

OECD/CERI ICT PROGRAMME

ICT and the Quality of Learning

A Case Study of ICT and School Improvement at
Integrierte Gesamtschule Bonn-Beuel, Bonn, Germany



October 24-27, 2000

Dr. Uwe Haass, Team Leader
Franziska Seeber
Ulrike Weininger

FWU Institut für Film und Bild in Wissenschaft und Unterricht gemeinnützige GmbH
Grünwald, Germany



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1. Introduction

The following study was carried out within the scope of the qualitative research project *ICT and the Quality of Learning* from OECD/CERI. The integrated comprehensive school in Bonn Beuel (ICS) was one of four case-study schools investigated from 24 October to 27 October 2000. The focus of this international study is first to examine the different ways that information and communication technology (ICT) relates to school innovation and improvement and under what conditions it functions as a catalyst for these. Second to uncover the critical variables that relate to successful implementation of school improvement and effective ICT. Furthermore, to detect undesirable impacts of ICT upon school functioning and student learning.

Not only was the ICT infrastructure at the ICS Bonn-Beuel of a very high level but numerous school innovations and improvements were being implemented at the school. An outspoken Headmaster, committed teachers and parents can be seen as conditions for creating an innovative environment, however to be able to implement ICT at school, financial and material resources are equally essential and if ICT is to be implemented on a wider scale at the school, more specific further training for teachers regarding the handling of ICT is necessary.

2. Overview

Figure 1: Schoolbuilding

The integrated comprehensive school (ICS) Bonn-Beuel is a state-controlled school in Beuel, a part of the town of Bonn in the Federal state of North-Rhine Westphalia (NRW). The school comprises Grades 5 to 13 i.e. Lower, Middle and Upper School, and students who would in the past have attended the Hauptschule (General Secondary School), the Realschule (Secondary Modern School) and the Gymnasium (Secondary Grammar School) are now taught together in one class. It is a whole-day school. Since 1985/86 the school has integration Grades where 5 handicapped and 20 non-handicapped children are taught together. Within the school building is a part of the town library to which the children have access.



The school is renowned beyond the town boundaries as it has won many prizes for innovative projects and pedagogic performance, among others, the first prize in the competition *Qualität schulischer Arbeit 2000* (*The quality of educational work 2000*). In 1998, the school won a NRW promotion prize for *Schulen online* (*Schools online*) awarded by the computer journal *Chip*. At international level, the school came third in the *Europäischen Wettbewerb für Multimedia Bildungssoftware* (*European competition for Multimedia Educational Software*) awarded by the European Union in 1996/97.

In 1997, the school participated in *Schulen ans Netz* (*Schools in the network*). The prize money invested in an Apple computer room and the school became a model school for Apple. In August 1998, ICS Bonn-Beuel became a *Microsoft Partner School*. Since 1999, it has also been a *Bertelsmann Media School*. All this has contributed to making the school one of 12 German schools which have been judged as particularly innovative in handling ICT (cf. Appendix E).

The school is attended by 1351 boys and girls^[1], of which 60 have special educational needs. The social catchment area of the school is "a cross-section of the town's population" (*Headmaster*). The average class size is 30. The school has a teaching staff of 125 whose average age is the end of forty. The staff have always described their satisfaction with the school as being at a very high level. Students, parents, teachers and the Headmaster repeatedly emphasise that the school is very popular. The Headmaster sees the high number of applicants for the school as a sign of its popularity. Innovation has always been present at the ICS Bonn-Beuel for reason of its special educational form and history. When comprehensive schools were first introduced into Germany they met with considerable opposition and such schools simply were forced to prove their quality. Teachers volunteered to teach at the ICS Bonn-Beuel with a view to being able to motivate the process and this led to the development of a good working atmosphere between teachers, parents and students since its foundation in 1978.

Information and Communication Technology (ICT)

The following describes aspects of ICT application. In view of the size of the school and the regularity and frequency with which ICT projects are carried out there, it is not possible to present a complete overview. For students in Grade 6, there is a week-long project aimed at teaching the children word-processing. In Grade 8, there is a week-long "Newspaper project" in the German class for all students where basic knowledge in word processing and a graphics program will enable the students to design a newspaper layout. There is an in-school company managed by students who repair old and defect computers and sell them again at a favourable cost. Further media projects, such as a training for *Computer pilots* in co-operation with the business world took place two years ago, or a *Human Rights Working Group* which uses the Internet to spread information are just a couple of the many projects, too numerous to mention. One project, however, should be mentioned and that was a model trial held by the regional government in Cologne called "*Kommunizieren, Informieren, Recherchieren, Produzieren, Präsentieren*" (*KIRPP*) (*communicate, inform, research, produce, present = CIRPP*), in which one 5th Grade of the ICS Bonn-Beuel took part from Summer 1998 to Summer 2000. The trial aimed at testing the introduction of ICT and development of new teaching models.

The use of ICT was increased in the CIRPP class especially in the subjects of Religion Instruction and Social Sciences (including Politics, Geography and History). A variety of media projects were carried out with the students in class, e.g. the planning and equipping of a playground within *Agenda 21*. The results were documented

in HTML in the Internet and a 3D model was designed. Using a digital camera the students created a photo novel to be presented in the Internet. Students in the CIRPP class have benefited in two ways: first through the infrastructure; as all students, including the socially disadvantaged, were given the opportunity to use a PC and Internet access at home by their parents for Christmas 1998. Secondly, the students received intensive basic training in information technology.

School innovation and improvement

The following describes a selection of school innovations whereby special emphasis is to be made on the strong involvement of the parents in educational work. At least 50 to 60 parents are currently active and committed in the school, for example, in looking after the cafeteria or in the Parents Council. Co-operation with and participation of the parents is a significant criteria for their child's admittance to the school. Parents reported that they enjoy helping at the ICS Bonn-Beuel.

For the past seven years, Grade 5 has been using an educational unit called "*Health Education*" based on a program for the whole school which is constantly reviewed. In Grade 11, the students have methods training throughout the whole of that school year, aimed at increasing and promoting independent learning. The ICS Bonn-Beuel has created an inter-subject science curriculum. From Grade 6 to Grade 8, the students are taught *Natural Sciences* combining the subjects of Biology, Chemistry and Physics with one teacher teaching all three subjects. The parents drew particular attention to the positive form of group work resulting from this project and the fact that their children are in school care the whole day. All the persons interviewed expressively emphasised the integrative character of the ICS Bonn-Beuel. Parents, teachers and students all equally agreed that the strength of the school was to be seen in the integration of handicapped children and the heterogeneous backgrounds of the students.

3. The past

ICT

It was a woman mathematics teacher who was mainly responsible for introducing ICT at the school when she canvassed for the new technologies at a school conference in 1996. A decision taken by the conference paved the way for the school's official target to define its ICT sector more strongly. ICT was to be more strongly integrated into the learning process and the installation of computer equipment accelerated. The teacher began work on ICT projects, integrating them into her lessons. Shortly after the new Headmaster joined the school, 1996/97, this woman teacher and a colleague who had co-operated closely with her left the school to take up new posts. This was followed by a period of stagnation regarding the introduction of ICT to the school. According to one teacher explaining the situation, *There was no money*.

Before the present Headmaster joined the school, it had not had a headmaster for 5 years. The Headmaster spoke of a *standstill in reforms* when he came to the school, therefore the first thing he did was to carry out an inventory among teachers, parents and children concerning what they thought *should stay as it is* and *what should be changed*. Twelve teachers and two external moderators formed a control group to evaluate the results of the poll. Among other things, ICT was given as a focus point and a basis was established for its further development in the school. Previously there had been no money to accelerate ICT at the school so the Headmaster began massive endeavours to find financial assistance and sponsors.

So I started to look for money and materials. I acquired things, I submitted project applications, I went from door to door ringing doorbells, got to know people, pulled a few threads here and there. ... It's just a question of talking to the right people in the right place at the right time (Headmaster).

It would appear to be important to mention at this point that the Headmaster was keen to make acquisitions of sponsors, money and materials not only for the ICT sector, although the ICT sector has increased the most. ICS Bonn-Beuel received little money from governmental sources for equipping the school. Using the money raised by the Headmaster, a group of three to four teachers and the school electrician began to push the infrastructure for ICT equipment. Rooms and the school office were equipped with computers. The school electrician was mainly

responsible for linking the school up with the Internet in 1997 and was supported by teachers who are still committed and active today, by students and one father. The link up with the net was undertaken step by step, also during the summer vacation.

