



## Drugs within a context of chemistry teaching

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### Abstract

*Synthetic drugs play an increasingly important role in today's meritocracy. The market for amphetamines has been expanding worldwide for several years [1]. In Germany, too, amphetamines and amphetamine derivatives continue to gain ground. There has been a steady increase in the quantities of amphetamine, methamphetamine and ecstasy seized [2,3]. While helpful approaches and teaching materials with regard to health education and addiction prevention are provided, for example by the German Federal Centre for Health Education [4], the subject is inadequately addressed in German curricula and does not guarantee a deep structure of the organic substance class. In order to present a practical-methodical implementation, especially for chemistry lessons, a learning set was constructed which introduces the topic to students within the framework of an intervention study at the Friedrich Schiller University Jena. The article presents ten innovative learning stations focusing on the illegal drugs amphetamine, methamphetamine and MDMA (3,4-Methylenedioxy-N-methylamphetamine, also known as ecstasy). New knowledge about the structures, historical aspects, production possibilities, modes of action and detection reactions of the substances can be acquired. The stations are didactically diverse. In addition to theory stations, games and other creative elements, the study places its focus on experiments. While, for example, the effects of MDMA are explained in a learning video, experiments can be used as models to demonstrate the effects of amphetamine and methamphetamine. The materials developed are aimed particularly at students at the age of 16 to 18 and chemistry teachers. They can also be used in interdisciplinary science lessons. The materials have already been tested and evaluated several times with students and teachers [5].*

Keywords: Educational transfer research, curricular learning modules, drugs

### 1. Initial situation

Due to the increasing prominence of the substance class of amphetamines, the primary goal of drug prevention is to provide young people with sufficient education and information. In Germany recent efforts show that the importance of addiction prevention has increased, that a large number of measures are implemented and that a wide variety of players are involved [6].

At state level, efforts by the Federal Centre for Health Education and the German Central Office for Addiction Issues envisage the development of substance-specific information and teaching materials for primary prevention that are accessible free of charge on the Internet [4,7-9]. At federal level, in addition to police crime prevention, measures are taken in the form of school and extracurricular projects which address different target groups. For example, specialists and coordination agencies for addiction prevention list initiatives which address illicit drugs and party drugs. In particular, a large number of amphetamine-related offers can be found in focus regions such as Thuringia, Bavaria, Berlin, Saxony and Saxony-Anhalt [6,10,11].

Overall, a range of informative, digital and interactive offerings for students and teachers has been developed. Often the projects can be implemented in a playful way, for example as part of participatory courses. Topics such as illicit drugs and party drugs are taught across all substances. Substance-specific programs which focus only on amphetamine, methamphetamine and methylenedioxy-N-methylamphetamine (MDMA) can rarely be found. As far as substance-specific measures are taken, the main part relates to methamphetamine/crystal meth, as is the case with the materials.



Although the topic of drugs appears in science curricula, no content or methodology is listed for the synthetic substance class in focus. Aspects are dealt with superficially or are completely absent. A positive example, however, is the Berlin-Brandenburg curriculum, which provides numerous approaches and impulses for teaching the topic of drugs in the elective subject of natural sciences in grades 7 to 10 [12].

As a result of the analysis of existing initiatives and reviewing of curricula, the constructed learning set is intended to provide added value in terms of in-depth chemical subject knowledge, to make a substance-specific contribution to addiction and drug prevention, and to be extended to chemistry education.

## 2. Aims of the research project

In order to follow the guidelines of contemporary addiction, drug prevention, health education, the strengthening of personal competence as well as risk and action competences are to be aimed at in equal measure through appropriate interventions [13].

The present intervention study is realized by designing a project day in the context of a laboratory study with constant framework conditions throughout the entire phase of data collection. Students at the age of 16 and 17 (grades 10 and 11) from five cooperating schools in Thuringia are acquired as target groups for the main study. Questionnaires in pre-post design were designed to investigate feedback on interest and prior knowledge regarding the topic, acceptance of the program and the individual stations, and lastly, learning gains as a result of the intervention. The way in which the stations are worked through (intervention) takes place in collaborative work forms and is documented with the aid of a structured observation protocol by a trained team of observers. Students have 2 to 2.5 hours of self-organized laboratory time for every intervention. The results are recorded on a routing slip. Between five to 30 minutes are required for the various types of stations.

