The impact of new technologies on distance learning students

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Abstract

The existing literature on the impact of technology on learning is sketchy and partly inconclusive. A detailed search of the literature shows that current research is nearly all on the impact of technology on children in schools. There is little or nothing on adult education, on lifelong learning or on distance learning. Goal of the EU project *Impact* (the impact of new technologies on distance learning students) was to provide a set of findings that help instructors understand the implications of various technologies for their students, and to provide research-based principles for how instructors can best use technology in their teaching.
This paper presents first results of a series of international surveys based on randomized controlled trials addressing the five fields of technology-based education: distance education, e-learning, synchronous e-learning systems, the use of the World Wide Web for the provision of education and training on university and college campuses, and mobile learning.

Keywords: distance learning, e-learning, open university, ICT.

Introduction

In distance education the use of technology is essential. It is not a supplement to the traditional forms of distance education: correspondence and telecommunications-based education. The history of distance education reaches back to the 18th century when it took the form of correspondence education first. It was supplemented later by telecommunications-based distance education, which relies on a synchronous form of delivery and interaction between tutors and students. But only after the early success of the British Open University a wave of foundations of distance teaching universities in Europe and the United States during the 1960s and 1970s provided real alternatives to traditional classroom-based higher education.

In Europe and elsewhere, developments in information and communications technology (ICT) throughout the last decade have substantially changed the format of distance education from correspondence-style courses to technologically based courses using the Internet. The use of various forms of electronic media, e.g., for the submission of assignments and their correction, for performing Internet-based seminars, laboratory experiments and collaborative class activities, has increased time and cost effectiveness and improved the exchange of information. Interactive computer-based learning applications, instructional animations, video or audio are believed to enhance the quality of learning materials. New methodological approaches to learning in technology-based educational scenarios have been developed, promising a wider range of teaching functions and a higher quality of learning, more interaction and feedback for distant students.

The World Bank (2005) and Cox et al. (2004) reach the conclusion, that the extant literature on the impact of technology on learning is fragile and inconclusive. A detailed search of the literature done within our project by Keegan et al. (2007) shows that current research is nearly all on the impact of technology on children in schools. There is little or nothing on adult education, on lifelong learning or on distance learning with a focus on the use of technology in education, which comprises five major fields:

- Distance education: The provision of education and training at a distance from open universities, distance education institutions and departments of conventional institutions.

- E-learning: The provision of electronic distance education and training on the internet and the World Wide Web, such as Web-based learning, computer-based learning, virtual classrooms, virtual learning environments and digital collaboration.
- Synchronous e-learning systems: The provision of education and training to geographically dispersed groups of students using live e-learning platforms with elaborate synchronous communication features such as Centra or Acrobat Connect Professional.
- WWW on-campus (blended learning): The provision of hybrid learning arrangements combining on campus presence in lectures, exercise and practice groups and online phases using the WWW and ICT.
- Mobile learning: The provision of education and training on PDAs (including palmtops and handhelds), smart phones and mobile phones.

The Leonardo da Vinci project *Impact* (the impact of new technologies on distance learning students (Ericsson, 2008)) set out to provide a set of findings that help instructors in higher and vocational education to understand the implications of various technologies for their students, and to provide research-based principles for how instructors can best use technology in their teaching (Keegan, 2008). The Impact consortium represents a good mixture of cultures and represents an interesting combination of target groups including campus education, distance education, and vocational training. The consortium consists of the Corvinno Technology Transfer Center, Hungary, Distance Education International, Ireland, Ericsson Education Ireland, Plovdiv University, Bulgaria, the University Roma Tre in Italy and FernUniversität in Hagen, Germany.

In the next section, we present our common research methodology and approach used in all seven surveys conducted. Then we report in detail on the analyses of the first three sets of survey data. We conclude with a summary of the core results obtained so far.

Research Methodology and Approach

The research methodology proposed by the project to test the impact of the introduction of new technology on adult learners was randomized controlled trials. We adopted a widely used rule of thumb that requires a sample size of 300 people with 150 in the intervention group and 150 in the control group. The members of the intervention group were supposed to have experience with the current topic of the questionnaire, e.g., with distance education at a higher institution, while the members of the control groups were selected such that they lack such experiences. Experiences with technology-enhanced learning were expected to vary in these groups.

Our research hypothesis comprises the following general facets:
- Technology does, in fact, have an impact on learning, and
- Technology does, in fact, have a beneficial impact on learning.

These can be supplemented by hypotheses relating to the special topics of investigation. For instance, for the *impact of technology on distance education* we claim:
- There is no significant difference in the judgment of people with or without experience in learning at an open university that the use of technology can overcome several disadvantages of this study model including impeded interaction between tutors and students, indirect communication, or reduced opportunities for social interaction.
- It is generally accepted that the education provided by open universities compares with that of campus universities and the degrees awarded by open universities are equally.

For each of the five fields of distance learning listed above and for two additional topics – namely *the impact of technology on learning for men and women* and *the impact of technology for older and younger learners* – questionnaires were designed. Each consisted of three sections: (1) personal information (see Tab. 1), (2) experiences with and opinions on technology-enhanced learning (see Tab. 2), and (3) Questions related to technology-supported

distance learning experiences (compare Tab. 3ff). The rationale behind this structure was to commonly use the questions of Sections 1 and 2 in the analysis of all facets of technology-enhanced learning and teaching. Only the questions in Section 3 were custom-designed to the corresponding topic under investigation.

