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Internet Forums in Class: Innovation for Science Education by Focusing on Social Media

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Internet forums are a part of the World Wide Web and are frequently used to ask questions and receive answers. They are popular platforms for exchanging information and comparing opinions. Many people query and retrieve information from Internet forums on various topics, many of which are related to science and technology. These include health, cosmetics, technical devices, and environmental issues. The reliability of the corresponding entries in Internet forums, however, should be approached with great caution. Answers found in general Internet forums are often provided by laypeople. Forum posts may contain information without scientific proof and are influenced by personal beliefs and opinions. This paper sums up the action research journey of a science teacher who looked into how secondary school students view and use Internet forums and how such Internet forums may be potentially useful for innovation in science teaching. The project encompassed different action research measures. It suggests that it is potentially beneficial for teaching to more thoroughly focus on social media in science education, like Internet forums. Such media provide examples of content and learning tools for science teaching, which can promote learning and develop critical (scientific) media literacy.

Introduction

Digital information and communication technologies (ICT) have become an important part of modern society in general and in teaching and learning in particular (Dori, Schanze & Rodrigues, 2013). A recent German study revealed that more than 80% of today's teachers in countries like Germany use digital media in the classroom for information searches with only 10% of teachers believing that students do not need further assistance in finding valuable and reliable information (Bitkom, 2016). Enhanced strategies are required to boost the younger generation's confidence and critical-thinking skills when searching for digital media offerings from in the Internet. Such strategies will allow them to responsibly use digital media offerings and to develop critical media literacy (OECD, 2005). Media literacy is an important cross-curricular goal which, if it is incorporated into science teaching, may raise the level of relevance of science education and students' perception thereof (Belova et al., 2017).

Internet search engines like Google provide easy access to corporate websites, wikis, news portals, and Internet forums. All of these web-based resources provide users with information on almost every topic from various perspectives, but with differing degrees of reliability. Searches frequently center around personal or professional interests, which may also be related to science and technology. For example, if the term "neutralization" is entered into Google, we find Wikipedia entries, online encyclopedia offerings, and other student-centered pages. Expanding the search to "neutralization of lemon juice", hits directly guide the user into Internet forums relating the concept of neutralization to cooking, household care tips, and chemistry homework assignments. In these various cases, different concepts of neutralization are offered, not all of which directly refer to acid-base theory in chemistry. This small sample demonstrates on the one hand that threads in Internet forums contain some general public interest in the concepts of neutralization. On the other hand, the different entries also show that competing understandings of neutralization are offered, which vary in their scientific accuracy. One answer speaks of "neutralizing" an acidic taste with sugar, whereas the chemical response yields a more specific description of neutralizing an acid with a base (or vice versa) – a divergence which can be readily used to kick-start chemistry learning efforts in the classroom.

Contributions taken from Internet forums can be used in many ways to aid innovation when teaching science. They can serve as context to increase student motivation and the perception of authenticity. They may also function to raise questions and provoke cognitive conflicts in the learner, which must be solved using scientific inquiry (e.g., Dittmar & Eilks, 2015 a; 2016). This article describes a complex action research project inquiring into the different aspects of Internet forums and their potential use for innovation in science education. This research provides a basis for increased usage of Internet forums in school and justifies why such forums should receive more attention in science education.

Internet forums and classroom learning

Internet forums are part of the diverse information resources found in the Internet. They are platforms for exchanging information and opinions in a given place, but not necessarily at the same time. Internet forums represent a place to pose a question and receive answers to better understand or solve any given problem. In other words, Internet forums can be a place of learning.

Both general and domain-specific forums exist, for example, specific forums dealing with answers to questions about chemistry or science (Dittmar & Eilks, 2015 a). While general forums lend

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themselves to all sorts of topics for discussion and are a space where no thematic structure is usually provided, the situation tends to be different in domain-specific forums. For example, in science forums that specialize in chemistry there may be various sub-forums for individual domains within chemistry such as organic or analytical chemistry. Dittmar and Eilks (2015a) have previously shown that forums tend to get smaller with increasing levels of specialization, generally have significantly fewer members, and are normally less-known to students and laypeople alike. All forums are, however, quite similar in overall structure and function.

