

The Development of In-Service Mathematics Teachers' Integration of ICT in a Community of Practice: Teaching-in-Context Theory

<https://doi.org/10.3991/ijet.v14i01.9134>

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Abstract—The goal of the present research is to describe five lower-secondary in-service mathematics teachers' development of ICT (Information Communication Technology) integration in their teaching as a result of mentoring pre-service teachers who practiced the integration of technology in their mathematics teaching. This is done through the combination of Schoenfeld's Teaching-in-Context theory and Goos' community of practice framework. To collect the research data, the researchers used semi-structured interviews with the in-service teachers at the beginning and end of the academic year. In addition, several observations of lessons taught by the in-service teachers with the assist of pre-service teachers were recorded towards the end of the intervention. The research findings indicate that the community of practice context can serve as an escalator that supports the decision of in-service mathematics teachers to integrate ICT in their mathematics teaching. However, these decisions were conditioned by taking care of the students' formal procedural mathematical knowledge.

Keywords—community of practice, in-service mathematics teachers, integration of ICT, pre-service mathematics teachers, teaching-in-context

1 Introduction

In-service mathematics teachers' integration of ICT has been researched from various aspects. Here, we try to study it using the lens of community of practice and teaching in context. In previous research, we used other frameworks as the innovation diffusion model of Rogers [20] and technology acceptance model of Davis [8]. The two theoretical frameworks that we use here are more related to the professional de-

velopment of the mathematics teacher, as well as the mathematics teacher's knowledge. As educators of mathematics pre-service teachers in a teachers' college and in the training schools, we consider it our role to encourage the integration of ICT in teaching among the mentoring mathematics in-service teachers. This role is founded on our conviction that ICT contributes to students' production of mathematical knowledge through supporting them in their mathematical investigations [14]. In the current paper, we describe, utilizing Schoenfeld's Teaching-in-Context theory and Goos' community of practice, the development of five mentoring mathematics teachers' beliefs and behaviors regarding the integration of ICT in their teaching in the context of a community of practice. For us, a community of practice is a context in which pre-service teachers, their school mentors and their college educators try to professionally develop together. This development is in-context, conditioned by the members' knowledge, beliefs and goals. Here, the development is in the integration of ICT in in-service teachers' practices.

1.1 ICT use in Teaching Math: Benefits and Obstacles Hindering this use

Different studies described the benefits of integrating ICT in education. These benefits are categorized as benefits for students (as contributing to their production of knowledge and their interaction) and benefits for teachers (as promoting new pedagogical practices and enhancing teaching). Becta in [3] clarifies the contribution of ICT to students' production of knowledge, saying that ICT causes students not only to receive information, but also to provide information themselves. This could be considered an indicator that ICT supports constructivist pedagogy, where pupils use technology to explore and reach the understanding of mathematical concepts, which specifically enhances students' understanding of basic concepts [14]. Becta in [3] also points at the contribution of ICT to students' interaction, saying that ICT enhances and encourages the interaction between students, as well as between students and the technology itself. ICT also contributes to teachers' instruction. Kreijns et al. in [14] claim that ICT can enable, promote, and reinforce the use of new pedagogical practices that correspond with the educational demands of the twenty-first-century knowledge society.

In spite of ICT benefits, teachers are often more reluctant than willing to use information and communication technology (ICT) [14]. Keong, Horani and Daniel in [13] and Jones in [11] identified different barriers to ICT integration: (1) lack of confidence of teachers in using technology; (2) lack of time in the school schedule for projects involving ICT; (3) insufficient teacher training opportunities for ICT projects; (4) inadequate technical support and lack of resources at the school for these projects; (5) lack of teachers' knowledge about ways to integrate ICT to enhance the curriculum; (6) difficulty in integrating and using different ICT tools in a single lesson; (7) unavailability of resources at home for the students to access the necessary educational materials and (8) the age of the teachers, where older teachers are reluctant to use new digital technologies. These barriers suggest taking care of teachers' professional development in ICT, where this professional development encourages and supports teachers in integrating technology in their teaching.

