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Two Inseparable Facets of Technology Integration Programs: Technology and Theoretical Framework

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This paper considers the process of program development aiming at technology integration for teachers. For this consideration, the paper focused on an integration program which was recently developed as part of a larger project. The participants of this program were 45 in-service teachers. The program continued four weeks and the conduct of the program was video-recorded. Along-with the video-records, the content of the program and the tools employed to document participants' development were analyzed. The analyses were performed on the basis of four components of integration program: objectives, content, teaching-learning situations and assessment. During the analyses, theoretical framework on which the program was based and the technology employed during the program was also evaluated. Based on this evaluation, this paper argues that in the process of both design and conduct of integration programs the technology employed during the program implementation as well as the theoretical framework which informs the use of technology during the program implementation need to be considered carefully. The paper provides evidence that technology and theoretical framework are two inseparable facets of both design and conduct of integration programs and a true understanding of the benefits of these programs could only be achieved through the consideration of these two along with the four components of any integration program.

Keywords: Program development, Technology integration, Theoretical Framework

INTRODUCTION

Technology integration is a complex and multi-dimensional process. Development of a program for teachers to acquire relevant and necessary skills for a successful integration of technology is a phenomenon comprised of complex relationships as well (McDougall and Squires, 1997). Hence, it is not surprising to see that there are considerable differences in the implementation and the efficiency of the programs developed for technology integration. During the design, conduct and evaluating the effectiveness of such programs, it is often the case that technology employed during the program and its effects are either ignored or not regarded as important. The programs aiming at technology integration are usually designed and conducted on the basis of program development principles or of the perspectives of the subject area (such as mathematics and science) in which the program is implemented. However, these two considerations are necessary for the implementation of integration programs, they are not sufficient *per se*. In this paper, I argue that in the process of both design and conduct of integration programs the technology employed during the program implementation as well as the theoretical framework which informs the use of technology during the program implementation need to be considered carefully and their effects on the implementation

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State of the literature

- There are many different programs aiming to help teachers gain necessary skills for technology integration. There are considerable variations in the design and conduct of such programs.
- It is often the case that such programs are designed with a consideration of program development principles and/or on the basis of the perspectives of the subject area. However, the effects of theoretical framework and technology are ignored, or at least not regarded as crucial, for the implementation and evaluation of such programs.
- In this paper it is argued that for the design and conduct of integration programs the technology employed during the program implementation as well as the theoretical framework which informs the use of technology need to be considered carefully and their effects on the implementation process need to be recognized.

Contribution of this paper to the literature

- The paper provides evidence that technology and theoretical framework are two inseparable facets of both design and conduct of integration programs and a true understanding of the benefits of these programs could only be achieved through the consideration of these two along with the four components of any integration program.
- Based on data, the paper proposes that developments assumed for teachers as a result of their participation in integration programs are formed, informed and transformed by the theoretical framework and the selected technologies.
- On the basis of the considerations among the theoretical framework, technology and program components, this study offers a series of questions that could guide the developers for their efforts to design and conduct effective integration programs.

process need to be recognized. Only then can one achieve an effective implementation of integration programs and could perform reliable evaluation on the effectiveness of such programs. To provide the rationale for this argument it is necessary to consider main components of integration programs in tandem with implications for the implementation process.

To this end, I will first begin with essential components of program process. Following this, the effect of technology and theoretical framework adapted for the use of technology on each of the component will be elucidated on the basis of a project, part of which focused on the development and implementation of a technology integration program. I examine this integration program to demonstrate the effect of technology and theoretical framework on each of the components. The paper ends with a discussion of the issues emerging from the examination of this integration program.

PROGRAM EVALUATION PROCESS

There are many different models proposed for program development process (Demirel, 2006, pp 53-65; Doll, 1996, pp 225 ;Ornstein and Hunkins, 1998, pp 212-215). However, there is recurring understandings and a shared view on the components of educational programs. It is often the case that program development process starts with the analysis of the needs for a certain group or groups of people (which might be termed as the target group). Having determined the needs, actualization of the program development proceeds with the following four components: objectives, content, teaching-learning situations and assessment. The differences usually stem from priorities given any of these components at different levels in program development models. However all the models seem to be in an agreement that the four components are essential to any educational program. There is a dynamic and interactive relationship between and among the program components. The evaluation cycle of components is a continuous process (Figure 1). A defect in any of the elements will affect the others. In essence, any effective program needs to establish and increase inter-operability of these main components by virtue of continuous improvement attempts as a result of program evaluation. The components of educational programs and the dynamic relationship are portrayed in Figure 1. I will now attend to each of the components separately and explain the nature of each component.

Objectives are desirable characteristics that are planned to be acquired by the participants (Ornstein and Hunkins, 1998, pp 274-282). It specifies what skills and competencies that participants should display and at what level. Objectives should be identified in a way that they are relevant to participants' characteristics and they compensate and complement participants' deficiencies. Objectives can be erased, corrected or re-written according to the result of program evaluation.

Content means the selection and arrangement of topics to achieve the objectives (Charney, and Conway, 2005, pp 77; Lawson, 2006, pp 102). It is the section in which the question "what to teach" is answered in accordance with the objectives. Content should be appropriate to the level of participants and should be taught within the designated time. Participants' thoughts about the content element are especially important for the evaluation of the programs in determining its effectiveness.

Learning-teaching situations are regulation and implemantation of necessary objectives so as to help students acquire target behaviors (Charney, and Conway, 2005, pp 253-254; Ornstein and Hunkins, 1998, pp 232-233). This is the section in which it is planned how to teach topics identified in the content. Participants' thoughts are important in the evaluation of this element as well as changes in their performances and practices are considered for the evaluation of its effectiveness.

The assessment component is the section in which it is identified whether or not the target behaviors are acquired or to what extent they have been acquired (Ornstein and Hunkins, 1998, pp 232-233). At this stage it is planned how to measure participants' improvement. It is important that measurement tools are prepared in accordance with the target objectives and serve for the program developers to make judgments as to the appropriateness and benefit of the program itself on the part of participants.