Anyone can register and become active in public Internet forums and simply reading postings commonly does not require official registration. Registration is, however, generally obligatory, if the user wishes to actively participate in discussions, to pose questions, or receive specifically tailored answers. In most forums, providing personal information like age and gender are not mandatory, which allows ubiquitous anonymity for personal traits. Thus, forum contributions may conceal an expert, but also present the possibility that an inexperienced layman is merely expressing his or her personal views. Information can be based on expertise or educated guesses. Unfortunately, the risk is unavoidable that misleading information might also be posted, which is either caused by a lack of understanding or by purposeful obfuscation. Most questions answered in forums reveal little to nothing to say about the emotional, cognitive, or socio-cultural background of the forum writer.

Due to the many questions there is a lively exchange in internet forums. Within every second, questions are posted and others answered, so that reliable control over the sheer number of questions and responses is hardly possible. Internal assessments can, however, be made on helpful answers and compliments, which that are rewarded with points. Providing helpful answers can eventually lead to being rewarded with the title of "expert". In gutefrage.net, the most popular forum in the German language, nomination as an expert results whenever 50 or more "most helpful" answers are given for a specific topic by one forum member within a defined period of time. Such awards are therefore regularly associated with continuity. As soon as the quality and the commitment of answers decline, the awarded title is lost (gutefrage.net, 2016). The requirements for "expert" status and whether or not an answer comes from an "expert" can be used to make an educated guess as to the quality of a forum answer.

Despite the large number of forums on the Internet, most forums are hardly used in educational settings, despite the benefits which have already been described for learners (see Schorb, 2013). Yet Internet forums can be visited flexibly in time (Uusiautti & Määttää, 2014), so that learners are not dependent on time of day in their learning efforts. A survey of 12- to 19-year olds in Germany found that almost two-fifths of young people purposely search out Internet forums, such as gutefrage.net, for everyday practical issues (Schorb, 2013), but do not do the same for school-related questions or as a part of formal education (Dittmar & Eilks, 2019b).

Internet forums can be understood as a kind of learning companion as suggested in Seibert et al. (2019) or Krause (2018). For example, Internet forums can be integrated into the classroom as fixed communication platforms to document communication and the learning pathway, as well as for a further exchange content of the lesson. The students can discuss possible content-related difficulties with each other or even ask for missing information.

Internet forums as the focus of science education action research – A case study

Based on the spontaneous idea of incorporating Internet forum threads into education, an action research project according to Altrichter, Kemmis, McTaggart and Zuber-Skerritt (2002) was initiated to motivate students to learn about neutralization in chemistry. The start of the project followed a teacher-driven approach as previously described in Altrichter, Posch and Somekh (2005). The project researched the chances for science innovation using content from Internet forums and using forum technology as a tool aiding science teaching and learning.

Prior to this action research project, information about student interest in and usage behavior with Internet forums among secondary school students was limited. The available research basically focused on general issues. There was a dearth of more specific information concerning science-related information found in Internet forums. Most of what was available centered primarily around specific fields such as health issues. The new action research began by inquiring into students' views on and perception of Internet forums. Then it was further refined to analyze Internet forums with respect to student interest in science topics. This action research initiative eventually led to curriculum innovation and implementation.

Action research measure 1: Literature analysis and a first informal inquiry

First, a literature review was performed by the action research teacher (J.D.). It revealed that very little information was available on the attitudes or manner in which young people dealt with Internet forums. In higher education, a few isolated studies had appeared, which either dealt with Internet forums in the context of learning (Thomas, 2002) or with how learning processes can be supported by the use of such media (DeSanctis et al., 2003). There were, however, no surveys available which focused specifically on the use of Internet forums in science education or with reference to the specific educational environment a given teacher was working in. The lead teacher in the new case study carried out a corresponding informal inquiry in her own classroom. This revealed that Internet forums, especially gutefrage.net, were well known by most of the students in her educational environment (age group 15-16). The informal inquiry confirmed that the students know Internet forums well, but seem to make use of them only for private purposes as passive consumers. A decision was made to deal more intensively with this question.

Action research measure 2: A survey on learners' use of Internet forums

Based on the initial, informal survey, a questionnaire study was begun (Dittmar & Eilks, 2019 a and b). A total of 668 lower and upper secondary school students (age range 12-19) in the local environment of the school were recruited. They completed the questionnaire, which asked about their interests, forum usage behavior, and personal perceptions of the reliability of Internet forums. The study confirmed the popularity of forums like gutefrage.net. It also provided insight into how domain-specific Internet forums in the fields of chemistry and science were less-well-known and how little they tended to be used by secondary school students for educational purposes.

