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A 'blended' in-service arrangement for classroom technology integration: impacts on teachers and students

Joke Voogt [a,*], Marinus Almekinders [a], Jan van den Akker [a], Bert Moonen [b]

[a] *Department of Curriculum, Faculty of Behavioral Sciences, University of Twente, P.O. Box 217, 7500 AE Enschede, The Netherlands*
[b] *CPS Educational Development and Advice, The Netherlands*

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Abstract

Many studies report that the implementation of technology in education is a complex innovation. Particularly teachers lack skills to integrate technology in their instructional processes. Therefore the potential of technology in the classroom is hardly realized. Teacher learning on classroom use of technology is considered important. In this contribution a 'blended' in-service arrangement to support secondary school teachers in the integration of technology in their classroom is presented. The arrangement consisted of workshops, exemplary curriculum materials and computer mediated communication. The article describes and discusses two studies that applied and evaluated the 'blended' approach to teacher professional development. The results of both studies show that this seems a promising arrangement for supporting the integration of technology in education. However, realizing the potential of technology to create 'communities of practice' remains difficult because for most teachers this use of technology is yet not congruent with their daily routines.

* Corresponding author.
E-mail address: voogt@edte.utwente.nl (J. Voogt).

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1. Introduction

Many studies (e.g., Mumtaz, 2000; Pelgrum & Anderson, 1999; Watson, 2001) show that the implementation of technology in educational practice is a complex innovation. Particularly teachers have difficulty in integrating technology in their instructional processes. Even though many teachers received training in basic technology skills, they hardly receive any continuous education that focuses on the pedagogical use of technology in instruction (Pelgrum & Anderson, 1999). Olson (2000) argues that technology often does not fit into the existing teaching culture and that it may even undermine the teacher's sense of efficacy. Teachers using technology therefore tend to domesticate the application in such a way that it becomes congruent with their prevalent practices. However, to make optimal use of the capabilities of technology often a change in pedagogical approaches and classroom management strategies is assumed. This implies that teachers have to change their routines (Sandholtz, Ringstaff, & Dwyer, 1997). The integration of technology in education requires a complex change, because not only new materials such as the operation of hardware and the use of software applications have to be learned, but teachers also need to change their behavior and beliefs (Fullan, 2001). To integrate technology in educational practice teacher learning is of paramount importance. One possible way to support such teacher learning is with carefully designed and validated curriculum materials, in which technology is indispensable. These materials can show how technology may be integrated in the classroom (Keursten, 1994; Van den Akker, 1988a, 1998b; Voogt, 1993).

Traditionally, teacher learning takes place through workshops. After the workshop, teachers return to their school and may or may not use what they have learned during the workshop. The work of Joyce and Showers (1980, 1995) has clarified that professional development is not finished when the workshop ends. Workshops need follow-up by coaching, study groups, or peer visits in order to yield a high return on investment. Establishing a teacher network is a way to organize collaboration between teachers involved in professional development activities that goes beyond the typical workshop and facilitates such follow up (Moonen, 2001). Loucks-Horsley, Hewson, Love, and Stiles (1998) define teacher networks as organized professional communities that have a common theme or purpose. A teacher network can be implemented by linking teachers in person or through electronic means with other teachers or groups to explore and discuss topics of interest, set and pursue common goals, share information and strategies, and identify and address common problems. Moonen (2001) reviewed a number of studies, which suggest that the use of electronic communication in teacher professional development activities: (1) might bring about a better integration of coaching and feedback activities; (2) will be suitable for exchanging experiences during the implementation of innovations; (3) can be used to continue the contact after the face-to-face meetings have terminated.

The in-service arrangement we developed for the integration of technology in the classroom has a 'blended' approach. Short workshops were alternated with periods in school during which the participating teachers could communicate with each other

and exchange lesson materials. The Internet was used for the communication and exchange during the in-school periods.

