ET4ET: A large-scale professional development program on effective integration of Educational Technology for engineering faculty

Sahana Murthy, Sridhar Iyer and Jayakrishnan Warriem
Indian Institute of Technology, Bombay
{sahanamurthy, sri, jayakrishnan.m}@iitb.ac.in

ABSTRACT

Several educators have recommended that the affordances provided by ICTs should be used to promote student-centered constructivist learning. While the actual use of ICT in education has increased, not much change has occurred in terms of the pedagogical practices followed. Information transmission models of teaching are still being followed, albeit with the use of ICT. Efforts at the school level attempt to address this problem via teacher education programs that emphasize ICT integration with constructivist practices. In higher education settings, most decisions related to the use of ICTs are left to the instructor and with fewer reported studies on ICT integration at a systemic level.

In this paper, we describe the design, implementation and evaluation of ET4ET, a large-scale professional development program (1138 participants) on effective integration of educational technology for engineering faculty in India. Guided by the Attain-Align-Integrate (A2I) model, the ET4ET program aims to train engineering college faculty across the country to implement ICT supported student-centric teaching strategies. To ensure engagement and learning of the participants in ET4ET, active learning strategies are implemented throughout the program. This paper traces the development of ET4ET, from a small-scale face-to-face implementation to a large-scale mode mediated by technology. Based on our experiences, we propose guidelines for training programs for similar goals.

Keywords
Teacher training, ICT integration, Large-scale, Constructivist alignment, Active learning

Introduction

The proliferation of information and communication technologies (ICT) has led to its widespread use in classrooms around the world in the last two decades. Educators and researchers have argued that the affordances provided by these technologies should be used to promote student-centric collaborative learning environments based on constructivist approaches (Jonassen, Howland, Marra, & Crismond, 2008). While the actual use of ICT in education has increased (Greenhow, Robelia, & Hughes, 2009), a number of challenges related to ICT supported constructivist teaching have been reported, such as teachers feeling inadequately prepared to use technology and implement new instructional strategies (Mumtaz, 2000; Brown & Warschauer, 2006), teachers' beliefs and attitudes towards technology (Ertmer, 2005) and constraints beyond an individual teacher's scope, such as curriculum and examination demands (Lim & Chai, 2008). As a result, student-centric active learning approaches with ICT are still not common, and the use of technologies is often limited to information transmission (Gao, Choy, Wang, & Wu, 2009; Lim & Chai, 2008).

Most teacher education programs include ICT as part of their courses and there are recommendations to include ICT in professional development programs (Lawless & Pellegrino, 2007). Of these, many efforts focus on the teaching of the skills of handling tools (Friedman & Kajder, 2006), however such skills alone does not prepare teachers to successfully integrate technology (Mishra, Koehler, & Kereluik, 2009). Current efforts emphasize the integration of ICT with constructivist pedagogical practices (Jonassen et. al. 2008), and some focus on teachers' development of TPACK (Chai, Koh & Tsai, 2010). Most of these efforts are for pre- or in-service teachers at the school level, but there are fewer systemic efforts at the college and university level (Schaefer & Utschig, 2008).

At the tertiary education level, decisions for ICT integration is often left to the individual instructors, leading to problems such as ineffective use of the tool (Selwyn 2007), isolation and inability of individuals to find know-how (Conole, Dyke, Oliver & Seale 2004), and lack of percolation of good practices (Ebert-May, Derting, Hodder, Momsen, Long & Jardeleza, 2011).

The above problems are compounded when teacher education programs have to be implemented at a large-scale. Complexities due to the scale include the availability of infrastructure, diversity in operating conditions, and resources available and ensuring engagement and learning. An attempt to address this problem is the Teach 10000 Teachers (T10KT) project in India, which promotes large-scale professional development programs for university faculty in various topics. The T10KT project provides the infrastructure for conducting such programs via synchronous remote classrooms, a blended learning solution. Within this project, we have developed Educational Technology for Engineering Teachers (ET4ET), a professional development program on effective integration of educational technology for engineering college faculty. ET4ET is a large-scale program guided by the A2I (Attain-Align-Integrate) model (Warriem, Murthy & Iyer, 2014) that originated from a research project. The main objective of ET4ET is to train engineering college faculty across the country to implement ICT supported student-centric teaching strategies. The content and its sequencing in the ET4ET program are chosen to address this objective, while taking into account the diversity of conditions and resources. To ensure engagement and learning of the participants in ET4ET, active learning strategies are implemented throughout the program.

In this paper we begin with a brief background of the Teach 10000 Teachers project. We review related work on teacher training programs emphasizing integration of ICT in constructive learning environments, and large-scale projects on use of ICT in teaching. We then describe how the A2I model led to the design and deployment of the ET4ET training program, and present data and analysis for the evaluation of the program. We reflect on the key factors that led to the effectiveness of the program and pitfalls to avoid. The contributions of this paper are: a flexible design for training programs that share the similar goal of effective ICT integration, but may vary in duration or choice of specific content, and recommendations based on our experience, that might benefit others who wish to implement similar programs.

Background and national context

The Teach 10000 Teachers (T10KT, 2014) project is part of a national initiative by the Indian government, the National Mission of Education through ICT (NMEICT, 2014). The goal of the T10KT project is to enhance the teaching skills of engineering college faculty. For this, 2-4 week training programs are conducted on the teaching of various engineering topics. To scale up participation, ICT is used to provide synchronous and asynchronous instruction. Participants attend the workshop at one of the 200+ remote centres across the country. The workshops contain lectures by experts, which are transmitted synchronously in the remote centres and include live two-way audio-visual interaction. Typical workshops also contain tutorials and labs conducted by ‘remote centre co-ordinators’. In addition, Moodle is used for asynchronous interaction, such as for assignments and quizzes. All workshop materials, including slides, assignments and videos of the lectures, are released in open source.

