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A New Way to Discover the Chemistry Laboratory: The Augmented Reality Laboratory-License

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Abstract Augmented Reality is a good way to enrich and expand not only the environment but also the students' learning. When students come to a chemical laboratory for the first time, it is important to internalize the special rules and regulations. For this reason, we have linked these two components and developed an Augmented Reality Laboratory License. The students should internalize the laboratory and its rules with the help of a rally. The students set off in the laboratory and discover the various symbols and rules with the help of augmented symbols. The standard symbols, such as safety symbols, warning symbols and hazard symbols, were used to provide augmented assistance at the various stations of the rally.

Keywords: *general public, middle school science, high-school, graduate education, research, collaborative/cooperative learning, computer-based learning, self-instruction, inquiry-based/discovery learning, multimedia-based learning, misconceptions/discrepant events, school book, augmented reality, informative and cooperative technology, ICT*

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1. Introduction

Since Pokémon Go, everyone has been talking about Augmented Reality. This technology is becoming increasingly important in our everyday digital lives. The question now arises as to why we do not simply take advantage of this expansion of reality in chemistry lessons. The following article will show an example of how to use Augmented Reality in a laboratory. The pupils will discover the laboratory by a Rallye and solve different exercises. The Augmented Reality will help them to get more information about rules and various symbols in the laboratory.

2. Augmented Reality in Chemistry Education and Schülerlabor

The use of digital media in educational institutions should always aim to enable pupils to use digital media responsibly in the sense of "competences in the digital world" [1]. This should give every pupil the opportunity to actively participate in the technological change and thus to be able to participate in society [2]. It should always be noted that the use of digital media is reflected and adapted to the respective learning group and learning situation. When used appropriately, digital media can support the learning process of students through self-directed, cooperative learning environments [3]. The use of tablets in teaching and learning situations is increasing all the time. Compared to permanently installed computers, the strength of tablets lies in their handy size, the interactive touch interface and wireless use [4]. Tablets have great potential in science education, especially in chemistry, as they have three didactic functions: As a learning tool, ICT enrich the cognitive learning process in the concrete learning situation and as experimental tool, ICT expand the possibilities for experimenting themselves by enabling learners to actively explore or document their surroundings with the technical sensors of the device, such as the camera or the microphone [5]. Furthermore, as learning companion, ICT can enrich learning beyond the specific learning situation or lesson and over a longer period by "accompanying" all learning processes [6,7].

Those three didactic functions of ICT build a base for two other levels, visualized in Figure 1. This methodical implementation represents the various operating modes away from the status quo (blue circle, Figure 1): **Conservation** of the prevailing culture**, Augmentation** of existing methods by innovative approaches using ICT, the **modification** of student tasks that characterize the essential design of the assignment, **Redefinitions** in that various apps allow tasks that were previously not possible, such as the creation of short video clips using an EXPlainistry. In our case we present a redefined method of how to build up pupil's knowledge about the rules and symbols in a chemistry laboratory [8].

The various degrees of individualization are represented in the outermost circle. In our following example the augmented laboratory license can help for individualization at least on the school level. The symbols and the exercise are created for a special laboratory that includes the used symbols.