The CIRPP project was taken on by one very committed male teacher and a woman colleague who was prepared to put the model project into practice in their Grade 5. The male teacher had specifically left his former post to join the ICS Bonn-Beuel four years ago *"with the expressed desire to develop ICT here"* (teacher). His particular concern is pedagogic concepts for ICT at the school.

In the year 2000, the first curricula for comprehensive schools in North-Rhine Westphalia appeared, prescribing the application of ICT in teaching for the Lower, Middle and Upper School. Since this school year, spread sheet analysis has been integrated into the mathematics lesson for Grade 11 and, in Grades 5 and 6, basic qualification in word processing in the German lesson. However, the Headmaster comments on the implementation of the curriculum as follows: *"It is not as if I could say, all the teachers use ICT. It is not that yet widespread. But many of them have"* (Headmaster)

One major problem regarding the implementation of ICT at the ICS Bonn-Beuel is the enormous amount of time the teachers involved are prepared to invest. One of them commented, *"Yes, there is a negative side to it. I don't get to see my family too often"*. Another teacher was of the opinion, *"No amount of duty working hours can make up for the amount of additional work we have put into the projects"*.

School innovation and improvement

Work began on the development of an overall curriculum for science lessons about five years ago with a group of very committed teachers mainly responsible for the organisation and implementation of the Science Curriculum. The curriculum was constantly revised to determine which subject was to be taught, how and to what extent. This discussion process took place at school and, according to teachers, did not always run smoothly as teachers tried to push through the interests of their own subject. The new curriculum was revised along the lines of experience gained in lessons in a systematic exchange process within the ICS Bonn-Beuel and then tried out. An obligation regarding the teaching of the curriculum was further discussed in a curriculum group consisting of representatives from comprehensive schools in North-Rhine Westphalia, including one teacher from ICS Bonn-Beuel. Two years ago, the Ministry of Education accepted the plan, revised it and it now has been officially in use in comprehensive schools in North-Rhine Westphalia for one year.

One of the greatest problems in the implementation of the Science Curriculum is that teachers who otherwise teach either chemistry or biology or physics now have to teach all three subjects. This involves an enormous amount of additional work and time as they must gain the knowledge they require in the other subjects auto-didactically, which causes extreme stress. According to some teachers, not all colleagues are willing to do this and there were also teachers who did not feel competent enough to teach - for them - foreign subjects, which for which they had no academic training - in Upper School classes.

The established Curriculum may have eliminated in the meantime the initial problem that teachers were teaching in different ways; *"We must wait and see if that is really the case in the end"* (teacher).

4. The Present

4.1 Organisation of Evidence

4.1.1 Diffusion Patterns

The introduction of ICT was initiated by a woman teacher. A small group began to accelerate the process. There was no flow of information between the few, well-qualified teachers and their other colleagues. The project came to a standstill when the main initiator left the school. With the arrival of the new Headmaster, a new small group of teachers became active once more in diffusing ICT, meeting with little resistance. Teachers who become involved early on with innovations are more prepared to question what they are doing and to try out new ideas. The ICT diffusion has not yet been diffused throughout the whole school.

The idea to introduce information and communication technology at the ICS Bonn-Beuel originated from a

woman mathematics and computer science teacher. In the initial stages, the innovation was supported by a very small group consisting mainly of teachers of scientific subjects. Many reported on the problems experienced at the beginning:

There were more or less two groups. One group, the smaller of the two, were the insiders. They knew what it was all about and how to deal with everything. In a way they were privileged. The rest just looked on in jealousy at what this group was doing and understood nothing of it. The reason was they were not at the same level as the group who all had taken part in further training and information sessions. In any case, it was a more or less private party, which, in my opinion, was not willing to pass on the knowledge they had to others. This led to, well, not conflicts, but there was a certain degree of friction (school electrician).

Another woman teacher said, *"In the Meantime, we had a two-class society in the staff room"* meaning those teachers who can, and those who cannot, handle computers. Only with the departure of the woman initiator and the arrival of the new Headmaster were any advances made concerning the further development of ICT at the ICS Bonn-Beuel whereby the Headmaster's commitment in this respect played an essential role. The financial and material resources he obtained for the school seem to have had a motivating effect on a small group of teachers. In *"a small involved team"* (teacher), they began to push the development of ICT at ICS Bonn-Beuel. The team consisted of a Computer Science teacher, a woman teacher for Biology and Geography, a Physics teacher, a teacher of English and Physical Education, a History teacher, a teacher of Office Administration and a teacher of Religion. In the following years, further training was in-house and attempts were made to involve a large number of teachers. The training imparted basic ICT skills among the teachers, removing their apprehensions against the new technologies.

Although the new infrastructure was quickly implemented at the ICS Bonn-Beuel, the use of the ICT in lessons and projects has not yet been widely diffused. According to the Headmaster, *"In the meantime, about two-thirds of the staff are able to integrate ICT into their lessons and perhaps half of them do on a more or less regular basis"*. One teacher remarked: *"There are one or two teachers who make such projects, or perhaps a few more. ... but, on the whole, we are still in the initial stages"*. He continued, *"if I had to make a guess as to how many really use the PC in the lessons, sporadically not regularly, let's say once every six months, then I would put the figure at around 30%, however, that is really a very rough guess"*. Students outside of the CIRPP class and one father said that the use of ICT at ICS Bonn-Beuel was not yet very advanced.

Well, at the moment I would say pragmatically that for my taste it is not enough because too few colleagues really make use of the opportunity. Many of them simply block the whole idea as it is too much extra work. ... As long as the majority don't really see it as a chance it will surely not progress as quickly as we have planned (father).

Nevertheless, several teachers, including those who had not yet worked with ICT in their lessons, emphasise that ICT is too omnipresent to be able to reject it permanently. The fact that many teachers used a PC at home in the preparation of their lessons had already effected a diffusion of ICT use and utilisation amongst the staff (cf. Appendix B, Table 2). The school is still in a *"development stage (woman teacher)* regarding ICT.

Resistance

Although the Headmaster claimed there had been little resistance in the school regarding ICT and innovative projects, one woman teacher commented on the *Newspaper Project* in the German lesson *"Yes, there was a lot of resistance, in any case against the German project ... all the women German teachers ... said: "It won't work anyway". It took up a lot of time and nothing really came out of it and there was really quite a lot of resistance (woman teacher)*. This opposition has been overcome, in the meantime. *"Some of the staff were sceptic"* (teacher) about ICT due to the fact that there were *"very few well-thought out, tried-and-proven pedagogic and didactic concepts"* (teacher). The amount of additional time necessary was also given as a reason for the lack of commitment. The CIRPP project aroused feelings of jealousy and competition among other teachers because it had found positive resonance amongst the public and it was incomparably well equipped.

Early/Late Adapters

The characteristic early adapters were those with scientific subjects who began to use ICT in lessons. According to one teacher, the use of ICT in teaching *"has nothing to do with science"*. One teacher was of the opinion that it was characteristic for teachers who adapted to innovations that they were willing to question themselves and what they were doing. To do this, a certain degree of frustration was necessary so that the confrontation would begin with the status quo which included changes. Many teachers said that increased receptiveness for innovations was a characteristic of innovative teachers.

Teachers who belong to the group of late adapters at the ICS Bonn-Beuel seem to be characteristically generally more sceptic in their approach to computers and The Internet. They question its use and differentiate its advantages and disadvantages more. Some expressed annoyance about the emphasis placed on ICT at the ICS Bonn-Beuel. These teachers do not want to raise the status of the computer to "*a religion*" (*woman teacher*) but see it only as a "*tool*" (*woman teacher*). Furthermore, they fear that by over-emphasising it, other aspects of learning and life would be neglected.

Many adults, and students too, really believe that ICT is the beginning and end of everything. They forget that we have other senses still, that we can taste and touch, that we can act for ourselves and feel. And, at present, all these things seem to be greatly ignored (woman teacher).

Sceptic teachers fear that ICT will lead to the loss of human relationships and communication between the students. It was conspicuous, that of those teachers interviewed, it was mainly women who were sceptic. Although they were critical, they worked with ICT and tried to integrate it into their lessons. There are differences of opinion as to whether age plays an important role when adapting to innovations. Some teachers thought that older teachers would probably refuse to work with ICT, others rejected this connection and said it was the teacher's "*basic attitude to school*" (*woman teacher*) which acted as a decisive variable in the willingness to accept innovation.

