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A Blended Learning Solution and the Impacts on Attendance and Learning Outcomes

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Abstract—Blended learning based on lecture videos and face-to-face teaching provides good opportunities for students for participation in education, regardless of time or place. The article describes a blended learning solution that is based on face-to-face teaching and the use of streaming lecture videos as it has developed in connection with master studies in mathematical information technology. The particular focus of this article is on the use of lecture videos and the impacts of blended learning on participation in education and on learning outcomes. According to the results, lecture videos have become very popular among students. Moreover the use of lecture videos increases participation activeness, and the increase in participation has a positive impact on completion of courses. However, the use of lecture videos does not seem to have any clear-cut effect on grades obtained.

Index Terms—blended learning; learning outcomes; lecture attendance; video lecture.

I. INTRODUCTION

Due to rapid changes in work life, especially in the field of ICT, lifelong learning has an important role to play. In practice, lifelong learning means that the needs of the adult learner must also be met. Adult education brings with it novel challenges for education providers. Adult students often are integrated in work life. This is quite common, especially in the field of ICT. In addition to being employed, these students have often family responsibilities, and they are continuously forced to make compromises between participation in education and family life. Thus, the biggest problems that adult students and students who work and study have, are related to time use limitations. This is shown, above all, as difficulties in participating in the education arranged.

To improve the opportunities for participation in education, the education provider must seek new solutions to increase the flexibility of education. That means, first and foremost, enabling new, flexible ways of participation. One way to increase the ways to participate is to provide education by blending together face-to-face and e-learning methods.

E-Learning is an umbrella term, which can be widely defined to include all electronic technology used for learning purposes [1]. Today, almost all teaching in higher education institutes involves some use of electronic materials. The potential that technology has brought to us can be utilized also in face-to-face teaching, and often at least lecture transparencies are available in electronic form. More and more frequently there are complete courses or at least parts of courses that can be studied via the web. Ac-

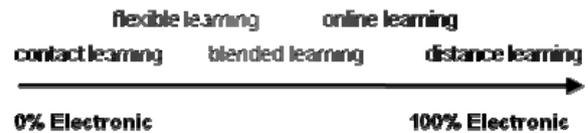


Figure 1. Spectrum of E-Learning [2]

cording to Procter [2], the spectrum of different E-Learning solutions can be shown as in Fig. 1. In the figure, the line represents the percentage share of teaching that is transferred electronically. The scale is flexible, and the terms often get their exact meaning only once they are being used.

The education model that is realized by combining face-to-face teaching and online learning is called the blended learning model [3]. The term "blended learning" thus describes learning with a mix of, for example, different location-bound activities (such as face-to-face classrooms), teaching that is not dependent on time or place (on-demand videos) and live E-Learning (real-time videos) [4]. Several slightly differing definitions for the blended learning model have been proposed (e.g., [3], [5], [6]). Indeed, it is hard to determine whether the term blended learning means face-to-face learning boosted by web technologies or online teaching made more efficient by face-to-face learning. It is also difficult to see what their mutual ratio should be so that the teaching could be referred to as blended [3].

In Master Studies in Mathematical Information Technology at the Kokkola University Consortium, the education provider does not force the courses to adapt to the contact learning, distance learning, online learning or blended learning model. The approach of the education provider is to offer education both in the form of face-to-face education and as online education implemented with the help of videos. The students in the education programme can freely choose the way to participate in education for each lecture. Solution that is based on face-to-face teaching and streaming lecture videos offers the students a full range of opportunities to participate in education regardless of time and place and in accordance with their own needs. To the student, education provided thus appears as a model of blended learning where the student can decide the degree of blending. The student can, if he/she so wishes, study solely through the face-to-face mode, but the student also has the choice to study solely through the distance mode.

