

UNIVERSITY OF BELGRADE
TECHNICAL FACULTY BOR

**52nd International October Conference on
Mining and Metallurgy**



PROCEEDINGS

Edited by

Saša Stojadinović

and

Dejan Petrović

November 29th – 30th 2021

Bor, Serbia

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ADVANTAGES OF MINING ENGINEERING CURRICULUM REALIZATION USING SOLUTIONS BASED ON FREE SOFTWARE

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Abstract

Higher education institutions mainly use commercial software in the realization of their teaching process. The transition to the online teaching process revealed certain problems when using this type of software and it was necessary to find an adequate solution to overcome the problems related to online teaching environment. Certainly one of the solutions is to find appropriate software alternatives that are free from certain restrictions which are manifested during commercial software use. The paper shows how these problems are practically overcome by introducing free and open source software within the implementation of the teaching process in two subjects of the study program Mining Engineering at the Technical Faculty in Bor. The specific reasons and proper analysis for making such a transition are presented, as well as the analysis of the results achieved during the previous academic years when the mentioned software is used in a real environment during the teaching process.

Keywords: *free software, freely redistributed software, higher education, open source software.*

1. INTRODUCTION

During the special circumstances of teaching in the past period in pandemic conditions caused by COVID-19 disease, certain problems related to the unavailability of school resources [1] were manifested, include computer classrooms. Computer classrooms are a key asset in the implementation of teaching that includes teaching units that cannot be mastered without adequate use of computers and appropriate software. By switching to the online teaching regime, the entire model of teaching, observed from the point of view of teaching in computer classrooms, moves from a homogeneous to a heterogeneous environment characterized by the use of students' own computers in the teaching process [2]. This heterogeneous environment entails in most cases the inability to use appropriate software used in the regular teaching process, as in most cases there is no possibility of transition of software related to use within computer classrooms in higher education institutions to students' personal computers mainly due to certain economic and legal restrictions that prevail in the field of use and distribution of software.

One of the potential solutions to overcome the above-mentioned problem was the possibility of replacing the existing software with related software that would not be proprietary and commercial, but that would be completely free to use in the given circumstances of the teaching process. The principles embedded in the way of using and distributing free software fully fit the academic community because they are based on freedom and free dissemination of knowledge [3] and accordingly such software is a perfect candidate for the implementation of teaching processes. Also, in the domain of well-known releases on the software scene, we have a situation that for years almost every well-known proprietary software has its equivalent in the FOSS (Free and Open Source Software) domain [4]. Efforts have been made for a long time to point out all the economic, legal and technical benefits that FOSS implementation at different levels of education brings [5]. The global tendency to migrate existing solutions to the FOSS world is becoming more represented in European countries, primarily due to the financial savings

achieved by implementing such solutions, but also gaining a certain degree of independence from software manufacturers [6].

2. ECONOMIC AND LEGAL ASPECTS

In the previous chapter, it was stated that the use of free software achieves significant economic benefits. This statement is completely true since free software not only implies freedom of use and distribution, but also implies the absence of any fee for its use.

Commercial software that would otherwise be used in teaching would realize three types of costs: software licensing costs per lecturer, software licensing costs per student and licensing costs of accompanying software (various types of OS and the like). For lecturer, the total cost of software licensing, with the realization of certain academic benefits during licensing, would be 458.73 euros per year (13.10 for OS, 227.18 for first software and 218.45 for second software) and for student, the total cost of software licensing, with the realization of certain student benefits during licensing, would be 110.93 euros per year (no cost for OS, 50.64 for first software and 60.29 for second software). Also, the basic minimum projections should include one license for the server operating system and the appropriate panel for administration, which amounts to around 843.24 euros per year. If the subject is attended by a group of, for example, five students, we come to a total projected cost of 1856.62 euros for the licensing of software for one academic year in the case of the implementation of exercises in the online domain.

Using FOSS these costs no longer exist regardless of the number of students who realize the exercises in the given subject. The use of the FOSS solution also eliminates the need to conduct special software procurement procedures for teaching purposes such as those in accordance with the Public Procurement Law of the Republic of Serbia, as FOSS is not covered by the provisions of this Law and similar legal procedures. It should be noted here that FOSS also relies on the use of appropriate licenses [7], but they are far different from those that can be encountered when licensing commercial software. One of the key differences is defining how the software is redistributed. In the case of commercial software, the rules of software redistribution are very restrictive and in most cases make it difficult or in some cases completely impossible to apply it in the implementation of the online teaching process that takes place outside the academic institutions. In the FOSS case, there is full applicability of this type of software in all forms of teaching, since the software can be freely redistributed and is not subject to any strict restrictions. This practically means that FOSS can be downloaded from official websites, but also that lecturers can freely copy software installations and give it to students.

3. EXAMPLE OF SOFTWARE REPLACEMENT AND ACHIEVED RESULTS

Due to COVID-19 restrictions, at the Technical Faculty in Bor, during the academic year 2019/2020, certain transitions were made from commercial to free software in certain subjects teaching process [2]. Due to the very short transition time due to the pandemic conditions that occurred, this was done for only one part of the semester and marked as a pilot program. After the success of the pilot program, during the academic year 2020/2021 in the regular online teaching process, exercises from the subjects given in Table 1 in undergraduate [8] and master [9] academic studies (study program Mining Engineering, Technical Faculty in Bor) were fully performed using FOSS. The subjects listed in Table 1 were suitable candidates for this realization, since more than 70% of the planned exercises were realized using computers and some appropriate software, since parts of laboratory and calculation exercises, in addition to computer, were done using appropriate software solutions.