Table 1 - Questions 1 – 6: Questions to the personal background

Item 01: What is your occupation?
Item 02: What is your age grouping?
Item 03: Gender?
Item 04: What is your level of education?
Item 05: To what extent have you used advanced technological equipment in your professional life?
Item 06: Have you had to change your way of working because of technological developments?

For the sake of succinctness and clarity, only closed questions were used. As we wanted to test primarily perceptions, attitudes and opinions about the impact of technology on distance education, it was decided to use stated views as questionnaire items in Sections 2 and 3 and allow answers uniformly on five-part scale ranging from a high degree of agreement to complete disagreement. The odd number of possible answers has the advantage that respondents can express their uncertainty about a particular item in the questionnaire.

A range of statistical analyses, which were all performed by Francesco Agrusti at University Roma Tre, were applied to the collected data. They include: *descriptive statistics* covering the whole population of respondents; *cross-tables* that allow one, for instance, to identify significant differences between the intervention and control group using the Pearson Chi-Square test (confidence level of 95%); *T-tests* that were used to compare the means of intervention and control groups, and the *Spearman Rho Correlation* to detect relationships between the different variables such as their direction and strength.

Major Findings

Following the structure of the questionnaire we first summarize the major findings derived from the answers to the items in Section 2. Then we present the results for the special sections of the first surveys whose data were already available at the time of writing this paper. They address: learning in open universities, learning in e-learning environments and learning in synchronous e-learning systems. Basically we focus on analysis results that achieve a confidence level of 95% or higher.

Evaluation of the Questions in Recurring Section 2 of Each Questionnaire: Experiences with Technology-Enhanced Learning

The questions examining the respondents' experiences with technology-enhanced learning are presented in Table 2. They cover special impacts of technology on students with disabilities (item 7), the intensity of contacts (item 8) and the frequency of communication (item 9), but also a more general estimation about the impact of technology (items 10 & 11) and questions examining concrete effects of ICT on learning (items 12 – 16). Our analysis will first focus on the results reported in detail in (Krämer, 2007), which deals with *the impact of technology on learning in open universities and distance education* in its special investigation section. Then we contrast these findings with the observations discussed in (Agrusti and Mileva, 2007) and in (Agrusti and Keegan, 2007) for the same set of items. In each case, we first sketch the characteristics of the groups surveyed based on the answers to the items in the first section of the questionnaire.

The intervention group of the first survey (Krämer, 2007) with 183 responses from students of FernUniversität exhibits the following characteristics: a majority of the students holds a technical and managerial position (47 and 36, respectively), while the other categories of-

fered (teacher or trainer, student, and unemployed) range between 15 and 16 members. The remaining respondents marked category *others*, but most of them can be mapped to category *technical*. The mean age is somewhat slightly above 30; the distribution between female and male is nearly equal. More than half of the respondents acquired a high school matriculation, 30 people have mastered one to three years post-secondary education, 53 even more years. An overwhelming majority of 131 people confirmed that they had to change their way of working due to technical innovation more than once and 12 of the respondents at least once.

Table 2 - Questions 7 – 16: Questions to the impact of ICT on learning in general

Item 07: Thanks to technology, the problems of access to learning for students with disabilities have been resolved.
Item 08: Contacts between students and teachers can have the same intensity in online education as in face-to-face education.
Item 09: Online communication allows increased amounts of communication between teachers and students when compared with other forms of education.
Item 10: Only optimistic people think that the impact of technology on learning is beneficial.
Item 11: From my personal study experience I find that the impact of technology on learning is valuable.
Item 12: ICT has usually been used to encourage us to be active participants in learning.
Item 13: ICT has been used to support the development of higher level thinking skills such as synthesis and problem solving.
Item 14: ICT has been used to support more individualized learning programmes tailored to our own individual needs.
Item 15: Learning is enhanced when text and pictures are integrated in a multimedia environment.
Item 16: Educational games motivate learners and contribute to developing skills such as Teamwork.

The samples of the control group – 176 respondents without experiences with distance and open universities that were equally distributed over the other partners' institutions – are mainly occupied in educational positions as teachers, trainers or students (125). Management positions are occupied by 30 persons, technical staff are 11 and unemployed are 8 people. Two did not provide an answer to this question. The mean age is about 30. Female participants are dominant with 108 to 66 male in the control group. The level of education shows 79 with high school matriculation, 37 with up to 3 years and 57 with three years and more post-secondary education. The majority of respondents had to adapt to advanced technological equipment once or more (17 and 100, respectively) but about one third did not experience this.

The following differences in personal background between the intervention and the control group are observable: We find a similar number of people in a managerial position in both groups but far less technical employees in the control group, which includes more teachers and students, instead. The age distribution is also different in both groups with a relatively homogeneous distribution among all age categories in the control group as opposed to a distribution with a centre at the age group of 30 – 40 years in the intervention group. In addition, the mean age in the control group is lower than in the intervention group. With 42 more female than male respondents the gender distribution is a little less balanced in the control that in the intervention group. A significant difference was detected with respect to the *need to adapt to advanced technological equipment* (item 6), which was more often necessary within the intervention group. This may be explained by the fact that the intervention group includes relatively many technical employees and that the mean age in that group is somewhat higher. The determination of significant differences referring to the age of the respondents supports this assumption as people in the age of 30 – 50 have *more frequently changed their way of working because of technological developments* (item 6) than users below the age of 30. Furthermore we can note that more male than female respondents *use advanced technological equipment in their professional life* (item 5) and – referring to the occupation managers and technical staff – less students use more *advanced technological equipment in their professional life* than other groups (item 5).

