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The development of college instructors' technological pedagogical and content knowledge

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Abstract

The ministry of education is launching an overall project to implement the use of ICT in the Israeli higher education institutes, as well as in the elementary through high schools. In the 2011-2012 academic year. Al-Qasemi Academic College of Education was chosen to receive support from the ministry of education to participate in this project. The project goals are to facilitate the ICT integration into teaching on all its aspects; i.e. facilities and instructors. The goal of the research was to accompany the implementation of the college plan and intervention, especially the steps which the college carried out regarding the instructors' preparation and support, with a research that primarily examines the development of the instructors' TPACK (technological, pedagogical, and content knowledge) and its various components, in addition to the instructors' attitudes toward computers and instructors' ICT proficiency. For this purpose we translated to Arabic and modified existing questionnaires developed by the MOFET institute and by previous researches.

The findings of the research indicate that instructors and pedagogical supervisors in Al-Qasemi Academic College of Education had relatively high positive attitudes toward computers before the college intervention. These attitudes did not change significantly after the intervention. The instructors' ICT proficiency improved significantly after the college intervention especially as a result of three components of this intervention: ICT center support, participation in workshop and availability of assistants. The TPACK level of the instructors and the pedagogical supervisors, improved after the college intervention. Another major change occurred in the number of pedagogical initiatives that involve special use of ICT in teaching proposed by the pedagogical supervisors, going up from only one before the college plan to at least six initiatives this year. Moreover, the number of WBLE (web based learning environments) constructed by the pedagogical supervisors and presenting ICT based learning units that they developed by themselves or with their students in the practical training increased from only two at the beginning of the college intervention to over thirty toward the end.

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Keywords: TPACk; teachers' knowledge; college instructors; ICT in teaching; ICT in learning; TAC; teachers' attitudes

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1. Introduction

1.1 TPACK

Shulman (1986, 1987) suggested the PCK (pedagogical content knowledge) model to represent the interaction of two types of teachers' knowledge: content knowledge and pedagogical knowledge. He proposed considering this interaction in order to understand teachers' expertise in teaching a subject matter. Various researchers (for example Koehler and Mishra, 2009; Niess et al., 2009), built on Shulman's PCK to describe the interaction of teachers' understanding of educational technologies with their PCK to produce effective teaching with technology. Specifically they talked about the technological pedagogical and content knowledge of teachers (TPACK), where the TPACK model is presented in Figure 1, and describes the interactions between and among the three main components of teachers' knowledge: content, pedagogy, and technology. These interactions result in new types of teachers' knowledge, namely the PCK, the TCK (technological content knowledge), the TPK (technological pedagogical knowledge), and the TPACK.

In this paper, we will describe the development of the TPACK of Al-Qasemi Academic College of Education, as a result of the college's initiative to influence the educational processes in the college to include more ICT elements.

"The TPACK framework articulates the role of technology in the process of teaching and learning in a truly integrated manner" (Abbitt, 2011, p. 283). Generally speaking, TPACK is the knowledge of how to integrate technology in teaching the subject matter. This knowledge also includes the appropriation between a specific technological tool and the teaching of a specific topic in the subject matter and being aware of the difference between using various technological tools in teaching a specific topic in the subject matter. Further, this knowledge means being aware of students' problems of the subject matter that could be overcome by using specific technological tools. On the other side, it means the awareness of students' problems of the subject matter that could result from using specific technological tools, in addition to how to overcome these problems (Koehler & Mishra, 2008).

