Crossing Boundaries: Examples for Interdisciplinary Teaching

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"First period biology, second period math and third period geography." – It is normal to divide the world in different subjects in school. Teachers are professionals in their respective subject and students study different topics in various separate subjects. Some are mandatory, others are electives. Furthermore, in higher education, when students choose a major, they focus on a special field of education once again. While some are quite broad such as "biology," others are more narrowed down and specific like "marine biology." This differentiation between individual subjects in the educational context is human-made and does not resemble how subject matter is observed in real-life.

What is interdisciplinary teaching?

The origin of separate subjects in educational contexts can be traced back to the 5th to 3rd century B.C. (Bomhard, 2011). In order to become a proper scholar, the Greeks had to study the disciplines grammar, rhetoric, dialectics, arithmetic, geometry, astronomy, music theory and gymnastics. Although the subjects have changed nowadays, the historic idea of dividing our world into "categories" is still present in education. Especially due to the rapid growth of knowledge it seemed necessary to structure and systemize this knowledge. Furthermore, focusing on a specific area allows scholars to become experts in a field and advance it even more (Moegling, 2010). However, it often is impossible to solve problems by just one expert of one field of research since the natural world does not have boundaries itself. In order to cope with this, interdisciplinary studies might be a solution. Klein and Newell (1996) define interdisciplinary studies as "a process of answering a question, solving a problem, or addressing a topic that is too broad or complex to be dealt with adequately by a single discipline or profession" (pp. 393-394). This definition does not only apply to high-level academic research but also to in-school teaching. In order for students to grasp "global warming" as a 21st century problem, they need to study chemistry and physics to understand underlying processes such as the greenhouse effect and how alternative energy sources work, biology in order to learn about the structure of ecosystems and possible consequences of the extinction of species, politics to learn about laws and political interests of different parties and countries, or economy to gain insights into potential costs and changes for the economy such as tourism and so much more. This example underlines Repko's (2012) definition: "[i]nterdisciplinary studies is a process of answering a question, solving a problem, or addressing a topic that is too broad or complex

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to be dealt with adequately by a single discipline, and draws on the disciplines with the goal of integrating their insights to construct a more comprehensive understanding" (p. 16).

Criticizing the status quo of separate school subjects

Even though the tradition of dividing the world into different subjects has positive aspects as we have pointed out in the preceding section, critical voices lament the "splintering" of formal education which is caused by the incoherent sequence of different subjects and topics during a school day (see Bomhard, 2011; Memmert, 1997; Wiater, 1995). This has several disadvantages such as:

- Isolated knowledge: to solve problems in "real life," complex knowledge and coherent thinking are necessary. Hence, it is not possible to depict real life problems by dividing school education into different subjects (Labudde, 2003). Without teaching about realistic problems, education might appear less meaningful to students. This in turn can negatively affect their learning performance (Styron, 2013).
- Pigeonholing: Complex problems are reduced to the perspective of one subject only, causing the overestimation of one subject and the underestimation of another one. (Memmert, 1997)
- Scrappiness of knowledge: Current subjects depict only a fraction of everyday-life and certain aspects, such as law, are hardly represented (Memmert, 1997).
- Dissection of knowledge: students only get a restricted view on certain phenomena. This can in turn lead to viewing reality and certain phenomena as less complex (Wiater, 1995).

Advantages of interdisciplinary teaching

A possibility to reduce those problems is seen in multidimensional educational settings. According to Häsing (2009), essential skills, such as problem-solving and social competencies, are not subject-bound and can best be trained in a multidimensional (i.e., interdisciplinary) educational setting. In interdisciplinary teaching, the holistic and comprehensive perception of a designated problem fosters the learning process (Herzmann, Artmann, & Rabenstein, 2011). Labudde (2008) argues that interdisciplinary teaching is better suited to relate to students' mental structures since all information is connected during cognitive processing. Therefore, it helps to integrate prior knowledge and preconceptions in teaching with ease and, hence, improves the growth of students' understanding.

As expressed by Wentworth & Davis (2002) interdisciplinary teaching can be defined as "…inquiries which critically draw upon two or more disciplines and which lead to an integration of disciplinary insights" (p. 17). By doing so, students have a more balanced appreciation of the different subjects (Hiller-Ketterer & Hiller, 1997) since they experience the potential but also limitations of each subject to solve a problem (Labudde, 2008).

