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The impact of COVID-19 Epidemic on Teaching and Learning

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ABSTRACT

Recently articles in Newspapers, University News Bulletins and Scientific Literature report about negative aspects of the wellbeing of students caused by COVID-19 epidemic. Half of the students have mental problems and don't participate in the teaching learning process anymore. In the Netherlands, Universities are surveyed by questionnaires, researching the mental health problems of students. In this paper we focus on students of Delft University of Technology. It proved from surveys, that many students complain about loneliness, fear, sleep deprivation and lack of study motivation. In this paper we report about experiments at the Faculty of Electrical Engineering, Mathematics and Computer Science, how students can be activated, motivated and socialized via study activities presented at the website of one of the Study Societies and via study-buddy groups. Students were personally invited to take part in discussions via a Forum, to enroll in group activities and to visit special lectures. A special COVID-19 didactics has been developed to stimulate students to make assignments in Calculus and Programing via Massive Open Online Courses developed in the framework EdX, an online learning destination and MOOC provider.

CCS CONCEPTS

• **Social and professional topics → Computing profession**; • **Human-centered computing → Human computer interaction (HCI)**; • **Computing methodologies → Modeling and simulation**.

KEYWORDS

COVID-19, inquiry-based learning, buddy learning, WHO-5 wellbeing index, MOOCs

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1 INTRODUCTION

March 2020 starts spreading of the COVID-19 virus in the Netherlands. Schools and universities got lock down. The vaccination campaign started. The start of the new Academic Year was problematic. The University was closed and all lectures were online. The large population of students from abroad was locked up at their study room. Nobody knows at that time how long the epidemic will last. Over time online courses were not attended anymore and replaced by viewing movies at Netflix. Students started worrying about their study and future. They invested a lot of money starting their study at Delft. Exams were coming soon and they did not feel prepared. Afraid for infections, students minimized their social contacts. They did not cooperate with peers anymore and did not participate in digital discussions. More than half of the students felt lonely, starts worrying and got afraid of possible inflammations. They did not participate in coming together parties (pubs and restaurants were closed). Students from abroad were considering returning home again, but realized that the study abroad was a failure, losing all their investments. The description of the living situation was the outcome of some survey studies under students and will be presented in the next section. There was some discussion about the representative character of the number of the sample of participants of the surveys related to the whole population. The number of responses was low, less than 20% but not unusual to anonymous questionnaires. But the question was if the number of students with mental health problems was over-sampled in the survey. Therefore, we decided to use a short questionnaire to survey undergraduate students of the Faculty Electrical Engineering, Mathematics and Computer Science (EEMCS) at Delft University of Technology (TUDelft) again.

About half of the students were suffering from mental health problems, mainly caused by missing social interactions with peers and common study activities and active processing of learning materials. The Faculty of EEMCS at TUDelft started a special social and study activation program to improve the mental health condition of students. The special program was a joint activity of the Faculty and the Study Society Christiaan Huygens. The Study Society organized special events for all students' members as special lectures, special ceremonies as Santa Claus celebration, computer games events, all activities took place online. An important role is the Website of the Society (see Figure 1), providing news and supporting communication between members. The new started activities are the following:

- Mentor/Buddy groups. A special new activity was the start of mentor groups [10]. One of the main complaints during lockdown was social deprivation. Mentor groups with group discussion and social games were supposed to be a restart of

social life of students. During the online mentor group sessions students got the opportunity to tell their story. In some cases, students were recommended to professional student counsellors from the Faculty. Second years students were selected as mentor. The study society had its own database with names, addresses phone numbers and e-mail of students. In a personal e-mail/phone call, freshmen were invited to take part in the mentor groups. Student mentors got an online group training from a team composed of professional counsellor, medical doctor, psychologist.
During COVID-19 pandemic, there were fewer opportunities for amusement and relaxation. Pubs, restaurant and sporting facilities were closed. The only happy event is viewing Netflix movies, but this was caused by quarantine rules also an individual and no social activity. Part of the mentor group meetings were reserved for happy events. Students were invited to cook in the style of their country, or Karaoke festival, or telling jokes or funny events during the happy hour. But most of the mentor group meetings were reserved for sharing each other activities focused on their daily activities, study topics or social events.