Table 1 - Structure of exercises for analyzed courses

Course		Share in exercises		
Name	Studies	Calculation	Computer	Lab
Process Measurement Techniques	Undergraduate	26.67 %	60.00 %	13.33 %
Process Control in Mineral and Recycling Technologies	Master	40.00 %	60.00 %	/

For the realization of computer and laboratory exercises, the GNU Octave [10] software in version 5.x was used which working environment is shown in Figure 1. GNU PSPP [11] software in version 1.4.x was used for the realization of part of the calculation exercises which working environment is shown in Figure 2. Both of the aforementioned software were initially run on Linux Fedora Workstation 32 [12], and later, after regular system upgrades, on versions of Fedora Workstation 33 (from November 2020) and Fedora Workstation 34 (from May 2021). Additional teaching content in the online teaching process was provided using two servers that initially ran Linux Fedora Server 32 [13], and after regular system updates, the servers ran on Fedora Server 33 (from the end of October 2020) and Fedora Server 34 (from the end of April 2021), respectively.

The software configuration described above was used in two ways. First, it represented the software configuration used on real computers, but also the identical software configuration was used in the creation of virtual machines that were also used in the process of realizing online teaching. Virtual machines are fully realized using Oracle VM VirtualBox [14] version 6.1.x with providing full functionality of virtual machines using adequate Oracle VM VirtualBox Extension Packs and Oracle VM Guest Additions.

These are the key software solutions that were used during the teaching process. However, it must be mentioned that in addition to these software, many other software packages have been used in terms of the implementation of additional types of tasks that cover some other processes in the implementation of teaching, e.g. software for image manipulation, for creating presentations, text editors and the like. All of this software was part of the Linux Fedora Workstation, so no additional demanding installation procedures were required and it was easily available for further work.

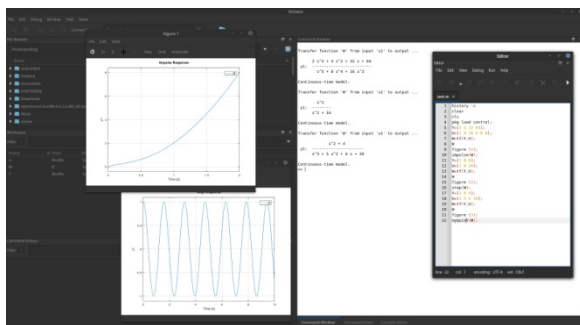


Figure 1 - GNU Octave working environment

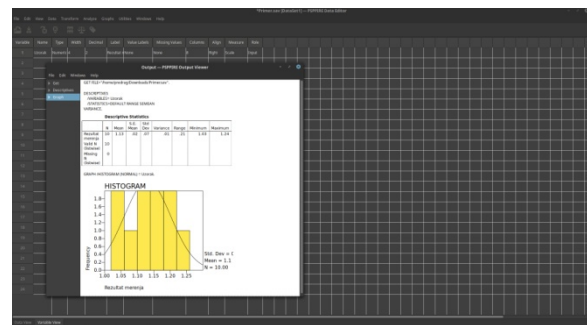


Figure 2 - GNU PSPP working environment

By using the mentioned software solutions, extremely positive effects were achieved on the teaching process itself, regardless of the development in rather difficult conditions. None of the students expressed any objections to the selection of the mentioned software, no problems were noted during the download of the software, their installation, or use. The work with the mentioned software went in accordance with the expectations observed from the side of the realization of the teaching process itself. None of the software required any additional registration during download, installation and use, so no personal data are additionally used during realization of teaching process which is in accordance with the Law on Personal Data Protection of the Republic of Serbia.

The realization of pre-examination activities in all cases is a maximum of 100 %, except in the case of subject in master academic studies in the academic year 2019/2020 where this realization is 80 % due to exceeding certain deadlines by one candidate. The success of candidates in taking the exams is also extremely high, which is shown by the average grades in the exams for the relevant subjects and academic years, which are shown in Table 2. As can be seen from Table 2, the lowest recorded average score is 8.75, while the other average scores are within the upper limits.

Table 2 - Achieved average exam grades for the appropriate academic year

Course		Average exam grade	
Name	Studies	2019/2020	2020/2021
Process Measurement Techniques	Undergraduate	10.00	9.50
Process Control in Mineral and Recycling Technologies	Master	8.75	10.00

4. CONCLUSION

From the previous analyzes it can be established that the transition from commercial software to FOSS in the implementation of the teaching process has been successfully completed. No indicators can be found that would call into question the participation of FOSS in various aspects of the implementation of the teaching process. On the contrary, the use of FOSS in the teaching process has achieved various benefits in economic, legal and technical terms.

In accordance with the obtained results, the use of FOSS is also planned for the implementation of the teaching process in the relevant subjects of Mining engineering at the Technical Faculty in Bor during the new accreditation cycle that started in the academic year 2021/2022.

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