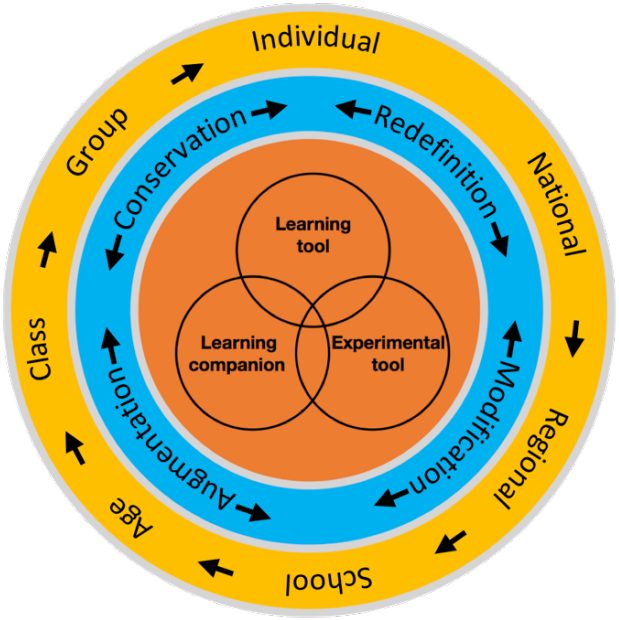

Figure 1. Model of Individualization and didactical functions of ICT in school [8]

Some national and international studies on the use of tablets in chemistry lessons provide evidence that this has a positive influence on the motivation, attention and independence of learners [9]. With Augmented Reality technology, the user's real environment is superimposed with digitally generated information in the form of virtual overlays. This allows the viewer to observe both real and virtual content at the same time. The use of Augmented Reality on ICT is done by corresponding apps, which use their own development environments (e.g. Apple ARKit). In this case, the camera of the tablet serves as a sensor to capture the real environment. This creates an image of the environment on the tablet's screen, which is enriched with digital content by the AR app. Due to the free accessibility and wide availability on mobile devices, such as tablets, this technology is also becoming increasingly interesting for the education sector. It offers the possibility to create interactive and individualized learning environments. A particular strength of this technique in chemistry lessons lies in the visualization of non-visible or non-observable phenomena, such as processes at the particle level. Through the simultaneous optical presence of the real environment (chemical experiment) and the virtual AR content (visualized explanation of chemical processes), the learning process of the students can be specifically supported [10,11].

3. The Augmented Reality Laboratory-License

The following materials have been developed to familiarize students with these laboratory rules on a first visit to the laboratory. Particular attention was paid to the safety symbols available in the laboratory and their meaning. Through this type of task, students will explore the lab in more detail using the Augmented Reality technology for a whole new experience. To do that, they use the App "HP Reveal" on their digital devices. This App uses the camera of the mobile devices to scan a "trigger" – a symbol which starts the digital augmented information. In our case, we used the symbols which are already placed in the laboratory.

These will usually provide the augmented background information in order to be able to answer the analog task. Figure 3 is showing the exercise sheet the pupils will get and should answer during discovering the laboratory and its rules.

Figure 2. Concept of using AR with an iPad

The first task is to explore the meaning of various safety symbols. In order to learn the various laboratory rules, such as wearing lab coats and protective gowns, tying hair together, wearing long trousers and shoes, and the correct handling of hazardous substances, the "No Access for unauthorized persons" symbol should first be augmented by the app (see Figure 4).

By touching on the info-button, a short video will be played, which briefly summarizes the laboratory rules. If necessary, this video can be played several times and thus the first task can be solved.

An important symbol, which the students also know from their everyday life, is the symbol of the fire extinguisher. The aim of the next task is therefore to find out which different fire extinguishers are available and more important how to operate them correctly. For this reason, Augmented Reality offers the choice between two integrated videos (see Figure 5), which on the one hand present the different fire extinguishers and on the other hand discuss the procedure in case of a fire.

