Cooperation of mathematics teaching and special education – seminar concept and experiences

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In cooperation with the Institute for Special Education and Inclusive Learning and the Institute for Mathematical Education, different seminars were conceptualized in which students studying elementary and special needs education examined the use of digital media in an inclusive classroom setting. We will now introduce the starting situation for such seminars and describe one of the seminar concepts in more detail. To conclude, we will consider impressions from students.

Keywords: Inclusive settings, multi-professional teams, teacher education, digital media.

Starting Situation

Nationally and internationally, political actors place demands on teacher training in the areas of inclusion and digital media:

- In the UN Convention on the Rights of Persons with Disabilities (2006), in addition to the right to education for all people (ibid., Article 24), access to information, etc. (ibid., Article 4) is required in order to enable full and effective participation in society.

- The "Equity Principle" of NCTM Standards (2003) demands that teachers must be professionalized in order to be able to deal with the heterogeneous starting positions of the students (ibid., p. 13f.). Learning mathematics with electronic technology is presented there as essential. It also offers many opportunities to support learning, especially for students with physical challenges (ibid., p. 25) and other handicaps.

- The conclusions on inclusion in diversity with the aim of high-quality education for all call for the basic and advanced training of teachers, "and foster their motivation and competences [...] to deal with diversity" (European Union, 2017, C 62/5). This also includes "systematic incentives and training to allow teachers to experiment with digital pedagogies" (ibid.).

- The Conference of Ministers of Education and Cultural Affairs (KMK) for Germany calls on the universities in particular to anchor media education in teacher training. The aim is to address the media experiences of the learners in the classroom. In addition, they should be able to analyze available media and use them as required for teaching and fostering (KMK, 2012). Work in multi-professional teams in teacher training should also be intensified in order to enable a multi-perspective view of the child and the interaction between teacher and child (KMK, 2015).

At the Justus Liebig University in Giessen there are no joint events for students studying elementary and special education due to the study regulations. A collegial cooperation with the aim of joint planning of lessons, however, requires knowledge to be acquired about the other profession, and this as early as possible (Hattermann et al., 2014).

Building on existing experience with interdisciplinary activities (Rudinger et al., 2018), new seminars were designed that address the use of digital media in inclusive settings and enable students studying primary and special education to learn together. These students are usually in their penultimate semester. The elementary teacher students study mathematics as a subject, while the special education students usually do not, moreover, their prior knowledge of mathematics didactics usually relates to only one compulsory module.

Digital media is seen as a special aid for differentiation and support in cooperative, inclusive teaching (Bonow et al., 2019). Digital media seems to have particular potential here, since, for example, direct control via input gestures on the screen of tablets eliminates the need for the computer to coordinate hand, eye and mouse (Walter, 2017). However, digital media also offers new possibilities for representing mathematics, e.g., by focusing on written and graphic communication in projects for chatting about mathematics (Schreiber, 2013) or on the oral presentation of mathematics when creating audio podcasts (Schreiber & Klose, 2017). In mathematics didactics, the possibility of creating or using videos is currently seen as a way of learning mathematics (e.g., Leinigen, 2020). In particular, the potential of synchronously linked representations (Schulz & Walter, 2019) can be used in the creation and use of videos in terms of mathematics didactics. Since the individual requirements of the learner can be addressed, there is potential here for use in an inclusive setting (Fehrmann, 2019).

Seminar Concept

The seminar “Explain! Videos in inclusive math lessons” is attended in equal parts by students studying to become teachers in primary and special education. The course has been offered since the winter semester 2020/21, and 42 students participated in the first two course offerings. The seminar program is divided into three different phases. First, basic theory is worked out, then work is done on a specific (Hirt & Wälti, 2012) substantial learning environment (SLE) (Scherer, 2019). Third, video sequences are created for this SLE. Working together in mixed teaching groups plays a central role in order to give the students their first experience of multi-professional cooperation.

In the first phase, important theoretical basics for the use of videos in mathematics lessons are developed. Particularly addressed is the point that explanation should not be given exclusively in the sense of transferring knowledge (Kiel, 1999) through the video, but rather the students should be encouraged by the video to negotiate or develop knowledge (ibid.) by explaining something themselves. The concepts of an SLE and natural differentiation (e.g., Scherer, 2019) are used as the theoretical groundwork for inclusive math lessons, and form an important basis for further work in the seminar.

Natural differentiation is characterized by having the same learning opportunity for all students. This learning offer is mathematically rich and complex, so that the processing can take place at different, naturally resulting complexity levels. Different learning requirements can also be catered for by giving the pupils the greatest possible freedom in the way they work on and solve problems or in the way they present them, and in the notation they use. This also enables social learning from and with each other in a natural way (Scherer, 2019).

