ARE FREE INTERNET TECHNOLOGIES AND SERVICES THE FUTURE OF SYNCHRONOUS DISTANCE LEARNING?

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ABSTRACT

Distance education is not a new paradigm, but the latest ways it can be delivered certainly are. In the past couple of decades, the distance learning implementations were mostly realized using videoconferencing technologies and/or learning management systems. Recently, various Internet collaboration services have gained enormous popularity in all areas of human living, especially in distance learning, where many of them are offered free of charge. In this paper we elaborate the deployment of a synchronous distance lecturing solution based on free audioconferencing and screen sharing networking technologies, and we discuss the benefits gained in the context of cost, functionalities, effectiveness and users' satisfaction. The experiences after three semesters of use indicate that this alternative approach provides quite valuable means for effective implementation of distance learning, where the students appeared to be highly satisfied by the possibilities and functionalities that the system offers.

Keywords: Distance education, distance learning, Internet technologies, video conferencing, audioconferencing, learning management systems.

INTRODUCTION

Educational institutions employ an ongoing effort to enhance their educational processes and effectively deliver the required knowledge to their students. For many centuries of education, the only method for such tasks has been the traditional Face to Face (FtF) method. But, the advent of modern communication technologies, especially the Internet, has brought to existence various means for delivering of lecturing activities to remote locations, where inhabitants are prevented to attend classes for different reasons. Such teaching concepts have extensively been researched in the last couple of decades, and reported as being quite beneficial to educational processes in the contexts of cost and time. The majority of systems for synchronous distance learning are built on videoconferencing concepts. In this manner, to name a few, Sagias (2002) looks upon the issues of a distance lecturing system based on videoconferencing technologies incorporating the MPEG-4 coding standard. In this research, multiple benefits are reported, while incorporating various teaching methods and approaches, including synchronous (online and offline lectures), as well as asynchronous, such as bulletin boards or forums. Chipps, Brysiewicz and Mars (2012) explore the effectiveness of videoconference-based tele-education for medical and nursing education of rural nurses and doctors from South Africa that have little opportunities to further their education and training. This research has also shown high participant satisfaction with the use of

videoconferencing as an educational technology. Tapsis and Tsolakidis (2015) compare the advantages of using virtual worlds and videoconferencing as supporting tools for educational communication in distance learning. In their research they conclude that both platforms offer similar benefits, but the choice should be based on the specific requirements of the course subject. Qi and Shi (2016) develop a distance learning system that in its basics works with video recording and streaming. In this research, a distance learning platform for students majoring in physical education is designed. The platform is based on 3D technologies and real-time video collaboration. The teaching platform includes many functions such as 3D real time recording and playing, access to information, generation of 3D simulation videos and video downloads. The authors report that the experimental results revealed improvement in learning efficiency and academic achievement among the participating students. Anderson, Beavers, VanDeGrift and Videon (2003) developed a distance learning system based on Internet videoconferencing and a pen-based computer system for presentation. Their analysis of qualitative data (observation notes, surveys and interviews) collected throughout the course suggest that technological interruptions increased the feeling of separation between the sites, while the integration of natural handwriting with presentation slides increased flexibility and was perceived quite positively by the students and instructors. Another implementation of videoconferencing in distance learning is proposed by Snow, Pullen and McAndrews (2005). The research presents the development of an open-source distance-learning system that is described as inexpensive, easy to use and operate, and highly effective. Based on videoconferencing technologies, the system provides many of the valuable aspects of the live classroom experience that are essential for learning. The system also makes recordings of classes available for playback and it is free for academic use.

Concerning the distance learning delivery using the http protocol, one of the pioneers in web-based multimedia learning were Chen, Chen and Hong (1999) who in 1999 suggested a system for synchronous distance education using HTML learning materials augmented with video materials of recorded lectures. The system is built in three modules: 1) video reorder for recording live lectures; 2) Event server for storing and serving content, and 3) browser for presentation of synchronized multimedia lectures. Furthermore, Giesbers, Rienties, Tempelaar and Gijselaers (2013) investigate the relations between motivation, tool use, participation and performance in an e-learning course using web videoconferencing tools like Skype or Adobe Connect and deduce valuable conclusions in the aforementioned contexts. Kear, Chetwynd, Williams and Donelan (2012) also investigate web videoconferencing implementation in distance learning. Their findings indicate that overall experiences of both tutors and students reacted positively to the opportunities that web videoconferencing technology provides for interactive teaching and learning.