1.2 Teachers' Professional Development in ICT

Clark-Wilson et al. in [7] postulate that the process by which teachers develop their professional identity and associated practices over time is experienced as “professional development,” which encompasses the full range of individual and collaborative activities in which a teacher engages inside and outside of school. These include participation in traditional courses, in-school initiatives, research projects, and professional networks.

The integration of ICT has been a key component of the agenda of teachers' professional development, where this agenda is influenced by three elements overlapping with each other to facilitate the use of ICT within schools [17]. These elements are institutions, resources, and teachers, where the main barriers preventing the implementation of technology in education are teachers' confidence, beliefs and attitudes towards the role of technology, and towards the ability of successfully implementing it within schools [16, 26]. Thus, it is important to examine teachers' beliefs towards the integration of ICT in their teaching as a first step towards leading them to integrate ICT in the classroom.

1.3 Teachers' Knowledge, Beliefs, Goals and Decisions

Schoenfeld's Teaching-in-Context theory [21] links teachers' decisions to their beliefs by arguing that teachers' knowledge, beliefs and goals influence their decision-making in the mathematics classroom. In a subsequent article, Schoenfeld in [22] claimed that the mathematics teacher enters the classroom with a set of goals in mind, and some plans for achieving them. Plans are chosen by the teacher based on his or her beliefs and values. Schoenfeld distinguished between two classroom situations, where in the first situation, there are usual events and the lesson goes according to plan. In the second situation, something unusual happens, which makes the lesson not proceed according to plan. In this case, the teacher sets a new goal and makes a new plan depending on his/her knowledge and beliefs.

Several researches agree with the assumptions of Schoenfeld's Teaching-in-Context theory. For example, Barkatsas and Malone in [2] found that teachers' beliefs affect their practices. Moreover, teachers' beliefs have mutual relationship with their interactions with students [28]. Furthermore, teachers' knowledge and attitudes influence teachers' practices [19].

As to teachers' decisions, teachers' decision-making and lesson-practice are inter-related [5, 10]. Researchers have attempted to characterize the factors that affect teachers' decisions to use technology in their teaching, and how these decisions affect their practice. For example, the authors studied teachers' decisions to use mobile learning in the mathematics classroom, and found that different factors have an impact on teachers' decisions regarding the use of mobile learning in the mathematical lessons. The factors include teacher's history of using technologies in teaching; teacher's perceptions of using technologies in teaching; the school community, including the principal and the coordinating teacher; rules regulating the use of technologies in teaching mathematics; and division of labor regarding this use, as who should prepare

the learning activities needed to be used for learning mathematics with the mobile phone.

Several researchers used Schoenfeld's Teaching-in-Context theory to study teachers' practice and decision-making in the mathematics classroom (e.g., Törner et al. in [27]). We follow these researchers to study in-service teachers' integration of ICT in the mathematics classroom. Doing so, we combine the previous framework with Goos' framework of community of mathematics teaching [9].

1.4 Community of Mathematics Teaching

Goos in [9] utilizes Wenger's community of practice framework to describe the joint professional development of mathematics teachers and herself as a researcher. This framework describes a model of social learning whose assumptions differ from those made in the common theoretical frameworks of teachers' competencies and professional development [6]. This shift in perspective on competencies and professional development connects the concept of identity to the concept of practice. According to Wenger's framework, Learning is developed through three modes of belonging: (a) engagement or mutual participation in joint tasks, (b) imagination, which is the willingness to explore and try new things, then reflect on how these relate to other practices, and (c) alignment, which is the convergence of a common focus, cause, or interest. In addition, Wenger's framework assumes that the community of practice develops through three practices: mutual engagement of participants, negotiation of a joint enterprise, and development of a shared repertoire of resources for creating meaning [9, 29].

1.5 Research Rationale and Goals

The present research attempts to analyze in-service teachers' integration of ICT in their teaching using two theoretical frameworks, which have been utilized in mathematics education. Little research has utilized these frameworks to analyze the development of mathematics teachers' practices and affective aspects as a result of participating in a community of practice which encourages ICT integration in teaching. We will use the teaching-in-context framework to analyze in-service teachers' knowledge, beliefs, goals and decisions, before and after the practices of the community. In addition, we will use the community of practice framework to analyze the community practices. Doing that, we try to understand how the community practices affected in-service teachers' knowledge, beliefs, goals and decisions regarding the integration of ICT in their mathematics teaching. The research results would help conduct teachers' workshops, including teachers' communities of practice, in order to encourage them to adopt innovative practices as ICT integration.