The two studies presented in this article had the intention to learn more about the use of this 'blended' in-service arrangement. The first study was conducted between 1997 and 2000. The second study could make use of the experiences in the first study and took place in 2001 and 2002. For evaluating the impact of this approach on teacher professional development, the approaches of Kirkpatrick (1994) and Guskey (2000) were used to distinguish among several effect levels (i.e., satisfaction, teacher learning, classroom effects, and student outcomes) of in-service education. In this article the focus is on teacher learning as experienced by the participating teachers, the effects on classroom teaching and the outcomes for students. The 'blended' approach aimed at providing support for teachers during the implementation of technology in the classroom through on-line communication facilities. Therefore, the use of and reactions towards the listserv (Study 1) and the website (Study 2) were also evaluated. Both studies used a range of evaluation data collected at various moments in the studies.

2. Study 1: teacher networks on Internet use in foreign language teaching

The *Teacher learning in in-service networks* study explored the potential of technology-enriched teacher networks as a strategy for in-service education. The in-service arrangement that was designed concerned the use of the Internet in teaching foreign languages (Moonen, 2001; Moonen & Voogt, 1998). Secondary school teachers teaching German and French as a foreign language in Dutch secondary schools participated in the study. The in-service arrangement consisted of two teacher networks, one for the French language teachers and one for the German language teachers. These networks were active for a period of 21/2–3 yr. The in-service activities that took place in the networks were divided in three stages. The duration of each stage was dependent on the technology skills and possibilities of the participants. The French language network needed more time than the German language network, because of the lower initial technology skills of the participating teachers. The first stage focused on familiarization of the participants with basic technology skills so that every participant had the same level of technology proficiency after this stage. In the second stage, the participants practiced the integration of the Internet in their classroom and were expected to reflect on the experience they gained. In this stage the teachers carried out an e-mail project and web-based lessons with the help of exemplary lesson materials. During the final stage it was expected that the networks were self-supporting, which implied that the network supervisors (one content expert and one network organizer) withdrew from the networks.

In the networks, workshops were organized (nine for the French language network and seven for the German language network). During the workshops a variety of issues were dealt with, for instance, a windows introduction (only French language network), e-mail introduction, educational use of the WWW, exploration of Internet sites, introduction and discussion of e-mail projects, introduction and dis-

cussion of WWW project. The exact agenda for each workshop was based on the development of each network. Between the workshops the participants had to carry out assignments (for example to make a planning for the e-mail project, to use the exemplary lesson materials in their lessons) and were supposed to communicate about their assignments and experiences using a listserv that was available for each network. Several exemplary lesson materials were used. For the e-mail project, the materials consisted of materials for teachers with detailed instructions on the preparation of an e-mail project including 20 fully elaborated lesson plans. The WWW project materials differed for each network, but consisted of a teacher manual and ready-to-use student materials.

3. Method

3.1. Participants

Sixteen secondary school teachers teaching German language and 10 secondary school teachers teaching French language participated in the study. Table 1 provides an overview of the background characteristics of the teachers.

As can be seen in Table 1 the teachers who participated in the networks differed in the experience they had with technology at the start of the networks. Most German language teachers already had basic technology skills, including the use of the Internet. However, the French language teachers were not yet proficient technology users.

Table 1
Background characteristics of French language and German language teachers

	French language teachers ($n = 10$)	German language teachers ($n = 16$)
Average age (SD)	43.1 (8.1)	43.5 (6.4)
Gender		
Male	3	11
Female	7	5
Average years of teaching experience (SD)	18.1 (7.2)	16.8 (8.6)
Knowledge of windows		
Good	2	12
Average	1	4
Poor	5	0
None	2	0
Knowledge of Internet		
Good	2	5
Average	0	4
Poor	2	4
None	6	3

3.2. Instruments

In the study a variety of instruments was used to collect data about the several effect levels of in-service education. In Table 2 an overview of the data collection instruments related to the effect levels is presented.

3.2.1. Teacher interviews

The participating teachers were interviewed three times, immediately after each in-service stage. With the interviews the perception of the teachers of the various effects of the teacher-learning scenario could be established. The interviews were audiotaped and transcribed. To analyze the interviews a coding scheme was developed. A first and a second reviewer analyzed the first 10% of the interviews. There were some minor differences in the initial coding, which were discussed and agreed upon. As a result the coding scheme was improved.