Some research is concentrated on well-established learning management technologies. In this manner, Hampel and Stickler (2012) base their research on a project in which multiple distance lecturing technologies are trialed and evaluated in a distance education institution. Afterwards, the university adopted Moodle ("Moodle — Learning Management System") as the platform for its virtual learning environment (VLE), to contribute to students' experience of studying in a distance education setting as well as improving learning in their particular subject area. Similarly, Ren and Wu (2015) present a design and application of a distance educational platform based on Moodle as well. The platforms is intended for use on tablets by professional peasants. The findings include stimulated interests of many peasants and it exhibited strong amusement reactions. On the other hand, Fozdar (2015) explores the potentials of open and distance learning (ODL) concepts in the national science and technology knowledge gain. In his research, an experience from a university in delivering science program through open and distance learning mode is discussed, where the results indicate a success in providing access to higher science education and leveraging the knowledge to a diverse learner population across the country. The solution includes collaboration platform for exchange of lectures augmented with multimedia content for support. We must also mention that there are research efforts that witness considerable challenges in the implementation of distance education.

In the research conveyed by Ayo, Odukoya and Azeta (2014), the focus is on empirically ascertaining the state of Open and Distance Education (ODE) in Nigeria, striving to evolve a pragmatic solution to the challenges of ODE in the whole continent. The researchers conclude that the imposed challenges present strong limitations for proper implementation of ODE and consequently many institutions have reverted to the traditional FtF teaching. But, realizing the benefits of ODE concepts they also conclude that there is clearly a need to the realization of the ODE core objectives that could cater for all categories of people, irrespective of their location or planned learning time.

One of the most interesting paradigms of present times is the Virtual Reality (VR) technology. As such, VR is present in many areas of human living, and it has certainly found its place in education. Considering this, Chang, Zhang and Jin (2016) promote VR technology as a platform for distance learning, where teachers and students are engaged in a simulated three-dimensional world with a vivid and lifelike learning environment in terms of vision, hearing and touch, having the students feel as participants in a real environment. The system developed on this research offers various activities for students, such as attending lectures, doing exercises and even making friends. The teachers are able to create lectures, review works of students and conduct examinations, while managers can manage the daily teaching activities and students' affairs.

There is also an ongoing research in exploring the possibilities of implementing distance learning for practical exercises. Thus, Ionescu, Fabregas, Cristescu, Dormido and De Keyser (2013) presents the development, structure, implementation, and some applications of a remote laboratory for teaching automatic control concepts to engineering students. The main conclusions of the feedback from both the students and the academic staff are that the experiences are quite positive and such practices, as a good pedagogical tool, are encouraged. Similarly, Xu, Huang and Tsai (2014) present a cloud-based virtual laboratory educational platform called V-Lab that provides a contained experimental environment for hands-on experiments using virtualization technologies (such as Xen or KVM Cloud platform) and OpenFlow switches. The evaluation demonstrates that the platform and curriculum have produced excellent results and helped students to understand and build up computer security knowledge to solve real-world problems.

Indeed, there is a variety of different technologies that can be effectively employed for development of synchronous or asynchronous distance learning. These technologies include VR, collaboration platforms such as Moodle or similar proprietary systems, but if we summarize the existing experiences in distance learning we can easily infer that the most frequently used is the videoconferencing technology. In all the cases the transportation infrastructure is the Internet, where some research activities use the videoconferencing for educational purposes as a web service. Furthermore, Martin (2005) confirms that the videoconferencing is of extraordinary importance to distance education, and that it is important that there is a new awareness of its vast potential in order to ensure that the technology is fully exploited for the benefit of learning communities. Nevertheless, besides the video presence, the importance of other possibilities required during a distance lecture, such as documents and links sharing, collaboration among the students, adequate presentation and screen sharing by both the teachers and the students, cannot be neglected. On the other hand, many distance learning systems that are based on videoconferencing are built on expensive hardware. These costs may not be significant influential factor in the developed world, but for the developing countries it is quite important to be reduced.

