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Learning Strategies in a Blended Learning Environment

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Abstract

Studies focusing on university dropout rates revealed that a high number of German students abandon their chemistry studies early on [1]*. In addition to numerous other reasons, the high demands of the subject in the first semester are often described as one of the main factors for dropping out* [2]*.*
In order to counteract this phenomenon, an introductory chemistry course was offered for chemistry majors and teacher students for secondary schools in September 2014 at the University of Göttingen. This introductory course, which took place three weeks before the semester began, aimed at preparing the students for their first term through revision and practice of high school chemistry skills. Furthermore, the introductory course was based on the method of blended learning [3]*.*
As part of the introductory course, an exploratory study on the students' learning strategies was conducted since hardly any previous studies focus on learning strategies in a blended learning environment. The study's aim is a description of the respective learning strategies used by students during the introductory course. Here, questionnaires (n = 70) were used for data collection.
This contribution describes the results of this qualitative study and discusses their relevance for the design of future learning scenarios within the framework of blended learning introductory courses.

1. Introduction

Blended learning is used frequently in school and university chemistry teaching. For example, blended learning courses were introduced in inorganic chemistry teaching at universities in english-speaking areas in order to improve learning and student satisfaction [4]. Learning management systems (LMS) like ILIAS, Stud.IP or Moodle are frequently used to support classroom teaching and enable teachers to develop interactive and multimedia teaching materials. Particularly chemistry research methods such as crystallography or NMR are often taught using such LMS-based environments [5].
Blended Learning is the combination of two different learning environments. On the one hand, there is the traditional face-to-face environment and on the other hand there is the e-learning environment which has become very popular especially in recent years. Blended learning unites both concepts which allows the specific use of their advantages depending on the situation. Through e-learning modules, participants have the opportunity to learn individually and at their own speed. In addition, motivational social contact with peers is provided by the attendance days. For these reason, the method of blended learning is used in the newly established chemistry introductory course at the Georg-August-University.
In this introductory course, ILIAS-learning units are combined with attendance days (see Fig. 1). The course begins with an introductory day during which the participants are welcomed and the course structure is explained.

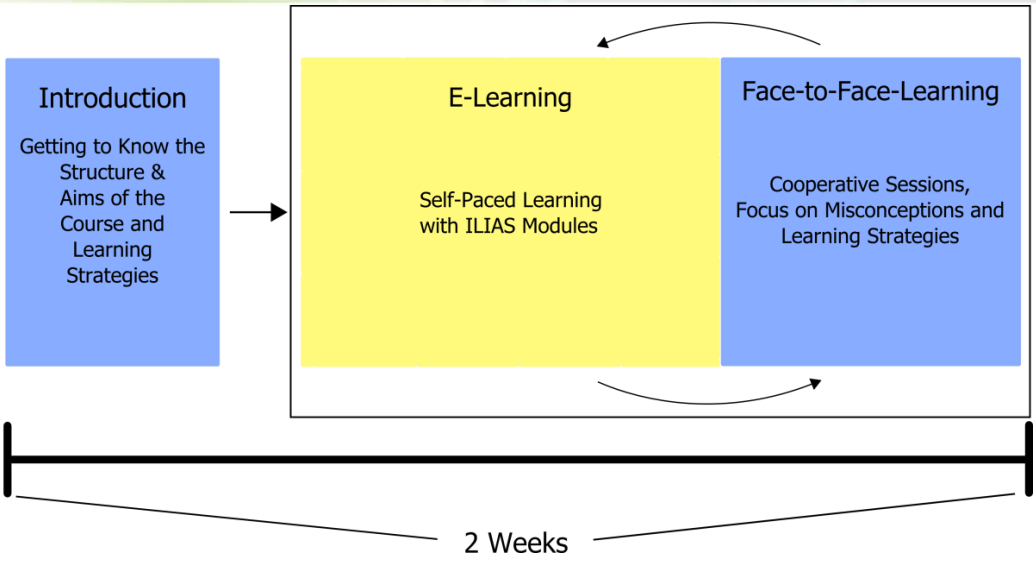

Figure 1*: Structure of the Blended Learning Introductory Course*.