Technology, Theoretical Framework and Program Components

Technology has a dynamic relationship with each component of the program and, as will be explained in sections ahead, it affects the relationship of these components with each other. As can be seen in Figure 2, the interaction between the technology and the program components is mutual. That is, a change in the selected technology would necessitate re-adjustment of each one of the components which, as a result, need to be revised and reformulated. Likewise, a change in any of the components necessarily affects the others as well as the preference and use of technology itself.

The effect of theoretical framework on the program components can be seen even at a deeper level. This is because theoretical framework defines and re-defines the relationships between factors and variables that are thought to be related to a certain concept or problem (Trentu University). The existence of a theoretical framework that explains the teaching, diffusion, integration and efficiency of technology will also form a certain order and focal point both in the design and conduct of programs with four components. As the theoretical framework affects all components it is preferable to support the theoretical framework with the literature. However, discussions and criticisms concerning the efficiency, accuracy, and actuality of the theoretical framework is an issue that will not be attended to here in this paper.

In what follows, the impact of technology and theoretical framework on each of the components will elaborated. During this elaboration, relevant examples, when appropriate, will be provided to allow the reader to better appreciate the indispensability of both technology and theoretical framework for the technology integration programs.

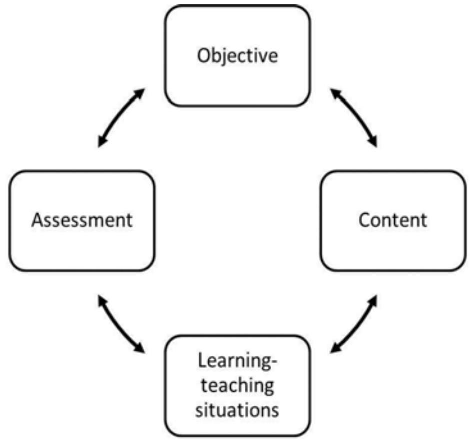

Figure 1. The Process of Program Components

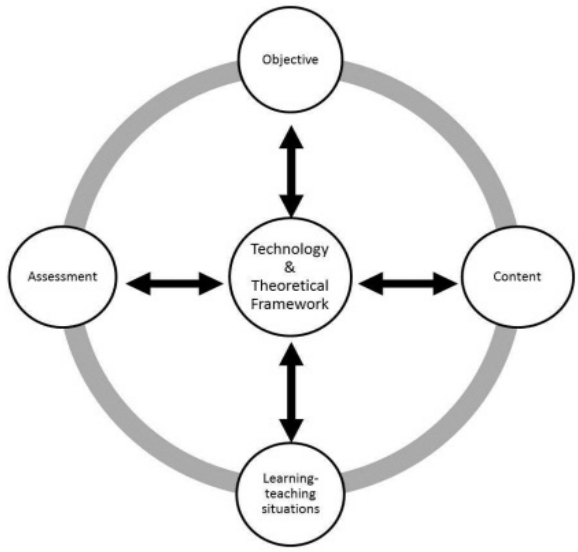

Figure 2. Technology Theoretical Framework and the Process of Program Components

Technology, theoretical framework and objectives

The relationship between technology and objective is rather apparent in that objectives need to be constituted with a consideration of the selected technology which will be employed during the integration programs. As the affordances and constrain of each technological tool differ, when the technology changes the relevant objectives need to be re-defined. It is also crucial to find appropriate technological tool for the determined objectives. If the desired objectives are to be reached then the most useful tool is needed to serve this purpose.

There are two essential issues for the theoretical framework and objective relationship. The first is that the theoretical framework should be able to explain selected participants' interaction with technology. When the preferred theoretical framework proves to be inadequate for explaining target audience's relationship with technology either the written objectives will not match with the theoretical framework or they will not be able to meet the needs of the target audience. According to the principles of program development, objectives should be identified in accordance with participants' needs and deficiencies in the specified field. For example, when we use the Technological Pedagogical Content Knowledge (TPCK) framework developed by Mishra and Kohler (2006) to develop technology leadership of administrator of educational institutions, the objectives will be inadequate in many areas such as sharing of institutional technology resources, technology vision, technology managers, and digital citizenship, which affect technology leadership. If the program is designed for technology leadership, then it should take, for example, "National Education Technology Standards for Administrators" (NETS for Administrators, 2009) as framework which guides administrator digital leadership in this area.

The second issue is that the theoretical framework should be reflected into the objectives appropriate for the target groups. Although the same theoretical framework might be appropriate for different target groups, significant changes in the determination of objectives are required depending on the specificities of the target audiences. For example, when in-service teachers are given digital citizenship education, actual classroom practices come to the fore, whereas theoretical knowledge will be much more prioritized than real problems for the class when pre-service teachers receive the same training. The theoretical framework should be reflected to the objectives in accordance with the audience.

Technology, theoretical framework and content

Technology-content relationship has four main dimensions, which would make it possible to judge whether technology is reflected into the programs at an adequate level. All these four are, generally speaking, related to the selection of technology.

First, selected technologies should be able to serve the objectives of the programs. In other words, selected technologies should be relevant to the objectives. This directly affects the issues related to content-technology relationship. It is a fact that the area of technology is changing more rapidly than many other areas. This inevitably brings current technologies to the fore. In this context, the inclusion of digital and current technologies to the program will strengthen and enrich the program.

The second dimension is related to the extent to which affordances and constrains of the selected technologies are considered while determining the content. Considering the limitations, the limitations could result from the technological tool itself as well as from the variations of the participants. In addition, accessibility and availability of the chosen technology is also important. For example, shapes and scripts can be shown to students through overhead projector transparencies. In this case the teacher has a chance to turn his face to the class when using the overhead projector. These are the affordances provided by overhead projectors. However, that overhead projector does not allow one to show moving images and that a certain amount of darkness in the classroom are required are constrains resulting from the vehicle itself. The fact that Graphical Analysis (Blokland et al., 2000) software cannot be used at grade four and five is a restriction resulting from the participants' situation.