4.1.2 Staff development

The school prefers to train the teaching staff in-house. The first basic ICT skills were achieved in this way but they are not comprehensive or wide enough. There is still a lack of concrete teaching of information as to how to implement ICT in lessons. The majority of the teachers have taught themselves.

ICT

Some years ago, exterior experts held a general Internet training at the school for teachers. The Headmaster said there had been little positive feedback about the training. Two teachers, who were responsible for the technical maintenance at the school before the Technical Specialist, were able to participate in an external initial training free of charge. Teachers remarked that external training was often too unspecific for teachers and the knowledge gained could not be implemented in class. Furthermore, the level of knowledge of the participants was often not taken into consideration and because of these difficulties with external training, the teachers at the school have gone over to "*Co-Teaching*" (*Headmaster*), preference now being given to the school's own experts. Some teachers who are involved in the ICT sector, hold in-school further training for those colleagues who are interested. The curriculum necessitates that all mathematics teachers can handle Excel software in the Grade 11. Two mathematics teachers who are competent enough are currently holding in-school further training for their colleagues. According to a poll carried out by the *Bertelsmann Stiftung*, 80 % of teachers at the ICS Bonn-Beuel have received in-school training.

Many teachers and students have obtained their ICT knowledge auto-didactically, according to the Bertelsmann poll, around 75 %. The majority of teachers can manage a word processing program otherwise their ICT skills are not very high. In summer 2000, teachers at the school were given an introduction into the network and utilisation of the class computer; although no definite instruction was given on how to use this knowledge in lessons: "*Further training ought now to be on the contents for each subject. How do I handle them? How can I make use of them in my lessons?*" (*teacher*).

In the previously mentioned Bertelsmann poll it was revealed that 65 % of teachers would like to be trained in the whole range of applications, beginning with word processing to spread sheet analysis, presentations and website creation. Approximately 30 % of the teachers said they had no training requirements where ICT was concerned.

Particularly since this summer, the ICS Bonn-Beuel has had an internal support system. Resulting from a request made by teachers, it was agreed that the Technical Specialist would be present in the staff room in the breaks to answer questions and deal with problems arising from ICT. Furthermore, the Technical Specialist or a teacher of Computer Science would support the teacher during the lesson should he/she be unsure how to handle ICT. Many teachers describe both forms of support as very helpful as the teacher is encouraged and his fears dispelled. This could be beneficial for further diffusion of ICT skills amongst the teachers of the ICS Bonn-Beuel. Currently the Technical Specialist is not conducting any further training sessions at the school.

There is no planned and definite introduction into the skills and use of ICT at the school for new teachers. Teachers who give in-school training are given, as a rule, a reduction in their normal teaching hours by the

Headmaster but no payments are made. Teachers must bear the cost of any external training themselves in most cases.

School Innovation and Improvement

Endeavours are being made to provide all teachers of scientific subjects with a comprehensive further training. Once every six months, an in-school training is offered with the aim of demonstrating how other subjects can be integrated into the teacher's own subject. Some years ago, individual colleagues were trained in the afternoons by teachers with science subjects and were given one or two hours reduction in teaching hours to compensate. Nevertheless, in addition to the further training, the teachers had to work out the contents for the Science Curriculum themselves. The Science teachers said they had a very good informal support system resulting from the good collegial relationship they had with one another.

In the meantime, the first training sessions for science teachers regarding ICT use in lessons has taken place. They were instructed in the use of a beamer. Two or three educational programs for Physics were presented and a Hypertext training was demonstrated.

4.1.3 Role of Leadership

The role of the Headmaster is characterised by his openness towards innovations. He supports an innovative environment in which changes are endorsed. In particular, transparency in all events happening within the organisation School and a personal commitment for his teachers support innovations.

Innovations at ICS Bonn-Beuel have received and still receive major support and promotion by the Headmaster. Special mention should be made of his skills in acquiring money and sponsors for the school and his massive commitment in obtaining them and making the necessary financial and material basis for innovations at the school possible. A further component which would appear to be important in implementing innovations at ICS Bonn-Beuel is an understanding of the Headmaster's organisation of the school. *"Whoever wants to organise the school, will receive support; and whoever wants to continue working as before, will not be prevented from doing so"* (Headmaster). For the Headmaster, this means that any teacher who has new ideas regarding the organisation of the school or innovations at school will have the opportunity to try them out and implement them. *"Innovative behaviour is systematically supported here by allowing the teacher to do what he/she has envisaged and, if it is necessary, by quickly providing any financial assistance"* (teacher). The Headmaster has been described as a supporter of innovations and their creation, his personal commitment, openness, receptiveness and support was emphasised by many teachers positively as they feel that through this their work is recognized and supported. Characteristic for the Headmaster is the positive way in which he talks about his staff. He describes all of them as being *"unusually committed"*. He is concerned for their welfare, sometimes pointing out to teachers, for example, the limits of their stress. In addition, he tries to create an incentive system for very committed teachers; for example, he personally spoke up for one teacher to be given a co-ordinating post for ICT at the school and *"thus a higher office"*. The Headmaster has given some teachers reduced teaching hours to compensate them for their work with ICT or for school innovation.

There has to be a system of incentives. Here there are a whole series of very fortunate conditions which makes the incentive system possible at least within our unfortunately limited scope. I would love to have more money available. I would like to be able to pay a bonus now and then, but, regrettably, I can't. (Headmaster).

One important factor for the Headmaster is that his staff is motivated and he emphasises his task as a moderator in innovative and school events.

A final factor enabling the Headmaster to guarantee innovations and make them possible at the ICS Bonn-Beuel is the transparency he strives for.

For every innovation there is always one sin the headmaster must not commit and that is not to provide transparency. That means, everything is possible here as long as everyone has the feeling that he or she can intervene at any time. Either by controlling or by participating, defining aims or simply by observing. But everyone must have the opportunity to do this. Then everything will run peacefully. (Headmaster).

He learned about transparency from experience because lack of it had led to opposition against the innovations. Above all, it was necessary to hold personal discussions and not just to issue dates and times in writing. *"That means that every break when I am not in the staff room available for discussion or questions and every conversation which I neglect to have costs me double the time afterwards"* (Headmaster).

It must, however, be mentioned that the Headmaster cannot do right by all the staff simply due to the large number of projects taking place at the ICS Bonn-Beuel. Some teachers were annoyed by this and felt they had been neglected and left out of account. Considering the size of the school and the number of projects, this would appear to be an unavoidable problem.

4.1.4 ICT-Innovation Connections

Initial embodiment of ICT into the curriculum has begun. The teacher skills however are still too few to guarantee that all of the students are granted a basic training in ICT. Technical and organisational problems make ICT use difficult. One catalytic effect of ICT on school innovation has been observed, namely that new concepts for ICT lessons are required.

The use of ICT at the ICS Bonn-Beuel is primarily embodied in short-term project weeks but the first innovative projects and basic ICT training is already taking place in lessons. In Grades 9 to 13, Computer Science is taught as an optional subject providing basic ICT knowledge. In Grade 11 there is an introductory course in Excel integrated into Methods training in the Mathematics lesson based on the new curriculum and in the German lessons, an introduction to word processing. Some teachers integrate educational programs into Science lessons and some committed teachers carry out innovative projects, mostly in Social Sciences and in Languages. The first Science teachers have begun to use a beamer in their lessons.

The following problems would appear to cause problems when using computers for ICT in lessons. The teachers often complained of organisational and technical difficulties. Access to the computer rooms is not easy to organise when several teachers wish to use them at the same time. In addition, they complain there is a lack of beamers, scanners and printers. In addition, there were technical problems with the computers and Internet which prevent the smooth running of a lesson and put teachers off using ICT in their lessons. *"I just pressed the wrong key, the computer crashed and I was unable to save it. So I thought, I will continue to give my lessons as I always have done"* (woman teacher). Problems such as these in the lessons simply lead to a loss invaluable teaching time.