According to some research participation in face-to-face education has a positive impact on course performance [7][8], and the provision of lecture videos might lure students away, without an acceptable reason, from face-to-

face education (example [9]). So it is a quite common belief that lecture videos have a negative influence on participation in face-to-face education and on learning [10][11]. One should keep in mind, nevertheless, that if participation in education is made more flexible, it also becomes more diverse. Thus, the strongest emphasis should not be put on the impact of lecture videos on participation in face-to-face education but rather on how the use of lecture videos affects participation as a whole and on the impact of video use on learning outcomes.

This study describes a blended learning solution as well as to examines the impacts of the use of the videos on participation in lectures and on study results. Based on the classifications of student's course participation, the article examines, in more detail, the impact of different participation modes on participation activity and learning outcomes. The article is extended and updated version of [13]. The results in this article are based on analyses of log data collected from transmissions of videos for 25 courses between 2008 and 2010, attendance statistics collected about face-to-face education, the register of study credits and on a survey [12] of master's students of information technology done in 2009.

The rest of this article is organized as follows: Section II reviews other related studies conducted elsewhere; Section III describes a blended learning solution for the Master Studies in Mathematical Information Technology, motivation for the use of blended learning and, briefly, the practice established for the production of videos; Chapter 4 classifies students and course participation on the basis of the amount of video use and, with the help of this, examines what the effects of the use of lecture videos on learning outcomes are. Finally, there are some conclusions.

II. RELATED WORK

When evaluating the impact of videos, it is important to observe the effects of video use on participation in education and on learning outcomes. However, research on lecture videos, for the most part, focuses on the ways videos are used or on the activeness in their use.

The impact of videos on participation in education has been examined especially from the viewpoint of participation in face-to-face education. Less attention has been paid to participation in education with the help of videos. Also in case of participation in face-to-face education the research results are conflicting. Some of the studies have found that videoing lectures has a negative effect on participation in face-to-face education (e.g., [10], [14]), but according to other studies there is hardly any effect (e.g., [9], [15], [16], [17]).

Neither have the learning outcomes in connection with the use of lecture videos been examined, to any great extent, in earlier studies. The results are contradictory and usually results cannot be directly projected from the topic of the investigation to other education programmes. According to the research by Gosper et al [14], students believed that lecture recordings had helped them in obtaining better learning outcomes. Dziuban et al [3] found that the learning outcomes in courses based on blended learning were somewhat better and cases of dropping out less frequent than in the corresponding online courses. When compared to face-to-face education, the blended model was found to be at least as good, in some cases even bet-

ter. According to a study by Dean et. al. [18], students got better grades when online sessions were added to traditional teaching. Also according to Traphagan et al [10], students who use video lectures a lot obtain higher grades in exams.

On the other hand von Kinsky et. al. [15], noticed in their research that the use of lecture recordings influenced completion of courses but had no influence on grades obtained. Wieling and Hofman [19] noticed that the amount of participation in face-to-face education and with the help of videos positively correlated with course performance. They found out that the greater the share of participation as face-to-face education the smaller was the positive effect of participation with the help of videos. Ross and Bell [20] investigated students who are able to participate in face-to-face education and view on-demand videos. They noticed that the more these students participate with the help of videos, the worse the grades they get. By contrast, they also investigated students who have only videos at their disposal and found out that the more they view the videos, the better the grades they obtain. Chiu et al [21] did not find any difference in course grades between those who took advantage of videos in their participation and those who did not

III. BLENDED LEARNING SOLUTION

There are approximately 100 students enrolled in Master Studies in Mathematical Information Technology at Kokkola University Consortium. All students in the programme are adults. For education providers, mature-age study brings with it novel challenges when compared with education directed to young students.