Analyzing the previous reported experiences with distance learning and bearing in mind the required reduction of development and implementation costs, we decided to explore an alternative solution using free Internet collaboration technologies and services. The solution we have chosen is not based on videoconferencing, but rather on audioconferencing using an existing VoIP communication platform. Besides the audio collaboration, the solution involves another Internet service for screen sharing that is

used for presentation and drawing over the screen. Both platforms are also used for documents exchange. The combination of these two free Internet services appeared as a quite feasible alternative for synchronous distance learning compared to the already established educational platforms. The implementation of the aforementioned free Internet services is realized for the distance education purposes at the "St. Kliment Ohridski" University – Bitola, Faculty of information and communication technologies (Faculty of ICT), Bitola, R. Macedonia.

The rest of this paper is organized as follows. Section 2 describes the implementation of a synchronous distance learning that is based on free Internet technologies and services, as a solution utilized by the Faculty of ICT for the purposes of realizing the educational tasks for the students that for various reason were not able to attend regular classes. Section 3 elaborates the experiences of the usage of distance learning approach and discusses the main findings concerning the students' satisfaction. Section 4 concludes the paper with a discussion of the most relevant findings of the referred distance learning implementation.

DISTANCE LEARNING IMPLEMENTATION USING FREE INTERNET TECHNOLOGIES AND SERVICES

Previous experiences with distance learning at the University in Bitola started with a TEMPUS project entitled "Video conferencing educational services – ViCES" (Caporali & Trajkovik, 2012), realized between 2009 and 2012 in which many universities from Italy, Serbia, Macedonia, Albania, Belgium and Hungary took participation. Besides, during the testing period, videoconferencing connections were established between Bitola and many other locations, such as Florence, Belgrade, Skopje, Leuven and Budapest. The solution was based on Polycom HDX 8000 terminal, along with eagle eye smart cameras, super sensitive microphones, and HD video projectors. This equipment was combined with an older Polycom equipment consisting of integrated Polycom PVS 1419 module, in order to experimentally implement distance learning in a distributed classroom in the city of Veles, located 120 km from the main premises in Bitola. The main difference between the two Polycom devices was the support for SIP signaling protocol that the older equipment did not offer, but this issue did not represent an obstacle since the main implementation of the videoconference communications was based on the H.323 protocol. The aforementioned Polycom equipment met the needs for a distance education, since not only it enabled establishment of teachers' virtual presence, but enabled presentations or combinations of video collaboration and presentation, as well as content sharing. It was a Point-to-Point (PtP) synchronous distance learning solution where the students were provided with an opportunity to follow live lectures, exchange documents and communicate with the teacher. However, even though this PtP videoconferencing solution was perfectly viable for synchronous distance learning, it appeared that it cannot fulfill the requirements of the specific circumstances emerged.

Namely, in recent years we noticed that many students that live in distant rural areas do not attend classes as often as they should, and even miss up to 80 % of the lectures. The reasons for this discontinuity of their studying were multiple, starting from weather conditions in the winter periods, the daily traveling costs, to spending a lot of valuable time while traveling to and from the faculty premises because lot of student living in rural areas have certain house or farm works during their spare time. In such circumstances, the aforementioned videoconferencing solution was infeasible because the distance learning implementation needed to enable lectures delivery to the students' homes so that they would be provided with the opportunity to follow the lectures out of the comfort of their own premises and with all the benefits that are provided for other students.