The third dimension is related to the balance between technology rarity and diversity. Programs dependent on specific and limited technology is very likely soon to lose their actuality and hence ultimately may not reach the desired outcomes. Therefore, taking this potential problem into account the program developers must provide diversity in technological devices. By allowing the diversity of technological tools during program implementation, program flexibility, which is one of basic principles of program development, will be ensured. Technology rarity/diversity balance should be sought out and each tool should be given priority according to its contribution to the achievement of the objectives. In addition, the dynamic relationship between content and other program components should not be ignored. In the case of excessive expansion of content, learning time may needlessly be prolonged. In this case, the program's efficiency would decrease.

The last dimension involves a consideration of whether or not using technology correctly as well as using correct technologies is included in the content. In general, certain technologies are planned to be used in the details of content. It is often assumed that available technology would solve all problems and hence more relevant and effective technologies are not sought after. For example, static and simple web pages can be prepared with Microsoft Word. However, to develop a simple and static as well as dynamic and user-friendly web page requires the use of higher-level software. In this case, making the necessary adjustment for the kind of technological tool and hence deciding upon a higher-level of technology means that correct technology is included (used) for the program content. Searching for and selecting the right technologies will also secure the diversity of technology.

I have so far considered technology and content relationship. No less important is the relationship between the theoretical framework and content. As a component of program, constitution of the content requires a decision upon both what is to be included in the content and in what order. Theoretical framework informs decisions upon both of these questions and hence plays an essential role for the determination of the content. The selected framework guide the developers what content needs to be provided to the participants depending on their needs. This is because different frameworks direct program developers to different contents even if the objectives remain the similar. The order of content is also deeply shaped by the framework's guidance and assumptions. For example, if one decides to develop an in-service training program for teachers to integrate technology within the framework of TPCK, then the order of the content is organized around the elements of TPCK such as pedagogical content knowledge, technological knowledge, technological content knowledge, technological pedagogical knowledge and so on. Hence the selected framework determines the content in at least these two ways: what to include and in what order.

Another important effect of theoretical framework on the content related to the issue of whether or not the framework itself should be provided to the participants as part of the content. Some frameworks need not be given to the participants. These frameworks play their role by giving the developers a direction to create the content. Yet others might be useful to be included into the content so that the participants could have a chance to see the whole picture. For instance, if TPCK is used as a framework, it could be shared with the participants, albeit with a simplified form, to allow them to have an overall grasp of the issues involved in the integration process.

Technology, theoretical framework and teaching-learning situations

The teaching-learning situations and technology relationship could be scrutinized with the perspective of the tool's intended use and its effect on learning process. In this context, the levels of technology-supported pedagogy mentioned by Hughes (2005) can be used. Hughes (2005) mentions levels of a) Replacement b) Amplification and c) Transformation. In this study, in addition to the levels defined by Hughes a fourth level at which no technology is used is proposed. Description of the each level can be given briefly as follows:

Level 0: The level at which no technology is used, or at which technology is used with no specific purpose.

Level 1 (Replacement): At this level, the educator use technological tools only to change the media. Turning the things that can be written on the blackboard into presentations and reflecting them on a screen so that students can read and write them is an example for this level. There is no change in participants' learning routines at this level of technology use.

Level 2 (Amplification): The use of technological tools at this level contributes to the effectiveness and promptness of learning process. No change in classroom routines is required. Doing an algebraic calculation quickly and correctly with a calculator or a computer can be given as an example of technology use at this level.

Level 3 (Transformation): At this level, there must be changes in learning and teaching routines and activities that lead students to comprehend better needs to be done. Technological tools enable the teacher to present content with a different impression, and serve to establish the relationship between concepts. For example, using Graphical Analysis software to teach different meanings of the derivative and the relationship between these meaning entails use of technology at this level (see Ozmantar et al., 2010).

When using technology to create transition between levels, trainers need to know how to manage the classroom and how to direct participants' attention to concepts rather than the tool. Reaching level three with activities ensures effective use of relevant technology and fosters effectiveness of the program.

Theoretical framework and teaching-learning situations are also closely connected in that the selected framework prescribe and proscribe not only what to teach but also how to teach. The framework also has certain implications for the kind and level of skills that the participants need to acquire to successfully integrate technology. Hence, the framework guides the efforts of developers in determining the ways to deliver the content to the participants.

Technology, theoretical framework and assessment

In assessment and evaluation, technology is both a tool and a quality to be measured. First of all, it must be determined whether or not tools that were included to the program at other dimensions can be used in assessment and evaluation. Hughes's (2005) adapted levels explained in the section about teaching and learning situations has a functional use in this dimension, as well. Definitions of four levels adopted from Hughes (2005) as appropriate for assessment and evaluation element are as follows:

Level 0: Assessment without using technology. At this level, the classical measurement tools are used in a routine manner.

Level 1: Technological measurement tools are used only to change the media. For example, at this level the teacher asks questions in written form and demands the answers in the electronic form. This is the lowest level use of technological tools for assessment.

Level 2: At this level assessment is done faster and more efficiently using technological tools and students are given feedback more quickly. Using optic forms in testing and thus accelerating the assessment is an application at this level. Another example is the online or computer-aided tests and questionnaires. Technology use at this level does not bring a different dimension or application to the evaluation process, but rather accelerates routine operations.

Level 3: Participants learning process must be re-structured for in-depth learning and interaction between different representations. To assess such learning, the assessment-evaluation process must be changed and participant's qualities that have not been identified before must be made suitable to be assessed with technological tools. The measurement tool is used effectively at this level. Trainee teachers' evaluation of their peers' courses in the micro teaching applications forms an example for this level. In the classical teaching process, the assessment is accomplished at the end of the calss and usually sound evaluations cannot be done because of the fact that qualities and criteria to be evaluated are dispersed throughout the class. However, when video recordings of the class are published online, other participants and the course teacher get the opportunity to do a sound online evaluation by watching the videos. Technology can help teachers change assessment-evaluation routines and accomplish more effective assessment-evaluation. Virtual applications are another example. In this application, participants are required to manage a virtual business and thus are given the chance to apply the things they have learnt during the program. With these technologies, the participants are subjected to process evaluation throughout the program and their progress is monitored.