2 Methodology

In the present research, we report the development of the integration of ICT by five lower-secondary in-service mathematics teachers in a community of practice context in which they were engaged in integrating technology in mathematics teaching. These teachers accompanied our 18 pre-service teachers, who are in their third academic year majoring in teaching mathematics and computer science in intermediate schools, in the frame of practical training under the Professional Development Schools (PDS) model [1]. All of them have a Bachelor degree in mathematics and a teaching certificate, with at least 10 years of seniority in teaching. The teachers had some experience in teaching mathematics using technology. Two of them were part of an experiment led by a courseware development company for a whole year. Their feedback about this experiment was mostly negative, for they claimed that it had destructive effect on their pupils' formal procedural knowledge in mathematics. It was a challenge for us to get these teachers agree once more to get involved in a new experiment in this field.

Our pre-service teachers are trained specifically to use visual and dynamic tools to investigate with their students' questions that encourage higher order cognitive skills, such as: 'Would the three perpendiculars in a triangle meet at the same point? If so, what could you say about the location of that point?' They would help their students phrase conjectures and discuss using mathematical reasoning the correctness of these conjectures. The in-service teachers are encouraged to use the visual and dynamic tools by themselves in order to encourage their students' conjecturing and justification of mathematical relations.

To encourage the in-service teachers to integrate technology, the following methods were employed: watching and analyzing video clips of past-years pre-service teachers performances during integrating technology in their mathematics teaching, preparing ICT-based mathematics lessons together with the pre-service teachers watching the present pre-service teachers teach ICT-based mathematics lessons, teach together with the pre-service teachers ICT-based mathematics lessons, teach with the support of pre-service teachers ICT-based mathematics lessons, and finally teach by themselves ICT-based mathematics lessons on their own.

2.1 ICT Tools Utilized by the Pre-Service Teachers and later by their Mentoring Teachers

Our pre-service teachers were required, in their third year of study, to integrate ICT in their practices as mathematics teacher trainees in the training schools. In this integration, they are requested to use various ICT tools and technological pedagogical models, which they were introduced to and discussed in the didactics courses. Examples of such tools and models include videos and presentations; digital books and digital tools; spreadsheets, applets and GeoGebra; applications of cellular phones; Wiki, Google Docs and Sites; and social networking sites such as Facebook. The mentoring teachers were encouraged by the pre-service teachers' educators to use the same ICT tools in their teaching of mathematics.

2.2 Data Collecting and Analyzing Tools

We used two collecting tools: observations and semi-structured interviews to collect data about different issues related to the integration of ICT in the lessons of the participating in-service teachers. In more detail, we used semi-structured interviews to collect data about the participating in-service teachers' knowledge, experiences and beliefs regarding the ICT integration in mathematics teaching at the beginning and end of the academic year. These interviews included questions, such as: “What ICT tools do you know that could be beneficial in teaching mathematics?”, “How do/would you use these tools in your teaching of mathematics?”, “What experiences do you have of integrating ICT in teaching mathematics?”, “What obstacles do you tackle when you try to use ICT in teaching mathematics?”, and “What are your attitudes toward integrating ICT in teaching mathematics? Explain these attitudes.”

At the same time, we also used observations to assess the community of practices outcome by the end of the academic year. Our community of practice, which extended through the academic year, included the in-service teachers, the pre-service teachers and the two college educators (The first two authors of the paper). We recorded observations of five lessons, one for each in-service teacher, at the level of teaching ICT-based mathematics lesson with the support of pre-service teachers.

To analyze the data, we used the deductive constant comparison method based on the categories derived from Schoenfeld's Teaching-in-Context theory in combination with Goos' community of practice framework. Using Schoenfeld's Teaching-in-Context theory, we studied in-service teachers' knowledge, experiences, beliefs and goals and how they influenced their decision-making, at the beginning and end of the experiment. Using Goos' community of practice framework, we studied how mutual engagement of the participants, the negotiation of a joint enterprise, and the development of a shared repertoire of resources for creating meaning influenced the participants' advancement of their knowledge, beliefs and goals.