The other requirements were that the solution should be suitable for fast implementation and with the least possible expenses. Thus, we turned to Internet technologies and we started to seek a solution that would fulfill our requirements, favoring the free solutions if possible. In this manner, the web inquiry reveled many existing Internet services that could be feasibly used for the purpose, but out of the many that we briefly reviewed two

free Internet communication technologies emerged as a quite adequate combination that would meet the specific requirements of the intended approach for synchronous distance learning solution at the Faculty of ICT. The technologies that we have chosen were TeamSpeak ("TeamSpeak – VoIP Cloud Services") and FreeScreenSharing ("FreeScreenSharing – Screen Sharing for Online Meetings").

TeamSpeak

TeamSpeak is a VoIP collaboration system designed to offer crystal clear voice, with the ability to scale up to thousands of simultaneous users, and multiple customization options. TeamSpeak is most commonly known as a gamming communication platform, but it is quite often used for education and training, internal business communication, and keeping in touch friends and families. The primary focus of the TeamSpeak creators is to deliver easy to use solution incorporated with high security standards, excellent voice quality, and low system and bandwidth demands.

TeamSpeak uses a proprietary VoIP protocol for audio communication between users on a chat channel, much like a telephone conference call, where users typically use headphones with a microphone. The client software connects to a TeamSpeak server of the user's choice, from which the user may join a certain chat channels. The TeamSpeak server runs as a dedicated server on Microsoft Windows, Mac OS, Linux or FreeBSD operating systems and provides a web based user interface, or a command-line interface, for administration and configuration.

TeamSpeak clients are available for Windows, MacOS, Linux, iOS, and Android. The TeamSpeak version 3 server can be used at no cost for up to 32 slots (simultaneous users). For non-commercial use, non-profit licenses are available that allow usage of the server with up to 512 slots at a time. With the use of 512 slots, a server administrator can choose to split up the slots into multiple virtual server instances. In this manner, the latest version of TeamSpeak supports virtual server instancing that allows up to 75 server instances to be contained in one process on the server. Additional server processes are possible as well. Featuring a client-server architecture, TeamSpeak is literally capable of handling up to thousands of simultaneous users. To maximize the collaborative experience TeamSpeak enables storing and sharing files directly on the server without having to mess with firewall issues.

Several additional features are also provided that aid to the functionalities required for distance learning environments, such as:

> ➢ **Text chat** – TeamSpeak enables the teacher to send text messages to students in a specified communication channel, or in a private one-to-one manner.
> ➢ **Robust system permissions** – With a powerful hierarchical permission system, the teacher has the complete control, deciding who can talk, who can join channels and much more.
> ➢ **Mobile connectivity** – Everyone using the platform can stay connected on the go, because the mobile versions of the user software are available for Android and iOS operating systems.
> ➢ **Security** – TeamSpeak incorporates AES based encryption that can be enabled on the entire server or on specific channels. To avoid potential threats arising from weak usernames and passwords, TeamSpeak uses public-private key authentication.
> ➢ **Customization** – TeamSpeak Client software can be customized to meet any personal style with the included plugins, themes and sound/icon packs. There a hundreds of add-ons contributed by the TeamSpeak community, that a user can choose from.

FreeScreenSharing

FreeScreenSharing is an Internet service that offers screen sharing for various online meetings. The system allows a single host to have up to 1000 participants, while having the possibility to switch presenter capabilities to any participant in the meeting, allowing them to share their screens as needed. FreeScreenSharing is frequently used for web conferencing, product demonstrations, webinars and other implementations that require online collaboration. FreeScreenSharing has a limit to a single meeting of six hours, which is more than required time for any distance lecture. The number of online meetings that a single host can organize is unlimited.

Using FreeScreenSharing is simple by the installation of a software that allows conducting a session or attending one. One of the disadvantages of FreeScreenSharing is the requirement for the installation of Adobe Flash, Java and a newer web browser with enabled JavaScript execution, in order to properly function, but the features offered are a plausible reason to neglect this issue. FreeScreenSharing is provided in versions for Windows and Mac OS operating platforms. FreeScreenSharing offers chat and allows the host to send messages to all or selected participants in the meeting, as well as enables document sharing among participants during online meetings in various file formats, such as Word, Excel, PDFs, Power Point presentations, and URL links.