It should not be deduced from the discussions so far that technology use in assessment-evaluation process is useless and needless except for level three. Each assessment tool is valuable to the extent that it serves the intended aim. The fact that a tool is technological does not necessitate its use.

Theoretical framework chosen to develop the program has a deep impact on the component of assessment. The framework clearly shapes the objectives of the program, which are essential to devise the assessment tools. In other words, upon the completion of the program, the assessment tools aim to determine the extent to which participants acquired the objectives shaped on the basis of theoretical framework. However, that is not the only effect of framework. There are more subtle ones. For instance, preparation of the assessment tools themselves are greatly influenced by the framework which has implications for the determination of expected level and the kind of technology use. Hence any of the program components cannot be thought of in isolation from the theoretical framework itself.

BACKGROUND OF THE STUDY AND METHODOLOGY

This paper stemmed from an ongoing research project called Öğretmen Eğitimi[1] (Teacher Training) which came into being due to a substantial curricular reform in 2005 in Turkey. Reform curriculum is constructivist in nature and stress student-centered teaching and aims conceptual understanding for students. The new curriculum also sets several key skills for the graduates of primary education (15-years-old), involving creative and critical thinking, problem solving, performing research and use of ICT technologies. However many studies (e.g. Ozmantar et al., 2009) conducted on teachers' preparedness to apply the new curriculum as intended by the policy-makers in Turkey show gaps between teachers' practices and the curriculum expectations.

This project aimed to fill this gap and equip teachers with the necessary skills and hence devise a professional development program to change the classroom practices of teachers in teaching science and mathematics in line with the expectations of the new curriculum. The program involves workshops on six areas: classroom norms, student difficulties, task design, problem solving, technology integration and assessment and evaluation. Each and every area involved 4 workshops in four consecutive weeks (24-week program, 96 hours in total) spread in one education year. The workshops are designed in such a way to get participants' active involvement and hands-on activities. The workshops were conducted by the academics including the writer of this paper who held a particular responsibility for the design, conduct and evaluation of the technology integration stage of the project. The participants were assigned certain readings, asked to prepared lesson plans. Further to this, curriculum scripts were examined, teachers' classroom applications were scrutinized and the participants were required to observe their peers' practices and reflect on and compare with their own practices.

The participants

Two "generations" of participants are planned to take part in this project. The first generation is composed of 45 teachers (15 mathematics, 15 science and 15 classroom teachers) who already completed the program. The second generation attendance (being performed in 2010-2011 education year) is planned to scale up the development program to a larger population (210 teachers in total). The first generation of participants is employed for the scaling-up purposes;

[1] Further information about this project can be obtained from its website at http://www.ogretmenegitimi.org/

that is, the participants in the first stage will be responsible to carry out the trainings for their peer teachers. The selection of the first generation teachers was achieved through interviews with the applicants. The participation was on a voluntary base but project team paid attention to select those teachers who are eager, has a desire for personal development, prepared to attend to the workshops, and willing to train second generation. In this paper, the data obtained from the training of the first generation (45 teachers) teachers are used.

Data collection tools and procedures

The project team collected data from the participants via several means including initial surveys (to find out participants' prior knowledge on each of the training areas), video records of workshops conducted by the academics, video records of participants' teaching practices, questionnaires with open-ended items, participant evaluation sheets, self-evaluation forms, semi-structured interviews. The data for this paper come from video records of the workshops, content of the workshops, Powerpoint presentations employed during the workshops, detailed teaching notes prepared for the project report.

The data employed in this paper were collected during the workshops at the technology integration stage of the project with the first generation of the participants (45 teachers in total). This stage, like the other 5, continued for 4 weeks (16 hours in total) and the video records of the conduct of the workshops in each week was obtained. The technology integration stage of project drew on the TPCK (Mishra and Kohler, 2006) theoretical framework (attended to below) which guided the design and the conduct of the workshops. Hence I call this stage TPCK integration program which will be the main focus of the paper. Content of the four week program was roughly as follows. Theoretical information about the technology integration and TPCK was given in the first week. Teachers were also given free time to explore certain software (e.g. virtual manipulatives) specified by the project team. In the second week, classroom application samples, and practical implementations were covered. In the third week teachers were asked to develop activities to perform in their classes with technology. They were given feedbacks on the planning of the activities and the role of technology employed during the activities. In the fourth week, video records of several participant teachers' classroom practices were examined as a whole class and evaluated by referring to the strengths and weaknesses, to the difficulties met and to the advantages of using technology.

In what follows, TPCK theoretical framework will be briefly described and the technologies employed during the integration stage of the project detailed.

TPCK Integration Program: the framework and the technology

Technological Pedagogical Content Knowledge (TPCK) developed by Mishra and Kohler (2006) was used as the theoretical framework for the technology integration section of the project. TPCK framework identifies how teachers' understanding of technology, pedagogy and content interact with each other to produce an effective educational technology and discipline-based teaching (Harris, Mishra, & Koehler, 2007). Technological Pedagogical Content Knowledge (TPCK) was formed by adding the technology area to Shulman's Model (Pedagogical Content Knowledge) (Cox, 2008). TPCK framework underlines the importance of relationships and interactions among content, pedagogy, and technology, the things that can be done and limitations on one hand, and suggests that these are essential for the development of a good teacher on the other (Mishra and Kohler, 2006). TPCK forms with each of the content areas here and their interactions. It is the knowledge of how the teacher uses the technology related to a specific area to enhance students' understanding. TPCK framework specifies certain characteristics as to what teachers should know and the importance of content knowledge when integrating technology in the practical business of teaching with technology (Archambault & Crippen, 2009).