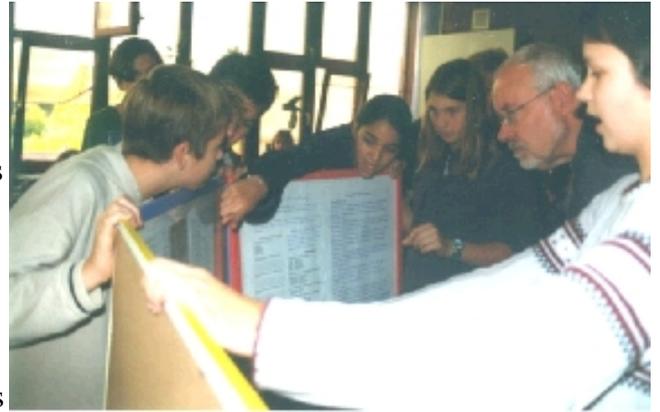
The teachers describe the lack of information regarding which educational programs can be best used in lessons as a major prevention to using ICT. Many teachers say the number of programs is too great to keep track of and that, as a rule, there are no instructions or demonstrations nor are they informed on how to use them in the lesson. There were also complaints that there is too little quality educational software for schools.

It was noted that since technical safety measures have been installed into the network and the computers have been better maintained, more teachers are plucking up courage and trying out ICT. One woman teacher claimed however that the computer rooms were often empty which for her meant that ICT use at ICS Bonn-Beuel was low. The use of ICT at ICS Bonn-Beuel is also impeded by the fact that too few teachers still do not have sufficient ICT skills. There is thus a divide between teachers and students which makes serious teaching difficult, particularly in obligatory ICT projects such as the *"Newspaper project"* for which the teachers need good ICT skills in order to teach this project. One teacher had this to say about the project, *"we have the problem of not every teacher ... mastering the skills so that he can teach his students correctly. There is still a lot of training to be done amongst the teaching staff"*. One father believed that the use of ICT in lessons is hampered because in addition to their teaching activities, the teachers are subjected to double the stress as they must also increasingly educate the students as well.

The fact that pedagogic projects such as the Science Curriculum or methods training for computer, beamer and Internet are now being applied in lessons does not necessarily prove there is a mutual influence of ICT and school innovations and improvement. Anyhow, they have not led to any changes in the conception of school innovations. The teachers responsible for the Science Curriculum all emphasised that the school innovations could all be carried out without ICT.

Nevertheless, it would seem that ICT may have an influence on school innovations and improvement in the future because the use of ICT requires new forms of teaching. *"The basic idea of the CIRPP class was to integrate ICT into normal lessons, which, regarding the thought itself, is complete nonsense. If we are to use ICT, then we won't be able to retain the normal method of teaching and lessons."* (teacher). This is linked to the condition that present methods cannot be transferred easily to ICT. New pedagogic concepts must be found, away from the old chalk and talk methods. There must be a new understanding for the theory of the media. The teacher in the

CIRPP class seem to have solved the problem very well. One aspect why the project was carried out so successfully would appear to lie in his constructivism approach. The aim of the teacher is being to get away from instructive lessons to progress to constructive lessons. During an observation of the CIRPP class, the students worked in groups, moving freely about during *Figure 2: Marking of student work*



the lesson and were designing placards with the help of the Internet and a word processing program. The child's work was marked in an amended form. The students evaluated themselves as a group. All the same, it was a very noisy class. The teacher must be willing therefore to deal with this type of teaching and its consequences. A new teaching model must be found and the CIRPP project can be considered as pioneering in this connection.

4.2 Outcomes

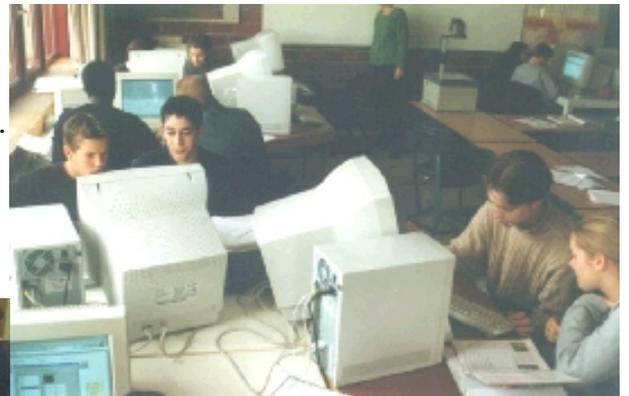
4.2.1 ICT Infrastructure

The school has a high level of comprehensive infrastructure. Three central computer rooms and individual PCs are shared by all classes. This leads to bottle-necks so that it is difficult for all students to receive full basic training in ICT. Since the summer, the technical maintenance has been in the hands of a network administrator in full employment who is supported by the teachers. Since then, the occurrence of technical problems has decreased. Most of the infrastructure was sponsored.

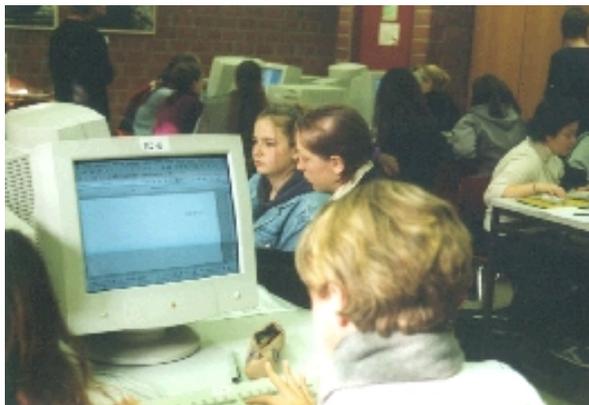
ICS Bonn-Beuel has a total of 127 computers of which 83 are multimedia computers and 116 computers are linked to both Internet and There are approximately 11 students to one computer. The internet link runs via a Linux Server and is free of charge.

Figure 3: Computer room

Figure 4: Apple room



The computers are installed in the computer rooms, in classrooms, in the staff room, the administration and the library. There are three computer rooms, each equipped with 14



PC's for the students and one teacher PC. One of the computer rooms is equipped with Macintosh computers and is mainly used by integrated classes. In each room there is also a printer and in the Apple room a scanner. All three computer rooms are linked to the Internet and are mainly used by students and teachers. The ratio of students to computer is approximately 32 to 1. There are two smaller rooms with older computers (3.86) which are not linked to the network. The rooms are sometimes used by the Science teachers for their educational programs. In the library there are eight computers of which one is linked to the Internet. The school has three beamers one of which is equipped with a CD burner permanently installed in the school Assembly Hall. One

beamer is only used by a handicapped woman teacher and a third, mobile beamer has been allocated to the Sciences the past quarter of a year. The school is currently working on extending its Intranet system.

ICS Bonn-Beuel has installed Microsoft ENCARTA on to many of the computers, otherwise there are educational programs and simulation programs to be used. In some classrooms are the first PCs with an Internet link. Several of the students interviewed did not yet have a PC in the classroom. The CIRPP class with three computers and three printers and a few other classes are an exception. Students and parents say that the available hardware is no longer up-to-date, but still suffices. The software used is however modern because Apple and Microsoft continually supply the school with new material. An email account is only installed for students in connection with projects if the teacher requests it. At the time this investigation was carried out, only students in the CIRPP class had an email account.

Technical maintenance

Since July 2000, the ICS Bonn-Beuel has had a trained network administrator in full-time employment as a Technical Specialist. He is mainly responsible for administrative software maintenance. The hardware is maintained by the School Electrician, Two teachers support the Technical Specialist and the School Electrician with the maintenance work. Four teachers are responsible for the Apple computer: a woman Biology and Geography teacher, a woman teacher for Mathematics and Physical Education, a teacher of English and Physical Education and a History teacher. The Technical Specialist admitted that the women knew more about the Macintosh computers than he did. The creation of a position for a Technical Specialist in the school was seen by many teachers interviewed as positive and essential.

The Technical Specialist is currently so occupied with implementing computers in classrooms and stabilising the technology that it is often difficult for him to look after the excellent infrastructure. Although the ICS Bonn-Beuel is one of the few schools who were able to recruit a Technical Specialist who is solely responsible for the administration, the high level of ICT infrastructure is reason enough for further resources. The number of technical problems has considerably dropped since the arrival of the Technical Specialist.

Financing

The yearly budget is DM 200,000 of which the school spends an average of approximately 20% on ICT. Sources of income are the town, parents, project promotion, sponsors and the school's sponsoring association. Most of the computer equipment has been sponsored by sources acquired by the Headmaster, teachers, students and parents. Only very recently, the school was given fifty second-hand Pentium II with 15 monitors by a sponsor.