THE PROPOSED SYNCHRONOUS DISTANCE LEARNING SOLUTION

The solution we built mostly relies on TeamSpeak, which is used for audio collaboration, as well as for documents exchange. We used the freeware version because the 32 channel slots were sufficient for the intended group of students per lecture. The TeamSpeak server version 3 was installed on a Linux machine running Ubuntu version 12.4. The server setup was realized in a single working day, which added to the appropriateness of the selected solution. The FreeScreenSharing was used mainly for presentation as well as for documents exchange. The selection of documents exchange option was left to the students' preference, and both options appeared quite adequate. But, concerning the audioconferencing for conveying the lectures, even though FreeScreenSharing offers some audio collaboration possibilities, TeamSpeak appeared quite more adequate offering functionalities that made it the preferable choice for synchronous audio distance learning. The following Fig. 1 presents the diagram of the synchronous distance learning system configured at the Faculty of ICT in Bitola, R. Macedonia.

The actual implementation comprised four steps: *i)* Provision of the required hardware; *ii)* Implementation of the audio service; *iii)* Implementation of the visual service; and *iv)* Provision of additional settings and/or services. For the realization of the first step, the minimum hardware requirements for the audio server were 512 MB of RAM, 800 MHz CPU and 5 GB HDD, thus we employed a machine consisting of 512 MB of RAM, 3.2 GHz CPU and 80 GB of HDD. In the second step we installed the TeamSpeak server according to the specific instructions given in the corresponding documentation. The third step, implementation of the visual service, included account creation at FreeScreenSharing, as well as installation of an executable file that is offered to the user at the first login. The fourth step, provision of additional required settings and/or services, among other requirements, includes possibilities to configure the TeamSpeak server for a dynamic network address using Dyn-DNS. The first implementation of our distance learning solution was based on the free Duck DNS ("Duck DNS − Free Dynamic DNS"), a free Dyn-DNS software.
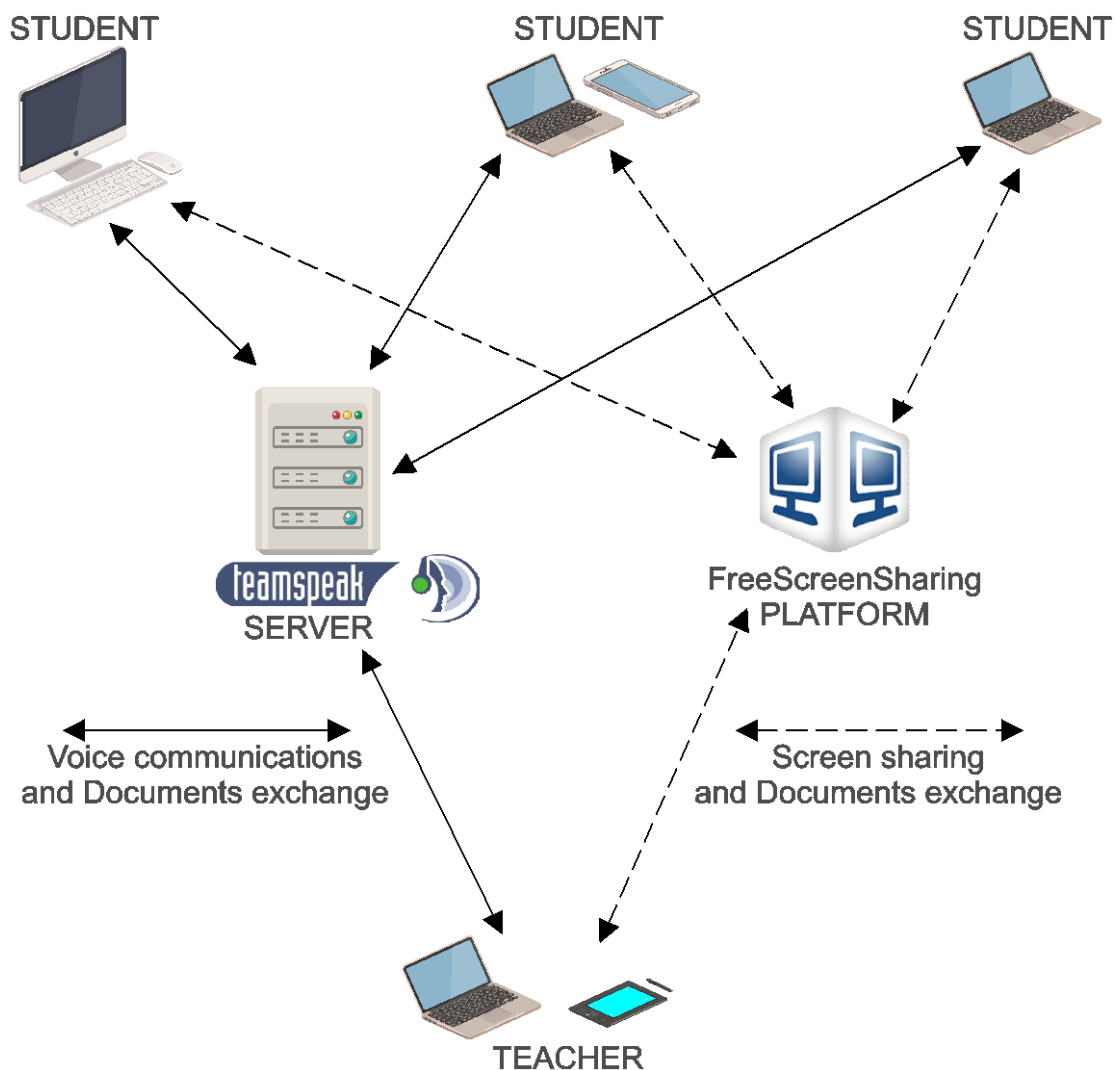
Figure 1. The synchronous distance learning system, based on free Internet technologies and services, deployed at the Faculty of ICT, Bitola, R. Macedonia