Interdisciplinary teaching allows to integrate real everyday-life problems since they are rarely solved by only one subject. Besides positive motivational effects of problem-oriented teaching, Labudde (2014) points out that it has a more global benefit as well. Our global world faces many challenges right now and will face them in the future; with our example of climate change being only one of them. In order to solve those problems on a global scale, it is important to understand how complex and interdisciplinary the problem-solving process is.

Although such problems cannot be solved in school itself, students can acquire different competencies that are necessary for future global players, leaders, and world citizens. Those competencies and skills are for example critical thinking, the ability to differentiate, problem-solving skills and communication skills. All of them are more likely to be fostered in interdisciplinary and problem-oriented teaching (Jones, 2009; Labudde, 2014; Styron, 2013; Wang, et al., 2020).

Limits of interdisciplinary teaching

Despite all the benefits of interdisciplinary teaching, educators have to be aware of the limits that might hinder an extensive implementation of it:

- "Wholeness Craze": Once looking at a topic from different subjects, many possibilities arise. It is often hard to draw lines between "necessary" and "unnecessary" connections to solve a problem. This often leads to an unconditional integration of different disciplines causing a cognitive (and timewise) overload (Popp, 1997). Therefore, it is equally important to somewhat keep a subject-perspective view on an interdisciplinary topic or problem.
- "Specialized depth": If subject teaching is completely banned, it is hard to ensure the kind of specialized depth in the different subject that is needed to solve interdisciplinary issues (Popp, 1997). Hence, subject teaching is necessary for building a sophisticated foundation that allows to solve interdisciplinary challenges.

This highlights that – although there are good arguments for interdisciplinary teaching – it is not a didactical concept that is meant to replace subject-specific teaching. Instead, the benefits of interdisciplinary teaching should be used to allow for such teaching phases or projects in school. By doing so, the necessary depth can still be acquired in the different subjects, but students see how the different content is connected and used to solve realistic problems. This balance of subject-specific and interdisciplinary teaching is highlighted as the desired implementation in education by many researchers (Moegling, 2010). However, it is still a rare concept in many schools around the globe. Factors that may contribute to this circumstance include the time-consuming preparation of (new) curricula as well as integrational aspects (e.g., confusion experienced by students) (Jones, 2009; Weinberg & McMeeking, 2017; Zapletal, 2010). Furthermore, teachers assume that they do not have enough expertise in other subjects to teach interdisciplinarily (Weinberg & McMeeking, 2017; Zapletal, 2010). Therefore, introducing interdisciplinary teaching on a university level could help to let future teachers experience the benefits of such an approach firsthand and reduce their concerns at the same time (Santaolalla, et al., 2020). Borromeo (2019) states that "interdisciplinary learning and teaching require, on the one hand, well-prepared teachers, and on the other hand, adequate teaching materials for every-day lessons in school" (p. 259).

Despite all positive outcomes, however, interdisciplinary teaching has yet to become a well-established practice in schools and universities across the globe. More empirical work about effects of interdisciplinary teaching in school and university settings is needed to strengthen the arguments to justify a broader implementation of interdisciplinary teaching (Kramer & Wegner, 2020; Santaolalla, et al., 2020; Woods, 2007).

Description of the special issue

With the help of a special thematic issue, "Crossing Boundaries: Examples for Interdisciplinary Teaching," the current objective is to obtain a global perspective of interdisciplinary teaching in all subjects and

levels of education. The different articles depict various aspects of interdisciplinary teaching with three focusing on high school education and one on the university level.

In the study "Preparing Students as Leaders with a Global Mindset: A Study Abroad Phenomenological Case Study," Acker and Bocarro literally cross boundaries. Within an interdisciplinary program, US-American university students immersed in three European countries in order to strengthen their skills to be global-minded leaders.

In their study "Becoming Proficient through Profile Classes: A Longitudinal Study on the Development of Scientific Competencies," Schulte and Wegner focus on scientific education and the obtained competencies in Profile Classes during a school year. Their article evaluates an interdisciplinary focus on scientific inquiry methods which is used within those Profile Classes.

In their study "Giving Meaning to the Subject: The Influence of Interdisciplinary Interventions on the Subjective Task Value of Biology and PE," Kramer and Wegner investigate an interdisciplinary approach to teaching biology and PE in order to increase student interest in those subjects. For this, they developed and evaluated a one-day intervention combining neurobiology with physical movement with four classes.

Cummings-Clay, Hayes and DiSanto combine an educational approach with online learning in their study "Shifting Modalities: Providing K-5 Montessori Education Online during the Pandemic." In their article they compare the didactical concepts of Montessori Education and Online Learning in order to describe the process of transitioning to online education that combines both pedagogical ideas in an innovative interdisciplinary way.

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