By this analysis Krämer concluded that – having the slight differences in personal background but also the construction of the two groups in mind (details are presented in his report) – a good mix of different nationalities, age groups, professional backgrounds and career or study stages, and different modalities of education including traditional face-to-face teach-

ing of young adults on campus, education of working adults in evening classes and in distance and open universities and vocational training for professionals has been achieved. The samples in both groups exhibit different levels of exposure to technology, in general, and in education, in particular, while experiences with distance and open universities – important for the special investigation topic of this questionnaire – only exists in the intervention group.

Concerning the questions on the *impact of technology on learning in general*, we can summarize that:

- 50% of the respondents believes that *the problems of access to learning for students with disabilities have been resolved thanks to technology* (item 7), as opposed to only a small percentage of respondents (around 10%) who disagrees.
- Nearly 60% disagree with the claim that *contacts between students and teachers can have the same intensity in online education as in face-to-face education* (item 8) but only around 30% agree with it.
- Nearly half of the sample agrees that *online communication allows increased amounts of communication between teachers and students when compared with other forms of education* (item 9), while around 30% disagree with this statement.
- Nearly 60% disagree with the negative statement that *only optimistic people think that the impact of technology on learning is beneficial* (item 10) and only around 20% agree.
- A large portion of respondents (nearly 80%) agrees that *based on personal study experiences the impact of technology on learning is valuable for their personal study* (item 11).
- More than half of them agrees that *ICT has usually been used to encourage students to be active participants in learning* (item 12) with only a small portion disagreeing.
- More than 50% agree that *ICT has been used to support the development of higher level thinking skills such as synthesis and problem solving* (item 13), while only around 20% disagree with this claim.
- Again more than 50% agree that *ICT has been used to support more individualized learning programs tailored to their own individual needs* (item 14), around 20% disagree.
- A majority of respondents (around 80%) agree that *learning is enhanced when text and pictures are integrated in a multimedia environment* (item 15).
- Around 70% agree that *educational games motivate learners and contribute to developing skills such as teamwork* (item 16).

To discover the differences in opinions about the impact of technology on learning in general that experiences in open universities and distance education can induce, the answers of the two groups need to be compared. The following significant differences – visualized in Figure 1 – were observed:

- The statement that *problems of access to learning for students with disabilities have been resolved* (item 7) is viewed rather positively in the intervention group, while agreement and uncertainty have a higher share in the control group and their values are nearly balanced. The higher degree of agreement in the intervention group could lie in the fact that distance students perceive the use of ICT more than others as a means to bridge the physical distance between learners, lecturers and tutors.
- The attitude of respondents to the fact that *contacts between students and teachers can have the same intensity in online education as in face-to-face education* (item 8) is rather negative in both groups with a significantly more positive trend in the intervention group. Again different experiences of distance students with respect to limited contact options in the past may have caused this difference.
- As to item 9, which states that *online communication allows increased amounts of communication between teachers and students when compared with other forms of education*, the degree of uncertainty is significantly lower in the control group than in the intervention group. The opinions are, however, relatively equally distributed between agreement and rejection. Here it is likely that participants in the control group are easier in find-

ing an opinion because they – other than many distance students – have experienced other forms of education.

- The negatively formulated item 10 about the *benefits of technology for learning* is negated in both groups by a majority of respondents (i.e., the benefits are recognized). But a significantly higher negation can be observed in the intervention group.
- The opinions to item 14 that *ICT has been used to support individualized learning programs* and item 16 that *educational games motivate learners* are seen slightly more positive in the control group. It could well be that ICT applications are viewed as additional offers and a supplement to other educational methods in the control group, while the intervention group considers them rather as a replacement for traditional forms of distance education.