The solution for synchronous distance learning, configured out of the two previously elaborated free Internet technologies and services, was used for three semesters and the experiences of the students involved was quite satisfying. The main comments were that it provides all the functionalities that a distance lecture requires.

EXPERIENCES AND DISCUSSIONS

Besides the online attendance data that we were able to collect during distance lecturing, after each semester of using the aforementioned free Internet technologies and services, we conducted a short survey about the students' satisfaction of this kind of distance learning. The surveys consisted of questions that answer some essential requirements concerning the educational activities, such as easiness to use, appropriateness for the specific lectures, possibilities for collaboration, initial hardware or software requirements, possibilities for exchange of documents, and a question about their preference between attending distance lecture in a distance classroom along with their accompanying colleagues (PtP), or attending distance lecture out of the comfort or their homes, i.e in a Point-to Multipoint (PtM) manner.

Concerning the primary issue of impaired attendance to lectures, as expected, the situation improved significantly. The average percentage of attendance for the students

from the aforementioned category increased from 15 % for the standard classroom lectures to more than 85 % for the distance learning. This was due to the fact that besides the possibility for each student to attend lecture out of his/her home, the time schedule for distance lectures was negotiated among concerned students and the teachers before reaching the agreement. In this agreement, besides the regular (FtF) lectures for a given subject in the main campus, the involved teachers were obliged to hold additional lectures for the distance class, but it was a necessary and mutual decision reached by the faculty management and the involved teachers.