T10KT has conducted close to 20 workshops, each consisting of 1000 to 9000 participants, and has trained 85,000 participants till date. Most training programs under T10KT are on specific domain-based topics, in various fields of engineering (such as Thermodynamics for Mechanical Engineering, Electronics for Electrical Engineering). An important need recognized was for a training program for engineering faculty focusing on pedagogical practices, and use of ICT in their teaching. ET4ET fills this gap by providing training on research based student-centric teaching practices for effective integration of ICT.

Related Work

Most pre-service teacher education programs in colleges and universities include courses on the use of educational technology. Pre-service education has been reported to be successful in teachers’ self-efficacy with ICT use (Lee, et. al., 2008) and found to have a strong impact on teachers’ future use of ICT (Gao et. al, 2009). However, problems with pre-service programs have been reported such as lack of exposure to pedagogical strategies to be used with ICT (Brown & Warschauer, 2006) and focus of programs mainly on ICT skills (Friedman & Kajder, 2006). Programs have been redesigned to address these limitations, especially with the help of theoretical frameworks like TPACK (Mishra & Koehler, 2006). The TPACK framework provides a means to understand and describe the different types of knowledge – technological, pedagogical and content knowledge - and their synthesis, which are needed by a teacher to achieve meaningful ICT integration.

In recent years, large-scale initiatives on ICT integration in education are being implemented all over the world. Some projects, like ITT in Chile are national or regional government led initiatives (Brun & Hinostroza, 2014). The 'Intel Teach to the Future' project (Intel, 2014), is a privately funded project implemented in over 35 countries. It uses a Train-the-Trainer model for K-12 teachers to integrate technology effectively into classrooms and promote hands-on, collaborative and problem-solving methods.

Colleges and universities too are becoming increasingly aware of the need to train their faculty in effective ICT integration. For example, the Xanadu project at University of Turin uses a gradual approach to introducing university instructors to technology-enhanced learning at various levels from basic to advanced (Trentin, 2006). Another example is that of National Effective Teaching Institute Program (NETI) workshops at North Carolina University focus on learning styles, outcomes, research based instructional strategies and evaluation, and are organized in basic and advanced stages (Brent and Felder, 2009).

Need for ET4ET

While there exist programs for training university faculty in ICT integration, their implementation designs are not suitable for direct adaptation in our setting, due to differences in operating contexts such as learner requirements or duration of program. For our context, we require a short-term program design whose goal is to train engineering college faculty across the country to implement ICT supported student-centric teaching strategies. The training program design should be able to address not only broadly recommended practices of ICT integration, but also specifically target technologies and pedagogical strategies suitable for engineering topics. This goal is addressed by the application of the A2I model to a large-scale setting.

Attain-Align-Integrate (A2I) Model

The A2I model was developed by the authors of this paper (Warriem et. al., 2014) to realize the need for a framework to design short-term training programs whose goal is to enable student-centered learning with ICT integration. The A2I model prescribes features of the training program design, namely, key topics for the above goal, their organization and sequence, and format of activities to be done by the participants.

Theoretical basis

The major theoretical basis of the A2I model that helps decide the topics of the training program is *constructive alignment* (Biggs, 1996). This is achieved when the teaching-learning activities and evaluation are aligned with the intended student learning outcomes. Constructive alignment also ensures that instructors utilize more constructivist, learner-centered practices while performing this alignment. Constructive alignment has been successfully employed by instructors in course redesign and is known to promote deep learning among students (Wang et. al., 2013).

Spiral curriculum (Bruner, 1977) forms the basis of the organization and sequence of topics in training programs guided by the A2I model. Spiral curriculum is characterized by an iterative process of revisiting content, with each successive visit addressed at a greater depth for learners to build on their initial understanding.

Active learning (Prince, 2004) forms the basis of the pedagogical strategies followed in training programs based on the A2I model. Based on constructivist teaching-learning philosophy, active learning encompasses several research-based strategies designed to engage students in the learning process, in which students go beyond listening, copying of notes, and execution of prescribed procedures (Meltzer & Thornton, 2012). The activities within the A2I-based training programs are designed using active learning strategies so that participants not only get engaged in the learning environment of the program, but also get exposed to student-centric strategies which they may then try in their own classrooms.

Features of A2I model

To facilitate constructive alignment by instructors, the A2I model prescribes three core modules in the training program - learning objectives, student-centered instructional strategies and assessment strategies related to ICT use. The actual topics for the training can then be selected based on these three core modules and the operating context.

The A2I model consists of a 3-phase design - Attain, Align, and Integrate - to provide a mechanism to connect the three core modules. In the *Attain* phase, participants are expected to attain preliminary knowledge of topics in each of the three modules, such as how to construct a learning objective, or what are the pedagogical affordances of the tool. The *Align* phase focuses on pairwise alignment between the modules, for example, writing assessment questions consistent with different levels of learning objectives, or choosing an ICT tool and associated teaching strategy for a higher order learning objective. The *Integrate* phase consists of constructive alignment of the three modules. The focus is on inter-connection of the modules so that teachers create instructional and assessment strategies for their course, which are aligned with the intended student learning outcomes. The instructional strategies chosen are constructivist-oriented and are implemented along with the use of appropriate ICT.