Participants have two days to independently work with a specific learning module. Existing modules are on the topics structure of matter, chemical bonding and chemical reactions in that order. On the third day, the participants work on the topic in small groups with the help of exercises. Moreover, students should explain key concepts of the module to each other in order to consolidate their knowledge.

Here, it is especially interesting to investigate the learning strategies used by the participants. In this context, learning strategies are defined as students' own behavioral patterns to control their learning process. On the one hand, it is interesting to explore learning strategies since it is proven that they have a big influence on learning success and learning behaviour. On the other hand, learning strategies in blended learning environments have only been explored minimally. Furthermore, it is important that the learning strategies are examined depending on the specific tasks they were applied on. This is due to Weinert who says that a general usage of learning strategies (e.g. "I always take notes during a lecture.") is less helpful than a task-specific usage of learning strategies (e.g. "Since today's lecture is on XY, I will focus on taking notes with respect to..."). [6] Therefore, an exploratory questionnaire study (n = 70) was conducted in order to analyze task-specific learning strategies. The goal of this analysis is to improve the learning material of the blended learning introductory course, keeping in mind learning strategies of the students. In this contribution, we will first explain the method of the data collection before showing the results of the exploratory study. Finally, there will be a discussion on how the results can be used to optimize the learning material.

2. Frame and Methods

Friedrich and Mandl [7] declared a system to classify learning strategies. According to this system, so called cognitive strategies, which are strategies of knowledge acquisition, can be subdivided into:

- mnemonic strategies (i.e. strategies of learning something by heart)
- organization strategies (i.e. structuring knowledge in mind maps, clusters etc.)
- elaboration strategies (i.e. transferring the acquired knowledge to other contexts, thinking about possibilities and boundaries of certain concepts, etc.)

Apart from that, so called metacognitive strategies consist of strategies for time management, planning and monitoring of the learning process etc.

To collect the data, questionnaires (n = 70) with open questions were used which have been filled by the participants of the introductory course. The data acquisition phase consisted of two consecutive steps. First, all participants were given task 1:

Task 1) Describe the process of dissolution of sodium chloride in water.

Task 2) Consider the following reaction, $2NO_{2(g)} \rightleftharpoons N_2O_{4(g)}$; $\Delta H_R = -92\ \frac{kJ}{mol}$, describe the influences of the following parameters on the system at equilibrium: partial pressure of $NO_{2(g)}$, partial pressure of $N_2O_{4(g)}$, total pressure, temperature and use of a catalyst.

Since both topics, equilibrium reactions and solution of salts, were subjects in the previous learning modules, these tasks can be classified as recall and application tasks in terms of Bloom's Taxonomy [8]. Second, the students were asked the following two questions:

- How did you learn about the process of dissolution of sodium chloride and the influence of factors on the chemical equilibrium?
- Which aspects of the introductory course were helpful for your learning process?

The same procedure was followed with respect to task 2.
Afterwards, the questionnaires were used as the basis for a qualitative content analysis according to Mayring [9]. The material was coded by two independently working researches and the differences between their codes were harmonized through discussion. At last, the codes were assigned to the classification system by Friedrich and Mandl.

3. Results

Table 1 shows the codes, the number of indications with respect to tasks 1 and 2.

	Code	**Number of Indications**	
		Task 1	Task 2
Individual Learning Strategie	*LRT:* Learned by Reading the Text	15	10
	LP: Learned with Pictures	21	5
	LA: Learned with Animations	18	0
	TN: Taking Notes	7	8
	CMM: Creating Mind Maps	5	5
	RPM: Referring an Appropriate Particle Model	3	3
	APK: Activating Prior Knowledge	11	15
Group Learning Strategie	*RG:* Recalling in Groups	3	5
	- (no comment)	23	24