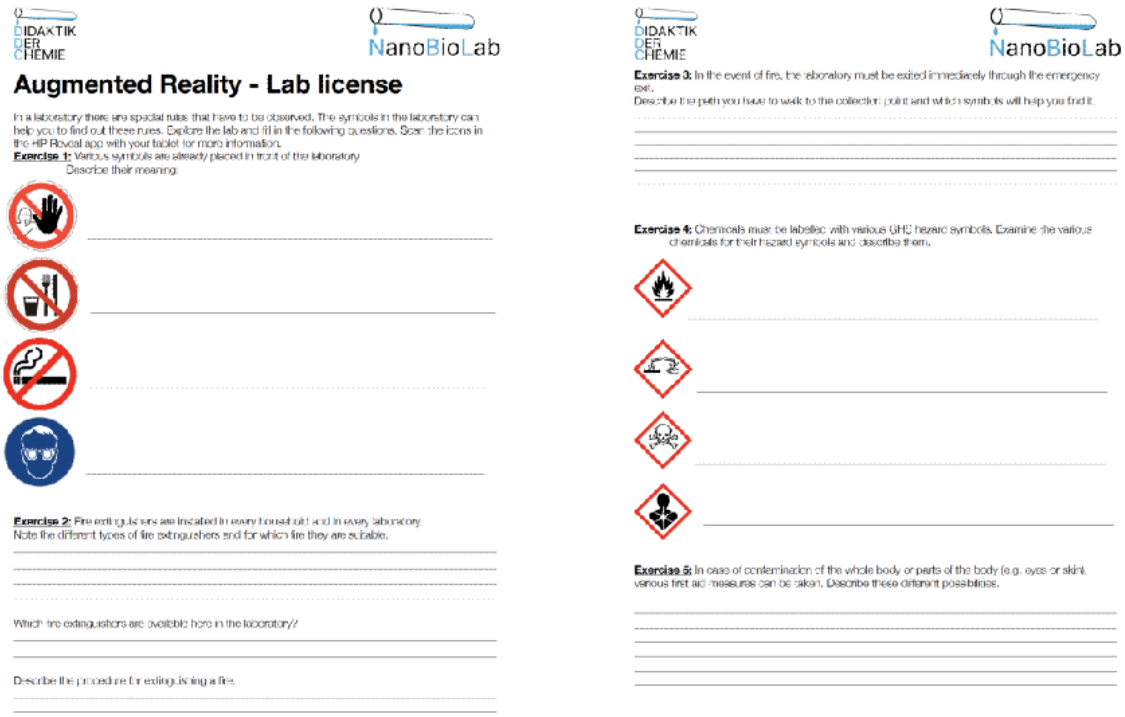
DIDAKTIK DER CHEMIE
NanoBioLab
Augmented Reality - Lab license
In a laboratory there are special rules that have to be observed. The symbols in the laboratory can help you to find out these rules. Explore the lab and fill in the following questions. Scan the icons in the HP Reveal app with your tablet for more information.
Exercise 1: Various symbols are already placed in front of the laboratory.
Describe their meaning:
Exercise 2: Fire extinguishers are located in every house exit and in every laboratory.
Note the different types of fire extinguishers and for which fire they are suitable.
Which fire extinguishers are available here in the laboratory?
Describe the procedure for extinguishing a fire.
Exercise 3: In the event of fire, the laboratory must be exited immediately through the emergency exit.
Describe the path you have to walk to the collection point and which symbols will help you find it.
Exercise 4: Chemicals must be labelled with various GHS hazard symbols. Examine the various chemicals for their hazard symbols and describe them.
Exercise 5: In case of contamination of the whole body or parts of the body (e.g. eyes or skin), various first aid measures can be taken. Describe three different possibilities.

Figure 3. Exercise Sheet for the laboratory license

Figure 4. Warning symbol without (l.) and with (r.) Augmented Reality

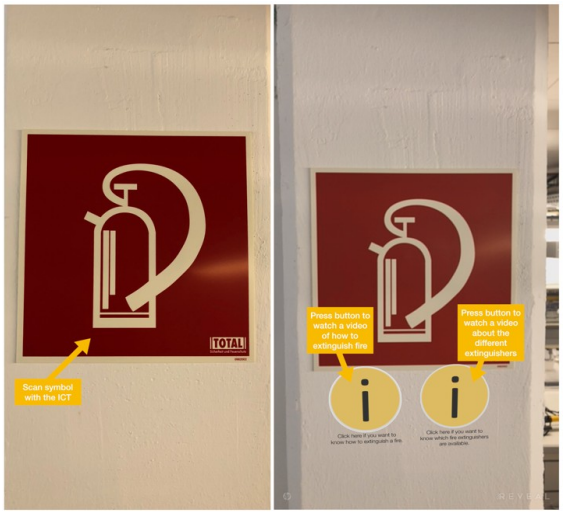

Figure 5. Extinguisher Symbol without (l.) and with (r.) Augmented Reality

Good safety training in the laboratory also requires knowledge of how to act in an emergency. This includes first aid measures such as eye and body showers.

