

MODELS FOR EVALUATION OF TIME NEEDED TO DEVELOP AND SUPPORT ZOOM-BASED LABORATORIES

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Abstract

Traditionally, the workload of lecturers and educators in academia is measured in “hours per week”, whereas hours are counted as time of frontal teaching only. This approach does not take into account educator’s time needed to prepare the course, to provide from time-to-time relevant changes in the materials of the course, grade student’s assignments, to calculate final grades, and deal with student appeals. This traditional approach became even more problematic when the course is provided by using cloud means like ZOOM. In this paper, attempt is made to evaluate the time needed to develop and support ZOOM and CLOUD-based laboratories. Results and time evaluations are based on the three ZOOM and CLOUD-based laboratories provided in the last three “COVID-19” semesters. Because of “COVID-19” restrictions, electronic laboratories were provided as CLOUD-based TinkerCad simulations. Set of tables summarizes educator’s time actually spent on each task. Those tables (after proper modifications relevant to the specific course) can be used to provide a more realistic prognosis of the educator’s workload required for the development and support of the specific laboratory.

Keywords: active learning, remote laboratory, ZOOM-based course, course development, COVID-19 restrictions, TinkerCad simulations

1. INTRODUCTION

Generally, academic contracts are “task-based” and not “hour-based (Byford 2018). In most colleges and universities workload of lecturers and educators is set before every semester, and is counted as “hours per week”, whereas in most cases hours are counted as time of frontal teaching only. This approach does not take into account educator’s time needed to prepare the course, provide from time-to-time relevant changes in the materials of the course, grade student’s assignments, to calculate final grades, and deal with student’s appeals because it is assumed, that work of the educator in the specific university or college is a permanent full-time job, and above shores are an inherent part of this specific job. Additionally, it is assumed, that for most departments, the creation of a new course is not a frequent event. However, in some departments, like electronics departments, dealing with fast changing technologies, there is a need for regular updates of existed courses and for the permanent creation of new courses. In that situation, better evaluation of the actual workload of the staff becomes really important. Traditional evaluation became even more problematic when the number of courses were forced to be adapted to the COVID-19 requirements: to use CLOUD means like ZOOM.

A number of academic staff workload models and workload evaluation reports were published. For example: Miller, J 2019, Tunan, Ryan, & Lamont-Mills 2013, and many others.

This paper will discuss practical workload details relevant to providing three electronic laboratories under COVID-19 restrictions. Courses in the frames of which laboratories were provided: Image Processing, Electronics Instrumentation, Real-Time Digital Signal Processing. Some practical logistics details concerning the above courses and laboratories were published before, whereas some are still in press. (Kosolapov, Sabag 2016, Kosolapov, Sabag 2018, Kosolapov 2021).

2. ZOOM AND CLOUD-BASED LABORATORIES

2.1. Laboratory for the Course “Image Processing”

In a “normal time” this laboratory was provided in a dedicated laboratory room equipped with PC stations connected to the Internet. Students can connect to the PC cameras, drivers of which were installed by a laboratory technician. In the frames of this laboratory, students must write code that implements Image Processing Algorithms explained during frontal lectures and exercises. To create the code, students use C and C++ languages and use Microsoft Visual Studio 2019. During the laboratory, students write a laboratory report. When ready, students present the report to the educator for grading.

Table 1 summarizes “Officially Counted Time” as it is counted for the course “Image Processing”. It can be seen, that the time spent for the development and support of most of the elements of the course is not counted

#	Course Element Name	Officially Counted Time (Hours per Week)	Comment
1	Lectures	2	Frontal Lectures. <i>Educator’ time needed to prepare and modify materials for lectures is not counted</i>
2	Exercises	1	Provided in the class. <i>Educator’ time needed to prepare and modify materials for exercises is not counted</i>
3	Laboratory	3	Provided in the specially equipped laboratory. <i>Educator’ time needed to prepare materials for laboratories and grade student’ reports is not counted</i>
4	Exam	0	Not provided. <i>Micro Projects presentations are used instead</i>
5	In-class Micro-Exams	0	Provided during Exercises. <i>Educator’ time needed to prepare and grade micro-exams is not counted</i>
6	Home Works	0	Non relevant for this course
7	Micro-Project #1	0	Students present their works during lectures. <i>Educator’ time needed to prepare and grade Micro Project #1 is not counted</i>
8	Micro Project #2	0	Students presents their works during lectures. <i>Educator’ time needed to prepare and grade Micro Project #2 is not counted</i>
9	Grade Appeals	0	<i>Educator’ time needed to deal with student’ appeals is not counted</i>

Table 1. Elements of the non-cloud-based course “Image Processing” according to the syllabus and their’ official time accounting.