A. Challenges

Almost all the master's students are employed and most of them work in the field of ICT. Typical of this field is that the workload varies, and to maintain one's skills requires constant study. Working alongside study significantly limits the time that can be dedicated for study. To provide the working students with at least some kind of opportunity to participate in face-to-face education, if they so wish, face-to-face teaching is arranged to take place on Friday evenings and on Saturdays during daytime. To improve the participation opportunities for students who work, attempts are made to keep the courses concise. During a single weekend, typically 2-6 traditional lectures are given. Thus arranged, a course can be carried out in a few weekends. The problem with this is that absences of one weekend can mean, in the worst case, that the student cannot attend 15-50% of the course's face-to-face teaching.

For most adult students there is also one special issue to consider: almost all of them have a family to look after. Having a family sets more limitations for the time the student can dedicate for study. The students are thus forced to make compromises in their allocation of time between participation in education, on one hand, and work and family life, on the other.

Competition over students has lead to marketing of master's education in information technology consciously on a national level. The students of the study programme typically live around a wide geographical area. The distance from the places of the farthest living students to the campus area is approximately 500 km. Long distances

naturally make it more difficult for the students to participate in face-to-face teaching. It is quite significant also that the number of students living farther away is continuously increasing. Of the students accepted to the programme during the last few years only about 1/3 live so near the campus that the distance does not impede with their participation in education.

The limitations due to work, family life and long distances are shown, above all, as worsening opportunities to participate in the programme. Thus, there is a clear need to add flexibility to study participation. This has led to the provision of education being very strongly supported by solutions of educational technology.

B. Adding Flexibility to Participation

The education solution for the Master Studies in Mathematical Information Technology is based, above all, on the use of lecture videos created by streaming technology. The aim is to improve the opportunities of students to participate, with the help of videos, in education provided. The student can participate in education through the face-to-face mode or by watching a real-time transmission. Participation in education in this case would be in accordance with a course schedule designed beforehand. However, real-time videos free the student from dependency on the place of study. If a student wants to participate in education in accordance with some other schedule, he/she can view the teaching through on-demand video.

An important principle in the education solution is that students do not need to decide about their participation mode beforehand; they can choose to participate in each lecture the way that is the most suitable in their own particular circumstances. Thus, in one course the student can participate in education in many different ways by flexibly combining various alternatives. Moreover, the student can always, if he/she so wishes, revise earlier teaching sessions with the help of videos.

As a support for the studies, in addition to videos, a web based Learning Management System (LMS) is used. The system includes all the material that is related to the study and communications. Course-specific communication and distribution of materials that the course requires is also carried out through LMS. Therefore, the information needed can be accessed always by the student when connected to the Internet.

1) Video Lectures

The approach for adding flexibility to participation in education has been that it must be applicable to all teaching provision in the education programme, not only to some individual courses. All face-to-face teaching provided by the educational programme is offered as real-time video produced from face-to-face teaching situations. This has been made possible by automation, as far as possible, of the production of lecture videos. During the production of a real-time video, the video is also recorded. This so-called on-demand video is offered to students for later viewing.

In connection with the videos produced for teaching information technology, the decision has been made to give priority to the visibility of lecture material. For this reason, a lecture video consists of sounds heard in the lecture theatre and of a picture of the electronic teaching material that the lecturer shows with the video projector in the teaching space. In addition to the computer and instead of

using a traditional blackboard, the lecturers use a document camera, touch screen or smartboard. Thus all the teaching material used by them can be stored in the video. Good visibility of teaching material is also the focus of constant development work. Currently it is possible to produce these materials for HD standard. Fig. 2 shows an example of a lecture video where the lecturer uses a document camera. Fig. 3 shows an example of a lecture video where the lecturer uses a touch screen in the presentation of electronic lecture material.

2) Use of Video Lectures

The students get their links to real-time video and on-demand video recordings through the Learning Management System. In this way the links to videos can be accessed only by students who participate in the course concerned. On-demand videos can be viewed by the students already during the evening of the lecture day. The videos are on the media server; they cannot be stored on the student's own computer. Students log in with their own personal IDs to watch the videos. Research related to video use has been made possible by the use of the media server, prevention of storage and user IDs.

