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Exploring effects of immersivity across three dimensions in Training Design: Technology Integration Training Workshop for Engineering Teachers in India

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Abstract: Short term training programs are relevant in Indian context as an effective teacher professional development program as it addresses the ever present problem of paucity of time among engineering faculty members and the need to keep abreast with latest technological offerings. Most of the training programs studied so far, deal with techniques to incorporate Technology, Content and Pedagogy in classroom teaching. However, they do not adequately represent the techniques required when technology and content are inter-related as seen in circuit simulations for instance. We propose training with immersivity in Technology, Content and Pedagogy as an effective format for TDP when the technology aspect is closely connected to the content. We specifically look into the integration of SEQUEL - a circuit simulation and analysis tool, in the context of teaching analog electronic circuit design. In this paper, we present findings from an implementation of short term training program, merging recommendations from TPACK framework and immersivity in the three dimensions of Technology, Content and Pedagogy, as the underlying design principle. Our study shows promising results and indicates a clear shift towards adopting technology and pedagogy principles to augment content in lesson plans by the participating faculty members.

Keywords: Immersivity, Technological knowledge, Content Knowledge, Pedagogical Knowledge, SEQUEL, Short term training program, Teacher professional development program

1. Introduction

In recent years, affordance of ICT has improved access to technology and its widespread application in classrooms. Educationist and researchers believe that the technology enabled classrooms promote constructivist learning to train students for 21st century skills. This demands need of effective technology integration in classroom by teachers (Harris, Mishra & Koehler, 2009). In-Service teachers generally utilize Teacher Professional Development programs (TPD) for improving their technology integration skills. In such TPDs teachers are trained for technology as well as pedagogy aspect along with the content (Lawless & Pellegrino, 2007; Mishra, Koehler & Kereluik, 2009).

Various frameworks and guidelines are available to design these workshops. TPACK is one of the theoretical frameworks which integrates three main dimensions i.e. Technology, Pedagogy and Content in training program (Koehler and Mishra, 2008). These guidelines are applicable to teacher training program for long duration. In Indian engineering education system due to constraints of academic load, time, and curriculum requirement, short term training programs (STTP) are preferred for professional development of teachers.

ET4ET- a large-scale faculty professional development program (Murthy, Iyer & Warriem, 2015) uses the A2I model which describes the need of constructive alignment to design TPD's. The A2I model (Warriem, Murthy & Iyer, 2014) assumes content expertise of in-service teachers (CK) that will enable them to readily start design of instructional activities with technology during the training (TPACK).

However, when TPD workshops are designed for teaching specific technology tool this assumption may not be valid and efforts are required to develop contextual knowledge as well. In a larger implementation of ET4ET, the authors have identified use of immersivity as a design driver for TPD to ensure sustainability of learning benefits. Immersivity is cognitively engaging learners in content through meaningful activities (Warriem, Murthy & Iyer, 2015). In this paper, we report our use of A2I model in a STTP by exploring the design driver of immersivity across the three dimensions of technology, pedagogy and content, as informed by TPACK.

Our workshop is designed to train faculty from electronics engineering domain. The training was conducted for the circuit simulator "SEQUEL". SEQUEL is a versatile circuit simulation program (Patil, 2002), developed at IIT Bombay. In order to assist teachers to integrate SEQUEL in their classroom, we designed the workshop using immersivity in content, pedagogy and technology. This paper provides guideline for workshop designers who wish to train faculty for specific technology tool.

2. Design parameters for STTP (short term training program)

There are a number of teacher professional development programs with different goals and therefore different design parameters. Goals of professional development training programs (TPD) vary from skill development of teachers (Mishra, Koehler & Kereluik, 2009) to training them in pedagogical practices for technology integration (Chai, Koh & Tsai, 2010).

Xanadu training program (Trentin, 2006) and the workshop by Joni de Almeida Amorim et al (De Almeida Amorim, Rego, De Siqueira & Martínez-Sáez, 2011) are TPD's that focus on content and technology knowledge improvement of teachers. They do not however address improving pedagogy knowledge of teachers. Online teacher training program for Professional Development of University Faculty (PDUF) on the other hand focuses on developing content expertise, pedagogical practices and teacher's belief about teaching learning process (Oliver and Herrington, 2003; Kandlbinder, 2003). The format however does not support instantaneous feedback on participant performance.