A majority of the students in this survey confirmed that they were basically passive consumers of forum entries. They generally posted neither questions nor answers. The questionnaire revealed that students felt insecure in both filtering information from the diverse forum content and in assessing the uncertain quality of information found in Internet forums. One person replied: ."If there is a question, there are several answers, if you don't understand the first one. The downside is that anyone can respond, so there is no guarantee that everything is right. But it is handy, if you enter any question on Google. The forums are displayed with the appropriate answers to your question." Another answer was: ."Concerning Internet forums, I have some good opinions, because they often help me. However, I do not know if everything presented is right. That's why I'm sometimes unsure." The results of these findings are clear. Secondary school pupils use Internet forums and perceive them as helpful resources. But they also feel insecure when it comes to the reliability of the information found. This uncertainty was expressed by many of the participants (Dittmar & Eilks, 2019 a and b). To a certain extent, the finding reflects the social consensus that the quality of information found in Internet forums varies widely, due to a lack of control mechanisms (Savolainen, 2011). This recognition led to further questions: How is the content quality in Internet forums perceived when it relates to science and technology? What does this content cover?

Action research measure 3: Analysis of an Internet forum

The action research teacher started to analyze an Internet forum in order to achieve a better feel for content found in and the reliability of public Internet forums. This was similar to what has been previously suggested in the literature in the fields of economics and health care (Franke & Hienerth, 2006; Cole, Watkins & Kleine, 2016). The most popular Internet forum among the students was selected: gutefrage.net. This website is one of one of the largest German-language Internet forum. It is a free discussion forum, which is used by at least several million registered members (Dittmar & Eilks, 2015 a). In addition to a high level of awareness among students, this forum was also identified as the most frequently employed forum by German teachers for lesson preparation (statista.com, w.y.).

Using Cole et al. (2016) and Mitchell, Sweitzer, Tunno, Kollins and McClernon (2016) as a guide, a specific point in time per week was chosen to make screenshots of the first twenty successive forum threads (a question with the associated answers and comments) for each search. This was performed for a period of eight weeks in order to provide a representative sample for the study (Dittmar & Eilks, 2019 b). These screenshots also contain the number of answer yields per thread and show whether responses were marked as a "most helpful answer" or an "expert answer". A descriptive evaluation of the data was carried out using document analysis (Bowen, 2009). The threads were assigned to specific topics and compared to studies on student interest in science, specifically the ROSE (Relevance of Science Education survey; Bögeholz & Holstermann, 2007) and IPN interest studies in science (Gräber & Lindner, 2009). Based on the screenshots, the number of questions, helpful answers, expert answers and unanswered questions were first identified in order to compare them with each other.

Similar to the study by Savolainen (2011), a total of 160 questions was analyzed. Of the total, 69% of the questions referred to issues that were related to science and technology. A further 48% of the total questions concerned everyday issues, 15% discussed the human body and 6% looked at science-related societal or environmental content. Many of the topics identified directly mirrored issues mentioned in other interest studies of science education (Bögeholz & Holstermann, 2007; Gräber & Lindner, 2009). Other questions concerned private topics. Typical private questions by (presumably) younger users discussed behavior towards persons of the opposite sex and any associated, interpersonal problems. A second, quite large category included tips for playing computer games. Other users wrote about problems in their family or asked for holiday destination information.

Everyday questions in relation to science and technology very often focused on technical issues. A total of 67% of science-technology questions regarded problems with the use of digital devices. For example, presumably younger contributors often asked for help on the installation of computer games or on technical issues to help them enhance their gaming experiences. Presumably older forum authors asked about computer performance, the pros and cons of certain computer equipment, or other technical issues. The same applied to mobile phones, although fewer questions were found in this area. In the field of society and environment, only job-related content was posted for discussion. For example, users asked if a document was a "good professional assessment", or how many semesters were necessary to complete a certain degree program. Discussion included the experiences of people entering into a new, totally different profession. Questions about chemicals or environmental awareness were not found in this survey. The area of the human body focused on issues dealing with body awareness. These were often health problems. Users asked about the experiences of other people having similar problems. The study found that 33% of the forum questions gave answers that were rated as helpful or expert out of the total of 160 questions. Only 6% of the inquiries remained unanswered. Of the

helpful answers, 83% concerned questions about everyday life, 13% asked about the human body, and 4% were job-related questions.