For some years now, the use of videos to diversify study has been an established practice in connection with the provision of education [12], [22]. The main principle is that the students have the opportunity to select between face-to-face education and video lectures as their lecture participation mode or combine both modes.

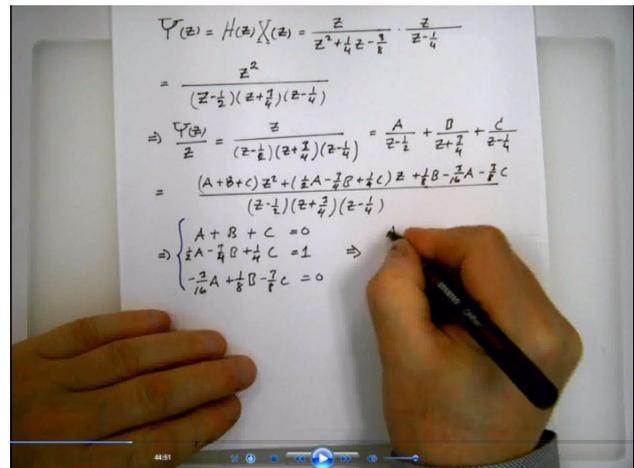


Figure 2. Example of a lecture video where the lecturer uses a document camera.

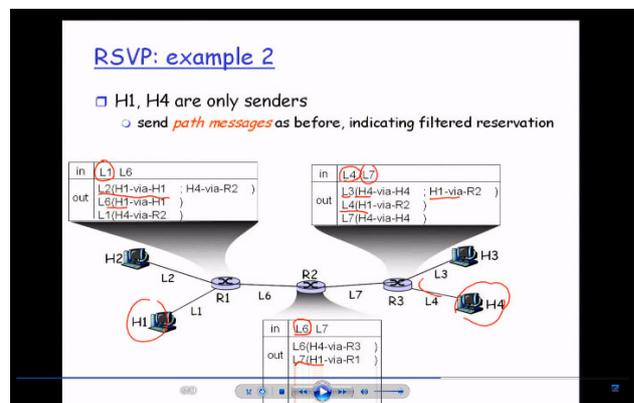


Figure 3. Example of a lecture video where the lecturer uses electronic material and a touch screen.

made use of lecture videos in study participation, and only 8% of the students always participated in face-to-face education. The opportunity, provided by lecture videos, to participate in a flexible way, increased also study participation. The participation percentages of both hybrid and online students during the study period were clearly above those of face-to-face students. The participation percentage of the latter group remained as low as 47%. This is clearly below the average participation percentage 67%.

The significant role of videos is partially explained by the results of the questionnaire that was directed to students in the spring of 2009 [12]. More than half of the students had the impression that lecture videos, together with other course material, facilitated their learning at least as well or even better than face-to-face teaching. About one-third of them thought that face-to-face teaching in some situations facilitates learning better than video lectures do. Only one-tenth were of the opinion that lecture videos cannot replace face-to-face teaching in any situation.

Table II shows the percentage of completed courses by student category. Based on the table, course completion by face-to-face students is clearly less than by hybrid students, and respectively, course completion by hybrid students is less than online students. For face-to-face students, only 42% of courses led to a grade that was approved. For hybrid and online students the corresponding percentages are 66% and 72%.

Fig. 7 shows the relation between course participation and completion. Based on the figure, face-to-face students participate considerably less in education and also complete clearly fewer courses than hybrid and online students who utilize lecture videos. On the other hand, hybrid students participate more in education but complete fewer courses than online students. However, according to t-tests the differences of participation and courses completed between hybrid students and online students are not statistically significant. Thus, the share percentage of completed courses seems to be dependent on the participation degree or the use of video lectures.