TPCK framework has been used for teacher development in different areas and at different levels: a) University, master of arts students (Koehler & Mishra, 2005; Koehler, Mishra, & Yahya, 2007) b) High school teachers and trainee teachers (Akkoç, Bingolbali, & Özmantar, 2008; Niess, 2005; Valtonen, Kukkonen, & Wulff, 2006) c) Middle school science teachers (Timur & Taşar, 2011), d) Primary school teachers (Hofer & Swan, 2008).

Various technology instruments and software employed during the TPCK integration workshops were as follows.

1. *Smart board*
2. *Virtual manipulatives*
3. *The National Library of Virtual manipulatives*
4. *Physics applets*
5. *Maths applets*
6. *Office software*
7. *Various flash animations and/or simulations*

These technologies and software were initially introduced to the teachers and then allowed the participants to explore and get familiar with different aspects of them. The aim here was to give the participants a chance to get involved into the workshops and take an active role in the training process. Further to this, within the limits of available time, we wished to introduce the participants with as many different technological tools and software as the time allows.

In the next section, the developed program will be examined on the basis of four components of program development with reference to theoretical framework and the technology detailed above.

EXAMINATION OF THE TPCK INTEGRATION PROGRAM

In this part of the paper, I will examine the TPCK integration program in terms of both design and conduct. The examination will be carried out on the basis of four program components, each of which will be evaluate with reference to both technology and theoretical framework. This examination is hoped to clarify and add depth to the theoretical considerations presented at the beginning of the paper on the relationship between and among the program components and technology-theoretical framework connections.

Objective-Technology-Theoretical Framework Relationship

As noted in the section about the relationship between technology and program elements, the TCPK theoretical framework was used in the project. Also, the objectives for the TPCK integration program were written in accordance with the theoretical framework of TPCK. As a result following list of objectives were determined:

- *Teachers recognize/know the technology which can be used in classroom.*
- *Teachers gain skills to solve problems faced while employing technology.*
- *Teachers know pedagogy of the technology they use.*
- *Teachers know the pedagogic affordances and limitations of technologies they use.*
- *Teachers know how the technologies affect the dynamics of the class.*
- *Teachers use technology to overcome the challenges students face when necessary.*
- *Teachers exhibit positive beliefs / attitudes towards using technologies in the class.*
- *Teachers know about technologies available for their content area.*
- *Teachers design technology-supported activities.*
- *Teachers use the technology effectively when teaching a particular topic.*
- *Teachers plan technology integration.*
- *They determine the purpose of using technology.*
- *They plan the assessment of technology.*

Objectives were set in compliance with the theoretical framework. The first and second objectives are within the scope of technology knowledge in TCPK theoretical framework. The third, fourth, fifth and sixth objectives are related to the technological pedagogical knowledge. The eighth objective is within the scope of technological content knowledge, while the ninth, tenth, eleventh, twelfth and thirteenth objectives are within the scope of the technological pedagogical content knowledge.

As for the interaction between objectives and technology, TCPK theoretical framework can explain the competency of teachers in technology integration. When identified objects are examined, it is seen that objectives concerning the pedagogical content knowledge were not determined, since the teachers are from different areas and teach different age groups. Moreover, identified objectives were expressed in general rather than as subject-based targets. In other words, objectives were expressed in compliance with participants' condition and in a way that reflects fully the theoretical framework.

Content- Technology-Theoretical Framework Relationship

The content of the integration program focused mainly on:

- *TPCK theoretical framework*
- *What to consider while planning the use of technology for teaching*
- *The principles of technology integration*
- *Exploring different technologies and software*

As was explained in the section on objectives-technology relationship, the main purpose of the program was to increase teachers' technology integration competencies with the perspective of TCPK theoretical framework. In this context, participants should be informed about how to integrate various software that can be used in specific areas. Selected technologies are tools that can be used to enhance participant teachers' technological pedagogical content knowledge. Further to this, for an effective and purposeful use of technology to ease, support and transform student learning, technology integration principles were shared with the teachers (see Bingolbali, 2010). The aim here was to give the participants teachers a sense of general direction independent of the specific content under consideration.

Different kinds of software are used to create example applications to achieve teaching objectives. Such applications were used especially in the second week of training. The applications were planned to explanatory and supportive of theoretical information.

Moreover, web addresses containing online course materials were given to participants so as not to spend too much time for Office applications. As can be seen in the objectives presented in the previous section, these objectives are neither topic-based nor technology-dependent. Different technologies must be used to achieve these objectives and hence we did so and include several different technologies.

Opportunities and constraints of each tool and facilities available during the conduct of the workshops were taken into account when selecting and sharing the tools with the participant teachers. For example, as there was no internet connection in the classrooms where we conducted the workshops, an NLVM program that can work offline and online with a similar function was preferred in the first week's application presentations instead of virtual manipulative requiring online connection. To eliminate the restriction resulting from the fact that NLVM's menu language is English, participants were given Turkish translations of menus before the application.

Different software were preferred in the study. The first factor in the selection of software was to understand restrictions. The second factor was to form an example on how to use opportunities and possibilities of different software. The third factor was to provide the balance of software rarity and diversity. Another factor was the ability to identify proper software. In order to increase the variety of software, the participants were invited to share software and information regarding the use of the software on the Moodle system. Teachers enriched their course materials by sharing the flash animations they found. However, different kinds of software were preferred for different samples (Science, Mathematics and Classroom teachers) to provide diversity. For example, during classroom practice (collective, group and individual) the Ohm's Law (Ohm's Law, 2010) physics applet was used, whereas a simple geometric transformation applet (Simple Geometric Transformations, 2004) was used to explain the principles of technology integration. The use of various technological tools was exemplified by using smart board in the first week, projector and flipchart in the second week, and only flipchart in some parts of the third week workshops.

In general, the technologies that were identified in the content were selected by taking into account their limitations and opportunities and checking whether or not they can serve to accomplish the objectives. Considering rapid changes in technology, the technology and software used need to be updated in future applications.

