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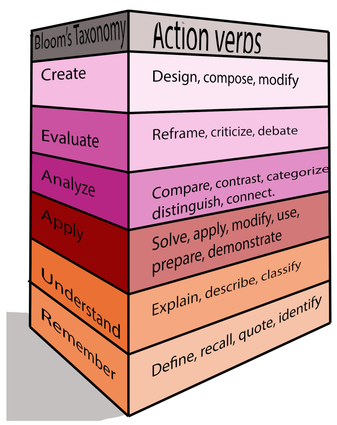
Flipped Learning:

Strategies towards improving learning outcomes

Principles of aqueous cleaning. Bachelor 3. semester

CICS
Cologne Institute of
Conservation Sciences

Technology
Arts Sciences
TH Köln



Introduction

Applied natural sciences in conservation and restoration at the Cologne Institute for Conservation Sciences (CICS) are taught simultaneously to the students of 5 specialisations namely 1. Textile and archaeological fibres, 2. Manuscripts, photography and graphic documents, 3. Easel paintings, Sculpture and Modern art, 4. Wall paintings and stone and 5. Wood and modern materials.

A group of theoretical disciplines concerning the principles of aqueous cleaning and synthetic polymers, taught in the traditional frontal lectures and evaluated in written exams, two issues were identified:

1. Only the lower taxonomy levels: **remember** and **understand** could be reached.
2. According to the feedback from the students, the relevance of these theoretical principles in conservation and the link with practice was not clear.

Methods for student engagement

To address the problems identified, flipped learning concept was applied. Two phases of learning are identified, direct instruction and active learning. With frontal lectures, the contact time is limited to the direct instruction phase. This principle of flipped learning is based on the recognition that , contact time or direct support to the learning process by teaching staff, should be transferred to the active learning phase. (Talbert , 2017) The direct instruction can be provided in the private learning space.

The content is carefully organised in seven subsections: 1. Nature of dirt. 2. Water 3. Buffers 4. Surfactants 5. Emulsions and microemulsions 6. Chelators 7. Enzymes. Examples from section surfactant are used to illustrate the approach.

Learning outcomes:

The students know the basic concepts of the chemistry of aqueous cleaning additives, aqueous solutions and basic concepts of scientific work. They can **connect** the principles of acqueous cleaning to the results from practical exercices. They can **modify** formulations of acqueous cleaning solutions to target particular dirt classes. (taxonomy level **apply** / **analyse**)

Conclusions: The motivation is to stimulate CICS students to engage in deep active learning. Provide tools that the students can use after graduating, when new techniques and materials are developed and decisions have to be made on how best to use them when the university support environment is no longer easily available. It has been observed that the level of learning has indeed improved and the feedback from students is positive.

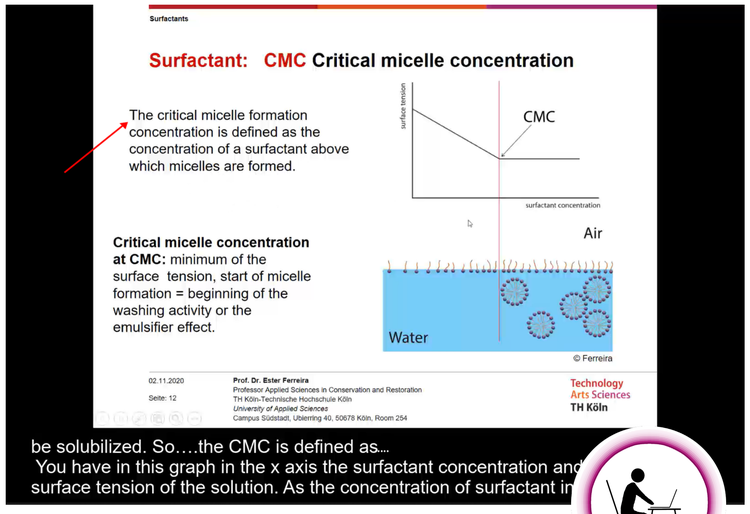


Figure 1: Screen shot from audio ppt introducing the theoretical principles. Subtitles are provided to allow a better understanding of the content.

Private learning space (Direct instruction)

In the private learning space, the first contact the student has with a subject is provided in the form of audio ppt of maximal duration of 30 min/week. To help with the self-assessment and to provide a progress feedback to the teaching staff, questionaires accompany the audio ppt. These are submitted (but not graded) weekly. According to the feedback from students at the end of the semesters, the weekly questionaires are important for orientation in the private learning space. The answer to these questionaires are discussed in the active learning sessions. Supporting literature list is given.

Figure 2: Example of a simple practical exercise to collect images of the contact angle of surfactant solutions with different concentrations (photo credits Lisbach, Ocello, Nemeth, Wiefel)

Supervised practical learning (Active Learning).

The definition of active learning is "any instructional method that engages the student in the learning process, in an active way, as part of group activity" (Talbert, 2017, p12 and references therein). In the practical sessions students are given a protocol to help built an simple experimental set up. They are encouraged to develop or modify the protocol if needed foccused on the research question at hand. In advance of the laboratory session they compile Health and Safety information on the materials used. The importance of repeting data collection is discussed and practiced.

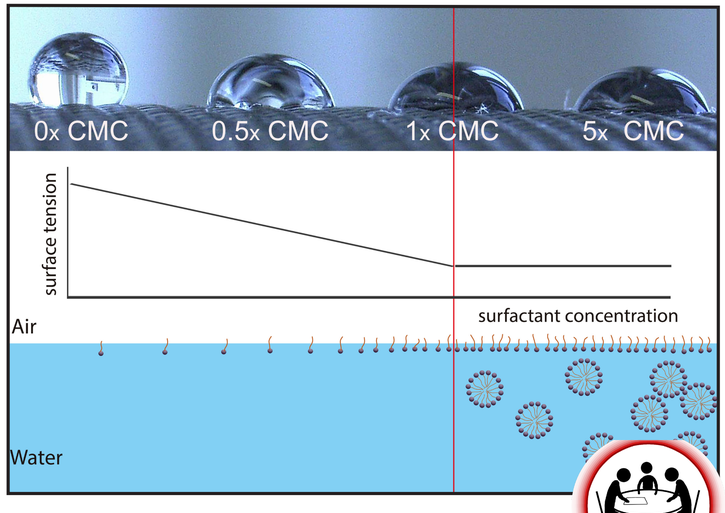


Figure 3: Experimental data processing and interpretation in the context of the theoretical principles.

Supervised group learning space (Active Learning)

In group learning space, the data is processed, the results presented and discussed in group.

In this section not only are the theoretical principles connected to the practical observations but also students learn data processing tools (image processing, statistic analysis, spread sheets), how to structure an experimental report and discuss possible sources of error.

Transfer of knowledge acquired to practical conservation is discussed in the context of all 5 specialisations.

References: LORIN W. ANDERSON AND DAVID R. KRATHWOHL (2001) Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives. Longman Publishers.
ROBERT TALBERT (2017) Flipped learning A guide for Higher Education Faculty, Stylus publishers Sterling, VA, USA. MICHAEL K. SEERY (2015) Flipped learning in higher education chemistry: emerging trends and potential directions, Chemistry Education: Research and practice, 2015, 16, 758.