The comparison of helpful answers to unanswered questions shows that one third of the questions were perceived as helpful or were answered by an expert. In the healthcare sector, a study by Cole et al. (2016) found that various discussions related to certain diseases were of acceptable quality in both general Internet forums and in a health-related forum. It is noticeable that helpful and expert answers mostly concerned topics taken from everyday life and less often questions about the human body. This also applied to job-oriented questions, where answers had been marked as helpful, but no expert was involved in the discussion. The unanswered questions related solely to everyday issues, with 70% concerning technology use and 30% other content. Beginning with this study, our search could identify Internet forum threads more closely related to topics in the chemistry curriculum which would later be used in class.

Action research measure 4: Curriculum innovation

Parallel to the investigating students' views and the analysis of an Internet forum, attempts were made to integrate Internet forums into the classroom following participatory action research (PAR) as suggested by Eilks and Ralle (2002). The process started with small interventions and focused in the end on the development of a new pedagogy for cooperative learning in science education (**Figure 1**).
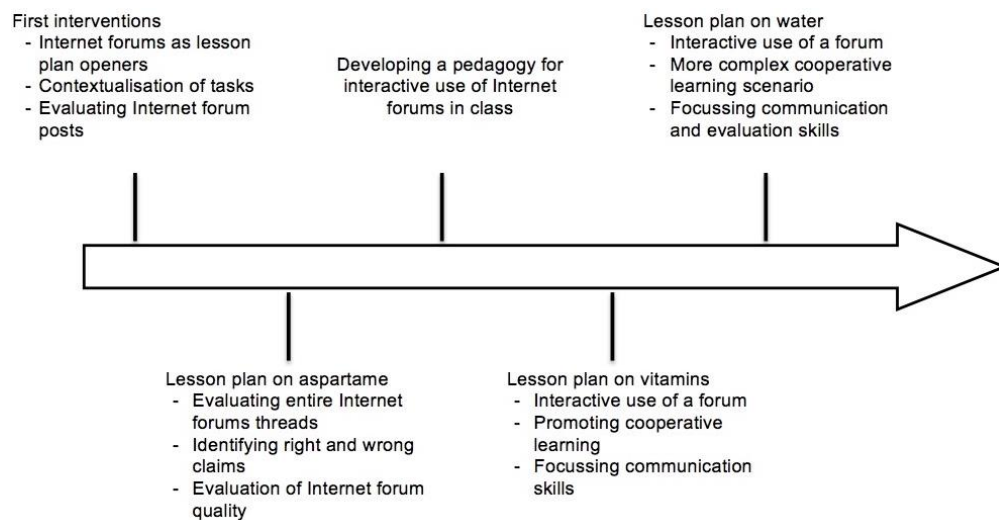

Figure 1. *Research process for the development of materials*

Interventions began with an example that kick-started the whole action research initiative. The question was raised whether the acid in the lemon juice can be "neutralized" by sugar. This lesson plan was initiated with the help of the authentic internet forum question: "acid + sugar = neutral?" (wer-weiss-was.de, 2014). The question kicked off the lesson plan by motivating students to investigate the chemical concept of neutralization according to acid-base-theory. Learners were expected to examine the everyday meaning of the word neutralization and differentiate between colloquial use of the term and the scientifically correct chemical concept of acid-base reactions. This helped the students to avoid misconceptions caused by the different meanings which many technical terms have acquired in everyday life language (Markic, Broggy & Childs, 2013). Classroom discussions of the example problem showed the action research teacher that the presentation of a problem via an Internet forum post is perceived by students as authentic and motivating. As the accompanying studies on students' perception of Internet forums and forum analysis showed, questions that are discussed in the Internet by the general public motivate learners and encourage them to find solutions to the problems discussed. Furthermore, the forum contributions also seemed to be easy to understand for the learners due to the use of everyday language (Dittmar & Eilks, 2016).

The example of neutralization introduced thinking about finding specific strategies for how to use Internet forums as a medium in the classroom. Based on previous projects, such as advertising in science education (Belova & Eilks, 2015), different scenarios for the application of Internet forums were developed and tested, e.g., as lesson plan openers, to introduce practical work, or to create tasks for assessment (Dittmar & Eilks, 2019 b). It became increasingly apparent that the learners reacted positively to teaching and learning sequences dealing with forum posts. Generally, contributions from Internet forums were perceived by the students as tangible for the learners because of their everyday nature. They were seen as motivating because of their authenticity, although the learners retained some skepticism about the reliability of Internet forum posts.