Fig. 8 focuses on the averages of the grades of only those students whose course studies were graded. Based on Fig. 7 and Fig. 8, the participation degree does not have any effect on grades. According to Fig. 8 face-to-face students have the best results and hybrid students the worst results, but the differences between categories are not statistically significant (Mann-Whitney U Tests). So, the results do not support the assumption that participation mode has some effect on grades.

B. Classification of Courses

Above, students' lecture participation for each course during the observation period was studied. The students can choose their participation mode as per lecture. Thus, a particular student can participate in one course as a face-to-face student and in another course as a distance student or a hybrid student. Thus, the importance of face-to-face and online participation in the classification presented above decreases and that of hybrid participation increases. A significant portion of hybrid students participated in some of the courses through the face-to-face mode only and in some of the courses only with the help of lecture videos. For this reason, the classification of students' course participation is also done as per course.

TABLE I.
CLASSIFICATION OF STUDENTS AND PARTICIPATION IN EDUCATION

	Students	Lecture participation
Face-to-face students	6 (8%)	47%
Hybrid students	39 (52%)	73%
Online students	30 (40%)	64%
Total	75	67%

TABLE II.
PERCENTAGE OF COURSES COMPLETED IN DIFFERENT STUDENT CATEGORIES

	Students	Completed	Not completed
Face-to-face students	6 (8%)	42%	58%
Hybrid students	39 (52%)	66%	34%
Online students	30 (40%)	72%	28%
Total	75		

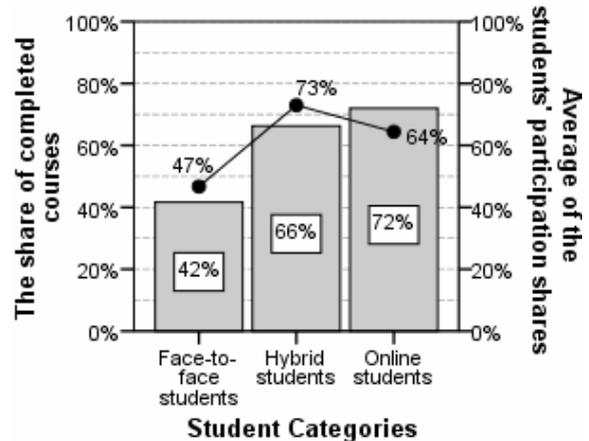


Figure 7. Average participation percentage (graph) and the share of courses completed (histogram) in different student categories. (n=75)

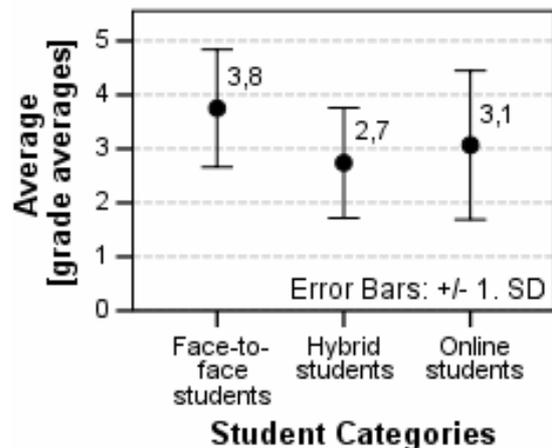


Figure 8. Grade averages and deviations (N=69) of the grades for completed courses. The courses are evaluated with 0-5 integral scale.

When classification concerns the student's course-specific participation mode, i.e., course participation mode, course participations by students and not the students themselves are classified. The students' course participations are classified in three categories as face-to-face

participation, hybrid participation, and online participation, which are defined as follows.

Category I (Face-to-face participations): Course participations by students in which all the student's course participations have taken place through the face-to-face mode.

Category II (Hybrid participations): Course participations by students in which the student's course participations have taken place through the face-to-face mode as well as with the help of videos.

Category III (Online participations): Course participations by students in which all the student's course participations have taken place with the help of lecture videos.