Because of COVID-19 restrictions, it was decided to provide Image Processing Laboratory by using ZOOM and Gmail CLOUD services (Kosolapov 2021). Students were organized by pair, but every student works from his home. During the laboratory, students have had the option to connect to the ZOOM session, but it was found impractical to do all the laboratory in ZOOM. So, after some short explanations concerning the assignment to be done, students were permitted to disconnect and work in pairs by using their’ preferred communication means. When specific pair of students finished some reports, they send it by using the Gmail CLOUD service. Educator periodically checked the arrival of new reports, evaluates them, and, if the report was found good enough, graded it. In case of serious problems rework of the report was requested. In that case, students were able to reconnect to ZOOM

session and ask for additional clarifications. It is clear, that new logistics did not change significantly the time spent by the educator to grade reports, but additional time was needed to modify course content in order to lessen the number of questions concerning laboratory assignments.

Table 2 presents the evaluation of time needed to develop and support CLOUD and ZOOM-based laboratory for the course “Image Processing” under “COVID-19” restrictions.

#	Course Element Name	Additional Time spent (Hours per Semester)	Time spent to Develop and support (hours)	Comment
1	Lectures	*1 14*2	*2 14*3	*1 14 Frontal Lectures recorded by using ZOOM must be edited and uploaded to the course site. *2 14 Frontal lectures presentations must be properly modified for different screens – from PC to smartphones. Additional materials explaining more details of the laboratory assignments must be added
2	Exercises	*1 14*1	*2 14*3	*1 14 in-class exercises recorded by using ZOOM must be edited and uploaded to the course site. *2 14 Exercises presentations must be properly modified for different screens – from PC to smartphones. Additional materials explaining more details of the laboratory assignments must be added
3	Laboratory	*1 6*1*N	*2 3*6	The time needed to prepare and grade laboratory assignments Students are expected to do 6 assignments N – number of students in the course
4	Exam	0	0	Not provided.
5	In-class Micro-Exams	10*N*(5/60)	10*1	The time needed to prepare and grade in-class micro exams 10 Micro-exams during the semester
6	Home Works	0	0	Non-relevant
7	Micro-Project #1	(1/2)*(N/2)	5	The time needed to prepare and grade Micro Project #1. Including time needed to check the code and reworked presentations. Reminder: students work un pair, hence (N/2)
8	Micro Project #2	(1/2)*(N/2)	5	The time needed to prepare and grade Micro Project #2. Including time needed to check the code
9	Grade Appeals	N*1	*1 2	The time needed to prepare the detailed answers to the appeals *1 The time needed to prepare a detailed list of typical errors and the influence of the specific error on the grade

Table 2. Evaluation of time needed to develop and support CLOUD and ZOOM-based laboratory for the course “Image Processing” during “COVID-19” restrictions.

In this table, there is a column summarizing “Additional Time spent” (in Hours per Semester) and a column describing “Time spent to develop” elements of the course. In this table, time spent may depend on the number of lectures per semester (it can vary between 14 and 13), the number of laboratory assignments (currently 6), and on the number of students in the course (N). The time written as a fraction, specify the time for the situation when this time is a fraction of an hour. For example, in the position “6”, record “5/60” must be treated as 5 minutes needed to grade micro-exam of the specific student, so that the total time needed to grade all micro-exams provided during the semester must be multiplied to 10 (number of micro-exams during the semester) and to “N” (number of the students in the course).

2.2. Laboratory for the Course “Electronics Instrumentation”

In a “normal time” this course was based on a concept “home laboratory” (Kosolapov, Sabag, 2018). In the frames of this concept pair of students have got a specially prepared set of electronic components, so that they will be able to create working systems at their homes by using physical electronic components.

Because of COVID-19 restrictions, it was decided to rework all assignments type from “physical implementation” to “Tinkercad simulations”. This decision required additional educator’ time: not all assignments were feasible by using simulation means, Hence, alternative assignments were created. It is clear, that this rework was time consuming.

In the “normal” time students were asked to physically demonstrate working systems they created in the frames of the course, assignments. In the COVID-19 time they demonstrated working simulations by using ZOOM cloud services. Additionally, students have sent the link to the relevant TinkerCad simulations. An educator was able to check their simulations, but this, obviously, required more educator’ time.

Table 3 summarizes “Officially Counted Time” as it is counted for the course “Electronic Instrumentation”. It can be seen, that the time spent for the development and support of most of the elements of the course is not counted.

