, three months after the workshop, teachers reported that positive experiences at integration of technology, resulting in changes at student-level, teacher-level and institution-level (RQ3).

We believe that the key features of the of the A2I2 model led to the successful design and implementation of the ET4ET program. The principles of immersivity and pertinency ensured that teachers' engagement was high during the program and led to higher intent to apply the learnings of the program. Constructive alignment, as prescribed by A2I2, was used throughout the program in its choice of topics, activities and sequence, and participants learn to constructively align their own teaching practice as well. The role of the Investigate phase of the A2I2 model is important in promoting sustainability of such programs. The Investigate phase guides the teachers in performing action research on their own practices of technology integration for student-centered learning, via systematic efforts of design, planning, implementation, evaluation and reflection. These efforts engage teachers beyond the duration of the professional development program, and provide them with relevant goals wherein they apply the learnings of the program. This helps teachers not only improve their practice, but ultimately propels them towards the scholarship of learning and teaching.

This chapter illustrated the implementation of the A2I2 model for one specific teacher professional development program: ET4ET, a 4-week blended program focusing on about three technologies and instructional strategies. The A2I2 model can be adapted to various scenarios with different modes of instruction, different duration, and different choice of technology or pedagogical strategies. We have previously used A2I2 to design a 1-week workshop in a face-to-face mode (Warriem, Murthy and Iyer, 2013a). In case of different instructional modes, the format of the activities had to be adapted to be suitable for the respective mode of instruction. If the A2I2 model needs to be used for a shorter duration, fewer technologies or instructional strategies should be chosen. If the duration is longer, more number of technologies and instructional strategies can be included. The additional technologies and instructional strategies should be such that they can be integrated well with the existing content in the program. In addition, more time should be allotted to the Integrate and Investigate phases. Regardless of the duration of the workshop, The Attain-Align-Integrate-Investigate cycle should be maintained, and the session on learning objectives should be always included towards the beginning. For newer or additional technologies, immersivity needs to be maintained. For newer or additional instructional strategies, the active learning nature of the strategy should be ensured. Participants should experience these strategies (as learners) at both individual and collaborative levels, and should create materials for their own courses (as teachers) during the Integrate phase.

Below are some more recommendations from our implementation that may benefit others who may wish to apply this model:

- The student-centered teaching-learning strategies and technology integration techniques should be illustrated via examples in the domains familiar to the teachers. Unless they can relate to the examples, they find it hard to apply it to their own context.
- For each technology being introduced, it is necessary to first equip participants with the skills to use the technology to bring out its pedagogical affordances in their relevant context before explaining its details. Similarly, for each instructional strategy being introduced, it is necessary to first implement the strategy as an activity that participants perform, before discussing the detailed process of the strategy.
- Teachers need to experience (as a learner) the active learning nature of instructional strategies first. Then they can design activities for their own context (as a teacher) using these strategies. This implies that the training program must be conducted using active learning techniques, regardless of the specific content included.

In summary, this chapter described the basis and features of the A2I2 model to design teacher professional development programs with the goal of technology integration for student-centered learning. The professional development program we implemented based on the A2I2 model enabled teachers to move towards effective technology integration and more

student-centered practices. While we have not yet directly measured student performance, changes in teaching practice and teachers' inquiry on the change indicates potential for improvement in student learning. We also saw evidence of changes at student-level, teacher-level and institution-level a few months after the program, indicating sustainability beyond the duration of the program. To conclude, we acknowledge our institution, which is the hub for conducting such training programs for several engineering colleges across the country as part of the Indian government's National Mission on Education through ICT. Thus both institution and government are playing a vital role in promoting SoLT activities within India.

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