A COVID-19 Teaching Experiment: Combining Competency-Based Assessment and Micro-Courses to Teach Technical and Non-Technical Skills

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Abstract—This innovative practice work-in-progress paper presents how a course has been designed to be fully taught remotely. The proposed design combines the two concepts of micro-course and competency-based assessments into a single and coherent pedagogical device. Micro-courses are used to structure the course and to help students better organise their learning. Competency-based assessments are used to propose a more personalised and individualised learning experience to students and to keep them motivated and involved.

To be able to efficiently follow a remote course, students have to practice several non-technical skills such as communication, digital fluency, autonomy, time management, etc. This paper also shows how the proposed device indirectly teaches these skills, in addition to the technical skills concerned by the course. This particular fact fosters students to be involved with the course, which is way more difficult in a completely remote setting.

The proposed course is being tested for the first time during this 2020–2021 academic year, with third-year bachelor students in electronics and telecommunications. A short survey has been conducted at the end of the year to get some results on students' perception of the pedagogical device. Results from the survey which collected qualitative and quantitative data from students show that they adhere to the course and find it suitable in a remote setting. Several elements to be improved for the next edition of the course have also been highlighted.

Index Terms—Competency-based assessment, Micro-course, Remote course design, Evaluation.

I. INTRODUCTION

The COVID-19 pandemic suddenly raised challenges in many sectors, among which education [1], [2]. Students continued to learn thanks to efforts made by teachers who switched from face-to-face instruction to online and virtual education. In such a setting, students practised several non-technical skills like communication, digital fluency, autonomy, time management, listening, etc. [3], [4] However, it is challenging to improve non-technical skills in an asynchronous online classroom environment [5]. Hopefully, distance education learning systems can achieve this goal if adequate learning processes are included in the course design [6]. Cultivating non-technical skills is important given their value in the labour market [7]. This paper is about a course that has been designed to be taught completely remotely, embracing the opportunity raised by the COVID-19 situation. The course has been broken down into micro-courses and has been designed to follow a competency-based assessment approach.

Micro-courses are used to structure the designed course into smaller self-contained courses [8], [9]. They are each defined with their specific learning objectives and can be completed on their own. The micro-courses decomposition approach aims at encouraging students to better organise their learning and at helping them catch up more easily in case of delay [10].

Competency-based assessments are used to evaluate students on the competencies they acquired and not just on their skills, abilities or knowledge [11]. Following a previous work by the author [12], this approach aims at proposing a more personalised and individualised learning experience for students. These latter are given a set of possible assessments to prove they master some competencies. Students select the assessments they want to work on and present their results during an interview with the teacher who bears the responsibility to validate the acquired competencies.

The proposed course design is supported by an online platform where students can follow their own progress for each micro-course [12]. This monitoring feature aims at maintaining a good motivation level for students by involving them and encouraging them to make progress. This paper also highlights the relation between the subject-related and the non-technical skills both trained with the proposed pedagogical approach. It also shows how the teacher-students relationship was close, even in a remote setting, thanks to the interviews where students present the assessments they worked on.

In summary, this paper presents a teaching experiment that has been led with two main questions in mind. The first question is whether is it possible to propose a more individualised and personalised learning experience in a remote setting, while keeping a fair evaluation and a good motivation level. The second question is whether it is possible to have students acquiring non-technical skills supporting them to efficiently follow a course remotely. At the end of the year, a brief survey has been conducted to collect preliminary results and pieces of evidence for this work in progress research.

The remainder of the paper is as follows. Section II briefly presents the concepts of micro-course and competency-based assessment. Section III explains how both concepts have been combined. Section IV presents and discusses the preliminary results of the ongoing experiment. Finally, Section V concludes the paper with future developments.

II. BACKGROUND

This section briefly presents both the micro-course and competency-based assessment concepts. It also defines more precisely the versions used in the frame of this work.

A. Micro-courses

There is no unique definition of what a micro-course is, but it is definitely related to micro-learning [13], [14]. This latter term refers to any pedagogy encouraging learning in small units paired with learning objective and as a step toward a broader goal [9]. Redondo et al. [15] developed a guideline to design micro-learning activities, ensuring that (a) the format is brief, (b) the focus on objectives must be clear and easily expressible, (c) the activity is independent, (d) the structure is made of simple information, (e) and the access to the activity is simple. When the activity referred to is a course, it leads to the micro-course concept typically used in distance education [16].