The question also arose of how learners can be better prepared to deal with Internet forums in a critical way and how students can be shown how to better understand the mechanisms of how forums actually work. One initial strategy was confronting learners with the forum posts in their entirety. A lesson sequence focusing aspartame as an artificial sweetener was developed and tested in class (Dittmar & Eilks, 2015 b). The topic was introduced by explaining the relevance of aspartame in light soft drinks, but also by highlighting the resulting mass of forum contributions in which the use of artificial sweeteners was critically discussed. Various forum contributions were analyzed together with the students. The analysis focused on content quality in order to identify correct or misleading statements. The lesson plan intended that learners discover which pages were available and how they should determine their overall reliability (Dittmar & Eilks, 2015 a).

Up to this point, only the forum contributions were the focus of the lessons, not the Internet forum itself. The approaches had not focused on an understanding of forums as digital learning tools to support learning or as a medium to actively contribute to in the sense of posing personal questions and discussing problems with others. Accordingly, the question arose of how Internet forums could be integrated as a technical tool in the classroom for interactive use as defined by the OECD (2005), not just to consume information, but also to create digital media content. For this reason, the development of a pedagogy arose, which used vitamins and tap water vs. mineral water as topics to establish Internet forums in the classroom as an exchange and discussion tool (Dittmar & Eilks, 2016; Dittmar, Krasowka & Eilks, 2017).

The intention of the newly-developed pedagogy was to introduce participants to Internet forums and to get to know them as technical tools. To test the methodology and determine its suitability in science education, a teaching concept was first developed for promoting cooperative learning via Internet forums. The topic was "vitamins" (Dittmar et al., 2017). It approached the problem using the socio-critical and problem-oriented science teaching approach (Marks & Eilks, 2009). This motivated the learners to pose suitable questions for exchange and to promote their communication skills. Behavior rules for Internet forums were also discussed and defined in order to prepare the learners for exchange in authentic forums. In addition to learning about vitamins, the focus also concentrated on dealing with the technical conditions found in Internet forums.

The positive feedback by both learners and teachers led to deeper engagement with forums as a digital tool in the classroom and their implementation in science education. Questions were raised as to whether this methodology could also be used for longer teaching units and how, in addition to communicative competency, it could also promote evaluation skills in the sense of critical media literacy. This resulted in a lesson plan on the quality of tap vs. bottled drinking water (Dittmar & Eilks, 2016). The opening question centered around the difference between mineral and tap water. Students were asked to investigate high quality, risk-free drinking water in the German context. Learners were required to develop and defend a well-founded position on the supply and consumption of safe drinking water, based on various aspects which had been introduced and developed by the teaching unit. The learners also dealt with subject matter such as the nature of the water molecule, the solubility of minerals in water, and the composition of both tap and mineral water. In addition, they expanded their experimental skills and performed practical work on different kinds of drinking water. All communication between the small groups of learners took place in a closed forum constructed with Moodle (**Figure 2**). Information exchange occurred only via the forum, in which discussion was initiated and administrated by the teacher. Tasks and information texts were created so that the class as a whole could only gain a comprehensive solution by piecing together the knowledge gained by each of the individual groups with the aid of the Moodle forum. One initial drawback was that the task of writing responses in the forum was only reluctantly and grudgingly accepted by the participants. During