Table 1: *Results of the questionaries.*

It is very remarkable that much more individual learning strategies were used and only one group learning strategy was mentioned. The strategy of learning by reading the text of the learning module was mentioned 21 times with respect to task 1 and 12 times with respect to task 2. Apart from that, six times more participants mentioned that they learned using the pictures and animations of the learning material with respect to task 1 (42) compared to task 2 (6). However, it is important to mention that there was no animation given in the learning modules for task 2. These strategies can be described as cognitive strategies in terms of Friedrich and Mandl. Apart from this, there are no other great differences in the use of strategies with respect to task 1 or 2.
The strategy of taking notes and the strategy of recalling the subject material in groups can be assigned to the mnemonic strategies. Both strategies help to consolidate the acquired knowledge. The strategy of creating a mind map is a prototype of an organisation strategy. It helps to connect concepts with each other and display a structure of one's own mental knowledge.
Applying an appropriate particle model can be considered an elaboration strategy, because it is used to deepen the understanding of a subject matter. Finally, the activation of prior knowledge can be

considered as an important metacognitive learning strategy. It points out to the learner what he or she is already capable of and what he or she has yet to learn.
To sum up, it can be seen that different types of learning strategies are used by the students. Apart from that, learning by reading and learning with pictures are the only two strategies that have a remarkable difference between their indications with respect to the task.

4. Discussion

From the present research on learning strategies it has become evident that mnemonic strategies as well as organisation and elaboration strategies are essential for learning success [4]. There are several possibilities of how to handle the results of the study. On the one hand, a feedback about helpful learning strategies of former students can be given to new participants to indicate the variety of the learning strategies available and to introduce them to new ones. This could happen in the form of a presentation on learning strategies on the first attendance day.
Moreover, learning strategies should be practiced with participants since current research indicates that untrained learning strategies initially constitute a burden and only contribute to success after having been mastered **[10]**. For this reason, it is useful to develop tasks where the presented learning strategies can be practiced. A short text with subsequent comprehension questions would allow the practice of deducing knowledge by reading. To promote the development of the students' ability to deduce content from pictures, students could be presented with a picture of a solution which they first have to describe before they interpret its meaning. During the processing of the tasks, students could be given task-specific practical recommendations.
Furthermore, the results can be used to create a summary of the learning strategies to improve the existing ones. On account of the fact that students often named the strategy "learning with animations" helpful for task 1, one could derive that animations should be created to show the effect of temperature, pressure etc. on the state of equilibrium (task 2).
In this study, the learning strategies were investigated based on two tasks in a Blended Learning environment. It is of great interest to investigate further learning strategies for other exercises in order to improve the study material. Moreover, the connection of single task-specific learning strategies with learning success should be examined, so that the material and the learning modules can further be improved.

References

[1] U. Heublein, J. Richter, R. Schmelzer und D. Sommer, Die Entwicklung der Studienabbruchquoten an den deutschen Hochschulen: statistische Berechnungen auf der Basis des Absolventenjahrgangs 2012, Hannover: Dt. Zentrum für Hochsch.- und Wiss.- Forschung, 2014.

[2] J.E.Hoyt und B. Winn, Understanding Retention and College Student Bodies: Differences Between Drop-Outs, Stop-Outs, Opt-Outs, and Transfer-Outs, NASPA Journak 3/41, 2004.

[3] H. Mandl und B. Kopp, „Blended Learning: Forschungsfragen und Perspektiven," Ludwig-Maximilians-Universität München, Department Psychologie, Institut für Pädagogische Psychologie, München, 2006.

[4] W. B. a. G. C. Neil A. Williams, „Improving student achievement and satisfaction by adopting a blended learning approach to inorganic chemistry," Chemistry Education Research and Practice, pp. 43-50, 2008.

[5] F. Hoffmann, M.Sartor und M.Fröba, „Couch statt Hörsaal," Nachrichten aus der Chemie, pp. 48-49, 2014.

[6] F. Weinert, „Lernen lernen und das eigene Lernen verstehen," in Verstehen. Psychologischer Prozess und didaktische Aufgabe, Bern, Huber, 1994, pp. 183-205.

[7] H. Mandl und H. F. Friedrich, Handbuch Lernstrategien, Göttingen: Hogrefe, 2006.

[8] B. S. Bloom und D. R. Krathwohl, Taxonomy of Educational Objectives: The Classification of Educational Goals. Handbook I: Cognitive Domain, 1956.

[9] P. Mayring, „Qualitative Inhaltsanalyse," in Qualitative Forschung, rowohlts enzyklopädi, 2009, pp. 468-474.

[10] E. Sumfleth, J. Neuroth und D. Leutner, „Concept Mapping – eine Lernstrategie muss man lernen. Concept Mapping – Learning Strategy is Something You Must Learn," CHEMKON-Chemie konkret, pp. 66-70, April 2010.