Liu, C.-C. et al. (Eds.) (2014). Proceedings of the 22nd International Conference on Computers in Education. Japan: Asia-Pacific Society for Computers in Education

A2I: A Model for Teacher Training in Constructive Alignment for Use of ICT in Engineering Education

Jayakrishnan Madathil Warriem[a*], Sahana Murthy[a] & Sridhar Iyer[b]
[a]*IDP in Educational Technology, IIT Bombay, India*
[b]*Department of Computer Science and Engineering, IIT Bombay, India*
*jayakrishnan.m@iitb.ac.in

Abstract: The outcome-based approach of education requires engineering faculty to be able to align the student learning objectives with their instructional and assessment strategies. With the increasing use of educational technology, faculty technology integration also becomes an essential part of this alignment. Though there exists instances of training programmes that help faculty to achieve this alignment and integration, there are no validated frameworks or models that will enable teacher educators to prepare good instructional development programmes for the faculty. Attain-Align-Integrate (A2I) is a model for teacher educators to create short-term training programmes (STTP) to achieve constructive alignment in use of Information and Communication Technology. In this paper we describe the model, its key features, then the instantiation of the model as a STTP. Following this, the evaluation of the STTP is described to explain the utility of the model for attaining faculty professional development goals. The results of STTP indicate that participants have shifted from a teacher-centric instructional strategy to a student-centered one, however they require more practice in the alignment to integrate it completely within their teaching learning environment.

Keywords: Teacher Training Model, Constructive Alignment, Technology Integration, Short Term Training Program, Engineering Education

1. Introduction

The engineering education system in India is affected with issues of decline in student as well as teacher quality (Bloom and Saeki, 2012). There exist numerous examples of teacher training programmes across the world, tailored in content and implementation (Dettori & Forcheri, 2003), to address the performance gap. Due to the wide differences in the operating contexts of these programs, their implementation designs are not suitable for direct adaptations. Thus there is a need for a validated framework or model for short-term teacher training program designs (Felder et.al., 2011). The proposed Attain-Align-Integrate (A2I) teacher-training model has been developed to address this problem. The major goals of this paper are: (a) To describe this model for designing short-term teacher training programme (STTP) that combines student-centered approaches with instructional alignment, and (b) Evaluate the STTP that emerged out the model for the learning and change in perception of faculty.

The A2I model consists of 3 phases - Attain, Align and Integrate, aimed at improving the knowledge of faculty in combining instructional alignment with student constructivist approaches, or constructive alignment (Biggs, 1996), within their course. The model prescribes creation of activity slices, for the programme design, that are sequenced based on the focus of individual phase and programme content-specific learning objectives. The complete description of the model along with an example of its implementation is provided in section 3.

A total of 23 participants, from the Electrical, Electronics, Computer Science and Mathematics domain attended the programme. Session worksheets, lesson plan, questionnaire survey, and focus group discussions were used as instruments to evaluate the programme. The following are the investigated research questions:

1. How did the participants fare in the alignment and integration of modules?
2. What are the perceived changes in teaching practices as a result of the workshop?

The results of evaluation showed that more than half the participants obtained medium or higher scores (4-9) in the alignment modules within training. The mean scores of instructional strategies and learning objectives (1.73 out of 3) were better compared to the modules involving assessment strategies. Also, participants started using student-centered teaching-learning strategies within their lesson plans as against the traditional lecturing. This hinted at a conscious shift of the faculty towards student-centered strategies for achieving better student learning outcomes. The results from STTP evaluation led us to conclude that A2I model provides teacher educators with a robust solution for quicker adaptations.

2. Related Work

There is an increasing need for faculty development programmes to focus on the alignment between domain content with assessment and instructional activities to help them engage in scholarly teaching (Stevler et. al., 2012). This is found to be both challenging and time consuming (Conole & Fill, 2005). The typical implementation of these programmes may be in the form of workshops/short-term training programmes, seminars, courses, mentoring etc. (Dettori & Forcheri, 2003;Felder et.al, 2011). There also exist longer faculty technology integration training projects like Communities of Designers, developed from generic framework of Technology Pedagogy and Content Knowledge (Mishra et. al., 2007).