Although the concept of micro-course is not uniquely defined, literature seems to agree on the fact that they are limited in time and content. A micro-course is typically a short video delivering some content, possibly with simple quizzes. In this paper, micro-course refers to a course extending over between three and seven weeks. It includes between one and two hours of lecture sessions and personal work periods to reach a total of about ten hours of student work. Figure 1 shows an example of the structure of such a micro-course.
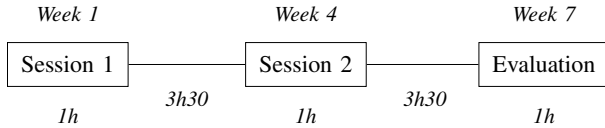

Fig. 1. A micro-course can, for example, extend over seven weeks with two one-hour lecture sessions, two personal work periods of three hours and a half and a final one-hour evaluation period.

The limitation of the lecture session periods is better suited for online education [8], [9]. It is an advantage of micro-course since long lecture sessions are exhausting for both teachers and students. Another advantage is that it is easier for students to focus themselves on one micro-course at a time, thanks to the split into smaller chunks of content [9]. Finally, micro-courses leave a large room for self-learning periods allowing students to better organise their time work asynchronously. This latter observation is also a weakness, since students must be kept motivated to work during these periods. On the teacher side, another difficulty with micro-courses is the delineation of the micro-course outline [15].

B. Competency-based assessment

When using a competency-based assessment approach, the aim of teachers is to determine whether students can perform a task by evaluating them on how well it has been done [11], [17]–[20]. With such a paradigm, assessments are seen by students as an opportunity for them to demonstrate what they learned. Students take assessments to prove that their mastery level increased for some competencies [12].

Combined with a continuous evaluation, competency-based assessment is a way for teachers and students to monitor students' progress during the semester. Each time students present an assessment to the teacher, there is an opportunity for feedback about students' work. The resulting continuous feedback allows them to monitor their performance during the semester [21]. The culture of assessments is changed as they become part of the learning process [22]. Students have better control over their learning and can choose the assessments that better fit their own learning style. The evaluation process is also more transparent for students, motivating them to be involved with the course [12], [21], [23].

The concrete implementation of competency-based assessment used in this paper follows a previous work by the author [12]. Course objectives are defined as a list of competencies to be acquired by students. These latter have to choose the assessments they want to work on from a set of given ones, to prove they acquired the competencies. Succeeding these assessments allows students to gain "competency stars", five being required to validate a competency. An online dedicated tool has been developed for students and teachers to keep track of the mastery level of each competency.

Preliminary results obtained from a previous work [12] shows that one strength of this approach is to allow students to work at their own pace while keeping the control over their learning. It also makes it possible to propose them a more individualised and personalised learning experience since they can choose the assessments that better fit their learning style. Another advantage is the continuous feedback to the students as they are presenting their work. On the other hand, defining the competencies list for a course can be very difficult. Also, enough assessments have to be defined to cover all the competencies and satisfy the different learning styles present in the classroom. Finally, a last difficulty is the time management for teachers who have to be available for the evaluations. They also must foster students to work regularly to avoid having all the evaluations at the end of the semester.

III. COURSE DESIGN

This section presents how a course has been designed to be taught completely remotely by combining the two concepts of micro-course and competency-based assessment.

A. Micro-course with competency-based assessment

The proposed approach aims at designing a course to be taught remotely. It consists in structuring the course with micro-courses and evaluating students on competencies.

Motivation of distance learning students is a critical aspect when it comes to leading them toward succeeding the courses [24]. Splitting a big course running over a long period into several micro-courses helps to keep students motivated to work and making progress, focusing on one micro-course at a time. It also helps them to approach the course more confidently, without being in front of a large amount of content at once. This latter aspect is critical for a remote course, and also important in the COVID-19 pandemic situation.

Issues of micro-courses about motivation can be tackled thanks to competency-based assessments. The self-learning periods between lecture sessions can be used by students to work on their assessments and make appointments with teachers to present their work. By selecting the assessments fitting their learning style, students can stay motivated. Micro-courses definition is based on the selection of competencies, which eases the delineation of their outlines. Such a structure fits well with a remote setting. It makes it easier for students to work asynchronously, and it limits long periods in front of a computer screen which increase the drop out likelihood.