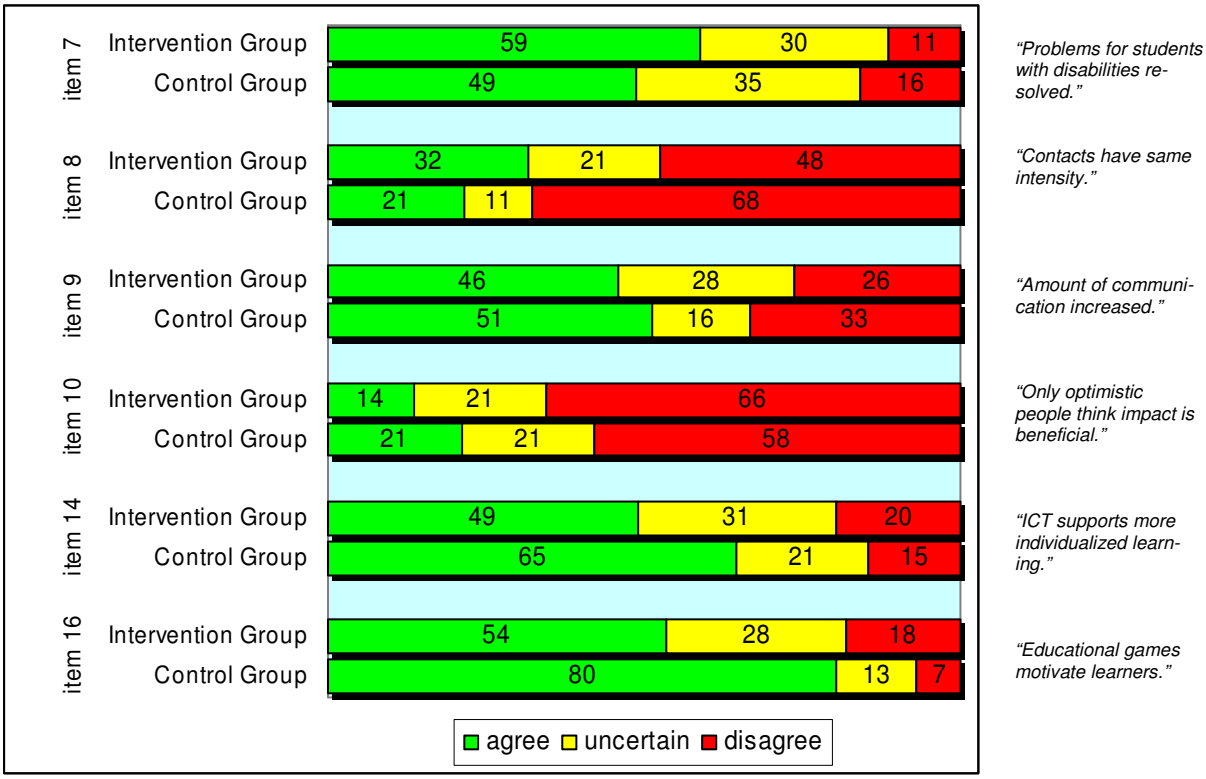

Figure 1 - Significant differences between intervention and control group (all values in percentage of valid responses)

Based on the personal background of the respondents we also investigated the influence of age, gender, education and occupation on their opinions. Significant results include:

- Age: The claim that *thanks to technology, the problems of access to learning for students with disabilities have been resolved* (item 7) shows a big difference among respondents under the age of 24 and respondents in the age range 25 to 29. The former have a more negative attitude than the latter. More people under the age of 24 or younger believe that *ICT has usually been used to encourage them to be active participants in learning* (item 12). More people under 25 believe that *ICT has been used to support the development of higher level thinking skills such as synthesis and problem solving* (item 13).
- Gender: More female respondents believe that *the problems of access to learning for students with disabilities have been resolved thanks to technology* (item 7), that *online communication allows increased amounts of communication between teachers and students when compared with other forms of education* (item 9), that *ICT has usually been used to encourage them to be active participants in learning* (item 12), and finally even that *educational games motivate learners and contribute to developing skills such as teamwork* (item 16). In summary, it seems that females have a more positive attitude toward the impact of technology on learning in general.

- Education: More people with high school matriculation than others strongly believe that *ICT has usually been used to encourage students to be active participants in learning* (item 12). The same group is also more positive than others about the claim that *ICT has been used to support the development of higher level thinking skills such as synthesis and problem solving* (item 13).
- Occupation: More students than other respondents disagree that *the problems of access to learning for students with disabilities have been resolved thanks to technology* (item 7). Managers and retired persons have a more positive attitude than teachers and students towards the item that *contacts between students and teachers can have the same intensity in online education as in face-to-face education* (item 8). Managers and teachers are more positive than technical staff and students about the claim that *online communication allows increased amounts of communication between teachers and students when compared with other forms of education* (item 9). Students have a more positive attitude than managers concerning the statement that *only optimistic people think that the impact of technology on learning is beneficial* (item 10). *ICT has usually been used to encourage students to be active participants in learning* (item 12) believe teachers and students more than other occupational groups, and the same groups are also more positive than others about the statement that *ICT has been used to support the development of higher level thinking skills such as synthesis and problem solving* (item 13). They also believe more than other occupational groups that *educational games motivate learners and contribute to developing skills such as teamwork* (item 16).

Applying Spearman's Rho calculation, linear relationships between the variables can be determined: The answers to the questions about the *impact of technology on learning in general* (items 7 – 16) are – as far as significant – positively correlated. For items 11 – 16 even a positively moderate correlation was found significant for each combination of items. Whoever had a positive attitude towards at least one claim about the *impact of technology on learning*, exhibited a positive tendency towards the other items, too. The following correlations are – because of their intensity – of particular interest:

- An agreement with the claim that *contacts between students and teachers can have the same intensity in online education as in face-to-face education* (item 8) is moderately positively correlated to an agreement with the claim that *online communication allows increased amounts of communication between teachers and students when compared with other forms of education* (item 9).
- Respondents who agree based on their personal experience with the statement that *the impact of technology on learning is valuable* (item 11) also tend to support the thesis that *learning is enhanced when text and pictures are integrated in a multimedia environment* (item 15).
- Responses to the claims *ICT has usually been used to encourage students to be active participants in learning* (item 12) and *ICT has been used to support the development of higher level thinking skills such as synthesis and problem solving* (item 13) are moderately positively correlated.
- Answers to item 15 (*learning is enhanced when text and pictures are integrated in a multimedia environment*) are moderately positively correlated to answers to item 16 (*educational games motivate learners and contribute to developing skills such as teamwork*).