Problems

Many of the sponsored computers, with the exception of the Apple room, are of varying origins and generations. No room is equipped with one and the same type of computer and all of them are out-of-date. It is not easy *to plant this old technology into a new environment* (Technical Specialist). It involves a lot of additional work and time for the persons responsible for their maintenance. Moreover, the Technical Specialist does not have the financial resources to carry out intensive maintenance on the infrastructure. Teachers reported that the computer rooms are not sufficient in number and they often only can use them once every two weeks. The problem of rooms has obviously not been solved taking into consideration that all students are to receive a basic ICT training

4.2.2 Effectiveness

The more frequently ICT is used in lesson, the more the level of learning motivation drops. ICT supports communicative and independent behaviour. It was observed that work is more superficial when the Internet is involved. Furthermore, searching the Internet is very time-consuming. Additional time is also required for teaching ICT skills and this reduced time for contents of the lesson. Access to Internet and computers at the school is strongly limited. There have been occurrences of abuse.

Learning motivation

Many teachers reported that most students see the computer positively and that it holds a great attraction for them. Students who were interviewed commented mostly positively about working with ICT. However, it was recently established that learning motivation is no longer guaranteed "*The enthusiasm we observed a few years ago when all of them cried "Hooray" when we went into the computer room, has disappeared in this generation of students*" (woman teacher).

Some of the students interviewed said they did not enjoy working with computers and the Internet. One mother

remarked that motivation in her daughter who was in the CIRPP class had dropped with time. Working with ICT in the CIRPP class had become normal day-to-day routine and it no longer offered any new attractions. The motivation to learn would seem mostly to depend on the contents of the lesson and personal interests. It cannot be generally stated that ICT increases motivation.

It is interesting to observe that in the CIRPP class a kind of anti-computer movement has developed. One girl student said, *"When everyone is doing something on the computer, writing a text or something like that, as we did in the project ... then we wrote a lot using the computer. That's quite boring when they are all doing it on the computer. That is why my group wrote everything by hand (girl student)*. This girl was one of a CIRPP class group who had begun to avoid working with ICT where possible. Although she had good ICT skills, she preferred to be independent and individual in her choice of work tools.

Learning behaviour/learning quality

figure 5: Students of the CIRPP class in lesson

Teachers interviewed often spoke of the fear that communication would decrease because of working with computers although this was not observed in lesson audits. As a rule, two students sat at one computer, discussed the problem together or talked about how they would approach the task. The children have considerably more freedom in the computer room to exchange ideas with one another, to move around the room and to help each other and these observations were confirmed by the students interviewed. It can be assumed that social behaviour can be advanced through ICT. Several teachers said that students at all levels and ages worked more independently and under their own initiative on the computer and with Internet and were becoming increasingly independent of the teacher. Nevertheless, it was emphasised that the basic values and aims of learning had not changed and that central teaching was still verbal communication between teacher and student.



Both advantages and disadvantages of the effect of ICT on learning quality were established. Many teachers commented positively on the appearance of work which students had done with the computer. Teachers also frequently noticed that students who had searched for information in the Internet often had not even read the print-out. That was one of the dangers which came from working with the Internet - that students did not bother about the contents of what they had found and did not process or work on the information sufficiently, leading to diminished learning quality.

Advantages/Utilisation

Some teachers found that working with computers in their lessons opened the door to making their lessons more individual and personalised. However, one teacher remarked that in order to hold an individualised lesson, the classes must be *"significantly smaller"* for ICT work to be effective.

In addition, it was mentioned that one advantage for the students was that when using ICT other senses could be activated in the learning process offering an opportunity to students who were better at visual learning than audible. ICT provides a more complex learning environment better suited to the students demands, taking into account the variety of learning needs.

There was another benefit for students who were disadvantaged in class events. The teacher of the CIRPP class reported two cases in which two girl students who had been excluded by the rest of the class went to great lengths to equip themselves with ICT skills. Not only did they profit from these efforts but their self-confidence also increased. Likewise, the benefit of computer work for the handicapped students at ICS Bonn-Beuel was also emphasised. Handicapped children found it easier to express themselves and to print out a legible text.

Problems/Disadvantages

Many students criticised the increased time spent in searching for information as a disadvantage of the Internet. As a rule, it took a long time to find anything in the Internet.

Anyway, it was much more interesting than going to the library and looking through books. But it took longer because in the Internet you really have to differentiate what you are looking for, There is such a lot of information that you must pick out what you really need. That takes a lot of effort and a lot of time. (girl student)

The variety of unselected and unsorted Information appears to represent a flood of knowledge and in the Internet there is no serious pre-selection. When using Internet in lessons, the teacher must provide a targeted preparation and explanation otherwise searches end up being time-consuming and ineffective *"When using the Internet, you have to be very well prepared in order to get the results you want". (teacher)*

Teachers also report another disadvantage in normal lessons that fewer contents can be taught regarding the subject when, at the same time, ICT skills are to be taught. However, one woman teacher remarked that when you get to the point that the student has mastered the techniques then the computer can be a good working tool, *"I hope it then saves as much time as the hours we have invested"* (woman teacher). Teachers and students at the ICS Bonn-Beuel both found it a disadvantage that typewriting had not been taught which considerably increased the time needed to work with the computer. A request was made that the teaching of the basics of this subject be obligatory.

Moreover, the concept of three to four computers in a classroom is not sufficient for an overall ICT utilisation. The teacher from the CIRPP class said he had had to use the computer rooms because the three computers in his classroom were not sufficient to teach all the students at the same time. Other teachers, too, reported if more than two students sat at one computer they did not work effectively. The students also find that three computers are not enough in one class *"we mostly quarrel in class because there are only three computers and we all want to have a go."* (student)

Another disadvantage is that teachers who work with ICT must invest more time in their lessons and preparations and this is particularly time-consuming for those teachers who are not so well acquainted with ICT. Teaching with ICT is, as a rule, also more work-intensive for the teacher. The dissolution of frontal teaching also requires the teacher to devote time to individual students and to walk around the classroom. Several teachers emphasised that in ICT lessons, they are more involved in what happens in the classroom during the lesson. Some teachers pointed out the considerably shorter time available to teach contents and to deal with problems in frontal teaching. It would appear to be essential to accept new forms of teaching if lessons are to be held using ICT. One teacher, however, said that it was the new form of teaching made necessary by ICT which made many teachers at the school reject ICT.

Control/Abuse/Responsibility

There have been occurrences of abuse of hardware and software at the ICS Bonn-Beuel. Students and teachers report that hard disks had been removed, graphic cards had disappeared, systems changed or Internet sites, which had been prohibited e.g. pornographic sites, had been opened. One woman teacher reported about abuse, *"Until the summer, it was a major problem"*. Since the installation of two safety functions in the summer 2000 abuse has been reduced. A PC guardian card was installed which returns the computer to its original status after being switched off so that changes in software can be reversed and the computer retains its normal function. Additional security was installed which creates server protocols. Students can only log in by using a password which makes it possible to trace which student opened up which website and when. Teachers said they would not trust going into the computer room alone with students before this system was installed. This would have led to increased ICT use.

One problem at the ICS Bonn-Beuel is that the arrangement of PC s in the computer room does not allow the teacher to be able to supervise all the screens at the same time. lesson protocols revealed that students had surfed around the Internet during the lesson. One teacher spoke of this deliberately in front of the whole class with the result that there was less surfing in Internet during the lesson. Another teacher claimed there was a general reduction in abuses by students which he thought resulted from increased ICT in lessons having become routine.

One woman teacher said she had noticed frequently in the meantime that students were taking essays and homework from the Internet which meant she had to spend a lot of time researching in order to find instances of abuse.

Teachers at the ICS Bonn-Beuel were not able to say how the responsible handling of computers was to be taught as they are still too seldom used in school. One teacher expressed the wish to introduce Media Education as a subject and teach the students a proper handling of ICT. There are current considerations to regulate the Internet by means of a security system which would make certain sites inaccessible to students.

School innovation and improvement

Several teachers remarked that the inter-subject Science Curriculum had benefited the students by providing and supporting a more global understanding of the Natural Sciences; *"It is easier in this way for the students to recognise links between the different sciences."* (teacher) In addition, one teacher said inter-subject lessons were more suitable in many respects for teaching complicated scientific phenomena. The Science Curriculum allowed subjects from Chemistry or Physics to be combined with Biology and be presented in an more comprehensible way and students had thus the opportunity to find a better idea of what the subjects mean for themselves.

The teachers emphasised, too, the fact that the Science Curriculum allowed them to spend more time with a class, get to know the children better and carry out long-term projects.

A further positive emphasis was placed on the good and informal support system of the Science teachers among each other which made them feel less alone. The *"lone warrior"* situation had been replaced by team teaching given by two Science teachers and support from the staff was motivation to continue with the innovation.