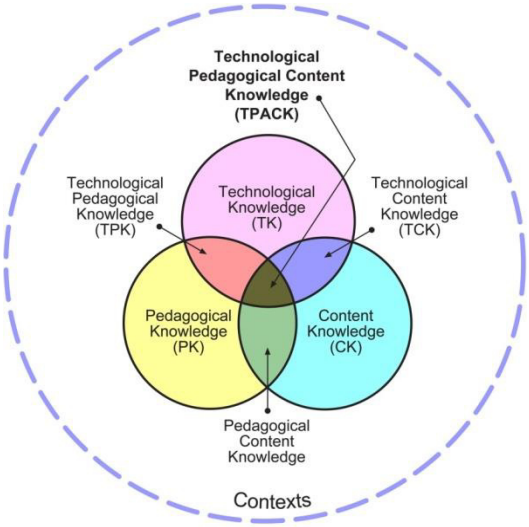

Figure 1: The TPACK model as in Koehler and Mishra (2009)

Niess (2005) mentions the following themes, adapted from Grossman's four components of PCK, as components of TPACK, when talking about mathematics as a subject matter: (1) An overarching conception about the purposes for incorporating technology in teaching mathematics; (2) Knowledge of students' understandings, thinking, and learning of mathematics with technology; (3) Knowledge of curriculum and curricular materials that integrate technology in learning and teaching mathematics; and (4) Knowledge of instructional strategies and representations for teaching and learning mathematics with technologies. These themes could be incorporated easily as themes of TPACK related to any other subject matter.

1.2 Instructors' attitudes toward computers

Al-Zaidiyeen, Mei and Fook (2010) surveyed the various definitions of 'attitudes' as used by previous researchers, for example, Allport (1935) defined the attitude construct as "a mental and neural state of readiness, organized through experience, exerting a directive or dynamic influence upon the individual's response to all objects and situations with which it is related" (p.810). Fishbein (1967) defined attitude as "a learned predisposition to respond

to an object or class of objects in a consistently favorable or unfavorable way" (p. 477). Other researchers (for example Zan & Di Martino, 2007) defined attitude in a simpler way: as a positive or negative emotional reaction toward a specific situation. These definitions show the possible influence of attitudes on behavior in general and instructors' behavior in particular. Thus researchers have been paying attention to this influence for decades, especially in the last two decades when the computer and ICT started to emerge as a possible tool for the improvement of teaching and learning.

Researchers' effort in verifying the relation between the instructors' attitudes toward computers and ICT and their use of these tools showed that instructors' attitudes toward the use of ICT in teaching and learning have major influence on the success and meaningful use of the computer and ICT in their teaching (Albirini, 2006; Al-Zaidiyeen, Mei & Fook, 2010; Baylor & Ritchie, 2002). Albirini (2006), for example, considers teachers' attitudes a major predictor of their use of new technologies in educational settings, while Al-Zaidiyeen, Mei and Fook (2010) say that teachers' attitudes toward ICT can play an important role in their acceptance and actual use of ICT tools.

In our research too, attention was given to instructors' attitude toward computers and ICT use, together with the development of their TPACK and ICT proficiency, as a consequence of participating in workshops and of the administrative emphasis on the use of ICT in teaching. Here we used teacher's attitude toward computers' questionnaire (TAC) because it implies teachers' attitudes toward the use of ICT in teaching and their intentions to do so (Baya'a & Daher, 2013). We were also interested in instructors' proficiency level in ICT as an indicator of their intention to use ICT in their teaching as the proficiency variable is reported to affect teachers' readiness to use the ICT in their teaching (Granger, Morbey, Owston & Wideman, 2002; ibid).

Regarding the instructor's type of work, it is expected that pedagogical supervisors would be more attendant to ICT use in schools than discipline lecturers. The goals for that are: (1) Pedagogic supervisors prepare the pre-service teachers as teachers in schools and not as regular students, (2) they are aware of the ministry of education intent and requirement to make ICT use a daily scene in the classrooms, so will probably work toward achieving this goal as teachers' educators.

2. Research rationale and goals

The main research goal is to examine the consequences of implementing a college plan to advance the use of ICT in college instructors' teaching. So the research will concentrate on examining the development of college instructors' attitudes toward computers, the instructors' ICT proficiency and the instructors' TPACK, as a result of implementing the college plan. This study will enrich the research on college instructors' attitudes toward the ICT and on college instructors' TPACK. What distinguishes this study is its examination of the relationship of the implementation of a college plan, which includes: college policy, college infrastructure, ICT technical and pedagogical support, participation in workshops and the availability of assistants, with college instructors' TPACK development, their ICT proficiency and attitudes toward ICT.