3.2.2. Lesson observation

Twenty-nine lessons (12 French language lessons and 17 German language lessons), where the teachers used the exemplary lesson materials, were observed by means of an observation scheme. The observation scheme focused on the following elements: lesson introduction, new subject matter, student activities, teacher activities, and end of the lesson. Finally, the observer gave his or her impression of the lesson by means of reactions on a five-point Likert scale to eight statements regarding the course and the organization of the lesson. Three research assistants carried out the observations. During the first observation the researcher accompanied each research assistant. Both the research assistant and the researcher observed the first lesson. There were some minor differences in the observation reports made by the two persons, which were discussed and agreed upon. The research assistants did the following observations independently.

3.2.3. Retrospective reports

The teachers completed a retrospective report after each lesson in which the exemplary lesson materials were used. The report focused on the actual lesson execution and the teacher's reaction to the exemplary lesson materials. In total 48 reports were completed (18 German and 30 French).

Table 2
Levels of effect and data collection instruments used in Study 1

	Interviews	Observation	Retrospective reports	TAC	Analysis of electronic communication
Satisfaction	X		X		
Teacher learning	X			X	X
Classroom effects	X	X	X		

3.2.4. Attitude questionnaire

The Teacher Attitude towards Computer Questionnaire (TAC; Christensen & Knezek, 1996) was used to determine the attitude of the participating teachers. The questions are answered on a five-point Likert scale (1 = strongly disagree, 5 = strongly agree). The following six sub-scales of the TAC have been used in the study: *enjoyment* (the pleasure someone experiences when using and talking about computers), *anxiety* (to use and talk about computers), *avoidance* (in using computers and gaining knowledge on ICT use), possible applications of *e-mail* for professional activities, a possible *negative impact* of computer use on society, and influence of computer use on the *productivity* of users. The scores should be interpreted as follows. The number 1 is the lowest possible score, which represents a negative attitude, while the number 5 is the highest possible score that stands for a positive attitude. The TAC was administered four times: at the start of the network and at the end of each in-service stage.

3.2.5. Analysis of electronic communication

All messages ($N = 516$) that were sent to the listserv of each network were categorized in four main categories: personal messages, messages concerning the innovation (the use of ICT in education), messages concerning the teaching subject (information related to the subject, but not on the use of ICT), and messages concerning education in general.

The messages concerning the innovation were analyzed in more detail using the approach of DiMauro and Gal (1994). They distinguished three types of electronic network use: *information-based communication,* which refers to the distribution of information to a group of recipients; *activity-based communication,* which refers to the use of the network for group activities directed towards the process of education, and *conversation-based communication,* which refers to the use of the network to exchange and talk about experiences. This latter type of network offers opportunities for professional development of teachers by means of reflective activities. The researcher analyzed all electronic messages. A research assistant analyzed 15% of the messages. The analysis of both researchers indicated an initial difference of 21%. After discussing the differences, the researchers could reach consensus.

4. Results and discussion

4.1. Teacher learning

For the majority of the teachers use of the Internet for private purposes became a routine due to their participation in the network. Particularly the participants of the German language network perceived the pedagogical aspects related to the integration of technology as an important learning outcome. This is probably due to the experience with technology most German language teachers already

had at the start of the network. About half of the French language teachers and the majority of the German language teachers regularly applied technology in their lessons. As a result of their participation in the network most teachers of both networks no longer avoided the use of technology. The decrease in anxiety to use computers was supported by the results of the TAC (Moonen, 2001; Moonen & Voogt, 2002). Table 3 shows the difference between the German and the French language network at the start and at the end. Complete data on the TAC could only be collected for 7 of the French language teachers and 12 of the German language teachers. Overall, the German network had a more positive attitude than the French network at the start as well as at the end. At the end of the network, the teachers in the German language network enjoyed the use of computers more ($M = 4.0$) than the teachers in the French network ($M = 3.4$, $Z = -2.373$, $p < .05$). The difference in avoidance of computers had disappeared, but differences in anxiety ($Z = -2.295$, $p < .05$), e-mail ($Z = -2.789$, $p < .05$), and productivity ($Z = -2.200$, $p < .05$) continued to exist.