3 Findings and Analysis

We present the in-service teachers' knowledge, experience, resources, beliefs, goals and decision-making related to ICT practice at the beginning of the academic year, then the community of practices and afterwards we present again their knowledge, experience, resources and beliefs at the end of the academic year.

3.1 Teachers' Knowledge, Experience, Resources and Beliefs at the Beginning of the Academic Year

At the beginning of the initiative, the first two authors of the paper, as college educators of pre-service teachers in the training schools, faced some difficulties and obstacles convincing the mentoring teachers to integrate technology in mathematics teaching. One reason for these difficulties was the moderate knowledge possessed by the participating in-service teachers in ICT and its proper use in teaching mathemat-

ics. In more detail, regarding the participating in-service teachers' technological knowledge, they reported that generally they were acquainted with some Office programs, like Word and PowerPoint, and with the Internet. This little technological knowledge resulted in the teachers being afraid to use these technological tools. They were also confronting technological pedagogical content knowledge obstacles, such as the need for pedagogical support in integrating technology in a specific mathematical topic.

The difficulties and obstacles were due also to the little experience of the participating teachers in integrating ICT in their mathematics teaching. For example, one teacher reported using ICT infrequently for one year, while another teacher reported using only presentations and online games.

Together with the moderate knowledge in ICT and the little experience of the participating teachers in integrating ICT in their mathematics teaching, all the teachers were confronting logistic obstacles represented in insufficient resources as insufficient technological infrastructure, students' density in the classroom, insufficient number of mathematics lessons for teaching the mathematical topics in the middle school.

In spite of the participating teachers' little experience in integrating ICT in their teaching and the obstacles they confronted and discouraged them to integrate ICT in the classroom, the participating teachers had generally positive beliefs about the ICT integration in mathematics teaching. These positive beliefs were expressed through the in-service teachers' description of the advantages of ICT integration in mathematics teaching. The in-service teachers talked about advantages of three types. First, advantages related to the curriculum (connecting mathematics with real life phenomena, embodiment and visualization of mathematical concepts, manipulation of the mathematical objects). Second, advantages related to the learner (contribution to the learner's cognitive skills, contribution to the learner's technical skills, contribution to the learner's imagination skills, bridging the gap among students, bridging the gap between students and the teacher). Third, advantages related to the teacher (providing tools that assist the instruction, contribution to the material coverage, explaining the content). At the same time, one of the participating teachers had some negative beliefs about the integration of technology in mathematics teaching, specifically regarding the incapability to help students develop formal procedural mathematical knowledge. She described these negative beliefs by saying: "technology indeed assists in supporting the conceptual mathematical knowledge of the students, but it does not assist in supporting their formal procedural mathematical knowledge".

We argue that the positive beliefs of the mentoring teachers about the use of technology in the mathematics classroom were probably due to the general atmosphere regarding the importance of technology in education. This general atmosphere consisted in the atmosphere across schools, as well as in the school itself. The positive beliefs of the mentoring teachers were also due to their preparation as pre-service teachers, where this preparation usually includes at least two courses in ICT integration in teaching. At the same time, one teacher had negative beliefs about the use of technology in the mathematics classroom due to her previous experiences.

3.2 Goals and Decision-Making related to ICT Practice at the Beginning of the Academic Year

The positive beliefs mentioned above were not enough for the in-service teachers' goals to include ICT integration in their teaching. We think that the in-service teachers were reluctant to integrate technology in their teaching due to their little technological knowledge and/or little technological pedagogical content knowledge. In addition, this reluctance was, for one teacher, due to the previous experiences with ICT integration that resulted in a loss of formal procedural mathematical skills among her students. The in-service teacher who had negative beliefs about ICT use in teaching mathematics stated: "I had to compensate for the insufficient formal procedural knowledge in the following year". It could be said that for this in-service mathematics teacher, developing formal procedural mathematical skills was an important goal to achieve. All the in-service teachers who participated in the research decided not to integrate technology in their teaching because of the previous mentioned factors.