While moving across the three phases, the core modules are visited at greater depth and complexity each time by following a spiral curriculum. For example, in the Attain phase participants first look at the hierarchy of cognitive levels for writing learning objectives. In the Align phase this is revisited when participants align assessment questions at different levels with learning objectives. In the Integrate phase, participants write an entire lesson plan using the same objectives and assessment questions from the previous phases.

Each phase of the A2I model follows a specific pedagogical format of the instructional activities, corresponding to the goals of that phase. In the Attain phase, activities are mostly instructor led, with a few being driven by participants at an individual level. In the Align phase, mastery in application of concepts is targeted. Hence most activities are participant-driven and are to be performed individually. Activities in the Attain and Align phase are 5 to 15 minutes long. In the Integrate phase, participants are primarily engaged in longer collaborative activities to solve real-life teaching-learning problems faced by them in class. Activities are mostly active-learning based, especially in the Align and Integrate phase, but also to a large extent in the Attain phase.

Some elements of the A2I model are derived from the TPACK framework (Mishra and Koehler, 2006). For example, the Attain phase looks at elements of Pedagogical Knowledge (PK) while Align phase stresses on the development of Pedagogical Content Knowledge (PCK) and the Technological Pedagogical Knowledge (TPK). The final Integrate phase addresses the synthesized TPACK of the instructor. (However, there is no explicit goal to increase instructors' TPACK.)

Implementation of ET4ET training program

The A2I model was first applied and evaluated in a pilot small-scale implementation with 30 participants for a 5-day training program (Warriem et. al., 2014). Results showed a conscious shift of the instructors towards including more student-centered learning strategies. Also, participants were successful in aligning their instructional strategies with their stated student learning objectives but faced difficulty in alignment of assessment strategies. This informed future implementations of the A2I model that more opportunity must be provided for practice of alignment of assessment strategies with the other modules.

Going from small to large-scale implementation, the key design features prescribed by the A2I model stayed the same, but the implementation was adapted to account for the scaling in terms of the number of participants, existence of remote classrooms and the duration of the program. The training program design also took advantage of the affordances of the ICT-enabled mode of implementation: the synchronous remote classroom mode provided by the T10KT project infrastructure, combined with the asynchronous interaction via Moodle. While scaling up, the following were the main design considerations:

a) The three core modules of learning objective, instructional strategy and assessment strategy remained the same.
b) Since the duration of ET4ET was longer than the pilot, more content was added. A larger number of ICT tools addressing different teaching-learning goals, and corresponding instructional strategies were discussed.
c) The active learning pedagogy stayed the same, however this got adapted to the ICT-enabled mode of implementation.

The training program was conducted across 7 weeks during June-July 2014. The program began with 3 days of sessions in the Synchronous Remote Classroom (SRC) mode, followed by 5 weeks of asynchronous Moodle-based interactions (considered to be equivalent to 5 days of synchronous sessions) and concluded with 3 days of synchronous sessions where participants reassembled at their remote centres. Each synchronous day contained four 1.5-hour sessions, dealing with one of the core modules or their alignment. Each asynchronous session spanned a week. Fig. 1 shows the distribution of content across the training program, categorized in terms of the three core modules and sequenced using the A2I model.

Content and organization of ET4ET

Fig. 1 shows the specific topics and their distribution across the training program. The topics are categorized in terms of the three core modules and sequenced according to the three phases of A2I model. Many instructional strategies discussed in the program such as Peer-Instruction are explicitly based on theoretical and empirical research, and have shown objective evidence of improvement of learning under prescribed conditions (Crouch & Mazur, 2001).