Disadvantages associated with the Science Curriculum are that students have problems in differentiating between the individual subjects. According to teachers, not all subjects can be dealt with in an inter-subject way. One problem for the teachers is when they teach a subject other than their own, they sometimes have only just a little bit more knowledge than the students.

4.2.3 Academic Rigour

The ICS Bonn-Beuel is currently integrating ICT into the curricula whereby orienting towards the official curricula of North-Rhine Westphalia. In the CIRPP class, a change in the marking of academic performance in connection with ICT was observed. From those teachers who completed the ICT questionnaire, 24.39 % said the students use of the computer was considered when marking (cf. Appendix B, Table 5). Whether or not a teacher strictly considers the use of ICT in lessons when marking, depends very much on the teacher and his/her competence.

Not much can be said concerning increased academic performance at the ICS Bonn-Beuel as ICT is not sufficiently used in lessons. Some teachers supposed that the level of learning would increase with the introduction of educational programs but had not yet tested it for themselves. The problem at the school is the wide range of performance levels among the students. It would appear that individual teaching, supporting students in a determined way could conceivably lead to an increase in performance. The Headmaster believes that the learning process and independent learning would be more easy to control with individual ICT, and commented on the students in his school working with ICT, *"These students will not be leaving the school with any more intelligence than those who left ten years ago"*.

4.2.4 Equity

Whilst girls work more purposefully with a computer, the boys have a more technical and enjoyable approach. Differences between high and low poverty children could not be resolved by the advantage of being able to practice at home. If high ability students apparently profit from ICT, then low ability students have an opportunity to compensate with ICT.

Many of the teachers estimate that between 60 and 80 % of the students at the ICS Bonn-Beuel have access to a computer at home and approximately 60 % of these have Internet access. Students at ICS Bonn-Beuel are given the opportunity to gain ICT skills in the obligatory project weeks; nevertheless this ICT basic training would appear to be insufficient.

Experiences made in my Grade 8 ... you think that at the age of 14, they can all handle a computer, but when it comes down to serious business ... there s not much there. I have to instruct them in practically all the details regarding word processing None of them know how to deal with it (teacher).

However, teachers were of the opinion that students can often handle the computer better than the teachers themselves. Regarding the qualifications of older students, *"In the Upper School there are students who are very, very good. But there are others who can only do the absolute basics. Everyone in the Upper School is able to handle word processing"* (teacher).

According to teachers, parents and the students themselves, the children like playing with the computer at home

and do it a lot. Students also said that they used the PC for their homework and essays and to search for information in the Internet. At school however, with the exception of the CIRPP class, no homework is set which must be done with the help of the computer or Internet as it is not said that each child has access to a computer or the Internet at home. Students use the ENCARTA and say they like sending emails, usually from the computer at home.

Computer Accessibility

Students have access to the computer rooms particularly during the lessons. The rest of the time, the student must find a teacher to accompany and supervise him/her, something which the students say rarely occurs. In the classroom, the computers are as a rule locked in cupboards or can only be operated after a teacher has entered a password. The only exception is the CIRPP class which can use the computers and the Internet outside of lessons, supervised by their own class members.

There is only one computer with Internet which is available to all students of the ICS Bonn-Beuel at all times and this is in the library. The library must pay for Internet use, therefore students can only use it with an Internet card costing DM10,- for one and a half hours.

Differences between students

figure 6: girls working with Computer

Various teachers pointed out the difference between girls and boys when using ICT and said that girls approach the computer in a different way to the boys. The girls seem to work more purposefully than the boys who showed more enjoyment and interest in the technical aspect of it. Whilst girls worked more conscientiously and carefully with the computer, the boys tried out more things, explored the computer and thus achieved quicker results. One woman teacher reported about her experience of girls and computers,

"as a rule, they do not like the computer. They simply use it as a tool." (woman teacher) Some teachers put the difference down to puberty and it had been observed that with increasing age, these differences became fewer. Nevertheless, one woman teacher noted that older girl students worked more with a target in mind. One teacher said there were more boys than girls in his Computer Science course, an approximate ration of 70:30.

Children from homes where there is no computer displayed a certain degree of insecurity in dealing with ICT. One woman teacher said that these students are at a disadvantage regarding their computer qualifications, *"It is clear that those who can practice again at home are at an advantage. That applies to other things as well. Of course, this is dangerous"* (woman teacher).

Not all were agreed that differences existed between high and low ability students using ICT. Some teachers had experienced high ability students profiting more from using ICT than low ability students. There were also reports, however, that ICT provided an opportunity for low ability students:

What I noticed was that there were children sitting there who had come from a general secondary school and did not have much basic knowledge - that is a weak point - but what they can do, is to handle a computer. For me, that was a very positive experience. I felt they would benefit more from it and demonstrate this in their work. (woman teacher)

These students had good results in a performance test although in other subjects their performance level is lower than that of their fellow students.

Students disadvantaged by their home backgrounds do not lose these disadvantages through access to computers at the ICS Bonn-Beuel because students from lower social levels have no opportunities other than those at school, whilst children who can use a computer at home can continue to train their ICT skills after school.



4.3 Projections

4.3.1 Sustainability and Scalability

Sustainability and further implementation of ICT at the ICS Bonn-Beuel would appear to depend to a large extent on the Technical Specialist. Maintenance problems were only minimised by his arrival at the school. He is familiar with the implementation of a further thirty to sixty computers in classrooms and can only do this job because he is in full-time employment at the school. He is, of course, supported by the School Electrician and committed teachers who were not able to fully guarantee maintenance of the ICT infrastructure before the arrival of the Technical Specialist. It is still not clear, whether the position for the Technical Specialist can be prolonged beyond 2001 or not although the Headmaster was optimistic, *"By then, I hope, all the politicians and those in administration will have understood that we can't manage without a network administrator"* (Headmaster).

One teacher is currently working on a training concept for teachers who wish to increase the use of ICT in their lessons and which aims at creating definite criteria regarding the ICT skills which each teacher should have. At the same time, the concept is to include a curriculum for the ICT skills of students. It appears that such a curriculum is essential if every student at every Grade level is to be guaranteed a basic ICT training and the ICT skills of teachers are to increase. Teachers will only overcome their shyness of better-qualified students if their own ICT skills are good. Teachers at ICS Bonn-Beuel expressed the particular wish to be trained in the specific use of ICT in lessons and to be taught how to handle software. It appears to be essential to have a curriculum-based definition of ICT skills for students which is continuous and not limited to projects because innovative projects are often not continued once they have been completed. For example, one mother remarked that ICT use in the CIRPP class had dropped drastically.

The wide range of innovative projects at the ICS Bonn-Beuel in pedagogic and ICT sector must be observed ambivalently. It harbours opportunities and risks. Particular mention must be made of teacher commitment, which is exceptional. However, the time resources of the teachers are so limited that they are no longer interested in involving themselves even more in the ICT sector to achieve a larger diffusion throughout the school.

The expressed wish of the Headmaster regarding a decentralised distribution of computers and no further additions to the three computer rooms in future should be considered critically. On the contrary it would seem that one or two additional computer rooms with a maximum of two students to one computer, would be more sensible if all students are to be trained in ICT skills.

A current topic at the ICS Bonn-Beuel is the introduction of laptops, an issue still to be discussed with parents and teachers.

Most of all, the Headmaster would like to see existing achievements sustained to ensure the maintenance of future innovations.

I mean that what we do and what has been tried and proven, we must look after it and sustain it and that costs time and energy. I do not want any further development I only want to continue with what we have already achieved. Of course, it can be revised, if necessary, I want it to survive from day to day, I don't want to lose what we have. (Headmaster).

On the whole, the Headmaster believes the school has reached the limits of its *"profile formation"* although the environment which the Headmaster has created in the school would appear to leave enough room for future innovations, with resistance low, thanks to his way of doing things.

It can be assumed that the Science Curriculum will be sustained as there are enough teachers involved so that the innovation has already diffused beyond a critical moment. One teacher is currently responsible for practical work which is planned to facilitate access and commencement of the Science Curriculum for those who are still apprehensive. This may firmly embody a further diffusion of the innovation in school events.

The Headmaster sees the most important resource at the school at present in *"human resources"*. He is particularly keen to guarantee job satisfaction for his staff, as only a satisfied teacher is willing to organise the school system. The continued support of the Headmaster for his staff is essential for further implementation of innovations and the teachers likewise welcome it. To diffuse the innovations further, especially in the ICT sector, it would be helpful to make use of the resource students involving them with their technical skills in ICT maintenance.