- Special COVID-19 didactic. A problem with online lectures is the passive attitude of students. In Rothkrantz (2015) [11] we introduced a new didactic "inquiry-based learning", supporting active learning. Now we added an innovative approach "answer-questioning system" stimulating active teaching and learning. The system was inspired by the well-known TV-quiz Jeopardy. During that quiz candidates were not supposed to give answers to questions of the quiz-master, but the other way around, defining questions to given answers of the quiz-master. During mathematical courses, with a focus on Calculus, students are instructed to solve mathematical problems. A common didactic is mastery learning. After examples of the teachers, students learn in an iterative process to define correct solutions to mathematical problems. A difficult problem is to teach students not just to imitate the teacher but first to analyze the given solutions in a critical way. One way to do this is to present (part of) solutions of mathematical problems to students and request them to define the problem. To present samples of solutions, even with (in-) correct solutions students were forced to analyze the solutions in a critical way and learn how to define a correct solution.

A similar approach was used for computer science students. It is well known that after some time many computer programmers are no longer able to read their own code. To prevent that problem, programmers are instructed to add a text explanation in natural language to explain functions and procedures. A good activation for students is to add text explanation to existing code. It provides them opportunities in reading code, understand code without writing code themselves. The hypothesis is that reading good pieces of code will help students in writing code themselves.

The outline of the paper is as follows. In the first section we present a problem definition. In the second section we describe related works. And in section 3 we report about the WHO-5 emotional well-being questionnaire. In section 4 we present the Buddy groups and in section 5 the special COVID-19 didactically approach. Experiments with mentor groups and using the special Corona didactic are reported. We end this paper with a summary/conclusion and references.

2 RELATED WORKS

In 2020 after the first lockdown three survey studies were performed, researching the well-being of students and teachers at Institutes of Higher Education in the Netherlands and Europe. It starts with a study in 2020 at 9 Institutes of Higher Education [5]. In this section we focus on research findings at TUDelft. It was the time that TUDelft was closed, and online teaching and homework was the norm. Most teachers used recordings of video lectures of their courses. Only a few used special designed MOOCs produced in the past years. After weeks, the number of students visiting the online lectures drops off. The University hired Newcom Research Consultancy to research the experiences of teachers and students of online teaching and studying from their home environment. All students and employees from TUDelft were invited to take part in a survey study. In total 209 students and 112 employees took part in the study. It proved that 3 out of 10 employees suffer from the Corona Crisis. They report less energy and sad feelings. Two out of three employees worked at home and experience mentally and physically problems and report loneliness, less energy and less motivation to start research. From the students 6 out of 10 report negative consequences from the pandemic. They had problems to adapt at working at home, feel lonelier, less motivated, lacking concentration. They spend significant less time to their study, missing feedback from peers and teachers and focus on coming exams.

One critical question is the composition of the size and selection of sampled students. In total 209 out of 2500 students took part in the survey research. Maybe students with negative feelings were dominant in the set of sampled students. For that reason, we repeated part of the survey research at the beginning of our research.

In Dopmeijer et al. (2021) [1], researchers studied the mental health of students in higher education for the whole Netherlands. In total 243.868 students were invited to take part in the survey research. More than 28.000 students were surveyed using an online questionnaire. The survey was composed of 275 items. It proved that 51% of the students experienced mental complaints such as fear and gloom and 12% of the students had severe complaints. There was an imbalance between resilience, positive mental health and life satisfaction. It also proved that many students experienced stress, performance pressure and sleep deprivation. The same holds for loneliness and lack of social support. Study progress and financial problem played a less important role. To increase the mental well-being, researchers ask for more attention for the well-being and personal development of students, provided by people from inside and outside the Institutes of Higher Education. The researchers observed a strong correlation with measures against spreading the pandemic such as closing Pubs and Restaurants and an evening lockdown. It is the intention of the researchers to repeat the study in one year to assess the progress of mental health problems.