The results of the study are expected to guide college instructors, researchers, college administrators, and professional development consultants regarding college instructors' professional development in ICT use, and regarding how to motivate college instructors to actually use ICT in their teaching.

3. The research questions

The main research question is: How the college intervention (college policy, college infrastructure, ICT center support, participation in workshop, and availability of assistants) will affect the instructors' attitudes toward computers, the instructors' ICT proficiency and the instructors' TPACK level? Three sub-questions are derived, as follows:

1. Will the college intervention improve the instructors' attitudes toward computers?
2. Will the college intervention improve the instructors' ICT proficiency?
3. Will the college intervention improve the instructors' TPACK level?

4. Research context, participants and procedure

Al-Qasemi Academic College of Education has set a three years plan to get college instructors ready to grasp and apply 21st century skills into their teaching processes. These instructors are expected to be ready, in three years, to lead the college into the 21st century education where ICT use becomes an integral part of the teaching and learning environment. This plan was approved and partially budgeted by the department of education.

Since the early years of the third millennium the college has been trying to implement modern technologies in the learning/teaching processes. Successful experiences and projects were reached and implemented, but did not extend to become a standard and a norm in the college teaching environment. Recently, about 10% of the college instructors constructed and used courses sites and integrated ICT in their teaching processes. This rate did not change since three years, in which there was a feeling of status quo regarding integrating ICT in education. The approved plan for preparing the college for the 21st century education opens an opportunity to boost up the expected change.

The college technological infrastructure was developed and improved continuously in the last decade; computers, projectors, internet access in most of the classrooms, college web sites, and LMS (Learning Management System) were acquired and installed in the college campus. In addition, an ICT center was established to provide technical and pedagogical support to assure proper use of the available technologies.

In order to implement the new plan, the college deployed intervention steps which included:

1. College policy: since the first year of implementing the plan, the college's administration required all instructors to enhance the use of ICT in their teaching, and college administrators stated this policy in all official meetings and occasions.
2. College infrastructure: special budget was directed toward improving the college technological infrastructure; all classes were equipped with appropriate and updated hardware and software (at least, a computer connected to over-head projector) and put up a wireless internet platform to provide fast and efficient communication from any point in the college campus.
3. ICT center support: to develop the instructors professionally in the field of using ICT in teaching, the college expanded the ICT center support staff in order to provide wider group and individual support in technical and pedagogical issues.
4. Participation in workshop: the ICT center arranged several workshops for the instructors and the pedagogical supervisors in the college. All the instructors and pedagogical supervisors who worked more than one third position (approximately 115 all together) were invited to participate in one of these workshops through the three academic years of implementing the college plan. 17 pedagogical supervisors and 13 instructors participated in two separate workshops in the college in the first year, while 6 pedagogical supervisors and 7 instructors participated together in the same workshop in the following year. 11 pedagogical supervisors of the 17 who participated in the first year introductory workshop participated also in an advanced workshop in the second year. In the introductory workshop the focus was on introducing the instructors to the various possibilities of using ICT in education and presenting examples of such uses, while in the advanced workshop the focus was on assisting the pedagogical supervisors in developing learning materials from various technological pedagogical models. In this workshop they developed ICT based lessons, constructed web-based learning environments (WBLE) (see the description of WBLE for example in Baya'a, Mia'ari & Baya'a, 2009), presenting in these environments ICT based learning units that they developed by themselves or with their students in the practical training. In total we had approximately 40 participants in the introductory workshops and 11 in the advanced one. These participants were the sample of our research. It is important to note that the college continues to offer these workshops for the instructors and pedagogical supervisors.
5. The availability of assistants: in addition to acting as role model for their students in using ICT in teaching, as any other instructor in the college, pedagogical supervisors are also required to train their students in implementing the use of ICT through the practical training in schools. They also are expected to help their students develop teaching materials that involve various ICT pedagogical models that suit their content field; that is developing their TPACK level. Therefore, special intervention was directed to the pedagogical supervisors, where each one of them, who participates in a workshop, gets from the ICT center an escort of a professional assistant in the field of web-based learning environments.