5. Conclusion to the Hypotheses

1. Hypothesis: Technology is a strong catalyst for educational innovation and improvement especially when the World Wide Web is involved. The rival hypothesis is that where true improvement is found throughout the whole school, technology served only as an additional resource and not as a catalyst and the forces that drove the improvements also drove the application of technology to specific educational problems.

There has been innovative, pedagogic work at the ICS Bonn-Beuel since its foundation and ICT is to be seen as only an additional innovative moment there. Nevertheless, a catalytic effect and influence of ICT on school innovations was observed. The reason is that ICT use in school is not compatible with conventional instructional and frontal teaching and that leads to the necessity for school innovations and improvement at the school. New teaching models must be conceived in order to justify ICT in the lesson.

2. Hypothesis: The diffusion of innovation/ improvement (and thus of ICT) followed the traditional diffusion patterns for innovations, as outlined by ROGERS (1995). The rival hypothesis is that technology functions differently from traditional innovations and that therefore different patterns occur.

The diffusion of innovations at the ICS Bonn-Beuel in the ICT sector followed the diffusion theory as outlined by Rogers. Diffusion was triggered by a *change agent* although at the beginning there were not enough *communication channels*. Not until the arrival of the Headmaster, a second *change agent*, and increased in-school further training was it possible to embody the innovations into school life. The *communication channels* became more transparent for the whole system. It still cannot be said that ICT has been implemented throughout the whole of the ICS Bonn-Beuel. The teachers must increase their ICT skills, in order that students can be given basic ICT training. Moreover, the communication channels in the whole of the ICS Bonn-Beuel must be opened and not remain limited to a small group of people

3. Hypothesis: Successful implementation of ICT depends mostly on staff competence in the integration of ICT into lessons and the learning process. This hypothesis assumes that teachers mediate ICT applications when they are successful and that ICT's academic value relates positively to teacher competence. The rival hypothesis is that it is the school's technical infrastructure and student ICT competence rather than staff competence that determine ICT implementation outcomes.

Successful ICT implementation does not depend on the infrastructure alone. A sufficient infrastructure is a necessary pre-requisite but its high level at the ICS Bonn-Beuel does not effect innovation throughout the whole school. It appears that the teacher ICT skills are decisive factors for embodying ICT throughout the school. Overall staff competence was increased by means of further training, thus overcoming initial stagnation, promoting the diffusion of skills amongst the teachers and linking up to increased use of ICT in lessons. An essential component of further training is pin-pointed teaching on how to use ICT in lessons and how it can be integrated into the learning process. Furthermore, a committed headmaster, motivated teachers and parents to support the innovations are all essential factors for successful ICT implementation.

4. Hypothesis: Gaps in academic performance between high and low poverty students will not increase when all students have equal access to ICT. The rival hypothesis is that equal access to ICT will lead to more advantaged student increasing the performance gap with disadvantaged (high poverty) students.

Equal access opportunities do not overcome the gap between high and low poverty students. High poverty students are disadvantaged because they are not able to train their ICT skills at home. More advantaged students have a decisive edge in having computer and Internet access at home.

5. Hypothesis: Successful implementation of ICT will lead to the same or higher academic standards in spite of the low quality of many ICT materials. Academic standards are a function of teacher and school expectations and not of the standards of textbooks, ICT materials and the like. The alternative hypothesis is that ICT use will lead to a lowering of academic standards as students spend more time on marginally beneficial searches and in browsing poor quality Web and courseware contents.

Working with computers and the Internet does not necessarily improve student performance. Information gained through the Internet was superficially processed, possibly because searching for it is so time-consuming. Furthermore, the implementation of computers and Internet in the student's daily school life was not necessarily motivating. One problem is that the teaching of ICT skills requires additional time which is lost for regular teaching and this can lead to a drop in academic standards.

6. Projection to the Future

One feature of the ICS Bonn-Beuel is the strong commitment of teachers, parents and the Headmaster resulting from the school's history of innovations. The transfer of such a feature to other schools mainly depends on the degree of commitment of everyone involved. The willingness to admit change, the space created by the Headmaster for the school through his openness have resulted in an innovative environment and are also factors which ought to be taken into consideration for a transfer. Particular mention should be made of the Headmaster's skills in raising material and financial sources. The acquirement of sponsors, committed teachers and, especially a full-time network administrator are major prerequisites and should in no case be lacking when transferring ICT implementation to other schools. Another important factor is the creation of an incentive and maintained system for teachers which supports innovations. If ICT is to be diffused throughout the whole school, it must be ensured that teachers acquire internal training, good computer, Internet, and software skills to be effectively used in lessons. It is just such skills, coupled with the new additional task for teachers - that of educating, which ought to be increasingly integrated into teacher education.

The project on which this survey was based was financed by the Bundesministerium für Bildung und Forschung (BMBF). The authors are responsible for the contents of this publication.

APPENDIX A: METHODOLOGY

The OECD research team consisted of two researchers from the FWU Institut für Film und Bild in Wissenschaft und Unterricht from Grünwald near München and four researchers from the Institut für Schulentwicklung (IFS) of the University of Dortmund, who were working on the SITES M2 study. The school was audited on four successive days from 24 October to 27 October 2000.

The combined IEA/OECD instruments were applied in the interviews. Interviews were held with the Headmaster (duration approx. 3 hours), with the Technical Specialist (duration approx. 2 hours) as well as interviews with teachers including 2 Physics teachers, a Chemistry teacher, a woman teacher of Biology, a teacher of Computer Science, a teacher of Religious Instruction, a woman teacher of German, a woman teacher of Music, and a teacher of English, the interviews lasting from one to one and a half hours. Furthermore, a teacher of Office Administration and a woman teacher of Mathematics were interviewed, following an audit of their lessons (each about 30 minutes). One parent was interviewed (for about 1.5 hours) and two telephone interviews were carried out with mothers of students from the CIRPP class; these were held later by a female colleague from Dortmund. Two groups of students, one group from the CIRPP class and one group from the Students' Council with 5 and 6 students respectively were also spoken to (duration about 45 minutes)

All interviews were recorded on a mini-disc recorder. The researchers applied the proposed observation protocol from the OECD Workbook. A total of seven lessons were observed: Mathematics, Physics, Computer Science and an English lesson in one of the two computer rooms; a lesson in Office Administration in the Apple computer room, a Chemistry lesson in the chemistry room and a lesson in Religious Instruction (CIRPP class) in the classroom.

In the evaluation, 42 questionnaires concerning *ICT Practices Survey for Teachers-I* and the *Nomination Form for a School Site* completed by the headmaster were included. Further material included in the analysis were the ICS Bonn-Beuel School Program, a Jubilee magazine issued for the school's 20th anniversary and two year books from 1998 and 1999. Further information was provided by concepts for innovative projects (cf. Appendix C),

photographs of the school and the school's Homepage.

The interviews were transcribed from the mini-discs and coded by the OECD research team via the German software program WinMax and analysed under qualitative aspects.

APPENDIX B: ICT PRACTICES SURVEY FOR TEACHERS^[2]

Table 1: Teachers feelings regarding different ICT tasks

How comfortable are you with using a computer to do each of the following?	Very comfortable	Comfor-table	Somewhat comfortable	Not at all comfortable	M.D. ^[3]
Write a paper	31	9	2		
Search for information on the World Wide Web	7	20	11	4	
Create and maintain web pages	2	1	6	32	1
Use a data base	4	6	12	19	1
Send and receive e-mail	14	15	8	5	
Programming		4	4	33	1
Draw a picture or diagram	9	12	14	7	
Present information (e.g. with Power Point)	4	9	10	18	1

Overall self-assessment	Good	Fair	Poor	M.D.
How would you rate your ability to use a computer?	8	21	12	1

Table 2: ICT use of teachers

Frequency of using a computer at home to prepare for teaching	Several times a week	Several times a month	A few times	Never
How often did you use a computer at home for preparing for teaching?	30	9	3	

Collaboration with other teachers	Yes	No	M. D.
Are you currently using technology to collaborate with other teachers (professional chat rooms, forums, or the like)?	8	33	1

Communication via e-mail	More than 12	6-11	1-5	None	M.D.
How many e-mail messages total do you send each day on average?		1	29	9	3