In Ralph et al. (2020) [9], researchers studied how COVID-19 affects software developers. This study is relevant for the Faculty

EEMCS at TUDelft, teaching computer science and mathematics students. The focus of the study was investigating the effect of the pandemic on software developers' well-being and productivity. The researchers composed a survey questionnaire from existing well validated questionnaires. Employees from 53 countries were approached to take part in the study. The questionnaire was translated in 12 languages. In total 2225 employees took part in the study. The researchers defined 12 hypotheses to be verified in the study varying from lower well-being and perceived productivity while working at home caused by the pandemic. It was researched if fear of pandemic was inversely related to change in well-being. The next hypothesis was about disaster preparedness and home office ergonomics. Finally, the disaster preparedness and fear was researched. The used questionnaires were Emotional well-being (WHO-5)[16], WHO's Health and Work Performance Questionnaire, Yong et al.'s individual disaster preparedness scale. The Bracha and Burkle's formula was used rather than factor analysis to analyze recorded data. The main outcome of the study was, that organizations have to accept lower productivity under pandemic circumstances. Productivity and well-being proved to be closely related, so the best way to improve productivity is to help employees to maintain their well-being. The authors realize that they were not able to random sampling respondents. The authors ask for more longitudinal studies. In the next section we discuss one of the used questionnaire.

3 EMOTIONAL WELL-BEING (WHO-5)

In the website of WHO-5 [16], the five-item well-being index was used to assess emotional well-being. We decided to use this questionnaire in our research on the well-being of students from TUDelft. Respondents taking part in this research have to assess each of the 5 items on a 5-point ordinal scale (see Table 1). The total score can be computed by summing up the score of each item. In Sischkaa et al. 2020 [14], the questionnaire was evaluated; it had a high sensitivity and construct validity.

A total of 327 first year's mathematics-computer science students were requested by e-mail to fill in the questionnaire. About half of them, 157 returned the questionnaire. The questionnaire was part of vitalizing program of EEMCS students. The average of the item score are displayed in Table 1. We observe a bimodal distribution. On the one side here are students who have no heavy impact of the Corona virus. They are used to work alone, can motivate themselves and have social contacts with their family and peers via e-mail. The other group suffers more or less of the COVID-19 pandemic and have a low emotional well-being score. Students from abroad have a prominent place in this group.

The survey was anonymous, so it was not possible to relate the scores with other variables as study results, nationality, and data from student counselor. Therefore, it is questionable if the number of students suffering from mental health problem were dominant in the survey sample. A negative or positive well-being could also be caused by other factors than COVID-19. But the results of the survey was in line with the reported studies.

4 MENTOR/STUDY-BUDDY GROUPS

"Christiaan Huygens" (CH) is the study association for students of Applied Mathematics and Computer Science at Delft University of Technology. Study associations are run for and by students. Study associations create a bond between students. One of the activities is the creation of mentor groups of first year's students, with older students as mentor. Especially in the epidemic time mentor groups play a special role. Students were personally invited by the Board of the Association, to take part in discussions via a Forum, enroll in group activities and visit special lectures. The key solution was to reactivate students by group activities and break the anonymity of students. The communication of between students and study association takes place via special designed website (see Figure 1).