Table 4 presents the evaluation of time needed to develop and support CLOUD and ZOOM-based assignments executed as TinkerCad simulations for the course “Electronic Instrumentation” during “COVID-19” restrictions. It can be seen, that creating and grading simulation is a time-consuming process. The specific technical problem was that not all known to the students electronic circuits pass Tinkercad simulation steps. In those cases it was an educator’ job to provide (and explain) working alternatives and explain additional electronic items.

2.3. Laboratory for the course “Real-Time Digital Signal Processing”

Organization and elements of this course are the same as for the course “Electronic Instrumentation”.

But complexity level of the algorithms used and complexity level of the hardware used are significantly higher than that of the course “Electronic Instrumentation”. As a consequence, in order to provide this course by taking into account COVID-19 limitation, much more educator’ time was needed.

Table 5 presents the evaluation of time needed to develop and support CLOUD and ZOOM-based assignments executed as TinkerCad simulations for the course Real-Time Digital Signal Processing” during “COVID-19” restrictions. It can be seen, that creating and grading simulation is even more time-consuming process than for the courses “Image Processing” and “Electronic Instrumentation”. The specific technical problem in this case was that systems operated as simulation are not as fast as real-life systems. Hence, speed requirements for all assignments were significantly lessen. Even more: students were permitted to lower the speed until real-time system will reliably work by using TinkerCad simulation. There were assignments simulation of which was problematic. In those cases, it was an educator’ job to provide (and explain) working alternatives and explain additional relevant items.

#	Course Element Name	Officially Counted Time (Hours per Week)	Comment
1	Lectures	2	Frontal Lectures. <i>Educator' time needed to prepare and modify materials for lectures is not counted</i>
2	Exercises	1	Provided in the class. <i>Educator' time needed to prepare and modify materials for exercises is not counted</i>
3	Laboratory	0	No official laboratory time was assigned. In the frames of "home laboratory" concept, laboratory assignment were implemented by using special electronic sets at student' homes.
4	Exam	0	Not provided. <i>Micro Projects presentations are used instead</i>
5	In-class Micro-Exams	0	Provided during Exercises time. <i>Educator' time needed to prepare and grade micro-exams is not counted</i>
6	Home Works	0	Executed by students during out of class time. <i>Educator' time needed to prepare and grade home works is not counted</i>
7	Micro-Project #1	0	Students present their works during lectures. <i>Educator' time needed to prepare and grade Micro Project #1 is not counted</i>
8	Micro Project #2	0	Students presents their works during lectures. <i>Educator' time needed to prepare and grade Micro Project #2 is not counted</i>
9	Grade Appeals	0	<i>Educator' time needed to deal with student' appeals is not counted</i>

Table 3. Elements of the non-cloud-based course "Electronic Instrumentation" according to the syllabus and their' official time accounting.

3. RESULTS

Three courses "Image Processing", "Electronic Instrumentation" and "Real-Time Digital Signal Processing" were provided under COVID-19 limitations, by using ZOOM and Gmail cloud services in the following semesters: 2020-03 - 2020-08; 2020-10 – 2021-03; 2021-03 – 2021-08(the last semester is not finished yet). During this period, all lectures were provided as ZOOM lectures. Video records of the lectures were properly edited and were available for all students enrolled in those courses. Laboratory assignments of the course "Image Processing" were executed by using student' home computers by using Microsoft Visual Studio 2019. Students write relevant code by using C and C++.

Assignments relevant to the courses "Electronic Instrumentation" and "Real-Time Digital Signal Processing" were executed by students from their home. Students created TinkerCad simulations by using their personal computers and by using online TinkerCad software.

It must be noted, that Micro Project #1 and Micro Project #2 in the frames of the course "Image Processing" contained C and C++ code that was written and tested by the students by using Microsoft Visual Studio 2019. Micro Project #1 and Micro Project #2 in the frames of courses "Electronic Instrumentation" and "Real-Time Digital Signal Processing" contained C and C++ code that was written and tested by students by using TinkerCad online simulator.

