

## **APPLYING CDIO THROUGH GUIDED INDEPENDENT LEARNING IN A CHEMISTRY PROGRAMME**

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### **ABSTRACT**

This paper shows how the CDIO standard 8 ‘active and experiential learning’ is implemented in a non-engineering study programme of Bachelor in Chemistry. Next to a general description of the all-embracing concept ‘guided independent learning’ at the Faculty of Technology, a good practice in the course of microbiology is presented. This paper is intended to inspire those seeking for implementing guided independent learning as a concretization of standard 8 in other disciplines.

### **KEYWORDS**

Guided independent learning, active learning, experiential learning, chemistry, microbiology.

### **BACHELOR OF CHEMISTRY**

The chemistry programme is one of the six programmes at the Faculty of Technology at University College Ghent. The Bachelor study programmes are practice-oriented study programmes intending to prepare students directly for specific professions in industry, research, commerce, etc. The Bachelor Degree in Chemistry offers three possible majors: Biochemistry, Environmental Technology and Chemistry [1]. Via bridging courses, graduated students can complete their studies and become chemical engineer at the Faculty of Applied Sciences [2] at University College Ghent.

### **REDUCING CONTACT HOURS IN FAVOUR OF GUIDED INDEPENDENT LEARNING**

In 2003 the Flemish Parliament adopted a new Higher Education Act ruling the so called bachelor-master structure as laid down in the Bologna Declaration. In order to respond to the needs articulated by industry and labour market, also some new general curriculum requirements were introduced [3]. In its policy paper, the University College Ghent pointed at e.g. the following issues: implementation of a powerful learning environment; competency-based curricula. The Faculty of Technology (one of the thirteen faculties of University College Ghent) required a more active participation from the students and reduced traditional face-to-face teaching hours in the different programmes in favour of more project-based learning and guided independent learning (GIL). The number of contact hours was reduced to twenty hours a week.

## THE INTERPRETATION OF GUIDED INDEPENDENT LEARNING AT THE FACULTY OF TECHNOLOGY

Guided Independent Learning is an all-embracing concept and is not restricted to one teaching method. GIL holds students responsible for their own learning. The goal of GIL is to make students active learners and more independent throughout their education. Although, GIL is broader than working with assignments or self study. The lecturer has to coach the student's learning process. It is the nature of the assignments, the feedback, the degree in which students are activated and the extent to which assignments are integrated in the student support, which are crucial. GIL applies to the first bachelor year as well as post academic education. In the beginning of the curriculum the guidance must be stronger than at the end [4].

At the Faculty of Technology, it is up to each titular teacher to translate this concept into his/her own educational context. The lecturer is responsible for the stipulation of specific objectives, the development of an evaluation system and the creation of a learning environment, where these three elements are geared to one another and this within the existing context. The targeted learning outcomes are different for each course, and so there is a wide range of applications of the concept. For example, in the course 'Water control', students have to investigate actual trends in water control and draft it in an article, in the course 'Chemical technology', students repeat small lab experiments in groups, in the course 'Communication', students get assignments to practice basic knowledge etc. In all of these courses independent learning is central, but support of the lecturers on regular basis is offered in a structured way.

The lecturers at the Faculty of Technology believe in the benefits of active learning in line with recent scientific developments regarding learning and teaching in higher education. Next to GIL, project based learning is widely accepted.

### GUIDED INDEPENDENT LEARNING IN THE COURSE MICROBIOLOGY

The first year course Microbiology includes theoretical face-to-face teaching (category A), practicals (category B) and guided independent learning (category C).

Study programme 1st year Bachelor in chemistry [Academic Year 2009 - 2010]					A	B	C	D	E
1	Communications skills	1			24.0	12.0	90	3	
2	Mathematics and statistics	1		36.0		24.0	120	4	
3	Physics	2		24.0	12.0	24.0	120	4	
4	General and inorganic chemistry	1		60.0	48.0	24.0	340	13	
5	Organic chemistry	2		48.0	48.0		300	10	
6	Chemical technology 1	1		24.0			75	3	
<b>7</b>	<b>Microbiology</b>	<b>2</b>		<b>24.0</b> (2 hours a week)	<b>24.0</b> (2 hours a week)	<b>24.0</b> (2 hours a week)	<b>160</b>	<b>6</b>	
8	Biology	2		24.0			100	4	

9	Project 1: chemical search	1		12.0	48.0	120	4
10	Project 2: bio-organic search	2		12.0	48.0	150	5
11	ICT	1		36.0		100	4

### **Learning objectives of the course**

Students have to gain insight in the characteristics and environment of microorganisms, they have to implement this knowledge in the lab in an appropriate way and eventually they should be able to make accurate written reports about the research findings.