One of the theoretical frameworks to design TPDs for integration of technology is the TPACK framework (Koehler and Mishra, 2008) which emphasizes need for integration of three forms of knowledge i.e. Content, pedagogy and technology. In addition, TPACK framework also highlights importance of interaction among technology, content and pedagogy for effective teacher training.

Most of the teacher professional development programs discussed in literature is long duration courses conducted for school or university teachers. At higher education especially at professional courses such as engineering, technology integration is left to instructor's discretion. Very few TPDs are available to train engineering faculty for technology integration. In addition, the course duration of TPDs is necessarily short due to academic constraints of engineering faculty.

In Indian context, for short duration training, ET4ET program (Warriem, Murthy & Iyer, 2015) has been designed for engineering faculty in online mode. The ET4ET uses the A2I model for its design and utilizes design drivers of immersivity and pertinency. A limitation of the existing implementation is that, it has looked at more generic technology applications like – Wiki, Visualizations etc. We believe that for such generic technology, the existing content knowledge would be sufficient. However, when it comes to technologies that are much more rooted to content (like Simulations) CK plays a greater role in enabling effective technology integration. The current work explores the three dimensions of Immersivity – Technology, Pedagogy and Content, and tries to identify the impact these have on learning and intention to transfer.

3. Implementation of SEQUEL training workshop

3.1 SEQUEL technology tool for simulating electronics circuits

SEQUEL is a general-purpose circuit simulation application for electronic and power electronic circuits. It allows learners to construct as well as simulate circuits rapidly and easily and has a very short learning curve. In addition to having an extensive library, SEQUEL supports model creation as well. An intuitive Graphical User Interface (GUI) facilitates easy schematic entry. SEQUEL provides

users with multiple simulation options such as DC, AC, transient and steady-state. The simulation results can be viewed as plots or tables. A repository of a number of circuits are available with the simulator. Learners can refer to these circuits and use the circuit files directly or with suitable modifications. We selected the course of electronic circuit to train faculty for SEQUEL workshop. The SEQUEL training program was based on three knowledge dimensions i.e. content, technology and pedagogy. For each dimension, we designed sessions using immersivity.

3.2 SEQUEL training sessions

3.2.1 Simulation design training session

We trained teachers to develop SEQUEL based simulations for their classrooms. We ensured immersivity by engaging the participants in designing SEQUEL simulations for a simple RC circuit such that, participants learnt about a new technology even as they updated their content knowledge. Subsequently, they designed simulations for their classroom application. The steps during training included preparing circuit schematic, defining output variables, specifying simulation type with relevant parameters and finally running the simulation to view output. We evaluated their simulations to find effect of adding technology immersivity in TPD sessions.

3.2.2 Conceptual *development through content training*

In this session the instructor applied active learning strategies such as 'Peer Instruction' (PI), and 'Flipped classroom' to demonstrate technology and pedagogy integration in classroom for developing conceptual understanding of students. We evaluated effect of immersivity in content by observing learning gains through the tests conducted during the sessions.

3.2.3 Pedagogy training session

Prior to the instruction on pedagogy, the participating teachers prepared a lesson plan detailing SEQUEL based strategies for their selected content. At the end of the pedagogy training session, the teachers re-designed the lesson plan for their classroom, integrating SEQUEL and active learning strategies in the plan aligned to learning objectives. We evaluated these lesson plans to explore immersivity in the three dimensions of TPD.

4. Evaluation of immersivity effect

4.1 Research Question

The research question of this study is "How does immersivity in technology, pedagogy and content of STTP design affect teacher's technology integration practices?" In order to answer this research question, a STTP was conducted for 11 participants who are faculty for polytechnic program, from Mumbai, India. All participants have experience in teaching diploma engineering students for more than 5 years. STTP was conducted for two days with multiple sessions per day. Each of the individual sessions was of 2-hour duration followed by evaluation test. Data was collected from various sessions of the STTP in different forms.

4.2 *Data collection and analysis*

We collected data at various points during the training sessions. In technology training session, participants were given a circuit simulation and analysis problem. We assessed their simulations based on circuit component assignment, selection of variable, type of analysis and final output. Fig 1 shows example of simulation designed by participants.