These two types of showers are available in every standard laboratory and therefore it should be addressed. It would also offer you to at least let the students try the eye shower to get a feel for it. In Figure 6 and Figure 7, the corresponding symbols are augmented and contain important information for use. The task of the students is to find out how such a shower can be used in an emergency.

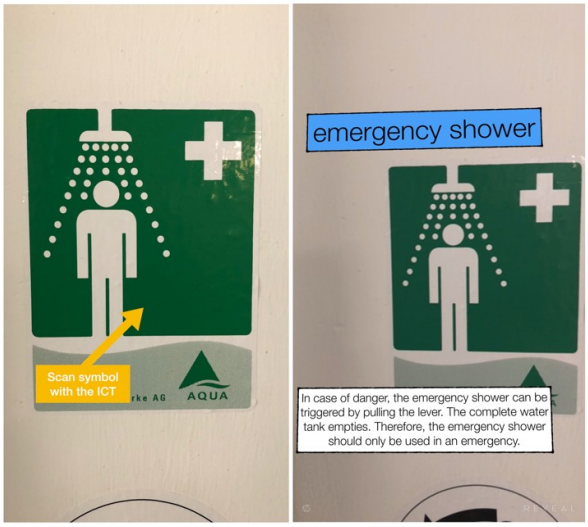

Figure 6. Emergency Shower without (l.) and with (r.) Augmented Reality

The sign from the next task is also one of those that the students know from their everyday lives. The emergency exit should be found in the event of an emergency and it is also important to be able to find your way to the common meeting point. The next task of the students is to describe the escape route to the meeting point with their own words.

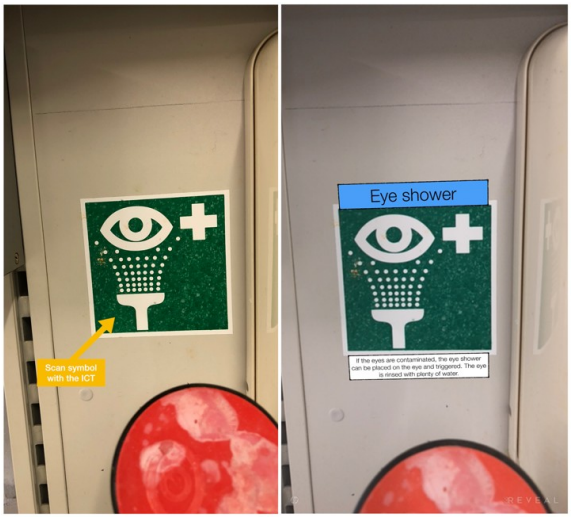

Figure 7. Eye Shower Symbol without (l.) and with (r.) Augmented Reality

In the normal non-augmented environment, it is difficult or impossible to find the way without knowledge. For students it is really difficult to understand the printed emergency plans, so we decided to use AR-technology to promote a faster understanding. We use the emergency door symbol and enriched it with a video showing a footpath to the vanishing point. In this way, the path can be reflected and internalized and called up in an emergency.

Figure 8. Fire Exit Symbol without (l.) and with (r.) Augmented Reality

Figure 9. GHS Symbols without (l.) and with (r.) Augmented Reality

In the chemical laboratory, the handling of chemicals is completely natural. For this reason, a final task is to get to know and describe the various hazard symbols of chemicals. For this purpose, we augmented the new GHS symbols by adding the corresponding designation and a detailed description of the symbol as an overlay.