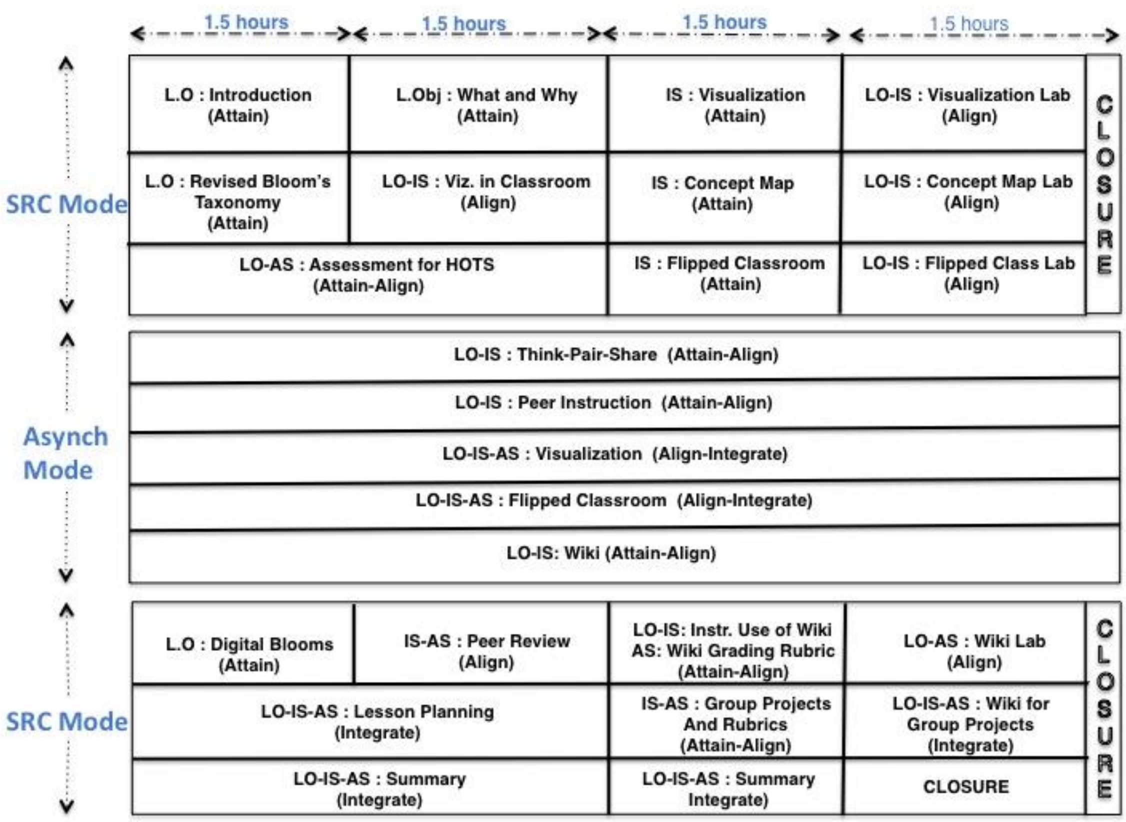

Fig. 1. Topics and sequence of the ET4ET program. (LO: Learning objective, IS: instructional strategy, AS: assessment strategy)

We explain how the trainers utilized the A2I model using two examples of integrating technology: i) a well-established technology of computer-based visualizations for conceptual and procedural understanding, and ii) a more recent technology – wiki, for collaboration.

Visualizations such as animations and simulations are recommended for scientific topics since they facilitate learning for abstract, complex contents that are otherwise difficult to observe, allow learners to practice 'what-if scenarios', and foster their analytical skills (Rutten, van Joolingen & van der Veen, 2012). While designing activities for integrating visualizations in classroom, participants first learnt about the need and types of visualization (Attain) on SRC-Day1 followed by aligning the different types of visualization corresponding to different learning objectives (Align) on SRC-Day2. The next few sessions targeted the rationale, features, and implementation know-how of active learning strategies such as Think-Pair Share and Peer Instruction (Align). This was followed by integrating visualizations in lesson plans (Integrate) using Lesson Module in Moodle during weeks 1-3.

The second example is that of teaching with wiki. The objective of the module was to get instructors to create a lesson plan for using a wiki in their own course for group projects. The Attain phase of the module focused on helping instructors identify the key pedagogical features of a wiki (like collaborative editing) that makes it a meaningful technology for group projects. Moodle was used to guide participants through two live wikis. In the Align phase, instructors used their knowledge to create a wiki implementation and evaluation plan for achieving specific objectives in their own course. This was done in synchronous mode and two TPS activities were used for participants to perform the planning. In the Integrate Phase, participants created a detailed implementation plan for a group project using wiki.

Active learning pedagogy in ET4ET

The activities in the ET4ET program were implemented using active learning strategies, many of which were similar to the strategies being discussed as part of the Instructional Strategy module. The rationale for this was two-fold:

i) Active learning strategies have been tested repeatedly in various settings and have been shown to be effective to improve engagement and learning. Hence one reason for the use of active learning strategies was to get participants to be engaged with the program content, and ensure effective learning.
ii) In order for participants to apply an instructional strategy in their own courses, it is essential that they experience the strategy themselves. This is especially true of constructivist-oriented active learning strategies, since participants may not be familiar with implementing such strategies. Once participants experience an active learning strategy first-hand in 'student role' with the help of scaffolds like worksheets or assessment rubrics, it becomes easier for them to shift to 'teacher role' and create activities. Additional scaffolds like activity constructors or templates were provided to design activities for their own course.

In the training program sessions, active learning strategies such as Think-Pair-Share, Peer-Instruction, debate, group problem solving and peer review were implemented, after adapting the strategies to the ICT-mediated Synchronous Remote Classroom mode (Warriem, Murthy & Iyer, 2013). Fig. 2 shows examples of such activities conducted in the session on Flipped Classroom.