Table 3: Carrying out programming and installation tasks

Have you ever done any of the following?	Average Number	No	M.D.
Made changes to a computer's hardware	15,80	19	3
Updated an application program (word processor, graphics program, etc.)	28,04	14	4
Recovered a damaged file	212,30	29	3
Created a web site	145,86	30	3
Developed a data base	17,44	20	4

Table 4: Frequency with which teachers assigned different types of ICT work

During the past school year, how often did your students on average do the following for the work you assigned?	Several times each week	Several times each month	A few times	Never	M. D.
Use the World Wide Web	1	7	29	4	1
Create web pages		1	3	36	2
Send or receive e-mail	1	2	13	24	2
Use a word processing program	4	16	20	1	1
Use a computer to play games	2		4	32	4
Use a spreadsheet	1	5	10	25	1
Use a graphics program		10	12	19	1
Join in an on-line forum or chat room		2	2	37	1
Use a presentation program		1	14	26	1
Use an instructional program		7	22	12	1

Table 5: Teachers about their use of ICT in classes

Answers based on experiences or policies from the last school year.	Yes	No	M. D.
Was student computer use ever evaluated for grading?	10	31	1
Did you create or modify a Web site with any of the classes that you taught?	4	38	
Did you participate as a student or instructor in a virtual course through the Internet/ World Wide Web?		42	
Did you involve your students in collaborative learning over the Internet/ World Wide Web with students from other classes?	3	38	1

Table 6: World Wide Web searching restrictions

	No restrictions	Some restrictions	Designated sites only	M.D.
If you assigned World Wide Web searching, how much freedom did you allow students in locating sites to visit?	14	13	10	5

Table 7: The portion of computer use in class

	All	Most	Some	Very little	M.D.
What portion of the computer use in your classes was directly related to the course content?	17	6	12	4	3
What portion of the computer use that you assigned was done by students individually?	1	16	17	4	4

APPENDIX C: DOCUMENTATION

Documents:

- FRÄNKEN, J. & KERSTIN, B. (1999). Überlegungen zum Einführungsprojekt in der Jahrgangsstufe. 11. (*Considerations on introductory projects for Grade 11*)
- FRÄNKEN, J. & KERSTIN, B. (2000). Methodenkompetenz in der Jahrgangsstufe 11. Unveröffentlichte Fassung. (*Methods competence in Grade 11. Unpublished version*)
- FRÄNKEN, J. & KERSTIN, B. (1998) Schülerfragebogen. Projektwoche 11. (*Questionnaire for students. Project week 11*)
- Published by ICS Bonn-Beuel. (1998) Festschrift: 20 Jahre Integrierte Gesamtschule Bonn-Beuel. Der Weg ist das Ziel. Jubiläum 1978 - 1998. (*Jubilee magazine 20 Years ICS Bonn-Beuel. The Way is the Target*)
- Published by ICS Bonn-Beuel. (1999). Jahrbuch Gesamtschule Bonn-Beuel 1998/1999. (*Comprehensive School Bonn-Beuel Annual 1998/99*)
- Published by ICS Bonn-Beuel. (2000). Jahrbuch Gesamtschule Bonn-Beuel 1999/2000. (*Comprehensive School Bonn-Beuel Annual 1999/2000*)
- Published by ICS Bonn-Beuel. (2000). Kurzfassung des Schulprogramms. (*Abbreviated version of school program*)
- Published by ICS Bonn-Beuel. (2000). Elterninfo. (*information for parents*)
- Published by ICS Bonn-Beuel. (ohne Jahresangabe). Jedes Kind ist einzigartig. (*no information on the year. Every child is unique*)
- MEYER, T.H. (1998). Klasse 5.3 im KIRPP-Projekt. (*Grade 5.3 in CIRPP project*)
- MEYER, T.H. (1998). CIRPP. Kommunizieren, informieren, reflektieren, produzieren, präsentieren. Medienkompetenzerziehung. (*Communicate, inform, reflect, produce, present*)
- SCHRÖDER, F.J. (2000). Ansätze für ein Konzept: Fortbildung im Bereich "Neue Medien" an der Gesamtschule Bonn-Beuel. Unveröffentlichte Fassung. (*concept strategy. Further training in ICT at the ICS Bonn-Beuel. Unpublished version*).
- SCHULEN ANS NETZ (1999). Fall 3: "Es ist wirklich unglaublich, was wir haben wollen, das kriegen wir". (*Schools in the Network: It s really incredible. Whatever we want, we get*)
- Institute for School development (2000). SITES. Technical questionnaire, Module 2)
- School s Homepage: <http://www.gebonn.de/>
- Photographs of the school
- Fotos von Schülerarbeiten: Fotoroman, Gruppenarbeit zum Thema Idole (*Photos by student work; photo novel, group work on the subject of Idols*)

APPENDIX D: BIBLIOGRAPHY

1. FLICK, U. (1999). *Qualitative Sozialforschung*. 4. Aufl. Reinbek bei Hamburg: Rowohlt Taschenbuch Verlag GmbH.
2. LAMNECK, S. (1988). *Qualitative Sozialforschung*, Bd.1. München: Psychologie Verlags Union.
3. LAMNECK, S. (1988). *Qualitative Sozialforschung* Bd.2. München: Psychologie Verlags Union
4. MAYRING, P. (1999). *Einführung in die qualitative Sozialforschung*. 4. Aufl. Weinheim: Psychologie Verlags Union.
5. ROGERS, E. M. (1995). *Diffusion of Innovations*. Fourth Edition. New York: The Free Press.
6. YIN, R.K. (1993). *Applications of case study research*. Newbury Park, CA: Sage.

APPENDIX E: PROMOTION PROJECTS FOR EQUIPPING SCHOOLS WITH MULTIMEDIA

- The promotion project *Schulen ans Netz (SAN)* is a joint initiative of the *Bundesministerium für Bildung und Forschung (BMBF)* and the *Deutsche Telekom AG*. Aimed at embodying ICT and Internet use in everyday school life. Between 1996 and 1999 a total of 10,000 German schools which were considered to be worthy of support in particular because of their *project activities for teaching and learning via the networks* were linked up to the Internet with *Deutsche Telekom AG* providing 36 Mio. DM and the *BMBF* 23 Mio. DM which covered the cable work and a start-up credit. The financing of subsequent costs was not satisfactorily clarified. After 1999, the *Telekom AG* increased their commitment by 60 million DM and the *BMBF* by 40 million DM. The support for the schools included a multimedia computer with an ISDN connection, Office software and , in some cases, teacher training. Since January 2000, the *Deutsche Telekom AG* has been providing all schools in Germany with a free Internet access on the basis of ISDN or DSL. *SAN* is further seeing to various online services and information platforms for teachers and students, as well as holding lectures and annual conferences. *SAN* is a member of the EUN *Europäisches Schulnetz*. (<http://www.san-ev.de/default.asp>).
- A further promotion initiative for the whole of Germany is the Initiative D21 which was initiated by the amalgamation of 100 leading enterprises and institutions in Germany from all business sectors in Germany 1999 as a consequence of the serious lack of IT specialists in Germany. Together with representatives from the central and regional governments, committees are working on concepts to qualify Germany for the Information Technology Era. Technology, ICT and Internet are to be both contents and medium for education whereby work is being carried out on an effective link of entrepreneurial and private initiatives with governmental programs in order to introduce IT equipment and teacher training into schools. (<http://d21.fujitsu-siemens.com/d21/index.htm>)
- The *Bertelsmann-Stiftung* is a private foundation of the *Bertelsmann* company which has set its targets on promoting and accompanying "*best-practice-schools*" over a period of three years. In a competition in the fall of 1999 the twelve "*best*" were selected from 110 schools and taken into the *Netzwerk-Medienschulen*. Since then, these schools have been in contact with each other working on joint concepts for ICT use in schools. They meet every six months and are financed by the *Bertelsmann-Stiftung*. Each school has five working groups in which teachers participate who work on the following subjects after the six-monthly meeting: media projects in lessons, learning with laptops in class, setting up Internet in schools, teacher training and professionalism, development of a media education curriculum. The aim of the initiative is to publish the joint work by 2002 as guidelines for future ICT work in other schools. The three-year project is financially supported by the *Bertelsmann-Stiftung* with 500,000 DM. (<http://www.netzwerk-medienschulen.de/dyn/1668.asp>).

[1] The term(s) "Teacher(s)" and "Student(s)" refer(s) to both boys and girls, men and women and in no way is meant to be discriminating.

[2] All results based on the responses of 42 teachers

[3] Missing Data