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New Approaches for Teaching Soil and Rock Mechanics Using Information and Communication Technologies

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Abstract

Soil and rock mechanics are disciplines with a strong conceptual and methodological basis. Initially, when engineering students study these subjects, they have to understand new theoretical phenomena, which are explained through mathematical and/or physical laws (e.g. consolidation process, water flow through a porous media). In addition to the study of these phenomena, students have to learn how to carry out estimations of soil and rock parameters in laboratories according to standard tests. Nowadays, information and communication technologies (ICTs) provide a unique opportunity to improve the learning process of students studying the aforementioned subjects. In this paper, we describe our experience of the incorporation of ICTs into the classical teaching-learning process of soil and rock mechanics and explain in detail how we have successfully developed various initiatives which, in summary, are: (a) implementation of an online social networking and microblogging service (using Twitter) for gradually sending key concepts to students throughout the semester (gradual learning); (b) detailed online virtual laboratory tests for a delocalized development of lab practices (self-learning); (c) integration of different complementary learning resources (e.g. videos, free software, technical regulations, etc.) using an open webpage. The complementary use to the classical teaching-learning process of these ICT resources has been highly satisfactory for students, who have positively evaluated this new approach.

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1. Introduction

Soil and rock mechanics are disciplines whose aim is to describe and characterize the behaviour of soils and

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rocks, respectively. If we take into account that civil works are always built on, in or with soil and/or rock, then the significance of these disciplines in civil engineering studies is evident. Soil and rock mechanics studies usually have a strong conceptual and methodological basis, which has to be understood and assimilated by engineering students for a subsequent application to solve real engineering problems. Our experience shows that undergraduate civil engineering students encounter serious difficulties in understanding this content, mainly due to a lack of key background knowledge of hydraulics and continuum mechanics, two disciplines closely related to soil and rock mechanics. This situation has motivated a greater use of information and communication technologies (ICTs) and to incorporate them into the classical teaching-learning process of soil and rock mechanics subjects in an effective way. The ICTs described in this paper are: (a) implementation of an online social networking and microblogging service (using Twitter) for gradually sending key concepts to the students throughout the semester (gradual learning); (b) online available detailed virtual laboratory tests for a delocalized development of lab practices (self-learning); and (c) integration of different complementary learning resources (e.g. videos, free software, technical regulations, etc.) into an open webpage.

2. Implementation of an online social networking and microblogging service

Nowadays, most students have smartphones or alternative devices (e.g. tablets, laptops, etc.), which are mainly for personal use. Additionally, students are regular users of social networks and media and are very familiar with them. Consequently, we used Twitter as a tool for regularly (daily) submitting short geotechnical ideas (up to 140 characters), called "geotechnical pills", which contain highly conceptual content previously explained during theory sessions (Figure 1). For example, in a tweet, we can briefly explain concepts like "a normally consolidated soil is one which has never been affected by an effective stress higher than the one acting on it at present" or that "the consolidation process finishes when the excess pore pressure is equal to zero". As a result, students gradually receive information related to the subject that can be also complemented with additional content on a webpage, allowing them to progressively assimilate the conceptual contents (Figure 1). The messages can also include news, videos, etc. from the area where they live (e.g. if a slope in their city has failed or if soil improvement is being carried out in a certain place) in order to provide a much more real vision and even to allow them to see and visit themselves the processes or phenomena under study.

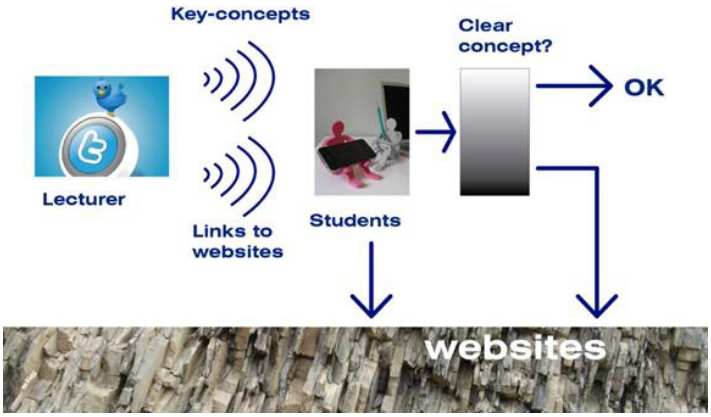

Fig. 1. Use of Twitter as a teaching tool for soil and rock mechanics.

3. Online virtual laboratory tests

Some geotechnical tests (e.g. an oedometer test) can last more than a week and cannot be fully performed during teaching hours. Consequently, we have prepared online laboratory resources (Figure 2), which allow the students to overcome this problem. These resources completely reproduce geotechnical tests (e.g. triaxial tests, oedometric