The current research followed the implementation of the plan and the college intervention through the first two years, including the administration of questionnaires to measure the advancement of the TPACK levels and attitudes toward computers of the instructors who participate in the workshops, as well as their ICT proficiency. Only 19 of the 40 participants in the introductory workshops completed the questionnaires twice (at the beginning and the end of the workshop) and 4 out of the 11 participants in the advanced one. Therefore, we concentrated our data analysis on the paired sample of the 19 participants of the introductory workshop.

5. Research instruments

The research instruments include three questionnaires as follows:

1. Technological, Pedagogical, and Content Knowledge (TPACK) – revised questionnaire: Different questionnaire were used in previous researches to assess teachers' TPACK. Abbitt (2011) provides an overview of instruments and methods for TPACK-based evaluation of pre-service teacher preparation experiences. The current research's questionnaire was constructed on the basis of the TPACK assessment instrument for pre-service teachers developed by Schmidt & others (2009). The first administration was before participation in the workshop and the second administration was at the end of the workshop.
2. Teachers' Attitudes toward Computer (TAC, v. 6.1) questionnaire: This questionnaire was tested by Christen and Knezek (2009) who concluded that the TAC (v. 6.1) is a well-validated and reliable instrument for teachers' self-appraisal of their attitudes toward computers. The TAC questionnaire was administered twice for the same participants and at the same time of administering the TPACK questionnaire.
3. The Use of ICT in Colleges of Education – Questionnaire for Teachers of Teachers (UICT): This questionnaire was developed by The MOFET Institute to follow the professional development of instructors in colleges of education including ICT proficiency. The appropriate part of the questionnaire, regarding the ICT proficiency, was administered twice for the same participants and at the same time of administering the TPACK questionnaire.

5.1 Statistical exams

The questionnaires were translated for the first time to Arabic language before administering them to the instructors. The questionnaires underwent validity and reliability exam.

Face validity: The Arabic translations of the questionnaires were given to a group of instructors who were required to examine if the questionnaires' statements are understandable to the reader. Some items of the questionnaires were restated to clarify their ambiguity.

Content validity: The questionnaires were given to a group of experts (three college instructors) who were required to examine whether the questionnaires' items cover the full domain of the different educational constructs and whether they cover constructs other than the appropriate ones. As a result of the experts' remarks, the TPACK questionnaire was modified.

The questionnaires' reliability: The scores of the instructors in both questionnaires: TAC and TPACK, as well as their various components (categories), before the workshop and after it, were examined for internal reliability using Cronbach alphas. The results show high Cronbach alphas (all above 0.85) indicating adequate internal reliability for the questionnaires and their various components. These results were expected due to the extensive use of these questionnaires in the literature.

Data processing: Research questions 1-3 were analyzed using paired-samples t-Tests to determine if there were significant differences between scores of instructors in the various questionnaires before and after the workshop. Cohen's d was also used to compute effect sizes to assess the practical significance of results.

6. Results

The analysis of the data was conducted according to the research questions taking in consideration the independent and dependent variables of each question. We should note that the independent variable of questions 1-3

is the college intervention which includes five components (college policy, college infrastructure, ICT center support, participation in workshop and the availability of assistants) was presented in the tables as having two values: before the workshop and after the workshop, to indicate the period that these factors were active and could have influenced the dependent variables values regarding the instructors. A ranking of the effect of these components as affecting factors as perceived by the instructors themselves was also carried out showing the participation in workshop as the leading factor. This ranking is also presented in this section. The sample size was 19 counting the instructors who completed and submitted all the questionnaires before and after the workshop. In some cases the size was smaller if some instructors did not complete one of the questionnaires. The following tables present the results of the research analysis.

Research question 1: will the college intervention improve the instructors' attitudes toward computers?