4. Conclusion

In summary, we have had consistently positive experiences with this Technology. Usually, laboratory and safety rules are not very interesting learning contents compared to exciting experiments. But with the Augmented Reality Technology we are able to create a whole new experience in exploring rules and the laboratory itself. We tried out the AR-Learning environment together with fifth graders and also with students and continuously optimized them. We observed, that the students totally forgot, that they are learning “rules”, they were motivated in independently exploring the laboratory with a “second pair of eyes”.

All in all, it can therefore be said that by enriching the real laboratory driving license with digital materials directly in the real world, a method has been found, that makes it possible to "reexplore" the chemical laboratory and also erase the motivation for science.

Additional Material

All necessary materials are available for download on our website www.medienkompetenz-unterricht.de. There you will find all worksheets and information on how you can try out the presented materials in your laboratory and also create them yourself. In addition there are two short videos available that present the descripted material.

References

[1] Sekretariat der Kultusministerkonferenz (KMK) (2016). Kompetenzen in der digitalen Welt.

[2] Petko, D. (2014). Einführung in die Mediendidaktik – Lehren und Lernen mit digitalen Medien. Weinheim/ Basel: Beltz.

[3] Hense, J, Mandl, H. & Gräsel, C. (2001). Problemorientiertes Lernen – Warum der Unterricht mehr sein muss als Unterricht mit neuen Medien. *Computer und Unterricht, 44*, 6-11.

[4] Krause, M. & Eilks, I. (2014). Tablet-Computer als Unterrichtswerkzeug für Lehrkräfte – Allgemeine Hinweise und Beispiele aus dem Chemieunterricht. In: J. Maxton-Küchenmeister & J. Messinger-Koppelt (Hg.): *Digitale Medien im naturwissenschaftlichen Unterricht*, Hamburg: Joachim Herz Stiftung Verlag, 64-69.

[5] Bresges, A., Beckmann, R. Schmook, J., Quast, A. Schunke-Gallay, J. Weber, J., Firmenich, D. (2014). Tablets beim physikalischen Experimentieren – zur Unterstützung des Kompetenzaufbaus. *Praxis der Naturwissenschaften Physik in der Schule, 63*(5), 11-17.

[6] Huwer, J., & Brünken, R. (2018 – im Druck). Individualisierung mit Tablets im Chemieunterricht. *Computer + Unterricht, 109*.

[7] Huwer, J., & Seibert, J. (2017). EXPlainistry – Dokumentation, Erklärung und Visualisierung chemischer Experimente mithilfe digitaler Medien in Schülerlabor und Schule. *Naturwissenschaften im Unterricht Chemie, 160*, 44-48.

[8] Huwer, J., Seibert, J. & Bock, A. (2018). The School Book 4.0: The Multitouch Learning Book as a Learning Companion. *American Journal of Educational Research, 6(6), 763-772.*

[9] Wu, H.-K., Lee, S.W.-Y., Chang, H.-Y. & Liang, J.-C. (2013). Current status, opportunities and challenges of augmented reality in education. *Computers & Education, 62*, 41-49. Hamburg 2017.

[10] Aufenanger, S. (2017). Zum Stand der Forschung zum Tableteinsatz in Schule und Unterricht aus nationaler und internationaler Sicht. In: J. BASTIAN & S. AUFENANGER (Hg.): *Tablets in Schule und Unterricht – Forschungsmethoden und – perspektiven zum Einsatz digitaler Medien*, Wiesbaden: Springer VS, 119-138.

[11] Thyssen, C. (2017): Augmented Reality (AR) in der naturwissenschaftlichen Unterrichtspraxis. In: Groß J., Schanze S., Messinger-Koppelt J. (Hrsg.): Lernprozesse mit digitalen Werkzeugen unterstützen - Perspektiven aus der Didaktik naturwissenschaftlicher Fächer. Joachim Herz Stiftung Verlag,