Through the conducted surveys, the student was asked to express their satisfaction from the use of this type of distance learning, considering the aforementioned requirements. Thus, in order to more adequately plot the survey results we decided to quantify students' satisfaction and requested that the answers in the surveys are within the range from zero to ten, where zero means unsatisfied and ten represents the highest satisfaction. Figure 2 presents the plot of the students' satisfaction regarding several important requirements.
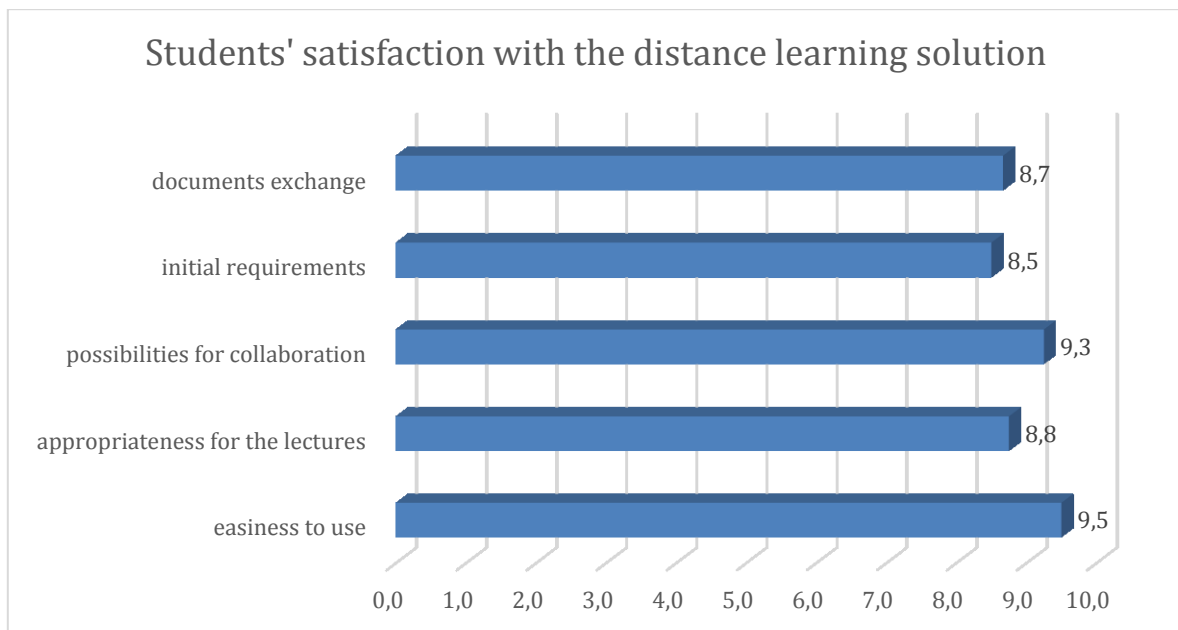

Figure 2. Students' satisfaction with the provided distance learning solution

Regarding the question about the students' preference between attending distance lecture in a distance classroom along with their accompanying colleagues (PtP distance learning), or attending distance lectures out of the comfort or their homes (PtM) distance learning), 44.4 % responded that they prefer attending the distance learning in a PtP manner, while 55.6 % prefer to enjoy the comfort of their homes while attending distance lectures. Additional students' comments were mainly concentrated on the requirement to enable recording and storing of lectures and possibilities for lecture downloads for later use. Some of the students pointed out that practical exercises are a necessity of educational processes and they find the distance learning solution deficient of such valuable learning assets.

CONCLUSIONS

There is an ongoing trend of innovative approaches to distance learning by the integration of technologies that facilitate different lecturing modalities. Considering the specifics of the problems imposed with the poor student attendance records, we decided to explore an alternative solution for synchronous distance learning using free Internet technologies and services. In a world wide web inquiry we reviewed many technologies that offer adequate online collaboration services, thus we decided to try a solution that combines two free Internet technologies and services, i.e. TeamSpeak and

FreeScreenSharing. From a viewpoint of an educational institution the deployment of such technologies emerged as a quite significant activity, because the services were offered as free to use on one hand, and because of the extremely short durations for setting up the required hardware, as well as the preparation of students to use the newly established system, on the other. The whole setup of the TeamSpeak server, as well as the preparation of the instructional material for the students was completed in a single working day. Concerning the students' satisfaction, the answers from the conducted surveys mostly range from satisfied to highly satisfied, which can be thought as a confirmation that the solution provided for distance learning activities completely justifies its' goals. In this manner we can conclude that certain Internet communication technologies and services do present a feasible alternative solution for distance learning, especially when are offered free of charge, and they impose substantial threat to the hardware systems that are still offered by an immoderate price.

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