A substantial learning environment (SLE) uses the principles of natural differentiation to teach slow and fast learners together. SLE is guided by core content, goals, and principles of mathematics instruction that have mathematical substance. Tasks should have a high cognitive activation potential that allows accessibility and independent activity by all learners (Hirt & Wälti, 2012).

In the next phase, the students work on an SLE for primary school students as described in Hirt and Wälti (2012). The SLEs address different mathematical topics: arithmetic, measurement and modelling, and geometry. The students should first analyze the SLE in terms of content and mathematics by working on the tasks themselves and making a well-founded decision as to which video formats can be used to support the subtasks.

A method developed by Schreiber and Schulz (2017) is used to create the film (see Figure 1). This is a method that, in addition to being used in teacher training, can also be used in schools to create films on mathematical content together with students (Schreiber & Schulz, 2017; Leinigen, 2020; Fehrmann, 2019). In addition to the products created, the seminar should also provide students with suggestions for using the method in school.

Figure 1: Process of film creation (Schreiber & Schulz 2017)

The video creation phase takes up most of the semester. Individual steps of the method can already be worked on in the theoretical phase of the seminar. **(1) Determine the Content**: The students decide on one of the proposed learning environments when they are divided into groups. **(2) Factual Analysis**: The students first work on the learning environment themselves in order to grasp the depth of the mathematical subject. The mathematical richness of a learning environment allows the students to make interesting discoveries beyond the content and learning objectives of the primary level. Dealing with the learning environment should also lead to considerations as to which subtasks could be supported by individual video sequences and what a meaningful, cognitively stimulating video application could look like. **(3) Script I:** Video sequences are planned in the form of scripts. **(4) Peer Review:** These scripts are discussed in groups in the seminar and students edit their scripts based on feedback from fellow students and instructors. **(5) Script II:** Only completely revised scripts are approved for video production. **(6) Film Creation:** The type of technical implementation of the video sequences is up to the students. For example, videos may be created using the laying technique, stop-motion technique, screencasts, etc.

The learning environment should be supported by at least two video sequences between 30 seconds and 2 minutes in length. Additional materials, such as worksheets, haptic material, etc., are also necessary for the implementation of the learning environment. Due to the corona virus pandemic, the students were not able to try out all the videos themselves in classes. However, the video sequences were occasionally used by teachers in alternating or online lessons, so the students received useful feedback from the teachers on their products. For a time after the pandemic it is planned that the students can also try out the videos themselves.

Seminar Focus and Goals

The goal of the seminar is for participants to get ideas for designing videos for inclusive mathematics classes. The guiding principle for this is the assumption that inclusive teaching can only succeed together – in multi-professional collaboration.

One focus of the seminar is to **work in multi-professional teams**. This is promoted by the mixed teaching groups in which the students work together during the entire seminar. There is a social exchange about experiences and competencies, which leads to different perspectives and roles in the classroom becoming clear. Particularly when creating the videos, different expertise and competencies become clear. The primary education students bring expertise in mathematics didactics, the special education students can accompany the planning from the perspective of special education. In this way, differentiation levels are built in, or special education needs are explicitly considered in order to make the videos accessible to the target group. Thus, the primary education students can achieve more understanding of individual support needs. In the peer review of the video scripts, the students benefit again from the different perspectives and previous experiences of fellow students, so that a wide range of feedback can be given. This intensive exchange about the scripts serves to build up knowledge about the qualifications and areas of responsibility of future colleagues and is intended to facilitate later cooperation (e.g., Rudinger et al., 2018; Bonow et al., 2019).

The second focus of the seminar is to **work with digital media**. The media skills of the students are first strengthened (KMK, 2012) by creating videos themselves using different techniques. Promoting media literacy also includes providing a meaningful rationale for the video sequences in terms of subject didactics (ibid.). Possible uses of videos in (inclusive) education are also reflected upon. For school practice, there is also a focus on the media competence of the students. The video creation method carried out in the seminar is also suitable for school practice (Schreiber & Schulz, 2017; Leinigen, 2020). Through the guided assignment, students can acquire media skills.

Results of the Seminar

To use videos within a naturally differentiated learning environment, care is taken that the videos are not only intended for passive consumption, but also cognitively stimulate the students. In the end, there should be an opening through a follow-up task or something similar. This can be implemented using different video formats. There are also many possible uses within a learning environment. The video can give a general introduction, it can provide additional, differentiated help, explain a task or a task format, or provide an impulse to discover a mathematical structure (e.g., Kristinsdóttir et al., 2018).

In the following, videos on the learning environment “rolling the die” for grade 4 are discussed as an example. This learning environment (Hirt & Wälti, 2012, p. 240ff.) is about recognizing and using symmetries and patterns by rolling a die with a colored side on a playing surface with square divisions (like a chessboard), until the marked surface is facing up again. In the middle of the game board is the starting square. The number of rolling movements is noted on the target square. If care is taken to reach the squares with as few rolling movements as possible, a symmetrical pattern results. The learning environment is enacted with the help of the videos. Since it naturally contains differentiating tasks, it should also be applicable in inclusive settings. All pupils in a class should be able to use the videos, as these videos should enable discoveries at different levels. Potentials for special education needs are also considered in the videos. The students use a mixture of discussed and animated PowerPoint slides with symbolic representations of the playing field and self-made video sequences in which they can be seen rolling a large cube on a playing field. The students start with a video sequence in which the “rules of the game” are explained.