testing, however, the teacher found that the participants gradually became more open to lengthy written communication as use of the forum continued. This suggests that learners open up to forum use through exposure. Similar to the findings by Uusiautti and Määttä (2014), the learners quickly recognized that forum use makes information exchange flexible and fruitful.
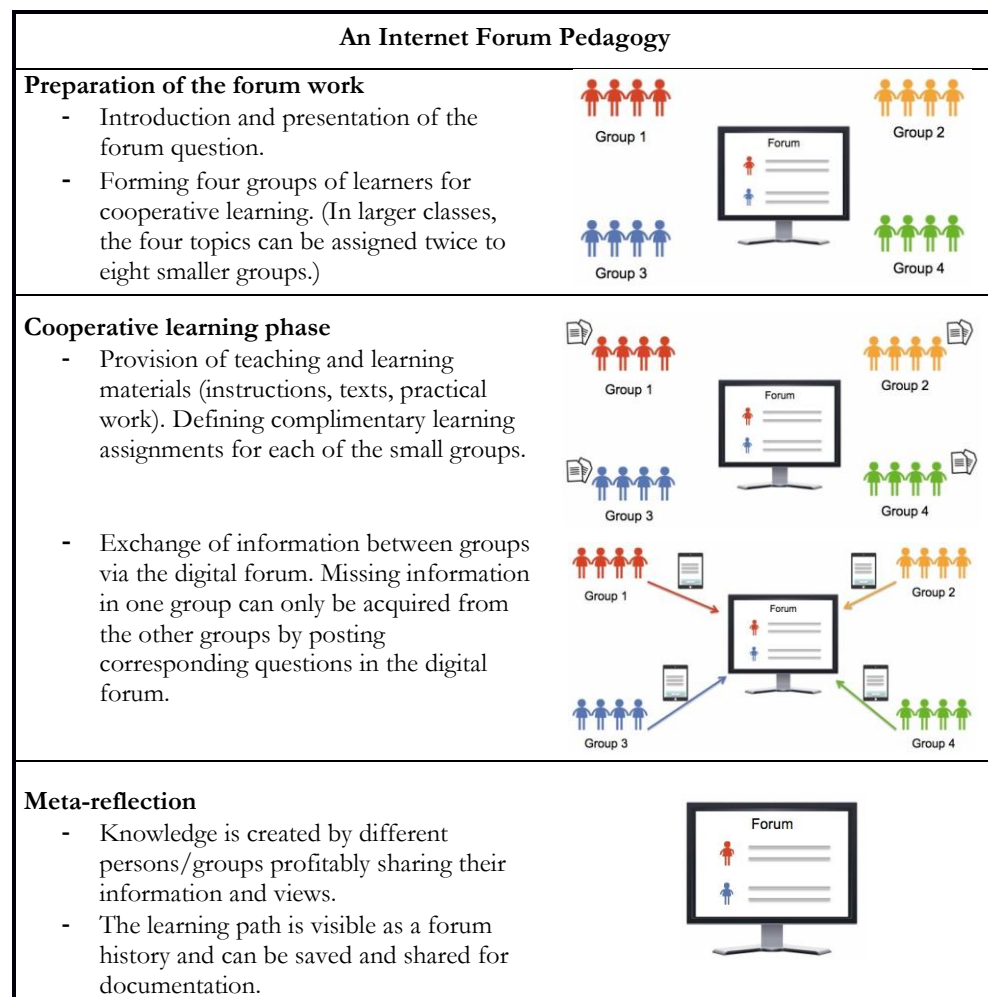

An Internet Forum Pedagogy

Preparation of the forum work
- Introduction and presentation of the forum question.
- Forming four groups of learners for cooperative learning. (In larger classes, the four topics can be assigned twice to eight smaller groups.)

Cooperative learning phase
- Provision of teaching and learning materials (instructions, texts, practical work). Defining complimentary learning assignments for each of the small groups.

- Exchange of information between groups via the digital forum. Missing information in one group can only be acquired from the other groups by posting corresponding questions in the digital forum.

Meta-reflection
- Knowledge is created by different persons/groups profitably sharing their information and views.
- The learning path is visible as a forum history and can be saved and shared for documentation.

Figure 2. *A potential Internet forum pedagogy*

Within the trials it was observed that placing student communication into a forum quieted the learning atmosphere and increased the overall level of exchange between the small groups in

comparison to the groups face-to-face. Likewise, the participants enjoyed working within the forum and the communication was perceived as motivating. Lower-achieving learners also stated that communication through the forum was easier for them than contributing to an open class discussion. Many students felt that they were more involved in the lesson thanks to the use of the digital forum made by Moodle.

Action research measure 5: Implementation

Much of the testing took place over several years in different schools. In most of the schools no digital media-oriented curriculum was available at that time. The teachers involved perceived the lesson activities as a positive contribution to increasing digital media literacy. Accordingly, teaching concepts for the use of digital forums became firmly anchored in the practice of science teaching.

At one senior high school (the school of the action research teacher), the lessons learned from this action research even transformed the chemistry curriculum in the introductory phase of upper secondary chemistry education. The finding that learners used digital forums more self-confidently and effectively through multiple exposures led to the incorporation of digital forums in a spiral curriculum for the school. The teachers found that digital forums and independent searches benefited weaker learners strongly. The learners expressed greater interest in topics, especially in the chemistry classroom. This led to an investment in digital media. Chemistry rooms were equipped with wireless Internet connections and laptops.