Comparing the first and the final measurement, the French language teachers had become less anxious ($Z = -1.992$, $p < .05$) towards computers and avoided computers less ($Z = -2.197$, $p < .05$). The attitude of the German language teachers changed between the first and the final measurement for anxiety ($Z = -2.404$, $p < .05$), e-mail ($Z = -2.118$, $p < .05$), and productivity ($Z = -2.589$, $p < .05$). The negative attitude towards e-mail probably had to do with the technical problems many teachers in the German network encountered.

4.2. Classroom effects

Six of the 10 French language teachers and 10 of the 16 German language teachers implemented the e-mail and WWW-based lessons in the classroom. The teachers that didnot implement these lessons argued problems of time (which probably was a lack of priority). No one claimed they were insufficiently prepared through the profes-

Table 3
Comparison of the French and German language networks on the TAC scores at the start and at the end of the network (5-point scale: 1 = strongly disagree; 5 = strongly agree)

	First measurement		Final measurement		Difference	
	French ($n = 7$)	German ($n = 12$)	French ($n = 7$)	German ($n = 12$)	French ($n = 7$)	German ($n = 12$)
Enjoyment	3.6	3.8	3.4	4.0*	−.2	.2
Anxiety	3.2	4.0*	3.9	4.4*	.7**	.4**
Avoidance	4.0	4.5*	4.3	4.5	.3**	.0
E-mail	3.3	4.0*	3.1	3.6*	−.2	−.4**
Negative impact	3.7	4.0	3.6	3.7	−.1	−.3
Productivity	3.5	3.8*	3.7	4.3*	.2	.5**

* $p < .05$ – analyzed with Mann–Whitney test.
** $p < .05$ – analyzed with Wilcoxon matched-pairs signed-ranks test.

sional development arrangement. During the interviews, the French language network teachers indicated that the e-mail project was not a big success in the French language network due to lack of proper preparation by the teachers themselves. Also in the German language network the international e-mail project was not a success, but the e-mail project between classes of the participating teachers was a success, which was determined through analysis of communication and interviews. The WWW-based lessons were a success in both networks, as is also shown in the results of the classroom observations (see Table 4). The teachers indicated in the interviews that they were able to fulfil the coaching role and were also able to give technical assistance when necessary (Moonen, 2001).

4.3. Communication through the listserv

Through the interviews a positive impact on teacher learning and classroom implementation of technology was reported by the teachers in both networks. However, as became clear in the interviews, from the several components of the network they liked the workshops and the exemplary lesson materials most. The listserv, which was supposed to support the teachers during implementation, was welcomed. However, it did hardly fulfil the function that was intended, as became clear from the analysis of the messages. Apart from technical problems some participants experienced with e-mail at the start of the networks (which was quite discouraging), the most important obstacle, as was mentioned in the interviews, was that the participants did not participate equally in the communication on the listserv. Only very few participants brought information to the listserv, while most participants only retrieved information. The analysis of the messages showed that the majority of the information that was shared on the listserv had an informative nature (for instance pointing to interesting websites) instead of a reflection on experiences with technology use. The network supervisors tried to stimulate the communication but were not very successful. Some teachers expressed in the interviews that they did not have much to bring to the listserv or they feared criticism from their peers. Some others made clear in the interviews that they preferred communication to one person instead of a whole group. Other teachers claimed to have no time for contributing to the listserv.

Table 4
Classroom observation results of the WWW based lessons of the French and German language network, indicating number of teachers per category

	French language teachers ($n = 6$)			German language teachers ($n = 10$)		
	Yes	Sometimes	No	Yes	Sometimes	No
Lesson implementation was a success	4	2	0	8	2	0
Students were motivated	5	1	0	8	2	0
Teacher could support the students	4	2	0	10	0	0
No problems during lessons	3	2	1	9	0	1