Table 1

Descriptive Data and Results of Paired-Samples t-Test for Instructors' TAC Level by Participation in Workshop (n=19)

	Before Workshop		After Workshop			
Outcome	M	SD	M	SD	*t*	*d*
TAC	4.08	0.23	4.09	0.33	0.15	0.04
Interest	4.78	0.41	4.48	0.51	2.32*	0.65
Comfort	4.50	0.46	4.58	0.48	1.00	0.17
Accommodation	4.83	0.34	4.89	0.32	0.76	0.19
Interaction	3.99	0.53	3.96	0.70	0.30	0.06
Concern	2.79	0.48	2.80	0.63	0.05	0.02
Utility	4.38	0.50	4.36	0.49	0.26	0.06
Absorption	3.52	0.49	3.77	0.57	2.44*	0.46
Significance	4.43	0.46	4.48	0.52	0.35	0.09
Perception	5.49	0.78	5.61	0.95	0.47	0.14

As displayed in Table 1, the results show that the paired-samples t-Test for the instructors' TAC level differs before the workshop and after the workshop for interest and absorption. T-Test found significant setback in the instructors' interest category in the TAC questionnaire after participation in workshop. On the other hand, significant gain was found in the instructors' absorption category in the TAC questionnaire after participation in workshop). Moderately large negative effect size of 0.65 (Cohen, 1969) was derived for interest and average positive effect size of 0.46 was derived for absorption.

Research question 2: will the college intervention improve the instructors' ICT proficiency?

Table 2

Descriptive Data and Results of Paired-Samples t-Test for Instructors' ICT proficiency level by Participation in Workshop (n=19)

	Before Workshop		After Workshop			
Outcome	M	SD	M	SD	*t*	*d*
Score of table 1 in UICT	2.85	0.51	3.39	0.40	3.76***	1.19

As displayed in Table 2, the results show that the paired-samples t-Test for the instructors' ICT proficiency level differs before the workshop and after the workshop. T-Test found significant gain in the instructors' ICT proficiency level after participation in workshop. Very large positive effect size of 1.19 was derived for the instructors' ICT proficiency level.

Research question 3: Will the college intervention improve the instructors' TPACK level?

Table 3

Descriptive Data and Results of Paired-Samples t-Test for Instructors' TPACK Level by Participation in Workshop (n=17)

	Before Workshop		After Workshop			
Outcome	M	SD	M	SD	*t*	*d*
TPACK	3.88	0.45	4.21	0.28	3.82**	0.90
TK	3.52	0.70	3.79	0.46	1.73	0.46
PK	4.18	0.41	4.46	0.44	2.34*	0.65
PCK	4.39	0.56	4.63	0.56	1.48	0.42
TCK	3.82	0.82	4.16	0.62	1.87	0.46
TPK	3.94	0.51	4.37	0.50	3.05**	0.85
TPCK	3.91	0.65	4.39	0.54	3.85**	0.81

As displayed in Table 3, the results show that the paired-samples t-Test for the instructors' TPACK level differs before and after the workshop. T-Tests found significant gains in the instructors' TPACK level after participation in workshop. Moderately large positive effect size of 0.65 was derived for PK and larger positive effect sizes of 0.9, 0.85 and 0.81were derived for TPACK, TPK and TPCK respectively.

6.1 Ranking of the college intervention components

The college intervention included five components: college policy, college infrastructure, ICT center support, participation in workshop and the availability of assistants. At the end of each workshop, the instructors were asked about the change in their perceptions, attitudes, abilities and behavior regarding the integration of ICT in teaching. Those who indicated positive change were asked to rank the components of the college intervention, as affecting factors of the change, from the most effective factor to the least effective one. The results concluded the following ranking of the factors, where the first one is the most effective: (1) Participating in the workshop, (2) the ICT center support, (3) college policy, (4) advancement in college technological infrastructure, and (5) the availability of assistants.