What is interesting, in the previous description of the factors that affected the participants' teachers' decisions related to the integration of technology in their mathematics teaching, is that the positive beliefs of the participating teachers about the use of technology did not affect sufficiently their goal to integrate ICT in teaching mathematics, where this goal was instead strongly affected by the negative beliefs related to previous experiences, as well as to other teacher factors related to moderate knowledge and insufficient resources as mentioned above.

3.3 Community of Practices

The five participating teachers agreed to permit the pre-service teachers' integration of ICT in their teaching. Nevertheless, they were afraid to integrate by themselves ICT in their teaching. In the frame of the professional development school, we, as pre-service teachers educators, guaranteed the collaboration of our pre-service teachers with them and promised to accompany them in their integration of ICT in their teaching. This negotiation convinced them to accompany our pre-service teachers in their integration of ICT in mathematics teaching; what resulted in their decision to participate in the initiative. In the interview at the end of the academic year, the mentoring teachers emphasized the importance of the support given by the pre-service teachers' college educators to them and to the pre-service teachers. One of the in-service teachers said: "this support gave us confidence to engage in using ICT tools in our teaching of mathematics. We had expert people to whom we could turn when facing a problem or a difficulty". Overall, it could be said that all the participating teachers, through collaboration that included negotiation, were engaged in the initiative; i.e. using ICT in mathematics teaching.

The pre-service teachers were an integral part of the negotiation that characterized the learning process of the community of practice that included the in-service teachers. These pre-service teachers provided resources of three types for the mentoring teachers: technical support (for example helping in drawing functions using GeoGebra), technological pedagogical content knowledge support (for example helping in

building technological pedagogical models (such as applets) using GeoGebra for teaching specific mathematical topics), and affective support (for example comforting the in-service teachers by showing understanding of the difficulties which the mentoring teachers encountered). In addition, the mentoring teachers' experiences also included tackling together with the pre-service teachers logistic obstacles while integrating technology in their teaching, but they looked at these obstacles as a natural part of engaging with ICT in teaching. One of the in-service teachers said: "Sometimes, we had logistic difficulties, but the pre-service teachers were there to overcome these difficulties. The assistance from the pre-service teachers made us decide to continue integrating technology in our teaching". Another in-service teacher said: "It was difficult for me to teach mathematics with technology. Watching the pre-service teachers doing that encouraged me to try myself integrating technology in my lessons". A third in-service teacher said: "together with the pre-service teachers, we not only prepared mathematical lesson plans that integrate technology for a specific lesson, but we prepared lesson plans for whole units in the mathematics book, together with the applets needed for teaching each lesson in each unit. This would encourage us to integrate technology in our teaching not only this year, but in the coming years". This is a good example of developing a shared repertoire of resources.

In addition to the said above, the college, educators held meetings every two weeks with the pre-service teachers alone, with the in-service teachers alone and with them together. In these meeting, the participants discussed issues related to integrating technology in the mathematics classroom in general and in specific topics in particular. This mutual engagement of the community members, together with the mutual engagement of lesson planning and teaching, especially through the collaboration of the pre-service and in-service teachers, facilitated the in-service teachers' integration of technology in their teaching. One important issue, which was repeatedly discussed and investigated, is the designing of a suitable applet using GeoGebra to investigate and discover specific mathematical relations between given mathematical objects.

To assess our methods of intervention, including the community of practices through engagement and negotiation, we recorded observations of five lessons, one for each in-service teacher, at the level of teaching ICT-based mathematics lesson with the support of pre-service teachers. These observations pointed at new actions in the in-service teachers' teaching and interactions with their students. These actions and interactions, which accumulated from our previous methods of intervention, could clarify their statements in the interview at the end of the academic year, and explain the change in their beliefs, goals and decision regarding the integration of ICT in their teaching. Following is some actions and interactions that were observed in these lessons or were stated by the mentoring teachers in the interviews at the end of the academic year.