#	Course Element Name	Additional Time spent (Hours per Semester)	Time spent to Develop and support (hours)	Comment
1	Lectures	*1 14*2	*2 14*5	*1 14 Frontal Lectures recorded by using ZOOM must be edited and uploaded to the course site. *2 14 Frontal lectures presentations must be properly modified for different screens – from PC to smartphones. Additional materials explaining more details of the laboratory assignments and simulations must be added
2	Exercises	*1 14*1	*2 14*3	*1 14 in-class exercises recorded by using ZOOM must be edited and uploaded to the course site. *2 14 Exercises presentations must be properly modified for different screens – from PC to smartphones. Additional materials explaining more details of the laboratory assignments must be added
3	Laboratory	0	0	No official laboratory time was assigned. In the frames of “home laboratory” concept, laboratory assignment were implemented by using special electronic sets at student’ homes.
4	Exam	0	0	Not provided.
5	In-class Micro-Exams	10*N*(5/60)	10*1	The time needed to prepare and grade in-class micro exams 10 Micro-exams during the semester
6	Home Works	3*1	3*(N/2)*1	The time needed to prepare and grade 3 home works of N students.
7	Micro-Project #1	(1/2)*(N/2)	5	The time needed to prepare and grade Micro Project #1. Including time needed to check the code and reworked presentations
8	Micro Project #2	(1/2)*(N/2)	5	The time needed to prepare and grade Micro Project #2. Including time needed to check the code
9	Grade Appeals	N*1	*1 2	The time needed to prepare the detailed answers to the appeals *1 The time needed to prepare a detailed list of typical errors and the influence of the specific error on the grade

Table 4. Evaluation of time needed to develop and support CLOUD and ZOOM-based laboratory for the course “Electronic Instrumentation” during “COVID-19” restrictions.

#	Course Element Name	Additional Time spent (Hours per Semester)	Time spent to Develop and support (hours)	Comment
1	Lectures	*1 14*3	*2 14*7	*1 14 Frontal Lectures recorded by using ZOOM must be edited and uploaded to the course site. *2 14 Frontal lectures presentations must be properly modified for different screens – from PC to smartphones. Additional materials explaining more details of the laboratory assignments must be added
2	Exercises	*1 14*2	*2 14*5	*1 14 in-class exercises recorded by using ZOOM must be edited and uploaded to the course site. *2 14 Exercises presentations must be properly modified for different screens – from PC to smartphones. Additional materials explaining more details of the laboratory assignments must be added
3	Laboratory	0	0	No official laboratory time was assigned. In the frames of “home laboratory” concept, laboratory assignment were implemented by using special electronic sets at student’ homes.
4	Exam	0	0	Not provided.
5	In-class Micro-Exams	10*N*(5/60)	10*1	The time needed to prepare and grade in-class micro exams 10 Micro-exams during the semester
6	Home Works	3*2	3*(N/2)*1	The time needed to prepare and grade 3 home works of N students.
7	Micro-Project #1	(1/2)*(N/2)	8	The time needed to prepare and grade Micro Project #1. Including time needed to check the code and reworked presentations
8	Micro Project #2	(1/2)*(N/2)	8	The time needed to prepare and grade Micro Project #2. Including time needed to check the code
9	Grade Appeals	N*1	*1 2	The time needed to prepare the detailed answers to the appeals *1 The time needed to prepare a detailed list of typical errors and the influence of the specific error on the grade

Table 5. Evaluation of time needed to develop and support CLOUD and ZOOM-based laboratory for the course “Real-time Digital Signal Processing”

In the frames of the courses “Electronic Instrumentation” and “Real-Time Digital Signal Processing” students were requested to prepare three home works. While preparing those Home Works, students, again, write C and C++ code by using their home PC and by using online TinkerCad simulations.

4. DISCUSSION

By analyzing above tables one can see, that preparation and support of the electronic courses consume significant educator's efforts and time. Important to understand, that video records, created by using ZOOM cloud services contain practically all materials of the course. This open moral and financial problem: an educator spends a lot of time to create, record and edit lectures, exercises, and other materials, that, at the end, become public in some way. By doing this, an educator assumes, that he can use these materials while being engaged to this specific course. However, administration is not obliged to engage this specific lecturer for this specific course. Administration can legally access all records and ask another educator to provide this course. It is clear, that this possibility is not healthy for the working atmosphere. It is clear, that some protection must be provided to the educator, that started to develop the new course. One possible solution is granting, say, at least 3-year grace period, during which administration is obliged to engage an educator for the specific course he created. And, additionally, it may be agreed, that during this, say, 3-year grace period, copyright for this course is not automatically transferred to the university. Without protection of that kind, motivation of educators to create high quality content will be low.

5. CONCLUSIONS

It can be concluded that tables provided in this article can be used to evaluate time actually needed to develop and support laboratories of the types described here. It is clear, that those tables must be modified if and when used for the evaluations relevant to other courses. It is clear, that some legal procedures must be created in order to protect rights of the educators that developed new courses, (materials of which can be used by others) at least for some period of time.

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