6.2 Outcomes of the college intervention

Before the beginning of the implementation of the college plan, only a hand full of instructors and pedagogical supervisors (less than 10% of the college staff) constructed and used courses sites and integrated ICT in their teaching processes. Only two WBLE (using Google sites platform) were constructed before the college intervention, while at the end of the second year of the college plan implementation, over thirty WBLE were constructed including ICT based lessons, units and learning materials that were designed and developed collaboratively by pedagogical supervisors and their students in the frame of the practical training. In addition a notable increase was apparent in the number of courses sites based on the Moodle platform that were developed and used by most of the instructors and pedagogical supervisors. These sites were used by the instructors to manage their courses including the use of ICT based teaching materials that would improve their teaching in the courses.

Another noticeable outcome of the college intervention was the number of pedagogical initiatives that involve special use of ICT in teaching in the college proposed by the pedagogical supervisors to the educational research center in the college. At least six initiatives were proposed this year as opposite to only one in the last year. These initiatives are directed to enriching the WBLE with special use of ICT in advancing the teaching methods in the training schools and/or encouraging higher order cognitive skills using ICT based learning/teaching materials among the pupils in these schools. All these initiatives intent to involve the college students and the training teachers in the development process, therefore the implementation of these initiatives would also advance the integration of ICT in the training schools. It is important to note that these initiatives come from various departments, such as: English language, Arabic language, Islam Studies, Science and Mathematics.

7. Discussion

The main research question was: How will the college intervention (college policy, college infrastructure, ICT center support, participation in workshop, and availability of assistants) affect the instructors' attitudes toward computers, the instructors' ICT proficiency and the instructors' TPACK level? The results of the research indicate several significant effects of the college intervention, which mainly pointed out improvement in the instructors' perceptions, abilities and behavior regarding the integration of ICT in teaching.

7.1 Instructors' attitudes toward computers

One of the main results of this research shows that no significant improvement was detected in the instructors' attitudes toward computers as an outcome of the college intervention. The main score of the TAC before the workshop (M=4.08) almost did not change after the workshop (M=4.09). But, in both cases the attitudes were very favourable toward computers. Even though, when looking at the subscales of the TAC we identify two significant changes: one negative change in interest and one positive change in absorption. Also in the case of the negative change in interest, both averages (M=4.78, M=4.48) were very high indicating great interest in computers. This interest could have dropped down after experiencing the work with computers during the period of the workshops, probably because the instructors did not have much experience working with computers before the workshop and were interested to experience it. After experiencing the work with computers, their willingness to work with computer dropped down a little bit because they were exposed to this instrument and experienced actual work with it, so their interest to do this experience lessened (like learning about the computer or how to use it). As for the positive change in absorption, the instructors expressed positive feeling toward the involvement in the computer world before the workshop. During the workshop they had the chance to be actually involved and improve their knowledge in computers. This might have improved their absorption of computers, for example improved their ability to solve problems related to the use of the computer in general or in the classroom; which encouraged them to insist to solve these problems, even if they were hard ones. This influence of teachers' experience in technology on their ability to solve technological problems is mentioned in DeLuca (1991) who says that prior technological knowledge and knowledge seeking (in our case improved as a result of participating in the workshop) help overcome technological problems in the classroom. Moreover, Baya'a and Daher (2013) found that the participating teachers have generally positive perceptions of their competence in technology. Further, they have positive attitudes toward their self-esteem in the presence of technology.

7.2 Instructors' ICT proficiency

An important result of this research is the high significant improvement in the instructors' ICT proficiency (M=2.85, M=3.39) as a consequent of the college intervention. Three major intervention components: ICT center support, participation in workshop, and availability of assistants, were responsible for this objective. In more detail, the assistants accompanied the instructors in the workshops and had regular weekly meetings with them to direct them in using technology in preparing their lessons. This made the instructors feel confident to construct ICT based teaching and learning materials, which improved significantly their ICT proficiency. This means that the college instructors need specific training, accompanied by assistants, to improve their ICT proficiency. This need of training

for teachers to improve their ICT skills and readiness to integrate ICT in their teachers was suggested by past researches, for example by Muir-Herzig (2004).