5. Study 2: in-service arrangement on technology in the physics classroom

The *ICT in rural schools* study, a collaborative project between Russian and Dutch partners, aimed at (1) supporting physics teachers with the implementation of a learner-centered approach to physics teaching in which use of technology is made; (2) exploring the potential of the WWW in an in-service arrangement for teachers that are geographically far apart. The study took place in two rural regions in the Russian Federation (Voogt, Gorokhovatsky, & Almekinders, 2003). The in-service arrangement had three stages. In the first stage, the teachers received training in basic technology skills and became acquainted with technology applications for physics. This stage (about three months) was organized by the Russian counterpart in the project and took place during workshops at the regional level. After this preparation stage the focus of the in-service arrangement shifted to classroom implementation. In the second stage, the teachers were introduced during a workshop to learner-centered pedagogical approaches including the potential of technology to support such approaches by means of exemplary materials that were developed in a previous project for urban (Russian) schools (Voogt & Plomp, 2001). These exemplary lesson materials were tried out in urban schools, and contained a number of lessons on optics and electricity. In the lessons the use of simulation software or micro-computer-based laboratories (computer used as a measuring device in lab work) were integrated. Besides learner-centered pedagogy, the teachers learned to use the website that was developed for the project. In the next three months the teachers were asked to adapt the exemplary lesson materials to their own situation, to use the adapted materials in their own classrooms, and to share experiences with their colleagues and a moderator (which was a Russian pedagogical expert) through the project website. Then all participants met again to prepare for the third stage of the in-service arrangement, the development of lesson materials. In the next three to four months teachers developed lessons, shared them with their colleagues and the moderator through the website, received feedback and tried out the lessons in their classrooms. Finally, the experts (Russian and Dutch pedagogical experts) observed and discussed a teacher-developed lesson during a visit to each teacher. About half a year later the teachers participated in a conference where they shared their learning experiences and examples with other science teachers and experts.

The website that was developed for the project had an open part with information about the project and a password protected part for use by the participants only. In the password-protected part the participants could make use of a discussion forum to exchange experiences and information and they could upload and download lesson materials.

6. Method

6.1. Participants

Eight physics teachers, five male and three female, participated in the study. Their age varied between 29 and 48 ($M = 40.4$, SD = 7.4) and their teaching experience be-

tween 7 and 29 years (M = 18.6, SD = 7.9) . For five of the eight teachers the project was groundbreaking, because they had not had any experience with computers before. The other three teachers had some to a lot of computer experience already at the start of the study. However, this experience was not related to use of technology in physics teaching.

6.2. Instruments

A variety of instruments were used to collect data about the several effect levels of in-service education. In Table 5 an overview of the data collection instruments related to the effect levels is presented.

6.2.1. Teacher questionnaires

An open questionnaire was developed to determine the change teachers expect for themselves, in their classroom and for their school, and about their specific needs for professional development. It was administered twice: at the start of the second stage and at the start of the third stage of the in-service arrangement. The second time the teachers were asked to add or amend to their original responses.

A closed questionnaire was developed in which all the activities that have taken place in the in-service arrangement were listed. It was administered during the dissemination conference (November 2002). The questionnaire was used to measure the satisfaction with each of the program's components. The six teachers who were present at the conference expressed their opinion about the usefulness of each activity on a scale from 1 (absolutely not useful) to 5 (very useful). Teachers could also add additional activities that were for example organized at districts or regional level.

Table 5
Levels of effect and data collection instruments used in Study 2

Effect level	Teachers			Students	Teachers		
	Teacher questionnaires	Stages of adoption	Interviews	CCEI	Classroom observation and discussion	Metaplan sessions	Analysis of electronic communication
Satisfaction	X		X			X	X
Teacher learning		X	X		X	X	X
Classroom effects			X		X		
Student outcomes			X	X			

6.2.2. Stages of adoption of technology questionnaire (SoA)

The SoA provides a measure of the teachers' stage of adoption of ICT use in educational practice (Knezek, Christensen, Miyashita, & Ropp, 2000). The teacher has to indicate one of these stages: (1) awareness; (2) learning the process; (3) understanding and application of the process; (4) familiarity and confidence; (5) adaptation to other contexts; (6) creative applications to new contexts. The SoA was administered at the start of the second stage and at the end of the third stage.