This video has great potential in many ways. For example, the video is suitable for beginners. The basic rules of the game and the task format are explained here. Students can watch the video several times to internalize all the rules. This is a cognitive relief, as the children do not have to read the rules for themselves. In addition, the combination of image and sound enables several levels of representation to be combined (Schulz & Walter 2019). In this example, understanding can be ensured by explicitly pointing to the edge. The fact that the die rolling is demonstrated directly on the real model reduces the cognitive burden, as there is no change to the symbolic level here.

The following video explains that the number of rolling movements of the die is considered. Two examples are used to determine squares that can be reached in 4 moves. The two protagonists take turns rolling the die. The main rule is to always begin on the starting square, with one student improving upon the other. The two squares reached are marked with the number 4 and colored in blue. The number 7 is given to the square directly below the start square. The other student protests that 3 is the correct answer. The video ends with the task: “Which girl is right? Check it. Try to find out the number of rolling movements for as many fields as possible.”

The video, created by students for the fourth grade, shows that mathematical learning videos can also be an explicit stimulus for learning through discovery: here a problem is posed, which the students should solve independently and in an action-oriented manner. Occasions for mathematical discussions may also arise and communication about mathematical phenomena becomes possible. Explanations need not necessarily be given exclusively through the video, but can also be developed and negotiated by the students amongst themselves based on the impulses of the video.

Coming back to the above posed question: Both persons are right. The square can be reached with 3 and 7 movements. An unambiguous answer is only possibly if the condition of using as few movements as possible is included. Furthermore, there are different possibilities to reach the square with 3 or 7 movements. This can also be discovered and become an occasion for discussion for the students. The further expansion of the task of finding out the number of rolling movements for as many squares as possible also allows processing on different mathematical levels. In this way, "simple" squares can be reached first, or the criterion of minimal movements can be ignored. The task is also solved if the playing field is not completely labeled. It is also possible for high-performing children to find different paths for other squares. The videos address the idea of natural differentiation and thus enable learning on the same subject. Both videos are designed in the sense of natural differentiation and are therefore intended for all children. Further differentiation is not necessary here, but the videos are only one part of the learning environment. In the implementation of the learning environment in class, there are further tasks or social learning opportunities, which must also be adapted to the inclusive setting.

Voices from the Seminar

The evaluation of the seminar refers to results of a pre-post questionnaire and to informal, oral statements by the students on seminar reflection. Using questionnaires, the students were asked about attitudes, experiences, and self-efficacy regarding inclusive teaching with digital media. The results from two course offerings are available from the beginning and the end of the semester. They show that the students mostly trust themselves to work in a team with teachers from other professions. This positive self-assessment of the students increased again at the end of the semester. While 3 people stated at the beginning of the semester that they did not trust themselves to work with teachers from other professions, after one semester all 42 students questioned agreed or completely agreed that they could. The students commented on this, for example, that working together in mixed teaching groups was “an enrichment because you could think outside the box”. It was noted that the group often did not know each other, but it was precisely this what enabled other perspectives to be taken throughout the intensive exchange.

The detailed feedback regarding the scripts, which was given during the peer review, was also rated positively. It could be observed that the different fields of expertise ensured that the scripts were dealt with in great detail and intensively, and that there were helpful tips on how to design the video sequences.

Regarding the use of digital media, the students report learning successes in terms of video creation and the beneficial use of videos in the classroom. For example, one student said, “I believe that using videos can lead to more motivation because it is rather unusual. In any case, this shows that math does not have to be taught in such a dry way!” It was also noted that the videos are “very suitable for natural differentiation” and thus offer opportunities for inclusive teaching.

In addition to successes, the students also report challenges on the technical level: the process of video creation was more complex than initially thought, and lighting conditions, camera position, speed, etc. must be considered when the video is produced. Moreover, time required to create the videos was also critically reflected upon. Therefore, this task was reduced for the second run. This feedback underpins the claim that the teachers themselves should acquire certain media-technical skills (cf. KMK, 2012).

Overall, the seminar not only enabled students to feel more confident when using and creating videos, but the results of the evaluation also show that the self-efficacy assessed by the students themselves in relation to the general use of different digital media in the classroom during the semester increased. The proportion of students who feel (rather) unsafe about using digital media was reduced from 10 to 4 people over the course of the semester, while the proportion of students who (rather) trust themselves to use digital media increased from 33 to 38 people. These positive results indicate that students benefit from their experiences using and producing digital media.

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