The Course Design and Teaching Workshop at McGill University and National Effective Teaching Institute Program (NETI) at North Carolina University are two short-term training programmes (STTP) that specifically target the alignment. The former workshop employs the design of alignment of learner outcomes, instructional strategies and evaluation to redesign an instructor's own course (Saroyan, et al., 2004). The content of this workshop include modules like concept mapping and active learning strategies to empower the faculty. The NETI workshops focus on learning styles, outcomes, research based instructional strategies and evaluation, and are organized in two stages – NETI I (basic) and NETI II (advanced) (Brent and Felder, 2009). Within the Indian context, it is seen that National Institute of Technical Teacher Training have developed a programme for civil engineering educators (NITTRC, 2013) targeting alignment.

All the programmes discussed in previous paragraph recommend the professional development to start from an authentic teaching-learning problem. The Course Design workshop at McGill comes closest to our requirement of an STTP focusing on alignment. However the workshop implementation process requires months of prior coordination with participants before the actual start of the STTP (Saroyan and Amundsen, 2004). The NETI workshop process also have a time gap of 6 months between the basic and advanced levels, rendering it difficult to adapt. Thus there is an absence of validated teacher training models that allow quick adaptations into a short-term instructional development design programme (Felder et. al, 2011). The A2I model is proposed to address this gap. The model contains the three modules of Learning Objective, Instructional Strategy and Assessment distributed across three phases and is situated within the teaching-learning problem of the faculty. Technology Integration is considered as part of instructional strategy while designing the model.

3. A2I Model

The major goals of the training programme are: (a) To introduce research based student centric strategies that can be implemented by the faculty within their classroom. (b) To train the faculty in aligning Student Learning Objectives with Instructional strategies and Assessment. (c) To train faculty in technology integration with available resources in their classroom.

The main theoretical basis of the model is the idea of constructive alignment. Constructive alignment is achieved when the teaching learning activities and evaluation are aligned with the intended student learning outcomes (Biggs, 1996). The model incorporates the constructive alignment by (a) Selecting Learning Objectives, Instructional Strategies and Assessment Strategies as explicit contents and (b) Providing three phases of Attain-Align-Integrate that allows for knowledge of alignment between these contents. Research cites that constructive alignment has been successfully employed by faculty in course redesign and promotes deep learning among students (Wang et. al., 2013). The major contents are then dealt with using a spiral curriculum i.e. 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.

3.1 Features of A2I Model

The entire model (see Table 1) consists of the following design components:

Table 1: A2I model for Constructive Alignment in use of ICT

Phase	Focus	Module		Format	Output
		Topic	Learning Objectives		
Attain	Introduction to concepts	Learning Objective - Sub Topics Instructional Strategy - Sub Topics Assessment Strategy - Sub Topics	Write phase wise learning objectives that focus on concept attainment.	Majority are Instructor led activity slices.	Identification of an LO, IS and AS relevant to their own course.
Align	Depth in Concepts and Intro to Alignment		Write Phase Learning Objectives that will help participants align learning in the modules pairwise.	Majority are Participant driven individual activity slices.	Examples of pairwise aligned modules in their course
Integrate	Depth in Alignment		Write Phase Learning Objectives that will help participants integrate learning from the three modules.	Most of the activities are Participant driven collaborative slices.	An Integrated Lesson Plan for one lecture within their course.

- *Phases* - There are three phases viz., Attain, Align and Integrate that is based on the various contents at differing depth.

  In the attain stage, the workshop designer will have to concentrate on the participant attaining preliminary knowledge on the three core modules of Learning Objectives, Instructional Strategies and Assessment Strategies. The alignment phase of the workshop looks at pairwise alignment between the modules. The integration phase workshop looks at the constructive alignment of the three modules.
- *Focus* - This column specifies the focus of the designed activities in each phase.
- *Module* - This column deals with content dealt within the phase. It is further subdivided into
  - Topics and Subtopics - This specifies the various sub-topics dealt under the three main modules of Learning Objective, Assessment Strategy and Instructional Strategy.
  - Learning Objectives - This specifies the topic level learning objectives.
- *Format* - This refers to the way sessions are held. The detailed split up of format is provided in Table 2 below. A single session comprises of several activity slices that involve specific actions by the instructor and participant during the teaching-learning interactions. There are 3 main types of activity slices 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 slices as shown in Table 2. The duration of an activity slice is also a key aspect, as studies show that the average attention span of an adult learner is nearly 20 minutes (Dukette & Cornish, 2009), which necessitates the span of instructor led activities to be lesser.
- *Output* - This specifies the tangible output at the end of each phase, which provides the learner with flexibility in application and the needed reflection on outcomes.