The main objectives of the practical are to develop accuracy, safety- and environmental consciousness and order together with knowledge about the different groups of microorganisms. The practical differs from the GIL part of the course in that way that students have to develop self-reliance and a sense of responsibility through GIL, they have to pick up the already acquired competences during the practical in depth.

### **Learning activities**

The approach of guided independent learning differs from the regular practical sessions. In the practical the students get pure cultures of yeast, moulds or bacteria. They learn the techniques to explore these organisms and their microscopic characteristics. They have a form with questions which they have to hand in for supervision. At the end of the practical they have to make a detailed drawing of the microorganism they examined.

For the GIL part the students get the assignment to isolate a microorganism and to identify it. For this purpose they have to find independently a good medium and all the necessary equipment and sterilization techniques to perform the isolation and the preservation of their isolate. When they have gained a pure isolate they have to study its macroscopic and microscopic characteristics. All these characteristics put together must enable them to identify their isolated microorganism. The students have to write a draft report with all their findings.

### **Support**

At the start of the course students get a study guide with the assignment and some hints, such as interesting questions for their research and some relevant references (books, websites from firms, etc.).

After their theoretical preliminary investigation, students get feedback on their draft report. This feedback is organized in groups of twenty students. In addition a demonstration is given how to set up preparations to the practical work.

In the next stage students get individually a microorganism on a natural medium such as tomatos, carrots or meat products. They have to realize the isolation with a few different techniques and present their result to the lecturer. In this stage the lecturer monitors the individual learning progress by giving the green or the red light to start the further identification procedure.

The study guide, the general support as well as interesting links are permanently available for consultation at the digital learning environment (Dokeos) of the University College Ghent.

## **Evaluation**

The draft report is marked on five points, feedback is given in detail. The result of the isolation and purification of the students microorganism is visually evaluated, also marked on five points. The final report is marked on twenty points. Feedback is given, once again in detail. This result marked on thirty points is put together with the result of the microscopic investigations of fungi and bacteria in the practical sessions of the course. It's clear that this sort of evaluation demands a lot of energy and time from the lecturers. Despite of this, this threefold assessment offers appropriate learning opportunities for all students.

## **ADVANTAGES AND ISSUES CONCERNING GUIDED INDEPENDENT LEARNING**

### **Advantages**

#### **Motivation**

The lecturers notice our students are more motivated to work on assignments, rather than listening to formal lectures. Bachelor students consciously choose for a bachelor program simply because of the practice oriented courses. They like learning by doing. Students articulate this in recruitment interviews. The courses at the Faculty of Technology, appeals students with a technical background in secondary education and guided independent learning is a concept that fits them. When students clearly understand the relevance of assignments for other parts of the subject matter, other courses or their future profession, they are more motivated to work on the assignments.

### **Issues**

#### **Work load**

One of the issues of guided independent learning is the work load for students as well as for the lecturers. To master the workload for students, it is recommended to make an overview of assignments and deadlines within the study programme. The implementation of GIL requires intensive communication between the lecturers. The objectives of each course must be clear and lecturers have to watch over overlap within learning contents. The head of the programme committee of chemistry notices a proliferation of interpretations of GIL and the time needed to complete all those tasks by the students is often underestimated. The time and energy spend by the lecturers at those teaching methods is underestimated by the governing body as well. Teachers who take GIL and the inherent feedback seriously, lack time.

#### **Structured feedback**

Lecturers can guide students by ICT (e-mail, e-learning) or by personal contact. The lecturer of the course microbiology noticed that when personal feedback was limited to a talk with no strings attached, students didn't step into it. It is recommended to plan personal feedback in a schedule and make feedback meetings compulsory for all students. Only in that way, feedback moments become learning moments.

#### **Clear expectations**

Students often act like empty vessels, waiting desperately to be filled. It is imperative to straighten the students responsibilities and the lecturers responsibilities in this teaching method right at the beginning of the course. Explain the objectives, the expected learning activities of the students (what do you expect from them?), the support activities of the lecturer (what can they expect from you?), the evaluation criteria and assessment methods. This introduction is crucial, especially for first year students. Strong guidance prevents that

students waste two or three weeks doing nothing, waiting till the next meeting or the next instruction from the teacher to come. Create a clear learning environment by using manuals, instructions on the digital learning environment and preferably start the learning process with verbal arrangements.

## CONCLUSIONS

At the Faculty of Technology lecturers believe in the saying: “*Who listens, forgets; who looks, remembers; who does, learns*”. (quotation of Confucius). They believe in the strength of guided independent learning as a teaching concept. Under the express condition that the chosen teaching methods serve the objectives (not just because), that lecturers gear the learning activities to one another (protect work load), that support is structured (otherwise ‘independent learning’) and that students are well informed about the expectations and preconditions. Learning must be useful.

## REFERENCES

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