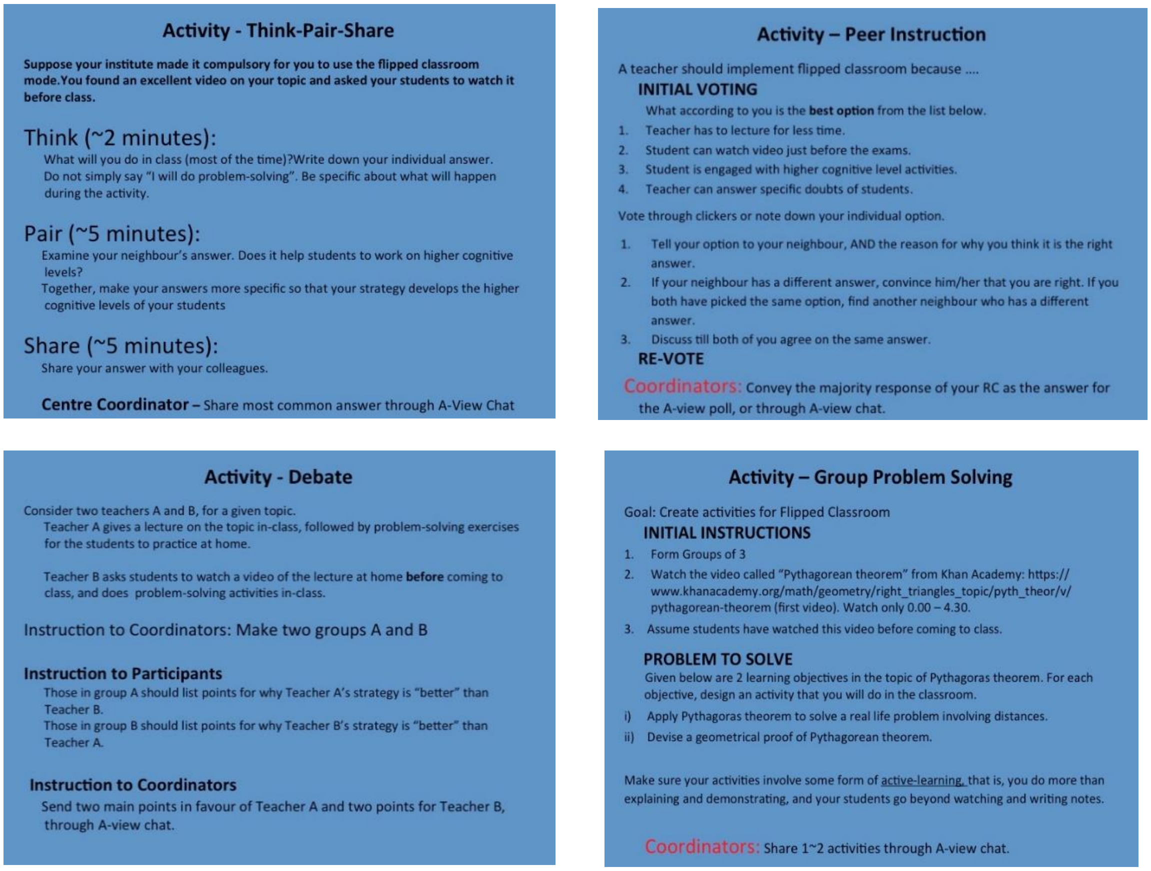

Fig. 2: Activities implemented in ET4ET based on active learning

In the asynchronous mode, various modules available in Moodle were used to ensure that participants were engaged in the content and collaborated with each other. Specific forums were created for participants to share their ideas of applying ET4ET content in their courses. Participants also used forums to elicit help in the use of technology in their setting, thereby creating a community of ET4ET practitioners.

Assessment

The workshop had a total of 16 open-ended assignments submitted through Moodle. In the assignments, participants created material for their courses for active learning techniques, and lesson plans for integrating ICT. Participants were provided with formative assessment rubrics and trained to use them for both self- and peer-assessment. In addition, the program training faculty sampled 10-20% of submissions for each assignment, identified common errors and provided feedback in the following sessions or on Moodle. This provided closure and made it possible to provide meaningful assessment even though there were large number of submissions.

Evaluation of ET4ET

38 engineering colleges from across various geographic regions of India participated in the ET4ET program. A total of 1138 faculty members from these colleges registered for the program, out of which 603 (336 males - 55.7%, 267 females - 44.3%) participants participated in a survey questionnaire provided at the start of the workshop to collect demographic details. Participating instructors had diverse teaching experience: 23% had 10+ years of experience, 41% had 3-10 years of experience and 36% had <3 years of experience. To evaluate the program, data were collected and analyzed for the following metrics: i) Participation rate, ii) perception of participants and iii) learning outcome of participants.

Participation Rate

Participation rates in the ET4ET program were measured via attendance in synchronous sessions and assignment submissions. The total number of registered participants were 1138, out of which 914 (80% of registered participants) attended on Day-1. The attendance on the last day of the program was 740, thus the attrition rate across workshop was 18.5% of the participation on Day-1. On each day, the gender distribution stayed constant: male – 60%, female – 40%. The details of attendance details of each day are given in Table 1 below:

Table 1: Attendance during synchronous sessions

Synchronous Day	**1**	**2**	**3**	**4**	**5**	**6**
Attendance total	914	903	878	780	760	740

Data related to assignment submissions (Table 2) were obtained from Moodle. While analyzing the assignments we looked at four levels of submissions – participants who submitted one assignment, 6 assignments (~40% of assignments), 12 (75% of assignments) and all 16 (100% of assignments).

Table 2: Frequencies of Assignment Submission

Number of submissions	**1**	**6**	**12**	**16**
Participants who submitted	840 (92%)	550 (60%)	311 (34%)	175 (19%)

In the program, participants who had completed 40% or more of the assignments were designated as having 'successfully completed' the program, and were given a certificate of passing. These were considered to be participants who were actively engaged through most of the course. Participants who completed 75% or more successfully were considered to have 'completed program with distinction.' We found that in ET4ET, 60% of the registered participants successfully completed the program, and 34% achieved distinction.

In many large-scale programs such as MOOCs, it is seen that as the course progresses, the attrition increases. Typical completion rates in MOOCs of comparable size are 10-12% (Jordan, 2014). Academicians have coined this as the funnel of participation (Clow, 2013) and have mentioned that funneling occurs right from stage of awareness about the program till its completion. We found that in ET4ET, the completion rates were higher. A possible reason for higher participation and completion rates can be the blended mode of delivery and use of active learning strategies compared to the fully online delivery of MOOCs. We believe that the synchronous remote classroom mode in ET4ET facilitated a sense of community among participants, which is important not just for persistence but also for commitment towards cooperation and motivation (Rovai, 2002).