As we examine all 25 course participations, we must keep in mind that the classification is no longer student-specific. A student can participate in one course purely through the face-to-face mode, in another course both with the help of lecture videos as well as through the face-to-face mode and in a third course solely with the help of lecture videos. In that case the student's course participations are, respectively, allocated to categories I, II and III.

Fig. 9 shows relationship between classification of students and the course-specific classification. According to the figure hybrid students constitute the main part of the face-to-face course participations. Similarly, nearly half of the online course participations are constituted by the hybrid students. Of the hybrid students, 20 participated in at least one course in the face-to-face study mode only and 26 participated at least in one course solely with the help of videos.

Table III shows the impact of course-specific classification on participation in education. Table III clearly shows the importance of lecture videos on participation in arranged education. Most of the course participations (84%) took place with the help of lecture videos, either as hybrid or online participation, and more than half (51%) of the course participations took place solely with the help of lecture videos. In addition, three out of four students participated at least in one course solely with the help of videos.

Table III shows that lecture participation was clearly most common (83%) in the hybrid participation category. Lecture participation percentages were good also in the face-to-face participation category and in the online participation category. Participation degrees were close to each other in these two categories.

Table III is clearer than Table I in presenting the importance of face-to-face teaching to students. According to Table I, only 8% of the students participated in face-to-face teaching. However, according to Table III, 35% of the students participated in at least one course in the face-to-face study mode only. Also the percentage of lecture attendance in Table III is substantially greater than in Table I.

The results can be interpreted as meaning that many students made an effort to participate, with the help of face-to-face teaching, in those courses in which they had the possibility to participate while keeping within the schedule. This is also reflected in Fig. 9, which shows that course participations by hybrid students was 75% of all face-to-face course participations. The desire to participate was also shown in the results of the student questionnaire

[12], according to which, more than 70% would have liked to participate in face-to-face education on Fridays and Saturdays if there had been no time-related problems concerning participation.

Table IV divides the students' course participations, by categories, to those that led to course completion and those that did not. According to the table, the completion percentages are same (62%) for the online participation category and for face-to-face participation category. However, the hybrid category students have the greatest chance of completing a course with their clearly superior course completion probability (79%).

Student Categories

- Face-to-face students
- Hybrid students
- Online students

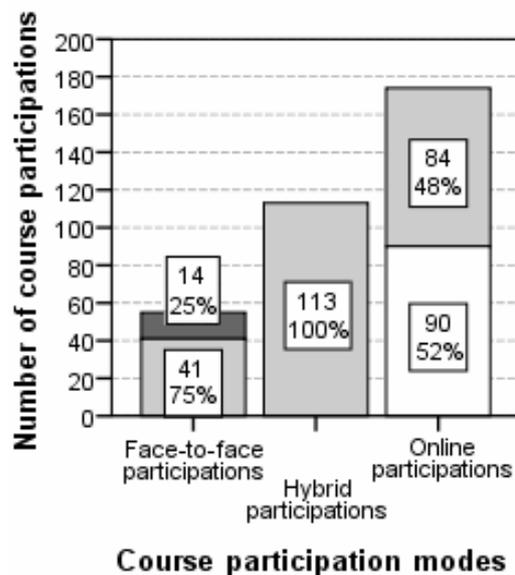


Figure 9. Relationship between classification of students and the course-specific classification.

TABLE III. COURSE-SPECIFIC CLASSIFICATION AND PARTICIPATION IN EDUCATION

	Number	Students	Lecture participation
Face-to-face participations	55 (16%)	26 (35%)	67%
Hybrid participations	113 (33%)	38 (51%)	83%
Online participations	174 (51%)	56 (75%)	66%
Total	342		

TABLE IV. PERCENTAGE OF COURSES COMPLETED IN DIFFERENT LECTURE PARTICIPATION CATEGORIES

	Completed	Not completed	Total
Face-to-face participations	34 (62%)	21 (38%)	55 (100%)
Hybrid participations	89 (79%)	24 (21%)	113 (100%)
Online participations	107 (62%)	67 (38%)	174 (100%)
Total	230 (67%)	112 (33%)	342 (100%)

Videos enable more flexible participation in education, and this is reflected also in course completions. Fig. 10 considers the effect of participation on course completion. According to the figure, the percentage of completed courses is dependent on the participation degree.