A comparison of these results with those of the two subsequent surveys about the *impact of technology on learning in e-learning* by Agrusti and Mileva (2007) and on the *impact of technology on learning in synchronous e-learning systems* by Agrusti and Keegan (2007) is not easy although the same questions have been used in Section 2 of all three questionnaires. A major reason for this difficulty are significant differences in the personal background of the respondents of these surveys. While e.g. the respondents of Krämer's intervention group has a mean age of slightly above 30 and many of them are in technical or manager positions, the respondents of the other two intervention groups are much younger (most of them 24 or younger) and are mainly (full-time) students. As these surveys aimed at other facets of dis-

tance learning the experiences of the respondents also differed significantly. Hence it is of little avail to compare the results. Rather, after all surveys have been concluded, the accumulated answers to Section 1 and 2 will be analysed.

At this point in time we can just sum up some important results of Agrusti and Mileva (2007) and Agrusti and Keegan (2007) on the impact of technology on learning in general:

- Similar to Krämer's observation, the agreement to *problems of access to learning for students with disabilities have been resolved thanks to technology* (item 7) amounts to about 50% while only a few respondents disagree (14% and 17%). Agrusti and Mileva observed a more negative attitude to this item for people in the age of 25 to 40 than in the age range under 24, but a more positive one for people with high school matriculation than others.
- Likewise similar is the negative attitude toward the *comparability of intensity of contacts between students and teachers* (item 8). More than half of the respondents disagree with this opinion (56% and 59%), with – in case of Agrusti and Mileva – even a higher degree of disagreement for people with high school matriculation. Compared with the intervention group, the control group of Agrusti and Keegan is (in the mean, too) significantly more agreeing, but also this group tends to slightly disagree with this item.
- All three analyses show an agreement of about a half of the respondents to item 9 (*online communication allows increased amounts of communication between teachers and students when compared with other forms of education*), whereas disagreement is varying between 20% and 30%. The data collected by Agrusti and Keegan shows differences depending on the gender of the respondents. Females tend to be more uncertain about this question. Agrusti and Mileva indicate a more positive attitude to this statement for people with high school matriculation or people occupied as students or teachers.
- The disagreement with the negative formulated claim that *only optimistic people think that the impact of technology on learning is beneficial* (item 10) is about 60 % in every of the examined questionnaires and is supported by an overwhelming agreement of nearly 80 % and above to *from my personal study experience I find that the impact of technology on learning is valuable* (item 11). Agrusti and Keegan depict yet a larger disagreement to item 10 for the intervention group, while Agrusti and Mileva detect that more people with high school matriculation have a positive opinion to item 11 than others.
- More than half of the respondents of the three questionnaires agree that *ICT has usually been used to encourage them to be active participants in learning* (item 12), that *ICT has been used to support the development of higher level thinking skills such as synthesis and problem solving* (item 13) and that *ICT has been used to support more individualized learning programs tailored to their own individual needs* (item 14) while the level of disagreement is mostly around 20%. The figures of Agrusti and Keegan show that the degree of uncertainty of females to item 12 is slightly larger; the agreement to item 13 is higher in the intervention group and for females. Agrusti and Mileva determined a higher agreement with item 13 for people with high school matriculation and students.
- The agreement to item 15 (*learning is enhanced when text and pictures are integrated in a multimedia environment*) is overwhelming (between 80% and 85%), and also to item 16 (*educational games motivate learners and contribute to developing skills such as teamwork*) an agreement of 70% to 77% of the respondents can be observed. Agrusti and Keegan depict for both questions a higher intensity of agreement (more strong agreements as agreements) for the intervention group.
- Noticeable is that Agrusti and Mileva found no significant differences between the intervention and control group towards their impression of the impact of technology on learning in general, in contrary to (Krämer, 2007) and (Agrusti and Keegan, 2007).
- A relative uniform picture is afforded by Agrusti and Mileva's observation on the significant differences between female and male respondents: more female respondents believe that *the problems of access to learning for students with disabilities have been resolved thanks to technology* (item 7) and that *online communication allows increased amounts of communication between teachers and students when compared with other*

forms of education (item 9) and even that *ICT has been used to support the development of higher level thinking skills such as problem solving and synthesis* (item 13). Only item 8, which states that *contacts between students and teachers can have the same intensity in online education as in face-to-face education*, obtains a higher degree of agreement from male respondents. In summary – just like Krämer observed – it seems that females have a more positive attitude toward the *impact of technology on learning in general*. The difference of attitudes of men and women will be analyzed at more depth within our project by an own special investigation topic questionnaire.

The Impact of Technology on Learning in Open Universities and Distance Education

The last section of Krämer's questionnaire especially looked at perceptions and opinions about *the impact of technology on learning in open and distance universities*. The questions are presented in Table 3. In its role as a distance teaching university FernUniversität was selected to form the intervention group for this investigation, while the other partners provided the control group. As described above, the samples in both groups exhibit different levels of exposure to technology, in general, and in education, in particular, while experiences with distance and open universities only exists in the intervention group.

Table 3 - Questions 17 – 21: Questions to the impact of ICT on learning in open universities

Item 17: The application of new ICT concepts to support learning and teaching and provide Internet access to student administrative processes, has improved distance education.
Item 18: Technology facilitates easier access to material for those studying part-time.
Item 19: University degrees awarded by open universities may be comparable to degrees from traditional face-to-face universities.
Item 20: There is no difference in learning outcomes between studying at an open university or at a traditional face-to-face university.
Item 21: Study at an open university is especially of advantage to adults who have work and family obligations.