Participants' perceptions

A questionnaire on participants' perceptions was administered via Moodle at the end of program. Questions were based on the constructs of participants' perception of their learning, and their intent to apply the knowledge and skills from ET4ET in their future courses. Each question was related to one topic discussed in the program (such as setting learning objectives, creating wiki-based activities etc). The Cronbach α reliability coefficient was calculated for questions in each construct: $\alpha = 0.8383$ for the 6 questions on perceptions on learning; $\alpha = 0.7279$ for the 6 questions on intent to apply. The questions contained a 5-point Likert scale from Strongly Disagree to Strongly Agree. In addition, participants were asked to provide open-ended feedback on the program. We show data of 178 participants (83 males – 46.6% and 95 females – 53.4%) who completed the questionnaire and gave consent.

12 questions relevant to these constructs and corresponding data are shown in Tables 3 and 4. (The remaining questions were related to demographics or organization logistics). For the construct of perception of learning, 89% participants either strongly agreed or agreed that they learnt from the program.

For the construct of intent to apply, 82% strongly agreed or agreed that they intend to use the knowledge and skills from the program in their own courses.

Table 3: Participants' perceptions on learning (N=178)

Questions on participants' learning ***I learnt how to…***	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Setup learning objectives and matching assessment	5	1	5	85	82
Setup a wiki-based activity for my course	1	8	38	108	23
Set-up a Peer Instruction activity in my class	1	3	9	103	62
Set up a Think-Pair-Share activity in my class	1	5	7	92	73
Setup a flipped classroom activity in my course	1	6	14	91	66
Use Visualizations along with an active learning strategy in my course	0	4	14	101	59
Average	**3**	**4**	**14**	**97**	**60**

Table 4: Participants' intention to use knowledge, skills and strategies from ET4ET (N=178)

Questions on participants' intention to apply ***I intent to … in my course in the coming semesters***	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
Specify learning objectives and matching assessments	16	1	7	103	51
Use wiki	3	6	46	96	27
Use Peer-Instruction activity	1	3	23	83	68
Use Think-Pair-Share activity	1	4	12	91	70
Use Flipped Classroom	2	5	37	90	44
Use visualization based activities	1	4	18	102	53
Average	**4**	**4**	**23**	**94**	**52**

In the open-ended responses, participants elaborated their views on their learning and intent to use the knowledge from ET4ET. For example, *"I will practice at least two techniques in my next semester's course"*. The following quote is from a participant who found the program beneficial enough that she/he attempted to disseminate the learnings to his/her colleagues who did not attend the program: "*Though only 10 faculty from our college initially participated in the program, we brought in others for the latter days. We conducted a 1-day workshop in our college that discussed the ideas that were presented in the [initial days of] the program*". This indicated a shift in the reform ownership (Coburn, 2003), which is an important dimension of scaling, that goes beyond numbers. Many open-ended responses of participants provided useful feedback related to the design of the workshop. For example: "*The online sessions were for too long period of time*" Such feedback will be considered in the next offering of the ET4ET program.

Participants' learning

The assessment in the training program required participants to complete assignments that reflected the tangible outputs specified at each phase of the A2I model. These assignments were evaluated using performance rubrics. As an example, we provide the analysis of result from participants' lesson plan assignment that was given at the end of workshop. A total of 391 participants submitted this assignment, out of which we selected 36 assignments based on the following sampling criteria:

a) Participants had to submit more than 12 assignments.
b) The remote center (of the participant) should have at least 2 submissions.
c) Random sampling of 2 participants per remote center.

Table 5 shows the criteria for evaluation and number of participants attaining each performance level.

Table 5: Participants' lesson plan rubric and number of participants in each performance level (Total N=36)

Criteria	**Target**	**Satisfactory**	**Inadequate**
Student-centeredness of instructional strategy	All strategies mentioned require active student participation, beyond mere listening or copying of notes or answering questions. (19 participants)	Majority of strategies require active student participation; however there are a few in which students are passive listeners or there is no clear description of student role. (9 participants)	Majority of strategies do not require active student participation or there is no clarity on the roles of students in these strategies. (8 participants)
Alignment between learning objectives and instructional strategy	There is a perfect alignment between all the learning objectives and the instructional strategies. (12 participants)	Most instructional strategies are aligned with learning objectives, however there are a few which are not aligned or not clearly explained. (20 participants)	Majority of the strategies are not aligned with the stated learning objectives or there is no clarity on how the strategies are going to be used. (4 participants)
Alignment between assessment and learning objectives	All assessment questions are aligned with the stated learning objectives. (14 participants)	Majority of assessment questions are aligned with stated learning objectives, however there are a few which are not aligned or unclear. (17 participants)	Majority of assessment questions are not aligned with the learning objectives or there is no clarity on how the assessment is to be implemented. (5 participants)
ICT Integration	ICT is used beyond routine procedural use in either instructional or assessment strategy. For example, use of wiki for Think-Pair-Share activity. (5 participants)	The teacher uses ICT for a useful but standard task. For example, submission of online assignments in Moodle, demonstration of videos. (20 participants)	The teacher does not use ICT at all. (11 participants)

From Table 5, we infer that:

a. Majority of the participants have consciously used student-centered strategies in their final lesson plan.
b. Most participants are able to align learning objectives with instructional strategies and assessment.
c. Participants are primarily using ICT resources for conventional or procedural tasks like demonstration, file submission etc.

Reflections and Recommendations

We found that the Attain-Align-Integrate approach of the A2I model is suitable for large-scale implementation of ET4ET. In this section we give some recommendations for the benefit of others who would like to undertake similar efforts.

1. While A2I can be used to create face-to-face programs, we found that a blended approach worked better in large scale. The blended mode, especially interspersing asynchronous sessions with the synchronous mode, made sure that participants had enough time to practice their learning and reflect on it, as well as had sufficient face-to-face interaction with their peers to keep up motivation and build a community.