In the school where this action research began, it became established practice for students to work independently with laptops in the chemistry classroom in order to support their personal learning process during theoretical and practical phases. This school could show that the number of students opting for further chemistry courses has increased since the changes inspired by action research took place. Not only the learners, but also the school supervisor evaluated the implementation of chemistry lessons using ICT-supported learning environments as innovative and positive for both learning and student motivation.

Discussion

This case study describes an action research project which began as teacher-driven action research using the suggestions of Altrichter et al. (2002). For the purpose of curriculum innovation and change, the project later was expanded to include participatory action research (PAR) following Eilks and Ralle (2002). This was carried out in connection with an action research network, which has been working on curriculum development for the past twenty years (Eilks, 2018).

The idea of using Internet forums in science classes initiated a long-standing process of research and action by one teacher in his own classroom and beyond (**Figure 3**). The activities have were performed on different levels using different focal points. They led to both a growing

understanding of students' media usage and an increasing level of complexity in the teaching and learning scenarios developed. It was not only learning by inquiring into one's own teaching practices in the sense of action research. The process also guided and expanded upon cooperation with other teachers using participatory action research (Eilks & Ralle, 2002). This culminated in the final scenarios discussed here and led to the development of the associated teaching and learning materials. These materials were disseminated to other educators via teacher journals, teaching materials collections (e.g. Dittmar & Eilks, 2015 a and b; 2016; 2017) and professional development workshops. This also led also to changes in the school chemistry curriculum and infrastructure in the action research teacher's own school.
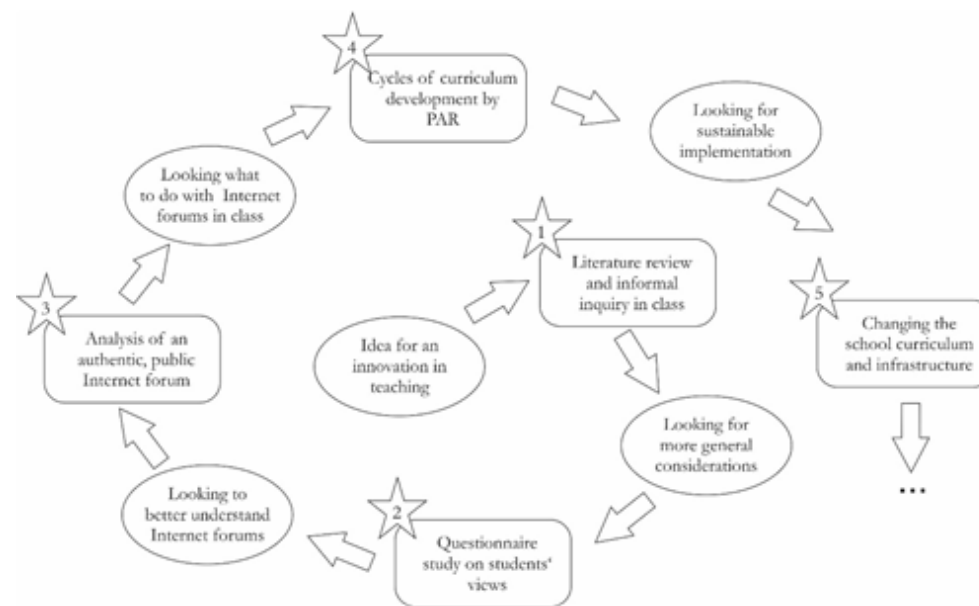

Figure 3. *Action research within the project on Internet forums*

This action research project led directly to changes in the pedagogy of science teaching. This was true for the subject itself and for the school as a whole. Especially in the sciences, many teachers face extremely low levels of interest and motivation. They also are confronted by a perceived lack of subject relevance when teaching science to pupils (Stuckey et al., 2013). It has been suggested that this lack in motivation is closely related to the learning environment (Hofstein & Kempa, 1985). From action research projects we can see that digital media such as social media can support lessons in both learning levels and in increasing enthusiasm for the subject (Liu, 2010). The internal school changes inspired by this action research project show how such efforts can

function in other schools. However, each school's structure also has to be taken into account, since the same prerequisites are not found everywhere.