The effect of theoretical framework on determination of the content was all too obvious. First of all, we included TPCK framework into the content so as to give the participant teachers an overview of the program and the kind of development that they were expected of. Secondly, the framework also gave a direction in ordering the content. On the basis of TCPK framework, the content of the program involved first introduction of different kinds of software (Technological Knowledge); second each software was discussed with the teachers in terms of affordances-constrains (Technological Pedagogical Knowledge); third designing activities via technology to teach a particular topic/concept was the focus of attention (Technological Pedagogical Content Knowledge). These two clearly exemplify the effect of framework on the content of program that was developed as part of the project for technology integration.

Teaching and Learning-Technology-Theoretical Framework Relationship

During the conduct of the TPCK integration workshops, various activities related to Hughes' (2005) each level were prepared and performed. Examples of these activities will be given here. In order to accomplish the objectives, the learning and teaching activities were organized by taking objectives and content into account. Examples of each levels of technology use were presented during the workshops.

Level 1 (Replacement): Presentations were prepared and used to deliver the content on each of TCPK components. At this stage, technological tool served only as the change of media.

Level 2 (Amplification): As is known, when the teacher uses the computer in the classroom, student management becomes a matter of difficulty and direction of student attention may not be achieved as intended. When emphasizing the important points, the teacher comes back and forth between the computer and the board and causes distraction of attention. The computer can be controlled with smart board and, in doing so, these problems can be easily overcome. Through "space block" in NVLM software (Space Block NLVM, 2007), the use of smart board has become easier and an effective learning process can be created by preventing waste of time.

Level 3 (Transformation): In the fourth week of the workshops, video record of a participant teacher whose practices were video recorded during the week was shared as part of course evaluation and feedback. The teachers were shown this video and asked to think and discuss over the kind of limitations experienced during the teaching practices and they were asked to devise ways to overcome the constrain. One particular incident utilized by the project team provides an example use of technology at level 3 during the workshops. The teacher whose practice was examined wanted his students to predict the result of certain additions. The teacher employed the Number Balance manipulative (Bunker, 2005) for that purpose.

As can be seen in the Figure 3, the balance beam includes two teddy bears on each end. There are four cells allotted for the numbers and two for the minus or plus signs and one for the equal (greater or lesser) sign (Figure 3). The teacher covered the cell value on the left side of the screen when it was zero (figure 4) and organized the right side as 4 + 0 and told his students to predict the sum (see Figure 5). As procedures in that application were not done automatically, some problems occurred in the class. The teacher encountered some problems, for he had planned that his students could examine the number balance (see Figure 5) and predict the result.