## 3. The stations of the learning set

A total of ten stations was constructed according to certain criteria and can be assigned to different learning occasions (Fig. 1).

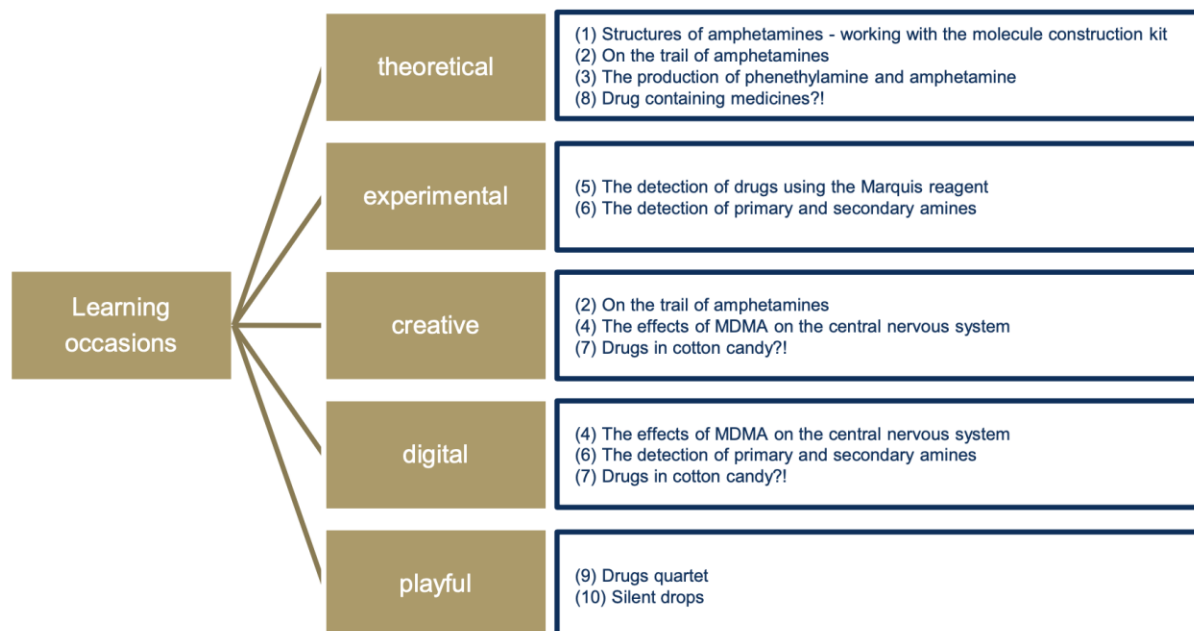


Fig. 1. Overview of the stations of the learning set

In addition to aspects of health education, the development is based on concepts of organic chemistry. Thus, basic chemical concepts such as the substance-particle concept, the structure-property principle and the concept of chemical reaction are focused on [14]. The project follows a comprehensive competence-oriented approach, since the stations vary methodically. In addition to the acquisition of specialized chemical knowledge regarding the three substances, students improve personal, social



and methodological competences. The principles of linking subject-specific science and subject-specific didactics have proven particularly successful in the design of stations 3 and 5, where both university and non-university cooperation have taken place.

As an introductory station, station 1 centers on substance-particle relationships in the construction of molecular structures. At station 2, historical aspects are learned through text excerpts and secured in the form of a crossword puzzle. Station 3's focus on the nitroaldol reaction as an addition reaction ties into the concept of chemical reaction. To combine digital aspects with health education aspects, a self-produced educational video on the mode of action of MDMA in the central nervous system focuses on biochemical expertise in station 4. Stations 5 and 6 have a significant position, as they generate novel experimental approaches to rapid drug tests in the form of model experiments.