6.2.3. Teacher reflective interview

A reflective interview was conducted with six of the eight teachers during the dissemination conference. It aimed to obtain information about teachers' perceptions of the program's effects. The interviews were conducted in the Russian language, audiotaped, and transcribed in Dutch afterwards.

6.2.4. Computer classroom environment inventory

The Computer classroom environment inventory (CCEI) measures student attitudes towards an inquiry oriented ICT rich learning environment (Maor & Fraser, 1996). It consists of 30 items along five scales: investigation, open-endedness, organization, material environment, and satisfaction. For each scale there are six similar items. Possible responses to an item are that what is stated in the item is: (1) never; (2) seldom; (3) sometimes; (4) often or (5) very often the case. The investigation ($\alpha = .81$), open-endedness ($\alpha = .74$), and satisfaction ($\alpha = .68$) scales are used for this evaluation. The CCEI was administered twice, namely, at the start of the second stage and at the end of the third stage.

6.2.5. Classroom observation and discussion

During the monitoring visit at the end of the third stage one lesson of each teacher was observed by the researcher and two didactical experts (one Dutch and one Russian) and afterwards discussed with the teacher. The lesson observations have been videotaped.

6.2.6. Metaplan sessions

The use of the website was evaluated with the participants in metaplan sessions at the start of the second stage and at the dissemination conference (see www.metaplan.com for more information). The topics that were discussed dealt with the appreciation of the contributions, the functionality of the website components, the role of the moderators and the experience of ownership of the website.

6.2.7. Analysis of electronic communication

The number of contributions to the forum was counted for each participant and for the moderator. Also the number of uploads were counted.

7. Results and discussion

7.1. Teacher learning

Teachers' learning has been discussed in detail with the participating teachers during the concluding reflective interviews. The teachers mentioned that as a result of the in-service arrangement they learned how and when to use technology applications in physics lessons. One of the teachers expressed her learning process as follows: *First I had to learn it myself, then together with the students; now I can use ICT without the help of an other teacher*. The teachers also reported that they had learned to use student-centered pedagogical approaches and they expressed to feel confident in applying those approaches in their teaching practice, as was articulated by a teacher as *I have learned to look in a new way at the role of the students in the learning process*. One teacher explicitly mentioned that he learned how to improvise with a limited number of computers and another teacher mentioned the possibility of communication with colleagues and experts as an important benefit of the in-service arrangement.

The reflections of the teachers are also mirrored in the results of the Stages of Adoption of Technology questionnaire that was administered after the preparation stage and at the end of the classroom implementation. All teachers indicated in the pre-test that they were at least at the stage of understanding and applying the process (*I am beginning to understand the process of using technology and can think of specific tasks in which it might be useful*) or higher. Already at the start of classroom implementation the teachers rated themselves relatively high in adoption of technology. This may be explained by the activities in the preparation stage, organized by the regional in-service training institutes and the Russian members of the project team. All teachers indicated in the post-test that they had reached a higher stage of adoption. Now half of the teachers indicated to have adopted technology at the highest stage (*I can apply what I know about technology in the classroom. I am able to use it as an instructional tool and integrate it in the curriculum*).

7.2. Classroom effects

All teachers prepared and executed lessons in which they integrated ICT and realized the intended innovative pedagogical approach. One of these lessons was observed by experts and discussed with the teacher. During the observations, it became clear that teachers were creatively engaged in using the computer and devoted considerable attention to integrating the use of ICT in an innovative pedagogical approach. The classroom observations also showed that all teachers used group work and applied a variety of activities. Learning by doing was realized in the practical assignments that students had to carry out, either in realistic lab assignments or through computer simulations. In most lessons the teacher determined the activities of the pupils, but whenever the pupils worked in a group tasks were divided by the pupils and to some extent they could also determine their own pace of work. The

integration of school learning and real life was hardly addressed by the teachers. During the reflective interviews, teachers were asked how often they made use of the innovative pedagogical approach. All responded that they used approaches like group work and a variety of activities in 25–50% of their lessons.