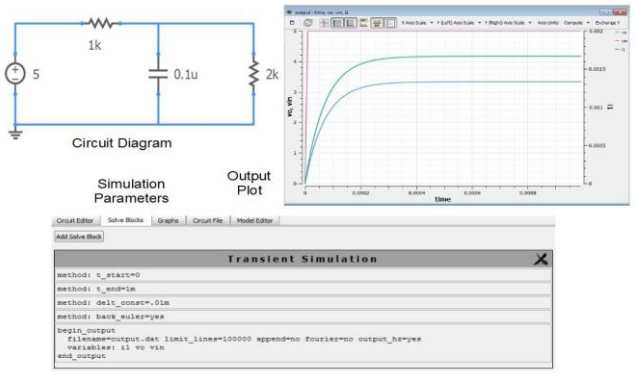

Figure 1. Example of SEQUEL simulations designed by participants

We found that all participants were able to select and assign components for given problem and also select appropriate measurable variables. Some of the participants faced difficulty in deciding the specific parameters in the final analysis. Technology training session helped participants to design simulations using SEQUEL.

In order to design SEQUEL simulations, participants need expertise in the domain knowledge as well as clear conceptual understanding. We therefore conducted a session to develop conceptual understanding of topics like amplifier design and OPAMP as Schmitt trigger. We designed the session by integrating technology with pedagogy to develop content knowledge (CK) of participants. This was done by integrating SEQUEL with peer instruction (Crouch & Mazur, 2001) to train faculty for content. In this session participants as students, experienced application of active learning strategy with SEQUEL integration. Effect of immersivity in content training is evaluated through pre and post poll answers. Table 1 shows transition of participant's answers after peer discussion. For all questions, number of participants with correct answers increased in post poll. In most of the questions participants converged to correct answers.

Table 1: Question wise transition in correct answers

Questions	1	2	3	4	5
Correct answers pre-poll	5	6	4	4	4
Correct answer post poll	11	9	11	7	7

We also conducted flipped classroom activity with SEQUEL integration. The activity included a pre-test and post-test using which we calculated the learning gain. Table 2 represents average pre-post scores and learning gain of participants.

Table 2: Learning gain in Flipped classroom

Av.pre-test score	Av.post-test score	Mean	t	p value
0.83	3.33	2.5	9.57	<0.01

The difference between pre and post test scores is significant (gain=2.5, t=9.25, $p<0.01$). Both the instructional activities indicated improvement in content knowledge of participants. Technology training introduced and prepared participants on how to include simulation design in classroom. Content related training therefore integrated technology and pedagogy. In both sessions immersivity was ensured as participants experienced all three aspects (technology, pedagogy and content) as a student.

Pedagogy training was designed based on ET4ET program in which we introduced participants with learning objectives and formal definitions of active learning activities in active learning mode. We investigated effect of immersivity in pedagogy training through lesson plans written by the

participants before and after pedagogy training. Fig 2 shows example of lesson plan written by participants before and after pedagogy training.

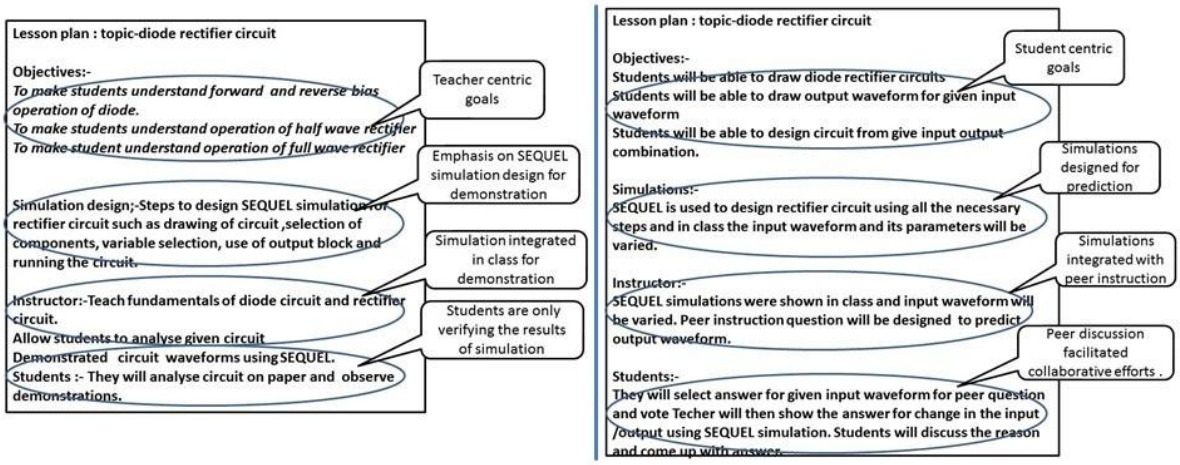

Figure 2. Example of lesson plan before and after pedagogy training

We coded these lesson plan design based on parameters such as appropriateness of learning objectives, quality of simulation design, alignment of simulations with objectives, and constructive alignment between instructional strategy, simulations and learning objectives. We found transition in lesson design plan from teacher centric approach to student centric approach. Table 3 shows the number of participants who changed teacher centric approach to students centric in all lesson plan components.