The competency-based assessment approach is used for each micro-course. Given the remote setting, questions and answers about assessments are asked on an asynchronous chat server and presentations are made during an oral interview with a videoconference tool. This helps teachers to keep a close link with students. Also, the opportunity to individualise and personalise the learning experience through the assessments helps to maintain students' motivation to a reasonable level.

Difficulties of the competency-based assessment approach are lessened by applying it on micro-courses. It is indeed easier to define the competencies and to produce the associated assessments since fewer are required and since they can be more focused. Splitting the course into several micro-courses also makes it possible to better spread the effort over the semester. It also avoids a rush for teachers at the semester end with many evaluations to handle.

By combining micro-course with competency-based assessment, advantages of one concept seem to compensate in some way the disadvantages or difficulties of the other one, and vice versa. This combination aims at producing a course design suitable and efficient to be used in a completely remote setting.

B. Non-technical skills

In addition to being suitable for a remote setting, the proposed course design approach offers an opportunity to indirectly teach some non-technical skills. First, students will learn to use digital tools in a training setting and to communicate and work collaboratively remotely. They are also indirectly trained to be more autonomous and to be able to manage their own time and schedule work period. Finally, they will learn how to auto-evaluate themselves about the acquired competencies. They indeed have to estimate if they are ready before making an appointment with the teacher to present their work.

C. Holistic view of the course

The proposed course design splits a big course into smaller micro-courses, each following a competency-based assessment approach. On the platform used to track acquired competencies, it is only possible to have them by micro-course. To help students to have a holistic view of the whole course at any time, a shared spreadsheet with their progresses in each micro-course was made available. The teacher also regularly sent emails to each student, with their personal global progress. Sometimes, a motivation sentence was added to encourage them to work continuously on the assessments.

IV. THE EXPERIMENT

This section presents how the proposed course design has been tested in a real setting and shows the results of a preliminary survey conducted among students.

A. Experiment

The course design presented in this paper is currently being tested, during this 2020–2021 academic year. The course that has chosen is one about digital transmission taught to 28 third year bachelor students in electronics and in telecommunications. It lasted from mid-September to mid-March and spread over sixteen half days. Five micro-courses have been defined, each having two basic competencies and two advanced ones.

All the slides and the assessments were made available through the school's Canvas platform. Lecture sessions and evaluation meetings were organised with the Microsoft Teams videoconference tool, available from the school's infrastructure. Questions and answers were asynchronously handled on a dedicated Discord server, to allow students to see the questions from others and the associated explanations. Finally, students have to make appointments on the Calendly platform where teacher's availabilities were encoded.

B. Survey

A short survey has been conducted among students to collect qualitative and quantitative data. Only twelve students answered the survey out of the 28 registered students. But since eight students dropped out at the beginning of the course, it means that 60% of the students who took the course answered to the survey. This latter contains 5-level Likert scale questions about the micro-courses, the competency-based approach and the global course and its suitability in a remote setting. It also includes open questions to collect students' opinions about the strengths and weaknesses of the proposed pedagogical device they perceived. Table I shows the results of affirmation students had to evaluate on a 5-level Likert scale.

Micro-courses were globally appreciated (A1), mainly thanks to short lecture sessions (A2) and the ease of hanging up in case of delay (A3). Students appreciated to be able to put the focus on one micro-course at a time (A4) and to better control their progress (A6). Finally, micro-courses seem to have helped students to stay motivated (A5). Competency-based assessments were globally appreciated (B1), mainly because students were able to progress at their own pace (B4) with a better control on their learning (B3). Students also felt they were better accompanied (B2) and that evaluations were more fair (B5). Finally, they globally liked the proposed approach (C1) and were unanimous about the fact that it was suitable in a remote setting (C2).

In addition to these eleven questions, qualitative data was also collected, asking students for the strengths and weaknesses of the proposed approach. The first set of strengths are related to the time management: *"the workload was better spread over the semester"*, *"it was possible to work at our own pace"*, *"continuous evaluation was a positive aspect of the approach"* and *"it was possible to demonstrate our progress*

A1 I globally appreciated the split of the course in micro-courses.