Internet searches are a popular methodological tool in the classroom in order to let students work independently and provide support (Dori et al., 2013). Students search for subject content in order to better understand or elaborate on it. In this realm, Internet forums can play a significant role and offer another information source for learners. Students can post their questions and viewpoints in order to gain advice from other experts besides their teacher. In doing so every learner, young or old, may experience various difficulties. Filtering out correct information from the Internet in general and from Internet forums in particular is a complex task. Learning proper behavior in contributing to such forums should also be an aim of education. These aspects of media education are required by all teachers across disciplines when planning and carrying out lessons (Bitkom, 2016; UNESCO, 2008). Thus, teaching should focus on critical media education, taking into account the direct use of such media in the classroom (OECD, 2005).

The different studies in this action research combine to show that Internet forums have great potential for informing science education. But they also show that forums can be used as an authentic medium in the classroom to promote learning. Internet forums are regularly used by secondary school students to inquire into issues in their lives. At a minimum, larger general Internet forums are well-known by nearly all students. In school, students need to be introduced to digital media as a ways to use forums for science queries beyond mere Internet searches. This can help them to become more self-confident, independent, and competent in using such media. The scenarios and materials developed by this action research study (e.g. Dittmar & Eilks, 2015 a and b; 2016; 2017) can also provide guidance to teachers for courses of action when attempting to implement media education using Internet forums in science education. Furthermore, continuing professional development is needed to effectively disseminate the developed strategies and materials from such studies and keep up with the fast-paced world of digital media developments (Mamlok-Naaman, Eilks, Bodner & Hofstein, 2018).

Since Internet forums are broadly used by students, they mirror to a certain extent what students are really interested in. In this sense, Internet forums can be viewed as a bridge between students' everyday lives and formal learning in school. Pupils are still largely passive consumers of Internet forums and view them with some insecurity when it comes to the reliability of forum postings. Many learners still fear publishing something wrong and lack self-confidence when publicly discussing science issues with strangers. This fear could be minimized, if such communication pathways have already been addressed in the classroom. Although most learners are passive consumers and remain skeptical about the quality of information found in Internet forums, they also appreciate the motivational character of using digital forums as an authentic medium for science education.

Conclusion

Internet forums have broad potential in science education for promoting critical scientific media literacy. Different scenarios have already been identified using action research initiatives (Dittmar & Eilks, 2015 a):

- Use of Internet forums posts as an authentic and motivating lesson plan opener
- Use of Internet forums posts to contextualize theoretical learning or practical work
- Use of Internet forums to practice communication and evaluation skills
- Use of Internet forum posts to reflect the role of science in the public debate

The developed scenarios and associated teaching and learning materials provide us with a basis for introducing learners to science-related content in Internet forums for different topics. Strategies for using Internet forums can be examined with the learners and can lead to motivating students to actively participate in Internet forums. With the help of the teacher, questions can be posted online and the responses from other users be jointly reflected upon in class. This can, for example, begin with the help of a closed Moodle forum, then later be expanded in actual, public Internet forums. In addition to the formulation of specific questions, it is also important to know how to search Internet forums, since many questions have been already posted and answered with sufficiently high quality. But differentiating between good quality answers and poor or even incorrect answers is something which must be practiced and learned. To do this learners need to analyze and compare examples of high and low quality postings and answers in a classroom setting. It would be advantageous if such concepts are established early on, at different places in the curriculum and across the various school subjects in order to accustom learners to this medium.

Further action research in science education should focus on how learners can be better introduced to and be made more familiar with different Internet forums focusing on science topics. In forums, there are numerous opportunities to connect curriculum content with learning from and through social media. In more specific Internet forums, the likelihood is higher that professionals are active and can help learners deal with science-related questions. Action research in the future might reveal under which conditions Internet forums with focus on science can best be used as a more interactive learning tool than school textbooks or traditional media generally represent. This can be seen as a strategy to prepare pupils for lifelong learning. One possibility for this preparation might be the creation of an in-house digital forum to accompany the lessons. The in-house offering can be constructed similarly to a public Internet forum. Throughout the year, learners can help each other by sharing knowledge and supporting one another in the digital environment. The creation of corresponding digital forums is now possible in many schools at least in developed countries, since there are platforms like Moodle which aid in the organization of lessons and classes.

We consider it a missed opportunity if schools do not use science-related Internet forums to consciously teach students how to search for knowledge from the specialists, or even educated amateurs, who regularly participate in forums. As with general forums, students can be guided to reflect upon the differing quality of answers in the various science-related forums, based on their knowledge gained in school lessons. Similar studies might also be performed with other social media, covering issues relevant to students and related to science, e.g. Facebook, Instagram, or the various health and beauty blogs.

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