3.2 Implementation of A2I model

The implementation of Attain phase for learning objective module is explained as an example. The module contained two sub-topics – What and Why of Learning objective. These sessions – a) explained the need for learning objective, and b) distinguished appropriate and inappropriate learning objectives. The total session spanned for 30 minutes with 5 activity slices. The first two activity slices spanned 15 minutes with more of Instructor led activities with participants being active learners. These were followed by three 5-minute slices of participant driven individual, collaborative and instructor led summary activities.

Table 2: Elaboration of Format within A2I model

Activity Slice	Examples	Role of Participant	Duration
Instructor Driven (In)	Instructor presenting the content to the participants. Instructor summarizing the content to participant	Learner	Between 5~15 minutes.
Participant Driven Individual (PIn)	Participant writing examples in worksheets meant for pairwise alignment. Participant performing a microteaching activity with visualizations.	Teacher	Between 5~10 minutes.
Participant Driven Collaborative (PCo)	Participants collaborating to write a lesson plan for a single lecture. Participants involved in Think-Pair-Share activity for aligning instructional strategies with learning objectives.	Shuttles between Learner and Teacher	Maximum of 45 minutes.

4. Evaluation

The evaluation of the programme is done at the two levels of Learning and Behaviour (Kirkpatrick, 2006). This is supported by reactions of participants to the programme, evaluated through a questionnaire survey. A positive result would imply that an instantiation of the model has achieved them and thus provide validation for the model. The research questions for evaluating each of these constructs are:

RQ 1. How did the participants fare in the alignment and integration of modules? (Learning)

RQ 2. What are the perceived changes in teaching practices as a result of the workshop? (Behaviour)

The total number of participants was 23 and the sample for each analysis was chosen from this population based on the number of submissions of lesson plans, worksheets and survey forms. We have used a questionnaire survey and focus group discussions to capture the participant perceptions about the various aspects of the workshop. The questionnaire survey consisted of 24 questions divided into three sections - Design, Learning and Application, and was administered at the end of the workshop. 21 participants had responded to this survey and these were considered for the analysis. The questions used for analysis had a 5-point Likert Scale from Strongly Disagree to Strongly Agree. A question like " I intend to explicitly specify Learning Objective for my class." directly captured the behavior of the participant at the end of workshop.

The evaluation also utilized lesson plan created in the integrate phase and technology integration worksheet created in the align phase. We analyzed the data of all participants who had submitted their worksheet using a custom evaluation rubric. The rubric consisted of 6 dimensions and 4 scales. Two raters were trained for the evaluation and the rubric had substantial inter-rater reliability (k=0.7) for two raters, after training. The workshop session on visualization had an individual worksheet in which participants had to write the visualization integration plan for achieving learning objectives in their chosen topic. This was also evaluated using the lesson plan rubric. After the completion of this

worksheet, participants performed a microteaching activity to explain their proposed visualization integration strategy to the others.

5 Results

As seen in Table 3, the participants have displayed sufficient mastery in individual modules of Learning Objective and Assessment Strategy with a mean score of 1.95 and 1.76 (out of 3) respectively. The participants are also performing better in the alignment of these two modules with a mean score of 1.76 (out of 3). This means that they would require more training within the alignment.

Table 3: Mean Scores for Attain and Align phases

Module	ATTAIN			ALIGN		
	Learning Objective (LO– 3)	Instructional Strategy (IS – 3)	Assessment Strategy (AS-3)	LO-IS (3)	LO-AS (3)	AS-IS (3)
Mean Score	1.95	1.76	1.19	1.76	1.14	1.19

The technology integration scores (in Table 4) also shows that more than half of the participants were able to score at least 2 out of 3, which gives a mean score of 1.67. This is giving a similar result of alignment as the LO-IS column in Table 3. Within the questionnaire survey, the participants have indicated high perceptions on learning about alignment but a common response in all 3 group discussions was that " [they] require more practice sessions to check whether what [they] are doing is right or not".

Table 4: Technology Integration Score

Rubric Scale	Missing (0)	Inadequate (1)	Needs Improvement (2)	Adequate (3)	Mean Score
Participants	3	3	9	3	1.67

In the questionnaire survey administered immediately after the workshop almost all the participants have positively agreed on their intent to implement learning within the workshop. 18 different participants had indicated their intention of using active learning strategies of Think-Pair-Share and Peer Instruction within their classroom. The analysis of the final lesson plans showed that 18 of the participants had also used these active learning strategies. This confirms a clear change in the mindset of the participants to consciously include student-centered approaches in their teaching-learning practices. Table 5 compares the data corresponding to the reported intentions to use strategies and actual use of strategies within the lesson plans. This shift was evident in the responses during the focus group discussions in which one group clearly identified that "[they] have to break the traditional way of teaching so that students can connect". The discussion also had a larger share of participants opting for Peer Instruction as a possible choice over Think-Pair-Share. All of them had a strong buy-in to use ICT in the class in the form of visualizations.