Fig. 11 considers the effect of participation on course completion. In the figure, the hybrid participations are further divided into five different categories on the basis of video use:]0,20[, [20,40[, ... , [80,100[. For example, [20,40[indicates students' course participations in which [20%, 40%[of those participations have taken place with the help of videos and the rest of them as face-to-face education. The figure shows that the percentage of the completed courses is, above all, dependent on the participation percentage and not on the relative share of participations that have taken place with the help of videos. For example, those course participations in which videos were used in [40%, 80%[lecture sessions did not lead to course completion as well as did participations in which videos were used either more often or less often.

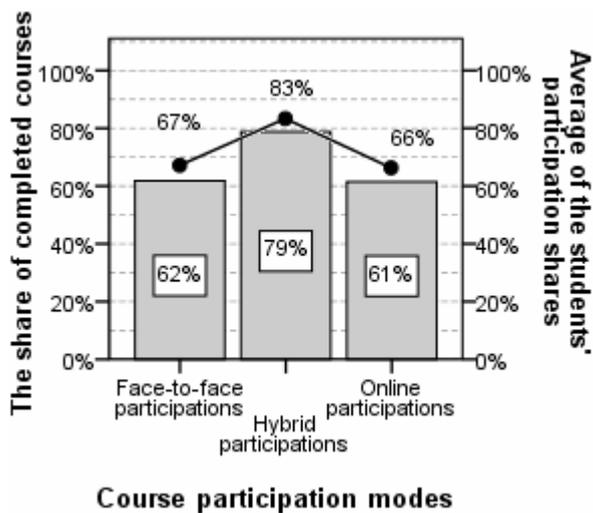


Figure 10. Average participation percentage (graph) and the percentage of courses completed (histogram) for different course participation modes.

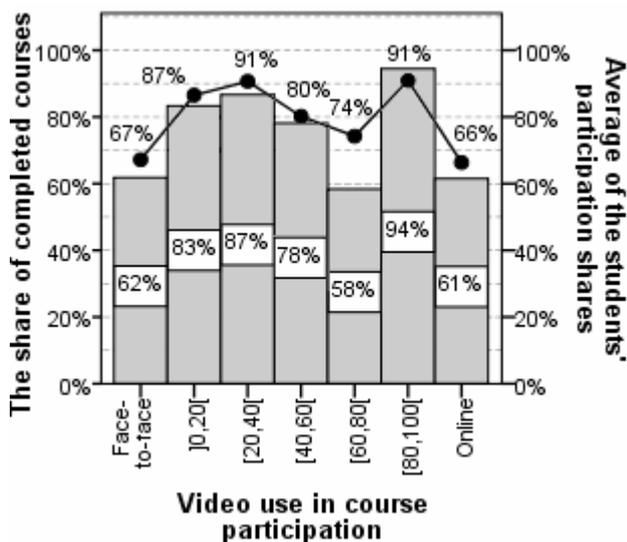


Figure 11. Average participation percentage (graph) and the percentage of courses completed (histogram) for different course participation modes.

Even though the participation degree explains completion of courses, nevertheless, even according to this classification, it does not seem to correlate with the grades obtained in the courses. This becomes apparent in Fig. 11-13. Fig. 12 and Fig. 13 show the averages of the grades for different course participation modes. According to Fig. 12 and Fig. 13, the grades for hybrid participation category are not as good as other categories. However, the differences between categories are not statistically significant (Mann-Whitney U Tests and Kruskal-Wallis Test).