2. It is crucial that teaching-learning strategies and ICT integration techniques be illustrated via examples in one or more domains. Even though ET4ET is not about learning domain knowledge, it is necessary that participants be able to relate to the examples used for illustrating teaching-learning strategies. If participants are not familiar with a topic used in the example for a strategy, they find it harder to think about the teaching-learning aspects, and may stop being engaged. This is especially true when the topics are at the college-level and participants are remote. Hence, it is important that the examples in sessions and worksheet questions should be from the participants' domain. If participants are from diverse domains, it is difficult to find examples from multiple domains. So it is desirable to conduct ET4ET for a single or related domains.

3. For each instructional strategy being introduced, it is necessary to first implement the strategy as an activity that participants perform, before discussing the detailed explanation of the strategy. For example, before discussing Peer-Instruction as an instructional strategy, the participants are involved in Peer-Instruction activities in previous sessions. This provides them a first-hand experience and time to reflect on the activity.

4. Participants not only have to learn new instructional strategies but also have to come up with plans to implement these strategies in their own class. So, it is important for them to be in 'student' role before they move to 'teacher' role. For each activity, it is useful to explicitly indicate to participants whether they are to be in 'student' role or in 'teacher' role. Not indicating the role explicitly causes mismatch of expectations.

5. For each technology being introduced, it is necessary to equip participants not only with the skills to use the technology but also with the pedagogical affordances of the technology. For example, participants first learn about wiki from a student perspective by doing an assignment, followed by skills training on use and setup of wiki, as well as pedagogical affordances of wiki. This culminates in participants moving to 'teacher' role and designing wiki assignments for their own students.

6. The use of active learning strategies in the training program is a must. In order to adopt a strategy from ET4ET into their own courses, it is not sufficient for participants to listen about the strategy or see it being implemented. They need to do hands-on activities required of the strategy in 'student' role, only then create instruction based on that strategy in a 'teacher' role. Moreover, such hands-on activities cannot be relegated to later lab sessions but need to be incorporated in a timely manner during discussion of a strategy.

7. Sessions in the program which had a mix of individual and collaborative activities worked better than those that had only one or the other. For any activity being carried out by participants, it is useful to have a participant driven collaborative activity following an individual activity. This ensures that group work occurs and individual participants learn more.

8. It is important to go beyond automated multiple-choice questions especially for 'applied' topics such as ICT integration in teaching. Scaffolds such as 'activity constructors' and templates were provided in open-ended questions. Performance rubrics are one method to assess responses to such open-ended questions, especially with large numbers. Peer- and self-assessment using such rubrics, ensures formative assessment for participants and are viable even in large-scale programs. In ET4ET, what was missing due to the scale, was individual expert feedback on participants' work. But a well-designed rubric combined with structured peer-review and closure (such as a session reviewing common mistakes) compensated for it to a large extent.

Conclusion

In this paper, we have described the design, implementation and evaluation of ET4ET, a large-scale blended-mode professional development program on ICT integration for engineering college faculty. The design of ET4ET originates from the Attain-Align-Integrate (A2I) model, whose basis is constructive alignment. The A2I model was first implemented in a small-scale face-to-face training program for similar goals. The model informs the choice of content, its organization and pedagogy of the training program. At the same time, it is a flexible model, and can be used by others intending to create training programs for a similar goal, since the breadth and depth of individual topics in the training can be decided based on the implementation conditions.

Evaluation of ET4ET showed that participants had high perceptions of their learning, and more importantly, their intent to use the knowledge and skills of ET4ET in their own classes. Preliminary analysis of learning outcomes, measured via instructors' lesson plans show favourable results. Future research involves the study of the impact of ET4ET on instructors' actual practice. To study the extent of the scaling (Coburn, 2003), we plan to conduct in-depth case studies of some participants in their field settings via observations of teaching practices and interviews of stakeholders.

A key feature of the program that we feel was responsible for its success was the emphasis on practice and reflection, which have been recommended to scaffold teachers' learning in systemic plans for ICT integration (Hsu & Sharma, 2006). In ET4ET, practice was best achieved through hands-on active learning strategies in which instructors work on activities relevant to their field setting. Reflection was provided via formative feedback on participants' performance, which is important to close the teaching-learning loop. In this paper we have provided other such guidelines and lessons learnt, after reflecting on our experiences. We hope that our recommendations will benefit other educational technology training program designers.

Acknowledgement

We thank the T10KT Project and NMEICT, Government of India for their support.

References

Biggs, J. (1996). Enhancing Teaching through Constructive Alignment. Higher Education , 32, 347-364.

Brent, R., & Felder, R. M. (2009). Analysis of fifteen years of the national effective teaching institute. In Proceedings of the 2009 Annual ASEE Conference

Brown, D., & Warschauer, M. (2006). From the university to the elementary classroom: Students' experiences in learning to integrate technology in instruction. Journal of Technology and Teacher Education, 14(3), 599-621.

Brun, M., & Hinostroza, J. E. (2014). Learning to become a teacher in the 21st century: ICT integration in Initial Teacher Education in Chile. Educational Technology & Society, 17 (3), 222–238

Bruner, J. (1977). The Process of Education, 2nd ed. Harvard University Press, Cambridge, Massachusetts.

Chai, C. S., Koh, J. H. L., & Tsai, C.-C. (2010). Facilitating Preservice Teachers' Development of Technological, Pedagogical, and Content Knowledge (TPACK). Educational Technology & Society, 13 (4), 63-73.