7.3 Instructors' TPACK level

As a result of the college intervention, the TPACK level of the instructors was significantly improved (from M=3.88 to M=4.21). This indicates that the intervention was successful in making the participating instructors improve their use of ICT in teaching their pre-service teachers who are the future teachers. This improvement would result probably in the pre-service teachers implementing ICT use in their practical training. This means that the college is stepping forward in applying 21st century skills into the teaching and learning processes, and as a result, in preparing its pre-service teachers for the 21st century education.

Looking at the average scores of each type of knowledge resulting from the intersection of two or three of the domains: technology, pedagogy and content, we see significant improvement in PK, TPK and TPCK. This could have happened because in the workshops, the instructors were not only exposed to ways of enriching existing pedagogies with exciting multimedia and required to implement them in their disciplines, but they were also introduced to new pedagogies that evolved recently in the era of modern technology.

The non-significant change in the TK score might seem contradicting the significant improvement of the instructors' computer proficiency mentioned earlier. In fact there is no contradiction because the computer proficiency, as measured in table 1 in UICT, refers to the instructors' actual use of technological tools, while, TK is involved with technology knowledge in general.

Regarding the pedagogical content knowledge, the instructors expressed high level of agreement with the PCK statements before the intervention, because they considered themselves experts in the pedagogy of their disciplines. This agreement increased after the intervention, but not enough to be significant. As for the technology content knowledge, the instructors started with above average agreement with TCK statements, where this agreement also improved after the intervention, but not significantly. This could have happened because the instructors were prepared for integrating technology in their teaching and not as a method to solve problems in the content.

It could be said that teachers' different experiences in the workshop improved their knowledge in types of knowledge related to their preparation in the workshop; i.e. pedagogic types of knowledge. Here too, experience through workshop preparation, including supporting instructors with assistants, helped teachers improve their knowledge in related domains, in our case PK, PCK and TPACK. It seems that teaming instructors with assistants led to teaching improvement, the same way as teachers' teaming leads to such improvement (Fulton & Britton, 2011).

It is important to mention that the advanced workshop which included 11 pedagogical supervisors out of the 17 who participated in the introductory workshop, had in it also department chairs. These chairs constructed in the advanced workshop WBLE rich with ICT based lessons and used these sites as a model for other instructors in the department encouraging them to construct their own WBLE. This act inspired several instructors and pedagogical supervisors to do so and resulted in the construction of over thirty WBLE as opposed to only two before the workshops. Another major change occurred in the number of pedagogical initiatives that involve special use of ICT in teaching proposed by the pedagogical supervisors, going up from only one before the college plan to at least six initiatives this year.

8. Conclusions and recommendations

The instructors and pedagogical supervisors in this study had relatively high positive attitudes toward computers before the college intervention. These attitudes did not change significantly after the intervention. The instructors' ICT proficiency improved significantly after the college intervention especially as a result of three components of this intervention: ICT center support, participation in workshop and availability of assistants.

The TPACK level of the instructors, especially the pedagogical supervisors, was improved after the college intervention. The introduction of new pedagogies that evolved in the era of modern technology in the workshops affected positively the instructors' pedagogical knowledge in general, their technology based pedagogy and the adaptation of these technologies and pedagogies to the disciplines. This improvement and the previously mentioned

ones would get the college instructors ready to apply 21st century skills into their teaching processes, and consequently would move the college further toward the 21st century education.

Our experience of this research leads us to recommend the following intervention components for colleges desiring to improve the ICT use in teaching among their instructors: (1) Providing appropriate workshops for their instructors: introductory and advanced ones, which expose them to modern pedagogies based on modern technologies. In addition, giving the instructors the chance to develop by themselves teaching materials for their disciplines using these pedagogies and technologies; (2) Enhancing the activity of the ICT center in the college, especially providing expert support for the instructors in the field of ICT tools and their use in teaching; (3) Establishing a clear support policy for ICT integration in teaching, where this policy includes involving the administrators, especially the department chairs, in this process; (4) Upgrading the college technological infrastructure and keeping it up-to-date; and (5) Providing escort of professional assistant in the field of web-based learning environments for each pedagogical supervisor. Of course it would be better if this assistant comes from the same discipline as the pedagogical supervisor.

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