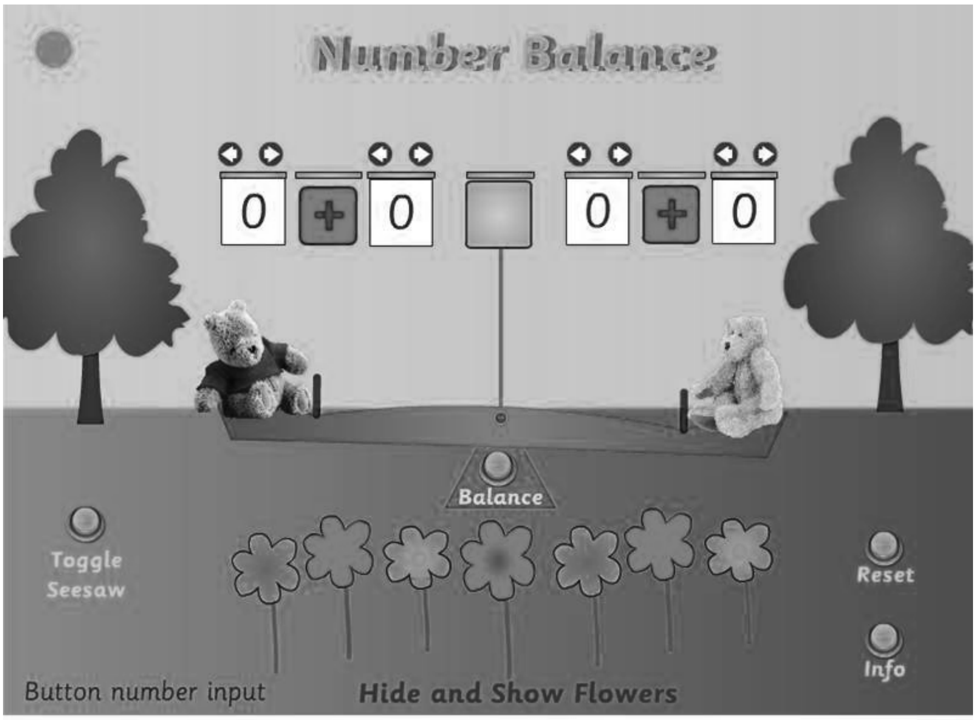

Figure 3. The Number Balance manipulative

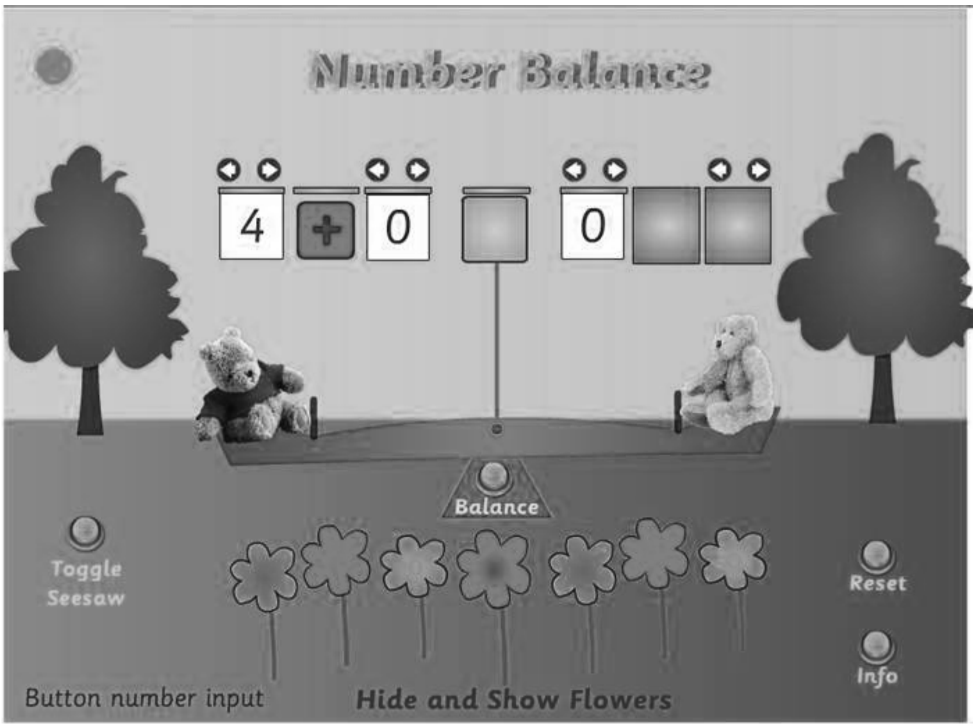

Figure 4. The Number Balance manipulative

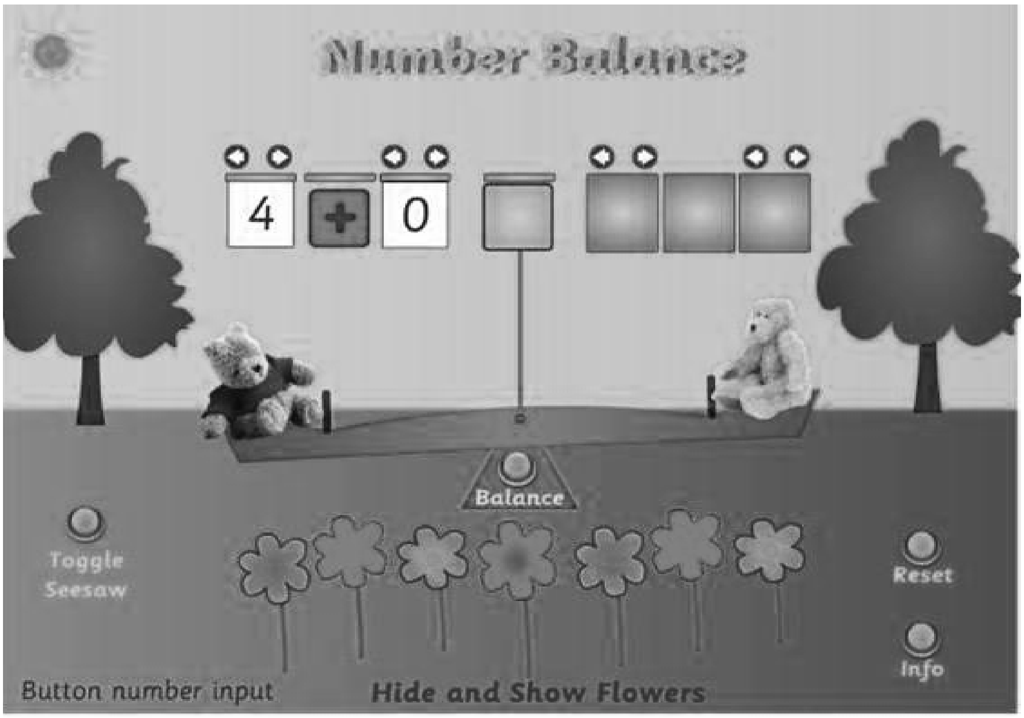

Figure 5. The Number Balance manipulative

However the result of addition need to be inserted manually. Hence when the numbers change the result remain the same unless the new result is entered simultaneously by the teacher. As the change in numbers required teacher to change the result manually, students were able to see the entered input (result) and student prediction was not achieved. This particular incident was shared with the participant teachers and asked them to reflect on this issue and decide upon how to overcome this difficulty by drawing on the features of the technological tool involved in the classroom activity of the video recorded teacher practice. Hence this incident was used as an opportunity to achieve a deeper understanding on the part of our participants as to taking constraints (limitations) and affordances into account while selecting technological tools and planning its use. That is, an example of the third level was created.

What effect did the theoretical framework have on teaching-learning situations? The underlying assumption of TPCK framework used in this study is that teachers learn technology integration by doing, which was what Mishra and Kohler (2006) call learning-technology-by-design approach. Hence integration of technology cannot be achieved solely by instructing teachers about the things that they should do in classrooms. TPCK framework insists that teachers should be given opportunities to actively involve into both design and conduct of technology-supported learning activities. In this direction, the participant teachers were asked to develop lesson plans and design activities for teaching particular topics with the aid of technology. Then the project team examined the products and gave feedback on the plans and also critically evaluated (and in fact suggested certain changes) both the usefulness of the plans and appropriateness of the technologies involved into plans. Following this, teachers were asked to apply their plans in classroom with their own students to see the effect of their approach. That way, the project team tended to support teacher skills to integrate technology effectively and efforts in this direction was clearly regulated by the framework of the study.

Assessment-Technology-Theoretical Framework Relationship

There are examples of technology use for the purpose of assessment at four levels adapted from Hughes (2005) in the present study. One of the main reasons behind providing examples for each level is to enable participants to have material experiences about each level. Assessment tools used during the TPACK integration program and could constitute examples for each level might be listed as follows:

Level 0: Self-assessment and meta knowledge surveys that are used to identify what teachers know, have learnt and to what extent they have learnt it during the TPCK integration program are related to this level. The survey was prepared as a printed form and distributed to teachers to be filled in and was collected when the application was over.

Level 1: Teachers were asked to fill in the “Technology Integration Observation Form” after observing their colleagues’ class. This teacher practice observation forms were distributed both in the printed form and electronically. After filling this form in a digital environment, the teachers were asked to upload it to Moodle content management system.

Level 2: Teachers were asked to fill in a questionnaire about their technology familiarity and technology infrastructure before the program and the questionnaire data was analyzed quickly owing to the fact that it was online.