Table 3: Change in technology integration practices

Lesson plan	Technology integration practices	Learning objectives	Simulation design	Instructor role	Student role
Lesson plan _before	teacher centric	11	8	11	6
	Student centric	0	3	0	5
Lesson plan _after	teacher centric	1	3	4	4
	student centric	10	8	9	9

We found change in the participant's lesson plan for technology integration practices. For learning objective all participants wrote teacher centric goals initially but after pedagogy training session most of them changed (10/11) to student centric goal. In initial lesson plan, most of the simulations were designed for only demonstrations. Technology practices indicated that simulations were applied in teacher centric mode to explain the concepts. Thus technology tool was used as another teaching aid instead of chalk and board. After pedagogy training it was found that most of the participants changed to simulation design for prediction of output and integration practice was changed to active learning method. Student's role changed from passive listeners to active learners. This indicates that immersivity in all three knowledge dimensions (technology, pedagogy and content) helped participants to change their technology integration practices. Most of the participants were able to write constructivist learning plan which reflected student centric approach.

5. Discussion and future scope

We designed STTP to train faculty for technology integration using immersivity in three dimensions i.e. technology, pedagogy and content. We used easily accessible simulator "SEQUEL" to train faculty. In this paper we reported the effect of immersivity in three dimensions of technology integration workshop. We found an improvement in the overall lesson plan design and also found alignment in all three dimensions. In our study we explored effect of immersivity in individual

dimension also. We found that participants were able to design SEQUEL simulations for given topic. In content training, we found improved conceptual understanding through high learning gain and we also found that most of the time participants converged to right answers after PI. Finally, pedagogy training helped them to change their technology integration practices from teacher centric approach to student centric approach. We thus conclude that immersivity in all three dimensions of TPD helped participants to design simulations as per their requirement and helped them to integrate these simulations in active learning mode.

This study recommends that to develop STTP for technology integration, immersivity should be design driver in each dimension. But in technology training especially with SEQUEL we need to focus more on analysis training part. This study is limited due to small (N=11) sample. We have assessed written lesson plans of the participants. However, to observe sustainability of these courses we need to further observe the practice of SEQUEL based classroom activity.

References

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.

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

de Almeida Amorim, J., Rego, I. D. M. S., De Siqueira, J. M., & Martínez-Sáez, A. (2011). Defining the design parameters of a teacher training course on the incorporation of ICT into teaching practices. *Procedia-Social and Behavioral Sciences*, 15, 653-657.

Harris, J., Mishra, P., & Koehler, M. (2009). Teachers' technological pedagogical content knowledge and learning activity types: Curriculum-based technology integration reframed. *Journal of Research on Technology in Education*, 41(4), 393-416.

Kandlbinder, P. (2003). Peeking under the covers: on- line academic staff development in Australia and the United Kingdom. *International Journal for Academic Development*, 8(1-2), 135-143.

Koehler, M. J., & Mishra, P. (2008). Handbook of technological pedagogical content knowledge (TPCK) for educators.

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.

Mishra, P., Koehler, M. J., & Kereluik, K. (2009). Looking back to the future of educational technology. *TechTrends*, 53(5), 49.

Murthy, S., Iyer, S., & Warriem, J. (2015). ET4ET: a large-scale faculty professional development program on effective integration of educational technology. *Journal of Educational Technology & Society*, 18(3), 16-28.

Oliver, R., & Herrington, J. (2003). Exploring technology-mediated learning from a pedagogical perspective. *Interactive Learning Environments*, 11(2), 111-126.

Patil, M. B. (2002). A new public-domain program for mixed-signal simulation. *Education, IEEE Transactions on*, 45(2), 187-193.

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(3), 182-196.

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

Warriem, J., Murthy, S., & Iyer, S. (2014). A2I: A Model for Teacher Training in Constructive Alignment for use of ICT in Engineering Education. In C. C. Liu, H. Ogata, S. C. Kong, & A. Kashihara (Eds.), *Proceedings of the 22nd International Conference on Computers in Education (pp. 896-902). Nara, Japan: Asia-Pacific Society for Computers in Education*.