V. CONCLUSION

Increase in adult education and the challenges it has brought with it put providers of education under pressure to find flexible ways to arrange teaching. A much used method is mix together face-to-face teaching and online teaching. The blended learning model has been implemented already for many years in face-to-face teaching and videos produced about it in Master Studies in Mathematical Information Technology at Kokkola University Consortium. In the model, students themselves decide how much to utilize the videos.

In the results of this article, the importance of videos in the participation of education provided was strongly emphasized. Three out of four students participated at least in one course wholly with the help of videos and almost all students utilized videos to a certain extent in their partici-

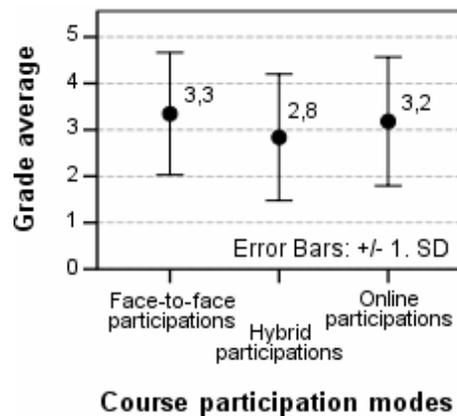


Figure 12. Grade averages and deviations (N=127) of the grades for completed courses. The courses are evaluated with 0-5 integral scale.

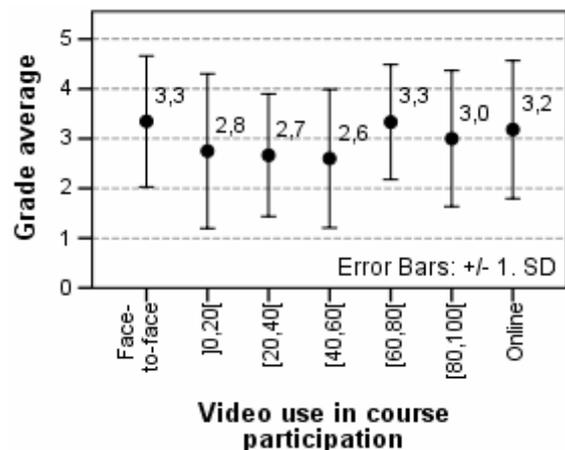


Figure 13. Grade averages and deviations (N=127) of the grades for completed courses. The courses are evaluated with 0-5 integral scale.

pation in education. The number of hybrid students, i.e. those students who use a different ways to participate to education, was high. The use of videos has increased substantially in recent years and the trend seems to be such that an increasing number of participations will take place with the help of the videos in the future.

Although the role of videos in participation for arranged education is strong, organizing face-to-face teaching is still well justified. According to the student classification, students who generally participate with the help of face-to-face education in all of the courses are a minority. However, with the course-specific classification it can be observed that more than every third student participates purely through face-to-face education in some individual courses. This seems to indicate that students often adapt their study in accordance either with the course or with their life situation. It also seems that many of the students might not have just one single mode to participate in the education provided.

The utility of the blended learning solution can be evaluated not only by participation in education but also in relation to learning outcomes. This article considered learning outcomes by focusing on the effect of the solution on course completions and grades. According to the results, use of lecture videos facilitates participation in a course. Similarly, it seems that the increased participation brought about by videos has a positive effect on course completion. Thus, provision of videos can be seen to demonstrate an indirect positive effect on learning outcomes. On the other hand, the use of lecture videos does not seem to have any effect on grades obtained.

The significant and increasing role of the lecture videos and a large number of hybrid students suggests that another kind of student classification could be useful. Therefore, the effects of video usage on learning outcomes have already been studied with the help of the classification that takes hybrid student better into account [23]. It is still a challenge to create a complete picture of the impacts of a blended learning solution realized with the help of videos. For example, one must be able to verify somehow the effects, on learning outcomes, of repeated use of videos. For this reason, further research on this field would be well justified.

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