Level 3: Owing to the fact that teachers communicated outside class hours through the blog, forum and file sharing in the Moodle system, they exchanged articles reflecting different views concerning technology use. If this system had not been used, it would not have been possible to track their improvement in technology use.

As to influence of framework on assessment component, TPCK has certainly gave direction to the project team in designing and determining the kind/nature of assessment tools and procedures. As the main purpose of the TCPK integration program was to get participant teachers gaining necessary skills to employ technology in their instruction effectively, it was essential for project team to collect data (and in fact evidence) to show the development of teachers in their everyday classrooms. In this respect, Mishra and Kohler (2006) insists that as part of TPCK, teachers should be given real world challenges and authentic tasks so that they can develop a true understanding of the issues involved in both design and conduct of technology integration activities. This underlying idea of TPCK was instructive for the project team and hence it was decided that teachers should be given authentic tasks to document their progress for the integration of technology. As a matter of fact, it was for this reason that the participant teachers were asked to prepare lesson plans (which were retained), apply their plans in their actual classrooms. Some of the classroom applications were video-recorded and the others were observed via classroom observation forms with the help of participant teachers. The video records were evaluated during the TPCK integration program and the analysis of the classroom observation forms were used to document the participants' development (the result of this analysis was also shared with the participants). All the means to assess participant teachers' development and the tools employed for that purpose hence are deeply shaped by the theoretical framework of the study.

DISCUSSION AND THE EDUCATIONAL IMPLICATIONS

As the technology integration involves complex and complicated dynamics, developing programs for that purpose cannot be thought of without complications. While developing such programs, it must be taken into account that technology affects program elements and its dynamic relationships. When developing the program, developers should recognize the importance of identifying the objectives of the program on the basis of the theoretical framework that in turn affects all the program components. The developers need to make sure that these objectives are compatible with the theoretical framework so that the effectiveness of the program could be secured. Correct technology selection in the content dimension of the program and presentation of technological diversity will foster this component. Accessing levels two and three in the technology use for learning-teaching situations and giving participants the opportunity to practice will increase the level of their satisfaction. As for the assessment dimension, choosing testing tools that are appropriate for four levels and that serve the intended aims and do the planning accordingly will increase the success rate of the program. Finally, in program evaluation, theoretical framework, technology and each program element should be analyzed and identified separately.

Technology is not only in dynamic relationship with each program development component, but also affects the relationship between the components themselves. With the inclusion of technology in the program development process, all components of the program change. For example, in order to make learning-teaching situations more efficient for the participants, if one decides to include web 2.0 applications (weblog, wiki, etc.) in the program then a change in all the program components beginning with the objectives will be necessary. The most important change among these is to add new objectives, content and assessment tools. More importantly, objectives that have been excluded from the program lest they cannot be accomplished can be included in the program again with the addition of new technologies. Especially, as it is difficult for participants to come together to work on a project outside class hours in programs aimed at adults, sections about cooperation are often disregarded. Due to newly developed applications (e.g. Google Documents) individuals at different locations can work on the same office file. As a result, cooperative tasks can be included even in such training programs.

At the assessment-evaluation dimension, new objectives must be written, content must be added and learning situations must be identified so as to bring about familiarity with the use of a newly added technological tool. For example, in the case of using printed exam papers or tests as the testing tool, it is not necessary to make changes in content and learning situations. However, participants' situation must be evaluated and changes must be performed in the content and teaching situations to make participants familiar with these tools when administering computer-aided exams.

The points to be considered with regard to technology as discussed hitherto cannot be isolated from the theoretical framework. In fact, the framework can profoundly change the whole program development process from the scratch. In this sense, a change in the framework cannot be construed and in fact must not be viewed in a sense of "window-dressing". The framework shape and reshape, constitute and construe its own approach and "flavor" for the program developing process. The development, the development process and the developmental trajectory assumed and envisioned for the individuals as a result of their participation in the programs are deeply informed, formed and transformed by the framework which hence means a new interpretation, a new design, a new conduct and in one word a new world-view for both the developing competencies and for the development of competencies required for the integration process. Therefore the selection of a framework is not (and indeed cannot be) simply a matter of personal choice for the developers; rather it reflects a vision, a horizon and a conceptual and practice base for the success of the integration programs. I personally believe that the integration programs, if ever to be taken seriously, need to explain with clear terms the framework chosen, justify the rationale and clarify the assumptions so that others can see and evaluate the gaps between the supposed and realized development of participants. Such an evaluation is of vital importance given that there are many different approaches/models present in the research literature and still findings at times conflict and approaches differ dramatically (Borko, Whitcomb, & Liston, 2009; Diaz & Bontenbal, 2000; Zhao, Pugh, Sheldon, & Byers, 2002). Adding this confusion to the complexity of the developmental process for technology integration, attempts in this connection at times becomes a real source of frustration for both researchers and practitioners. Hence theoretical frameworks need to be realized as one of the main constituents of the program development and hence its selection needs to be justified and only then can the developers use as a base upon which the whole program can be built.

On the basis of the considerations among the theoretical framework, technology and program components, this study offers a series of questions that could guide the developers for their efforts to design and conduct effective integration programs. These questions essential for development of such programs are as follows:

- *Is there a theoretical framework?*
- *Is the theoretical framework sufficient in explaining the participants' interaction with technology?*
- *Are the objectives organized according to participants' situation?*
- *Will technologies serve adequately to achieve the objectives?*
- *Are restrictions and facilities taken into account in technology selection?*
- *Are right technologies selected?*
- *Are technologies used correctly?*
- *Is there technology scarcity and variety?*
- *At what levels (Replacement, amplification, transformation) are technologies planned to be used usually used?*
- *Are participants given the opportunity to practice?*
- *Have high-level applications of technology use been accomplished in assessment and evaluation?*

These questions, I believe, can be used as a check-list for the programs developed for technology integration. The findings as to the participant teachers into TPCK integration program, which was developed with the guidance of these questions, would be the subject of further research papers. However usefulness and guidance power of these questions in different settings should be investigated in further research studies.

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