7.3. Student outcomes

The CCEI and questions during the reflective interviews were used to provide information about the impact of teacher learning on students. The three used CCEI scales provided an indication whether the perceptions students have about their learning environment changed over the course of the project with respect to investigation (e.g., *in this class, I carry out computer investigations to test my ideas*), open-endedness (e.g., *in this class, I can go beyond the regular instruction and do some problems on my own*), and satisfaction (e.g., *the work with computers in this class is enjoyable*). A one tailed t test for matched pairs showed that all observed changes are significant. The results are summarized in Fig. 1.

The results show that student satisfaction had increased from 4.32 (SD = .59) to 4.49 (SD = .44), $t = 3.81$, df = 151, $p < .05$. Students also regarded their learning environment as more investigative, with an increase from 3.07 ($SD = .72$) to 3.32 (SD = .72), $t = 3.71$, df = 151, $p < .05$. Finally, they regarded their learning environment as more open-ended, with an increase from 2.75 ($SD = .75$) to 2.99 (SD = .75), $t = 3.36$, df = 151, $p < .05$. Teacher reports about their students can be added to these results. An increase in motivation for physics due to the use of ICT was reported. Most teachers also reported that their students not only used ICT during physics but also used it for finding information and for communication.

7.4. Use of the website

Based on the experiences with on-line communication in Study 1 a website was designed that was 'owned' by its users. A website was preferred above a listserv,

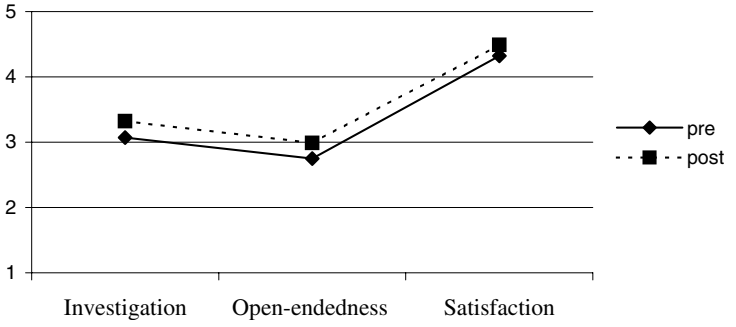

Fig. 1. Student scores on pretest and posttest of CCEI scales investigation, open-endedness, and satisfaction: 1, never; 2, seldom; 3, sometimes; 4, often; 5, very often.

because using a forum on a website makes it easier to structure the line of discussion and to keep track of conversations. Besides, one of the main aims in Study 2 was to enable teachers to exchange materials in order to discuss implementation in their specific context. An upload facility was considered more realistic for this purpose than attaching large files to e-mail messages. To realize ownership the design of the website was developed in close cooperation with the participants. One important design decision was to have the site password protected so that the teachers could communicate in a safe environment. To stimulate participation distinct tasks were assigned between the workshops with an explicit role for the moderator (one of the Russian experts) in stimulating and guiding the discussion. To what extent the teachers indeed felt that the website was important for them was evaluated through the analysis of the electronic communication, the metaplan sessions, and the reflective interviews. Each teacher was involved in the discussions on the website forum, although the intensity of participation differed a lot, also due to problems with connectivity, in particular for the teachers in the most remote areas. Next to communication via the forum teachers could also upload lesson materials that they had developed in the frame of the project. In total, 15 lesson plans were uploaded from six teachers. Particularly for this facility technical problems played a role. For some of the teachers it took hours to upload a file with the risk that they had to start all over again when the connection crashed.

The majority of the teachers agreed that the website was important, because it was easy to work with, the materials were useful and the site provided teachers with the possibility to jointly carry out activities and search for solutions of problems. According to the teachers the forum provided a good opportunity to discuss lessons and lesson plans. Some teachers had a few more critical remarks, related to the intensity of the discussion. They felt that their colleagues could be more active in the discussion. Others noted that technical problems also hampered the discussion. Most teachers were satisfied by the way the moderator directed the discussion and encouraged the teachers to participate. The teachers also experienced that they and the moderator had to learn how to organize the discussion on the forum. For instance, it was better not to discuss the whole lesson at once, but to take a specific aspect of a lesson, such as the goals or the motivating elements in a lesson. Also it was decided to discuss a theme during a specific period and finalize the discussion with some concluding comments from the moderator.