Clow, D. (2013). MOOCs and the funnel of participation. *Third International Conference on Learning Analytics and Knowledge* (pp. 185-189). ACM

Conole, G., Dyke, M., Oliver, M., & Seale, J. (2004). Mapping pedagogy and tools for effective learning design. Computers & Education , 43 (1), 17-33.

Coburn, C. (2003). Rethinking scale: Moving beyond numbers of deep and lasting change. Educational Researcher, 32(6), 3-12.

Crouch, C. H., & Mazur, E. (2001). Peer instruction: Ten years of experience and results. American Journal of Physics, 69(9), 970-977.

Ebert-May, D., Derting, T. L., Hodder, J., Momsen, J. L., Long, T. M., & Jardeleza, S. E. (2011). What we say is not what we do: effective evaluation of faculty professional development programs. BioScience, 61(7), 550-558.

Ertmer, P. (2005). Teacher pedagogical beliefs: The final frontier in our quest for technology integration? Educational Technology Research and Development, 53 (4), 25-39.

Friedman, A., & Kajder, S. (2006). Perceptions of beginning teacher education students regarding educational technology. Journal of Computing in Teacher Education, 22(4), 147-151.

Gao, P., Choy, D., Wong, A. F. L., & Wu, J. (2009). Developing a better understanding of technology-based pedagogy. Australasian Journal of Educational Technology, 25(5), 714-730.

Greenhow, C., Robelia, B., & Hughes, J. E. (2009). Web 2.0 and classroom research: What path should we take now? Educational Researcher, 38, 246-259.

Hsu, P.-S., & Sharma, P. (2006). A Systemic Plan of Technology Integration. Educational Technology & Society, 9 (4), 173-184.

Intel. (2014). Homepage of the Intel Teach Program Worldwide. Last retrieved on Sep. 22, 2014 from http://www.intel.com/content/www/us/en/education/k12/intel-teach-ww.html/

Jonassen, D., Howland, J., Marra, R., & Crismond, D. (2008). Meaningful learning with technology (3rd ed.). Upper Saddle River, NJ: Pearson.

Jordan, K. (2014). MOOC Project. Retrieved September 23, 2014, from www.katyjordan.com/MOOCProject.html

Lawless, K. A., & Pellegrino, J. W. (2007). Professional development in integrating technology into teaching and learning: Knowns, unknowns, and ways to pursue better questions and answers. Review of educational research, 77(4), 575-614.

Lee, C. B., Chai, C.S., Teo, T., & Chen, D. (2008). Preparing pre-service teachers' for the integration of ICT based student- centred learning curriculum. Journal of Education, 13, 15-28.

Lim, C. P. & Chai, C. S. (2008). Teachers' pedagogical beliefs and their planning and conduct of computer-mediated classroom lessons. British Journal of Educational Technology, 39(5), 807-828

Meltzer, D. E., & Thornton, R. K. (2012). Resource letter ALIP–1: active-learning instruction in physics. American journal of physics, 80(6), 478-496.

Mishra, P. & Koehler, M.J. (2006). Technological pedagogical content knowledge: A framework for teacher knowledge. Teachers College Record, 108, 1017-1054

Mishra, P., Koehler, M. J., & Kereluik, K. (2009). The song remains the same: Looking back to the future of educational technology. Techtrends, 53(5), 48-5

Mumtaz, S. (2000). Factors affecting teachers' use of information and communications technology: a review of the literature. Journal of Information Technology for Teacher Education, 9 (3), 319-342.

NMEICT. (2014) Homepage of the Government of India's National Mission on Education through ICT. www.sakshat.in , last retrieved Sep. 22, 2014.

Prince, M. (2004). Does Active Learning Work? A Review of the Research. Journal of Engineering Education, 223-231.

Rovai, A. P. (2002). Sense of community, perceived cognitive learning, and persistence in asynchronous learning networks. Internet and Higher Education, 5, 319-332.

Rutten, N., van Joolingen, W. R., & van der Veen, J. T. (2012). The learning effects of computer simulations in science education. Computers & Education, 58(1), 136-153.

Schaefer, D., & Utschig, T. (2008). A Review of Professional Qualification, Development, and Recognition of Faculty Teaching in Higher Education around the World. 2008 American Society for Engineering Education (ASEE) Annual Conference and Exposition.

Selwyn, N. (2007). The use of computer technology in university teaching and learning: a critical perspective. Journal of Computer Assisted Learning, 23 (2), 83-94.

T10KT. (2010). Homepage of the 'Teach 10000 Teachers' project. http://www.it.iitb.ac.in/nmeict/pages/mhrdworkshops.jsp , last retrieved on Sep. 22, 2014.

Trentin, G. (2006). The Xanadu project: Training faculty in the use of information and communication technology for university teaching. Journal of Computer Assisted Learning, 22, 182-196.

Wang, X., Su, Y., Cheung, S., Wong, E., & Kwong, T. (2013). An exploration of Biggs' constructive alignment in course design and its impact on students' learning approaches. Assessment and Evaluation in Higher Education, 38 (4), 477-491.

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 the 21st International Conference on Computers in Education. Bali, Indonesia: Asia-Pacific Society for Computers in Education, 990-996.

Warriem, J., Murthy, S., & Iyer, S. (2014). A2I: A Model for Teacher Training in Constructive Alignment for use of ICT in Engineering Education. In Proceedings of the 22nd International Conference on Computers in Education. Nara, Japan: Asia-Pacific Society for Computers in Education. (In Press)