In summary, we can report that:

- Most users (approx. 75%) agree that *the application of new ICT concepts to support learning and teaching and provide Internet access to student administrative processes, has improved distance education* (item 17).
- Nearly all respondents (around 90%) agree that *technology facilitated easier access to material for those studying part-time* (item 18).
- Around 50% agree that *university degrees awarded by open universities may be comparable to degrees from traditional face-to-face universities* (item 19); disagreement ranges at 25%.
- No agreement can be determined for item 20 (*there is no difference in learning outcomes between studying at an open university or at a traditional face-to-face university*).
- That *the study at an open university is especially of advantage to adults who have work and family obligations* (item 21) is shared, however, by an overwhelming percentage of respondents (around 90%).

Differentiating in terms of experiences with open universities we observed: The improvement factors (items 17 & 18) are largely confirmed by the intervention group with a higher value on the strong agreement. That *degrees awarded by traditional face-to-face universities and open universities compare* (item 19) is also seen positively with a slightly higher value in uncertain and negative judgments. With respect to the *learning outcomes of systems* (item 20), agreements predominate but the uncertainty factor is quite high. That the *study at an open or distance university is especially of advantage to adults who have work and family obligations* (item 21) proves politicians who supported the installment of open and distance universities in the 1970s and 1980s to have taken the right decision with a strong agreement.

An interesting observation related to the control group is the relatively high number of more than 20 missing answers in this section of the questionnaire, whereas this rate is below 5 otherwise. Overwhelming is the agreement to the claim that *new ICT concepts have improved distance education and related student administrative processes* (item 17). Attitudes

to the claim that *technology facilitates access to material for part-time students* (item 18) are even stronger on this item. The answers to the statement about the *comparability of degrees awarded from traditional face-to-face and from open or distance universities* (item 19) shows a high degree of uncertainty in this group with a slight tendency to disagreement. A similar profile depicts the graph of opinions about the *learning outcomes between an open and a face-to-face university* (item 20). Finally we observe an extremely high agreement, even strong agreement, with the claim that *study at an open university is especially of advantage to adults who have work and family obligations* (item 21).

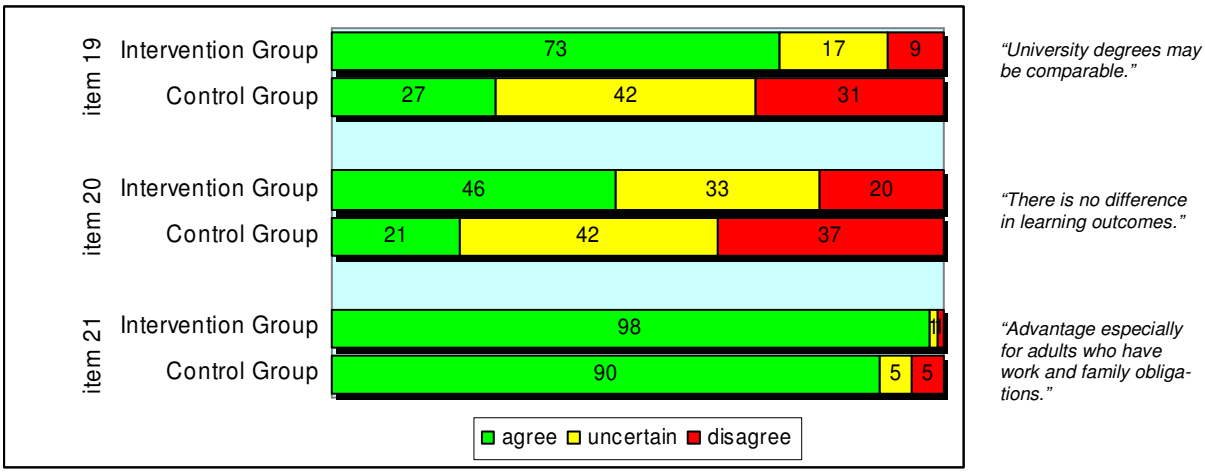

Figure 2 - Significant differences between intervention and control group (all values in percentage of valid responses)

In this group of items Pearson's chi-square indicates the following significant differences which are depicted in Figure 2:

- A striking difference shows up in the respondents' opinion about the *comparability of degrees awarded by face-to-face and distance universities* (item 19): The control group is much less certain about this aspect than the intervention group. About 42% of this group are uncertain, while agreement and disagreement are nearly balanced. The intervention group shows a significantly higher agreement.
- Results with respect to the *quality of learning outcomes in both systems* (item 20) differ analogously but both groups show differences in the distribution among the five answer categories. Finally, there is also a bit more doubt about the specific advantage of the distance study system in the control group than in the intervention group. This can probably be explained by the lack of experience of the participants in the control group.
- The agreement to *study at an open university is especially of advantage to adults who have work and family obligations* (item 21) is overwhelming in both groups, but in the intervention group the agreement is even significantly higher.