Table 5: Intentions of use of Instructional strategy Vs. Actual strategies used in Lesson Plan

Strategy	Think-Pair-Share	Peer-Instruction	Visualization
Intended (Actual) Use	12(10)	18(13)	12 (8)

6 Discussion and Conclusion

While answering the learning gains from the workshop, it is seen that participants show better gains at the attainment of individual modules. Higher scores are reported for alignment of instructional strategy and learning objectives (Mean score of 1.76 and 1.67 for Lesson Plan and

Technology Integration). This means that the programme fared better in alignment considering the challenges with short time duration reported in literature (Conole & Fill, 2005). In the current workshop, participants had opportunity to practice the alignment of instructional strategies with learning objectives during the microteaching activity. This might have had a positive effect on those alignment scores. But more importantly this also informs the future implementations of the A2I model to provide explicit practice for alignment of assessment strategies with the other two modules.

The second research question on the changes in faculty behavior was seen from the match between the actual uses of same strategies in the lesson plan with the numbers reported in the post-workshop survey. 18 participants had used active learning strategies within their lesson plan and also indicated the intention to use these in classroom in the post-workshop survey and focus group discussions. This confirms a conscious shift of the faculty behaviour towards student-centeredness as demanded by constructive alignment theory (Biggs, 1996).

Successful implementation of the training programme and the positive results in both learning and behavior indicates that A2I model can be utilized for designing teacher-training programmes in constructive alignment for use of ICT in engineering education. For faculty training programmes in Electrical, Electronics, Computer Science and Mathematics, the examples and design of the current STTP can be directly used. For other domains, the activity slices have to be modified based on examples relevant to those domains. The smaller participant strength and constraints for verification of actual classroom practices are two major limitations of this study.

Acknowledgements

We would like to thank all the research scholars and staff within our department who helped us during the design and implementation of this programme.

References

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

Blom, A., & Saeki, H. (2012). Employability and Skill Sets of Newly Graduated Engineers in India: A Study. *The IUP Journal of Soft Skills , 6* (4), 7-50.

Brent, R., & Felder, R. M. (2009, June). Analysis of fifteen years of the national effective teaching institute. In *Proc. 2009 Ann. ASEE Conf.*

Conole, G., and Fill, K. (2005). A learning design toolkit to create pedagogically effective learning activities. *Journal of Interactive Media in Education*, 8(08), 2.

Desimone, L. M. (2009). Improving Impact Studies of Teachers' Professional Development: Toward Better Conceptualizations and Measures. *Educational Researcher , 38* (3), 181-199.

Dettori, G., & Forcheri, P. (2003). A Retrospection on ICT in Teacher Education: What can we learn? In A.Méndez-Vilas, & J. González (Ed.), *2nd Internat. Conf. on Multimedia and ICT in Education* , (pp. 17-21). Badajoz.

Dukette, D., and Cornish, D. (2009). *The Essential 20: Twenty Components of an Excellent Health Care Team*, pp 72-79, Dorrance Publishing.

Felder, R. M., Brent, R., & Prince, M. J. (2011). Engineering instructional development: Programs, best practices, and recommendations. *Journal of Engineering Education, 100*(1), 89-122.

Kirkpatrick, D.L., & Kirkpatrick, J.D. (2006), *Evaluating Training Programs, 3rd Edition*,San Fransisco, USA;Berret Koehler Publishers.

Mishra, P., Koehler, M. J., & Zhao, Y. (2007). Communities of Designers. In P. Mishra, M. J. Koehler, & Y. Zhao (Eds.), *Faculty Development by Design: Integrating Technology in Higher Education* (pp. 1-22). Charlotte, NC, USA: Information Age Publishing.

NITTRC. (2013). *National Institute of Technical Teachers Training and Research.* Retrieved March 2014, from http://nitttrc.ac.in/files/Engineering_colleges_brochure_2013-14.pdf

Saroyan, A., Amundsen, C., Weston, C., McAlpine, L., Winer, L., Cowan, S., et al. (2004). The Course Design and Teaching Workshop: Why and What? In A. Saroyan, & C. Amundsen (Eds.), *Rethinking Teaching in Higher Education: From a Course Design Workshop to Faculty Development Framework* (pp. 3-14). Sterling, Virgina, USA: Stylus Publishing LLC.