In particular, at station 5, a carbenium ion as a key chemical structure which can stimulate process thinking based on reaction mechanisms is created (Fig. 2) [15,16].

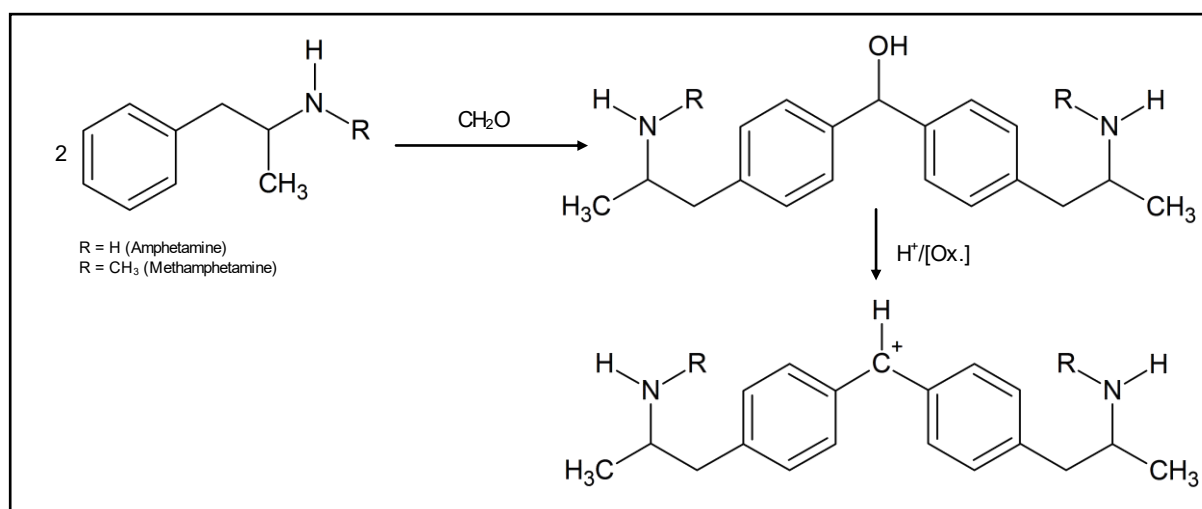


Fig. 2. Marquis reaction [17]

When amphetamines react with a drop of Marquis reagent, which is composed of concentrated sulfuric acid and 40% formaldehyde solution and is located at the bottom of the glass vial, it comes clear, that the produced carbenium ion is the cause of the color due to the newly formed conjugated system. As a result of the color reaction, new possibilities are created to make the submicroscopic level tangible. In addition, the students gain insight into the police work involved in handling the rapid test from ESA-TEST GmbH of Eisenach in Thuringia (Fig. 3) [18].



Fig. 3. Course of the color reaction (from left to right: after 10, 30, 60, 120, 180 and 240 seconds); own photography (taken on 20.12.2017)

Station 6 is also based on the structure-property concept and enables desired color reactions through structure-like compounds. While stations 5 and 6 aim at experimental action competences, station 7 deals critically with the handling of the rapid test. Advantages and disadvantages are summarized in a radio play. In the context of health education, station 8 focuses on behavioral and risk competences in dealing with stimulant drugs and their structural similarities with the three illegal substances. The playful stations 9 and 10 are available as didactic reserves and characterize further drug classes, in which elements of health education and specialist knowledge are coupled in a quartet and a memory.



#### 4. Outlook

Initial results of a pilot study yielded positive feedback of the program and individual stations. Both content and methodological changes were made for the main study. In order to be able to make a contribution to drug prevention in Germany, the materials are supposed to be available for use both in and out of school. Teachers have the opportunity to acquire specialist knowledge within the framework of teacher training courses. The provision of a manual with subject-specific information, instructions for experiments, copy templates and solutions can provide subject-related and interdisciplinary impulses for implementation in schools. The data evaluation of the main investigation will show whether this is an acceptance-oriented attractive learning arrangement.

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