In relation to personal backgrounds, only following differences are significant:

- Age: That the *application of new ICT concepts to support learning and teaching and provide Internet access to student administrative processes, has improved distance educatio*n (item 17) is believed by more respondents in the age between 30 and 40 than in other age groups. Users under the age of 30 have a more negative attitude than users at the age 30 – 50 towards the two assertions *university degrees awarded by open universities may be comparable to degrees from traditional face-to-face universities* (item 19) and *there is no difference in learning outcomes between studying at an open university or at a traditional face-to-face university* (item 20).
- Gender: More female respondents strongly agree that *the application of new ICT concepts to support learning and teaching and provide Internet access to student administrative processes, has improved distance education* (item 17).
- Occupation: Teachers have a more positive attitude than students against the claim that *the application of new ICT concepts to support learning and teaching and provide Internet*

access to student administrative processes, has improved distance education (item 17). Teachers and technicians are more positive than students about the statement that *technology facilitates easier access to material for those studying part-time* (item 18). *University degrees awarded by open universities may be comparable to degrees from traditional face-to-face universities* (item 19) is viewed more negatively by teachers and students than by retired people. Finally, students are a bit more pessimistic that *the study at an open university is especially of advantage to adults who have work and family obligations* (item 21).

Applying Spearman's Rho calculation, we found several significant correlations between the answers to the items of this section:

- Responses to the claim that *university degrees awarded by open universities may be comparable to degrees from traditional face-to-face universities* (item 19) and the claim that *there is no difference in learning outcomes between studying at an Open University or at a traditional face-to-face university* (item 20) are strongly correlated, i.e., for the respondents a comparable degree coincides with an undistinguishable study success.
- The agreement with the idea that *technology facilitates easier access to material for those studying part-time* (item 18) is moderately positively correlated to an agreement with the claim that *the application of new ICT concepts to support learning and teaching and provide Internet access to student administrative processes, has improved distance education* (item 17).
- The responses to items 17, 18 and 19 are moderately positively correlated to the agreement with the statement that the *study at an open university is especially of advantage to adults who have work and family obligations* (item 21).

Significant results provided, we found only moderate positive correlations between items of the groups *impact of technology on learning in general* (items 7 – 16) and *impacts of technology on learning at open and distance universities* (items 17 – 21). However, an exception was the correlation between the responses to *educational games motivate learners and contribute to developing skills such as teamwork* (item 16) and to *university degrees awarded by open universities may be comparable to degrees from traditional face-to-face universities* (item 19). Their answers are moderately negatively correlated. Respondents who consider educational games as motivating rather negate the comparability of degrees awarded by open universities and traditional face-to-face universities.

The Impact of Technology on Learning in E-Learning

Due to limited space, we can only sketch core results of the survey on the *impact of technology on learning in e-learning* (Agrusti and Mileva, 2007). The questions used in Section 3 of this questionnaire are presented in Table 4.

Table 4 - Questions 17 – 21: Questions to the impact of ICT on learning in e-learning

Item 17: The integration of blended learning approaches in campus teaching has enhanced the effectiveness of learning.
Item 18: The use of the WWW is an obstacle to learning.
Item 19: The technology allows students to have frequent interaction with the tutors.
Item 20: The first effect of technology is to facilitate the communication of the learning content.
Item 21: Those who study online have difficulty in organising their learning.

Agrusti and Mileva found out that:

- Most users (approx. 64%) agree that *the integration of blended learning approaches in campus teaching has enhanced the effectiveness of learning* (item 17) while nearly a quarter of them is uncertain.
- Nearly all respondents (around 80%) disagree that *the use of the WWW is an obstacle to learning* (item 18).

- Around 65% agree that *the technology allows students to have frequent interaction with the tutors* (item 19).
- With item 20 (*first effect of technology is to facilitate the communication of the learning content*) agree 63% of respondents.
- No agreement can be found on the following claim: *those who study online have difficulty in organising their learning* (item 21). While over a third of the respondents is uncertain, over 40% even disagree.

Comparing intervention and control group, it was found that:
- Although the answers to item 17 (*enhancement of the effectiveness of learning by blended learning*) are similar in both groups, a significant difference in the numbers of people that are uncertain is observed (38 versus 68).
- There is a bit more doubt whether *online courses bring difficulties in learning organization* (item 21) in the control group than in the intervention group. This can probably be explained by the lack of experience of the respondents in the control group.

Concerning the personal background of the respondents, the following results were detected:
- Age: Respondents in the age group of 25 – 29 have a more positive attitude (84% versus 74%, 75%) than users at the age up to 24 and 30 – 40 towards the assertions that *the use of the WWW is an obstacle to learning* (item 18). Respondents in the age group up to 29 have a significant more positive attitude (72% versus 52%) than respondents over 30 years old towards the assertions that *the technology allows students to have frequent interaction with the tutors* (item 19).
- Gender: More female respondents disagree that *those who study online have difficulty in organizing their learning* (item 21).
- Education: More people with high school matriculation than others believe that *the technology allows students to have frequent interaction with the tutors* (item 19) and *the first effect of technology is to facilitate the communication of the learning content* (item 20).

The Impact of Technology on Learning in Synchronous E-Learning Systems

(Agrusti and Keegan, 2007) reports on the findings about the *impact of technology on learning in synchronous e-learning systems* in detail. Below we can just review the most important outcomes. The corresponding questions are presented in Table 5.

Table 5 - Questions 17 – 21: Questions to the impact of ICT on learning in synchronous e-learning systems

Item 17: Synchronous e-learning is not a complete replacement for direct personal communication.
Item 18: Acceptance of the virtual classroom environment is important.
Item 19: Studying in synchronous e-learning courses is better than asynchronous e-learning courses.
Item 20: Synchronous online courses replicate traditional face-to-face education.
Item 21: Synch. online study offers the same possibilities of socialisation with other students as traditional face-to-face courses do.