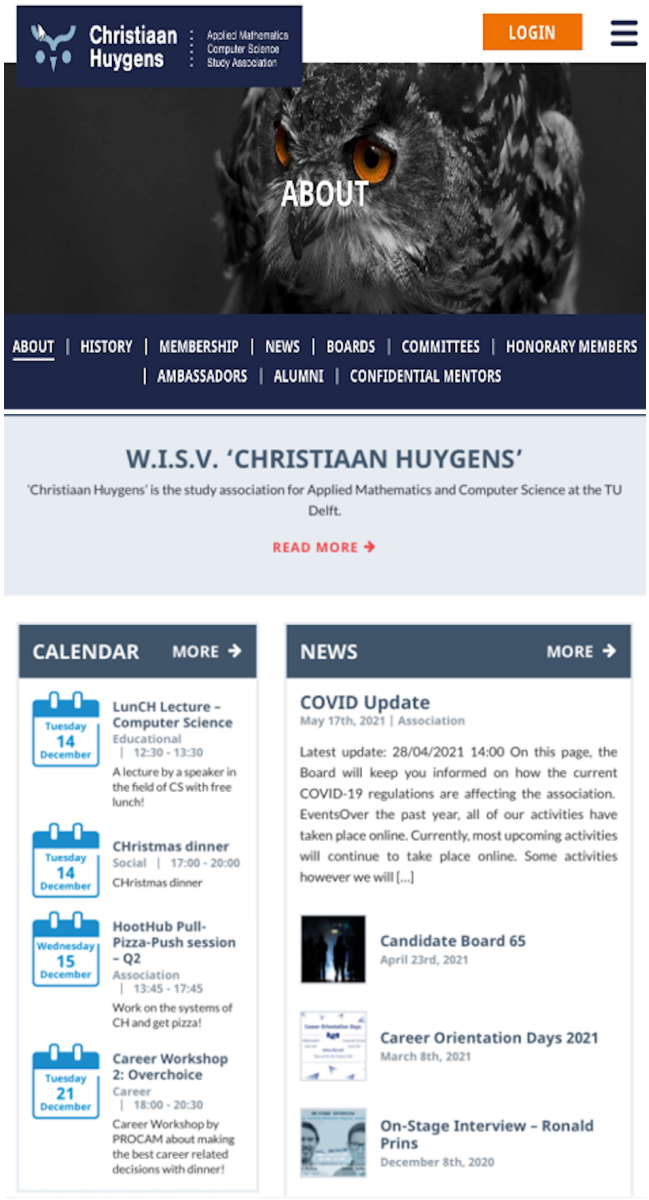

Figure 1: The website of the Study Society Christiaan Huygens (https://ch.tudelft.nl)

Table 1: WHO-5 Well-being index

Over the last two weeks	All the time	Most of the time	More than half of the time	Less than half of the time	Some of the time
1. I have felt cheerful and in a good spirit	13	21	24	28	14
2. I have felt calm and relaxed	16	27	18	27	12
3. I have felt active and vigorous	9	21	28	22	10
4. I woke up feeling fresh and rested	7	30	31	23	9
5. My daily life has been filed with things that interest me	10	26	19	27	16
Average	11	25	24	25	15

- **Calendar**. Official information on the studies can be found on the website of the Faculty and student counsellors. But information that is usually shared during real life lectures is now posted on the website.
- **Forum**. Students were invited to report about their personal situation, life and study experiences. Informal messages were posted by students. Other students give support and mention places where to find help.
- **Happy hour**. During the pandemic sad events are dominant. To cheer up students several measurements were taken. Regular there is a karaoke with popular songs from the home countries of students. There were also special movie events organized with special Netflix movies.
- **Social alert**. During the pandemic it proves that many students live in increasing isolation. Many students were afraid to be infected, deprived from the social contacts with peers during lectures, or feel ashamed or worried about their daily living. Students were contacted to play the role of study buddy for fellow students to keep them out of anonymity.

4.1 Experiment COVID-19 Study Buddy

At Delft University of Technology student societies play an important role. They take care of the well-being of students in parallel to the study. Unfortunately, during COVID-19 pandemic the Society building was closed, so common diners, social evenings could not be organized in real life. The society takes care of its members. In the past years the Society organized a mentor system supervising the study behavior of students. During the pandemic the focus of a mentor is more on the well-being of students and called study-buddy. A buddy student has been assigned to groups of 10 novice students. A buddy is an elder student member of the society, becoming a friend of novices and introducing them in the rules, nuances and practicalities of the student society. One of the main tasks of the buddy is to prevent the student from drop-out. If a student does not show up at a meeting, he will be contacted by his buddy. The concept study-buddy is known from literature in social psychology [15].

By the introduction of distant learning courses as MOOCs a new phenomenon appears. Some students feel isolated and not motivated to start the study of the course topics. It appears that only half of the students are intrinsically motivated [10] and have enough self-discipline to study the course and complete the assignments. Virtual study buddies have been designed and their main task is to control if students spend enough time to their study [7].

The Corona epidemic causes additional problems in distant learning. Students feel lonely, isolated, missing study motivation and have to master serious mental problems. It proves that students are no longer able to solve their problems. For many students the convocation of the study buddy was the first contact with the faculty for a long time. It was decided to set up a buddy experiment with all 327 first-year students Computer science and Mathematics. The idea was to compose buddy groups of 10 students supervised by a second year's mentor. The first question was how to compose the buddy groups. From anonymous questionnaire it was known that about half of the students suffer from mental problems, but this information could not be used because of privacy reasons.