3.4 Teachers' Knowledge, Experience and Beliefs at the end of the Academic Year

The mentoring teachers reported that their experience of accompanying the pre-service teachers in integrating technology in teaching mathematics added to their

knowledge regarding technology itself, as well as its integration, and encouraged them themselves to engage in the integration of technology into their own teaching. One of the in-service teachers said: "The pre-service teachers' accompanying was crucial for us. They made our integration of technology into our own teaching easier and, in a way, enjoyable". Another in-service teacher said: "the pre-service teachers helped us improve our technical skills, which assisted our ICT use in teaching". They also reported that the pre-service teachers helped them get familiar with new ICT tools and internet sites, as well as how to use them beneficially. One of the in-service teachers said: "I utilized the GeoGebra with the help of the pre-service teachers to let the students investigate and discover the effect of changing the "a" parameter in the linear function ($f(x)=ax+b$) on the slope of its straight line. I am sure that these options in GeoGebra could be applied to discovering other mathematical concepts and relations". It could be argued that the in-service teachers decided to use GeoGebra applets in their teaching as a tool for dynamic illustration, for their students' exploration of mathematical concepts and relations, and for carrying out interactive discussion with their students. This argument has its merits also in the observations of the in-service teachers' lessons. The in-service teachers concluded that as a result, they improved their knowledge how to integrate ICT in teaching mathematics.

At the end of the experiment, the mentoring teachers had the same positive beliefs about integrating technology in the mathematics classroom, but now these beliefs seemed to be founded on their own experiences and not only on their previous studies and the general atmosphere regarding the importance of ICT in education, especially in mathematics education. Moreover, the mentoring teachers became more knowledgeable regarding what to do with ICT in the mathematics lessons.

3.5 Goals and Decision-Making related to ICT Integration at the end of the Academic Year

Regarding their goal to use ICT in their teaching, the mentoring teachers expressed their decision to integrate ICT in their future teaching of mathematics, but not all the time. For example, one mentoring teacher said that GeoGebra is best for students to investigate and discover mathematical relations, but the pencil and paper are needed for the students to assimilate and improve their formal procedural technical mathematical skills. Another mentoring teacher said that using applets and GeoGebra visually and dynamically to facilitate mathematical discourse and investigation can serve students' investigation of mathematical concepts and relations, but justifying the relations need to be done mainly without GeoGebra. It should be stressed that in spite of the restrictions that the in-service teachers put on the use of ICT in the mathematics classroom, they talked about their decision to use ICT as a main tool that supports students' mathematical learning. For example, one in-service teacher said: "My attitudes towards ICT use in teaching changed positively as a result of this experiment". Another teacher stated: "It is difficult now to imagine any mathematics classroom without the use of technology".

4 Discussion

In the present research, we attempted to analyze the development of in-service mathematics teachers' integration of ICT as a result of being part of a community of practice that worked on that integration. Being part of a community of practice, the participating in-service mathematics teachers substantiated, with classroom-evidence, their starting beliefs regarding the integration of technology in the mathematics classroom. In more detail, the pre-service teachers' initiatives and experiences in teaching mathematics with ICT constituted the first phase of negotiation between the researchers and the in-service teachers; i.e. the negotiation started as a result of the pre-service teachers' initiatives and experiences, which constituted resources for the in-service teachers that they could rely upon to engage in utilizing technology in mathematics teaching [12].

The second phase of negotiation in the community of practice regarding utilizing technology in the mathematics classroom came from the in-service teachers' own experiences of integrating ICT in their mathematics teaching, where this integration was enabled due to the pre-service teachers' support. The negotiation, and thus development of the in-service mathematics teachers' engagement and practices regarding the integration of ICT in their teaching, would probably not have happened without the community of practice, for it helped create a community of professionals that encouraged certain teaching behaviors, and substantiated beliefs regarding these behaviors. The community of practice was optimal for the in-service teachers to substantiate their positive beliefs about the integration of ICT in their teaching. This is due to the fact that in this context, it was possible for the in-service teachers to experiment teaching behaviors with the support of the pre-service teachers. This facilitated their decision whether to adopt these behaviors or not. The experimentation supported by the pre-service teachers, negotiated and improved their initial technological pedagogical content knowledge. This second phase of negotiation encouraged the in-service teachers to further use ICT in their teaching of mathematics. It could be claimed that the community of practice in which the in-service teachers, the pre-service teachers and the researchers were part of, was effective due to the characteristics of the community of practice that included the three components of a community of practice, as described in [9]: engagement, negotiation and utilizing/developing shared repertoire of resources. This shared repertoire of resources included different objects (as video clips of past-years pre-service teachers utilization of technology in their mathematics teaching), as well as different processes (as collaborative preparation of ICT-based mathematics lessons and teaching units by the in-service and the pre-service teachers).