A2 I have the feeling that it was easier for me to follow the lecture sessions because they were limited to one hour.

I have the feeling that the split in micro-courses helped me to...

A3 ...gradually recover from a delay.

A4 ...focus on one micro-course at a time.

A5 ...be better motivated for the course.

A6 ...control my progress in the course.

B1 I globally appreciated the competency based assessment approach.

I have the feeling that the competency based assessment approach helped me to...

B2 ...be better accompanied in my learning.

B3 ...better control my learning progress.

B4 ...progress at my own pace.

B5 I have the feeling that the evaluation process with competency-based assessment was more fair, with less room for chance.

C1 I globally appreciated the course design.

C2 I have the feeling that this device is suitable for a 100% online course situation like the one I have been experiencing since the COVID-19 pandemy.

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continuously, avoiding to only do it once with a single final evaluation." Three comments were about the motivation and autonomy: *"it encouraged us to work all over the year"*, *"it forced us to work in autonomy and to search for additional documentation"* and *"it allowed us to take the course remotely and autonomously, doing personal information research and asking questions on Discord."* Finally, two last identified advantages are related to the competencies and assessments: *"I appreciated the continuous evaluation with several kinds of assessments (quizzes, missions, etc.) that helped me to better integrate the concepts of the course"* and *"the stars progress allowed me to evaluate myself about my progress."*

On the negative side, several weaknesses have been identified. The first set of remarks are about the competency stars: *"it was not easy to get the link between assessments and stars"* and *"an evaluation without a grade as a number out of 20 but with competency stars was quite abstract."* Two comments were about the time spent: *"working on the assessments took much time"* and *"the evaluation for each student can take much time depending on the size of the classroom."* Several answers are related to the follow-up of the teacher: *"the follow-up with the teacher was not always easy with the pandemic"*, *"the teacher could have made comments on the progress of each student more often and signal him/her if the situation was bad"* and *"it is not always easy to get a meeting for the interview."* Finally, one last remark was about the holistic view: *"the organisation of the course as a whole was not clear enough."*

C. Discussion

Even if the quantitative data collected from the survey are enthusiastic and show that students globally adhere to the proposed approach, there are still several weaknesses to the proposed design. These latter have been identified by the qualitative collected data, and by the teacher's experience over the year. A first issue is about the holistic view of the course as a whole. The course design should include a way to give more sense to the set of micro-courses. Another issue is about the teacher's availability for the interviews. The proposed approach is indeed difficult to scale to large classrooms. A possible solution would be to use automatically online graded exercises to obtain the first competency stars. Also, to avoid all students rushing to the teacher at the end of the semester, deadlines to present the assessments for each micro-course should be put during the semester. Finally, a last point of attention is to find a way to keep students motivated all over the semester. The autonomy inherent to the approach is indeed a strength and a weakness at the same time. A possible idea would be to send more regularly an update about their progress to students. These updates may include personal motivation message and advices about what to work on. Keeping track of students' motivation and finding ways to increase it is clearly a big and important challenge to address.

On the positive side, the combination of micro-courses with competency-based assessments seems to work well. Students' non-technical skills also improved during the semester. The teacher was indeed less solicited over the semester by questions about how to use the digital tools, which assessment to work on, and how to organise their own time. Being able to indirectly work on non-technical skills is an advantage of the proposed approach since students will need them in their future professional activities.

V. CONCLUSION AND FUTURE WORK

To conclude, this paper reports on a teaching experiment that has been led due to the COVID-19 pandemic which was an opportunity to design a course to be taught completely in a remote setting. In the proposed design, the course is structured into micro-courses, each using a competency-based assessments approach. The identified advantages were that the course design helps to keep students motivated in a remote setting while keeping a close relationship between them and the teacher. It also opens an opportunity for students to learn several non-technical skills mainly related to efficient remote work and collaboration, time management and autonomy.

However, there are still areas for improvement. First, it has to be evaluated more thoroughly to measure its impact on students' learning. Then, the logistics of appointments and evaluations should be simplified and better structured, to make it less cumbersome. Also, ideas to keep students' motivation at a good level during the whole semester, gamification elements may be introduced in the proposed course design. Finally, the micro-courses should be better presented to the students, for them to keep the whole picture of the course.

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