Agrusti and Keegan found out that:
- Three quarters of the respondents agree with the negatively formulated item on the *completeness of the replacement of direct personal communication by synchronous e-learning* (item 17), only 10% believe that the replacement can be complete.
- With the question whether *acceptance of the virtual classroom environment is important* (item 18) agree 73% of the respondents, while only 7% disagree.
- Although about 40% agree with the claim that *studying in synchronous e-learning courses is better than asynchronous e-learning courses* (item 19), the degree of uncertainness is nearly equal.
- More respondents disagree than agree (36% and 18%, respectively) to the claim that *synchronous online courses replicate traditional face-to-face education* (item 20), again with a high degree of uncertainty.

- Nearly two-thirds of the respondents reject the thesis that *synchronous online study offers the same possibilities of socialization with other students as traditional face-to-face courses do* (item 21).

The following significant differences between intervention and control group were identified:

- The intervention group – having experience of synchronous e-learning study – has a more clear opinion to the statement that *these systems are not a complete replacement* (item 17), i.e., more respondents of the intervention group than of the control group strongly disagree but also strongly agree to this.
- To the statement that *acceptance of the virtual classroom environment is important* (item 18), the intervention group is stronger agreeing, while the control group feels relative uncertain.
- The difference between both groups is similar for item 19 (*studying in synchronous e-learning courses is better than asynchronous e-learning courses*) but the degree of agreement or uncertainness is even higher.
- The statement that *synchronous online courses replicate traditional face-to-face education* (item 20) is viewed rather negatively in the intervention group, while agreement and uncertainty have a slightly higher share in the control group. Only the strong agreement is more pronounced by the intervention group but the number of respondents sharing this opinion is altogether very small.
- The same analysis result holds for the last claim that *synchronous online study offers the same possibilities of socialization with other students as traditional face-to-face courses do* (item 21) with an overall more negative attitude.

In addition Agrusti and Keegan found a significant influence on the attitude towards the questions on the impact of technology on learning in synchronous e-learning systems caused by the gender of the respondents: concerning item 17 (*completeness of the replacement of direct personal communication by synchronous e-learning*) and item 18 (*acceptance of the virtual classroom environment is important*) males have sharper attitudes, i.e., they are more frequently strongly agreeing or strongly disagreeing to the questions than female respondents. In addition, more males than females reject item 21 (*synchronous online study offers the same possibilities of socialization with other students as traditional face-to-face courses do*), while the degree of uncertainty is considerable higher for females.

Conclusions and Future Work

Our research hypotheses that technology does, in fact, have an impact on learning and that this impact is beneficial is approved by our analysis results. Especially the high disagreement to the claim that *only optimistic people think that the impact of technology on learning is beneficial* and the even higher degree of agreement to *own good experiences* shows, that most respondents of our questionnaires strongly support our research theses. In addition, the acceptance of claims like *thanks to technology, the problems of access to learning for students with disabilities have been resolved* as well as the positive attitudes towards special impacts of ICT (item 12 – 16) prove our hypotheses.

We have seen for the impact of technology on learning in open universities that most participants agree that *ICT facilitates easier access to material for those studying part-time* and its *application to support learning and teaching and providing Internet access to student administrative processes has improved distance education*. The agreement that *a study at an open university is especially advantageous to adults, who have work and family obligations*, is overwhelming. However, we have to note that – rejecting our thesis of general acceptance of the comparability of education provided by open universities and face-to-face universities – especially in the control group a great deal of uncertainty exists about the *comparability of degrees awarded open universities and traditional face-to-face universities*. Because of observing much less uncertainty and a twice as high agreement from experienced respondents

of the intervention group, this results may indicate, that the public presentation of studying on open universities could be improved.

We have seen in the field of e-learning that many users agree that *the integration of blended learning approaches in campus teaching has enhanced the effectiveness of learning* and that *the technology allows students to have frequent interaction with the tutors* and even that *the first effect of technology is to facilitate the communication of the learning content*. But none of them believes that *the use of the WWW is an obstacle to learning* or that *those who study online have difficulty in organising their learning*.

While many respondents *do not believe that synchronous e-learning is a complete replacement for direct personal communication* and are also very sceptical about *the comparability of the socialisation possibilities of synchronous online study and face-to-face courses* we have observed a high degree of uncertainness for *studying in synchronous e-learning courses is better than asynchronous e-learning courses* and *synchronous online courses replicate traditional face-to-face education*.

Moreover, we have identified interesting differences between opinions dependent on age, gender, education, occupation, and personal experiences. For example, several comparisons show that respondents with special experiences towards distance learning (students from the different intervention groups) tend to be more positive to the impact of technology on learning, but also that female tend to be more positive on this than male.

The results of all surveys and analyses concluded by now and those to report on
- the impact of technology on learning from the WWW on-campus,
- the impact of technology on learning in mobile learning, and furthermore on
- the impact of technology on learning for men and women, and
- the impact of technology on learning for older and younger learners

will be published on the projects home page (Ericsson, 2008). In total, the project will have acquired more than 2.100 responses. Especially for the questions on the impact of technology on learning in general, a common analysis of this impressive database collected from six countries across Europe may provide further conclusions with high confidence.

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