It was decided to start 32 buddy groups with 32 mentors via the website of the study association Society. First-year students were requested to enroll in the buddy groups of their first choice. Students were pushed by e-mails to assign for a buddy group. About 50% of the students made an initial choice. The buddy groups were completed with left overs. Then all the students got an invitation to be present at the first virtual buddy meeting. Students who did not show up the first meeting got a second invitation via a personal phone call to visit the next meeting. About 90 students had no interest to participate and probably some of them belong to the anonymous group of students with mental problems. Every buddy group meeting starts with a roundabout where students report about their life and study experiences from last week. The mentor invites them to report about their social experiences. Other group members are invited to discuss the experiences and to provide mental support. At the end of the teaching period, after 7 weeks, the mentor buddies were invited to fill in a questionnaire. This questionnaire is inspired by the WHO-5 well-being index. Mentors report about their observation of behavior of the students in the group and their life experiences (see Table 2).

5 SPECIAL CORONA DIDACTICS

A well-known phenomenon with Calculus teaching-learning is the following. Good teachers are able to give students the feeling that they master the learning material during lectures. Unfortunately, if they have to practice themselves, it proves that many are not able to make assignments themselves and have to look up the lecture notes of the course. After reading the solutions of assignments again and

Table 2: Summation over all Buddy Mentor observations over all buddy groups (percentages)

Over the last week	All the time	Most of the time	More than half of the time	Less than half of the time	Some of the time
1. Student has felt cheerful and in a good spirit	6	26	32	22	14
2. Student has felt calm and relaxed	8	22	36	24	10
3. Student felt active and vigorous	5	18	42	31	4
4. Student comes to the buddy group meeting feeling fresh and rested	4	16	39	33	8
5. Student was involved in interesting things	6	12	35	37	10
Average	7	17	37	30	9

again, most students are able to solve similar assignments. But to get deep understanding students are supposed to solve problems and not only to remember solutions of the teacher [2].

In distant learning courses students are supposed to motivate themselves to active learning [12]. In Rothkrantz 2015 and 2017 [11][13], we introduced a new didactic model based on inquiry-based learning. Students have to ask themselves critical questions with respect to the learning material. This keeps them alive during lectures and proved to be a first step to processing the learning material. We go one step further by introducing an "answer-questioning" approach. In a mastery learning approach students are supposed to make assignments again and again until the moment they are able to solve similar problems. In our approach we offer students solutions to mathematical problems and request them to define the problem. This requires critical reading of solutions and association of solutions to problems. After reaching the mastery level students have to solve problems in a regular way.

5.1 Experiment COVID-19 Didactic

We tested our approach in an experiment during the lockdown of the academic year 2021-2022 in the first-year course Calculus on a group of 325 computer science students. The group is composed of many non-Dutch students, but students coming from abroad. Before the start of the course, students were invited to take lessons of two MOOCs. In Figure 2 we display the interface of the selected MOOCs (https://online-learning.tudelft.nl/courses/).

- The MOOC "Pre-University Calculus" is supposed to repair gaps in the secondary school mathematics education of students. The original version of the MOOC developed under the framework EdX, includes many assignments, defined as problem and students were supposed to find the solution. We replaced the assignments by the solutions and the question was defining the problem corresponding to the given solutions.
- The MOOC programming in Scratch. In this course students learn the basics of programming. Programming principles taught in Scratch can also be found in JavaScript and Python. The instruction videos explaining programming are accompanied by assignments where students can practice programming. Students are also confronted with programs and are supposed to provide specification and comment in natural language explaining the essence of that piece of code.

Figure 2: The Website of the MOOCs Pre-University Calculus and Scratch

6 CONCLUSIONS

It was found that during COVID-19 epidemic about half of the students suffered from mental health problems. This was demonstrated in many research papers. In this paper we started our research at the faculty EEMCS with a survey research at Delft University of Technology and came to the same conclusion. Students suffer from

loneliness and decreased study motivation. To activate students, we designed a special COVID-19 didactic, a variant of inquiry-based learning. To get students out of their social isolation a special study-buddy system was tested. The first preliminary results show that students leave their Corona bubble and participated in online social activities.

COVID-19 epidemic not only affects students. The university was closed for a long time and members of the staff have to work from their home environments. It proved that online teaching got a lot of attentions. Lectures were recorded and broadcast. But research suffered from a significant drop. Especially young researchers including PhD students missed their interaction with fellows and supervisor. Online conferences attracted less researchers and papers. In some papers it is stated that COVID-19 pandemic has changed teaching and learning forever [8][6][4][3].

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