Apart from the opportunity for discussion through the forum, the website also had the possibility for sharing materials through the upload/download facility. Despite the technical problems most teachers welcomed this facility. Nevertheless, one of the teachers expressed that he found it rather difficult to put down his ideas for lessons on paper. Yet, he said to learn from the plans written by others. Another teacher felt somewhat uncertain about the quality of the lessons he developed. He proposed that before sharing lesson materials with other teachers, pedagogical experts should approve them. Also the issue of intellectual ownership was identified as a possible problem area. At several occasions the teachers and the Russian experts expressed the fear that others might make incorrect changes and then distribute the

materials while these would still carry the name of the original author thus jeopardizing the author's professional reputation.

8. General discussion

The results of both studies show that the 'blended' in-service arrangement that was applied seems promising for supporting teachers in implementing complex innovations, such as the integration of technology in education. In the first study, the 'blended' in-service arrangement was embedded in a teacher network that was in place during quite some years. In this study, the face-to-face meetings together with the exemplary curriculum materials were considered the most important components of the approach. The potential of on-line communication was not used as was anticipated in the two networks. Several reasons were mentioned: lack of time, ICT not being part of the teachers' daily routines, and not being used to collegial learning. Particularly the lack of balance between bringing and getting information contributed to the non-functioning of the listserv (Moonen, 2001). Other studies (e.g., Selwyn, 2000; Tannehill, Berkowitz, & LaMaster, 1995) report similar reasons.

In the second study the 'blended' in-service arrangement lasted considerably shorter. Also here the face-to-face workshops and the exemplary curriculum materials were important, next to the development of own curriculum materials, the school visit, and the on-line communication possibilities. In this study we worked with teachers who were living and working really far apart. More so than in the first study these teachers could experience on-line communication as a possibility to overcome their professional isolation. We assumed that this need would trigger them to use the possibilities for sharing experiences and resources on-line, despite the fact that most teachers in the second study were not experienced technology users. We could not influence the time that the teachers had available for their participation in the in-service arrangement, but we tried to anticipate their unfamiliarity with collegial learning. Therefore, a moderator, who was an expert in science pedagogy, had an explicit role in encouraging and guiding the discussion. Through the design of the website we tried to create 'ownership' among the participants. In the second study the teachers exchanged their approach to lesson implementation and reflected for instance on the motivating features of a lesson. They also exchanged lesson plans, which was appreciated by all participants. Nevertheless, also in this study we noticed that some teachers felt unsure about their contributions. The potential of technology to create 'communities of practice' (Bos, Krajcik, & Patrick, 1995; Putnam & Borko, 2000) is not that easy to realize. This is also the conclusion of Zhao and Rop (2001) who performed a review of the literature on electronic networks for teacher learning. They proposed that further research in this area should take the teacher's ecology more into account. Not the potential of the technology but the teachers, their teaching and their needs should be the focus. The central question then is 'How could computer-mediated communication make the teacher better?' (Zhao & Rop, 2001, p. 91).

In both studies the face-to-face meetings were important because they provided time for hands-on experience and also because participants got to know each other. The exemplary lesson materials helped the participants to get a better understanding of the integration of technology in their subject and helped them during implementation in classroom practice. Particularly the challenge to adapt the exemplary materials to the teachers' own setting and to personally develop lesson materials using the exemplary materials as a model were very helpful in Study 2. This finding is in line with Borghi, Ambrosius, and Mascheretti (2003) who argue that it is essential to create proper conditions for teachers to personally prepare plans of work and materials for their students. The on-line communication was considered as additional support for teachers during the implementation process, because it was believed that through the use of technology peers and experts could give personal feedback and coaching. The results of these studies show that using technology for this purpose is a learning process, both for the teacher and the curriculum designer.

In-service arrangements that provide support for teachers during the implementation of technology in their educational practice seem a promising approach. In such an arrangement face-to-face meetings, computer mediated communication and exemplary curriculum materials have a significant role. One has to realize that the use of technology in such an arrangement assumes that teachers use the technology as their students do, when they communicate with their peers. However for most teachers this use of technology is yet not congruent with their daily routines.

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