The third phase of negotiation started when the in-service teachers began to teach using ICT on their own. The participating in-service teachers reported that teaching on their own encouraged them to set new goals and make new plans regarding their integration of ICT in their mathematics teaching. In fact, the pre-service teachers' practices as well as the mentoring teachers' practices regarding using technology in teaching mathematics encouraged the mentoring teachers to set new goals and make new plans that included utilizing ICT tools in their teaching. The ICT scene could be considered the unusual scene that encouraged the mentoring teachers to set new goals

and make new plans and decisions regarding the use of technology in their teaching of mathematics [21, 22].

In addition to the arguments above, it could be claimed that the community of practice provided for the in-service teachers a context in which they developed shared vision among all the participants in the community of practice, which is needed for the success of the practice. This shared vision was there from the beginning, but the practices of the community strengthened it.

This positive influence of the community of practice on the educational scene is described by several researchers; for example Price in [18] found the community of practice had positive influence on students' learning, where it enabled them to build on the contributions of others, develop a shared understanding appreciation for the mathematical resources used, and begin to see themselves as mathematicians. Steele in [25] reported that a community of practice, which was formed in a professional development course, had positive influence on the induction of a first-year mathematics teacher into her school. Furthermore, Shúilleabháin in [24] found that, as a result of participating in a community of practice that worked through lesson study context, the participating teachers' content knowledge, teaching approaches, pedagogical content knowledge and awareness of student thinking have been enhanced, which resulted in increased confidence in their knowledge of the mathematics curriculum. In addition, Boote in [4] reported that the community of practice, in the frame of a professional development school, influenced positively mathematics pre-service teachers' emerging pedagogical content knowledge. In the present research, the findings indicate that the community of practice has also positive influence on mathematics mentoring in-service teachers' practices; specifically on their decision to practice ICT integration in mathematics teaching.

5 Conclusion and Recommendations

The community of the in-service mentoring and pre-service teachers together with the college educators utilized a repertoire of resources as the video clips of integrating ICT in mathematics teaching carried out by previous pre-service teachers. In addition, they were engaged with and negotiated together the ICT integration in mathematics teaching in the training school. This community of practice improved the technological pedagogical content knowledge of the in-service mathematics teachers, and their experiences in using ICT in mathematics teaching. At the same time, the community practices strengthened their positive beliefs about the integration of ICT in mathematics teaching. These knowledge, experiences and beliefs led the in-service teachers to set new goals and decisions related to the active integration of ICT in mathematics teaching [21]. These decisions were conditioned by taking care of the students' formal procedural mathematical knowledge.

Depending on the research results, we recommend that teacher-training colleges utilize the community of practice framework in order to improve pre-service teachers', as well as the mentoring in-service teachers' technological pedagogical content

knowledge as well as their beliefs and, as a result, decisions regarding implementing new pioneer pedagogies, such as innovative ICT use, in the mathematics classroom.

Furthermore, we recommend utilizing different frameworks to analyze the development of teachers' innovative practices. One of these frameworks is the commognitive framework suggested by Sfard and Prusak in [23]. Using this framework, we could say that the in-service teachers were part of a community of practice, where their identity moved towards closing the gap between the actual identity and that designated by the researchers through experimenting with the pre-service teachers. It seems that the identity of the in-service teachers reached equilibrium, regarding their use of ICT in their teaching of mathematics. This equilibrium was between their actual identity before the experiment and that designated by the researchers. Closing the gap or reaching an equilibrium between the actual and the designated identity of teachers indicates that the in-service teachers underwent professional development; in other words learning [23]. This explanation is but an initial one, and more research, using the commognitive framework, is needed.

6 References

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Article submitted 03 July 2018. Final acceptance 03 August 2018. Final version published as submitted by the authors.