From Complex Maths to Simple Stories: A Knowledge Management Approach to Education

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Abstract: Our research investigates the question: how can the power of tacit knowledge be activated for learning mathematics more easily? To this end, an innovative approach using storytelling as a knowledge management method to capture and share knowledge has been conceived and applied to high complexity subjects, such as mathematics. The approach's core characteristic lies in the idea of making use of collaborative story writing in online classrooms to enable learners to access highly abstract knowledge in a lively and memorable way. The didactic concept introduced in this paper has been developed within a pilot project which is run as part of an online course for mathematics at the Swiss Distance University of Applied Sciences. Its key findings will be introduced and discussed below as a current response to our research question. To this end, in the first part we describe the concept in its educational and theoretical context (chapter 1). In the second part, we illustrate its setting, components and practical application (chapter 2) before making reference to the next project milestones in the outlook (chapter 3).

Keywords: digital storytelling, tacit knowledge, knowledge wheel, higher education

1. Research question

In this chapter we show how our research question has emerged first as a generic question and how a more specific question has appeared on this background.

1.1 Generic

How to deal with tacit knowledge as an open issue in higher education? This generic question emerged in our research by connecting Polanyi's insights into tacit knowledge with higher education.

"We can know more than we can tell" – this is what Polanyi (1966) said almost half a century ago, illustrating the fact that we apply a wide range of sensory, experience-based and conceptual knowledge in practical situations of everyday life without being able to express this knowledge verbally.

In education and in higher education settings in particular, this becomes a critical factor for the learning success of students. For instance, the German language has two different terms to talk about education, underlining its tacit elements. 'Erziehung' is mostly used for learning processes which are initiated on purpose. 'Bildung', on the other hand, is pretty much trickier to summarise and refers to learning processes which happen in school contexts in particular and which are often tacit in their results. Thus, the impact of teaching goes beyond the learning purposes which can be verbalised and evaluated in various assessments at the end of a course module. Hence, a bigger part of the individual learning outcome is only accessible in terms of the experience, perception, concepts and other structures within which they are embedded.

1.2 Specific

How can we activate the power of tacit knowledge for learning mathematics more easily? This more specific research question appeared by considering that tacit knowledge becomes even more relevant in scientific subjects like mathematics, physics or chemistry since acquiring such subject-related knowledge implies a high level of abstract understanding as this content often has few links with the learner's everyday life. This makes (verbal) access to this knowledge more demanding. Thus it is not surprising that maths and the like come out as the most hated subjects of students, across all ages and school levels. They are accused of being 'too complicated', 'too incomprehensible' and 'not tangible and applicable enough'. As consequence, many students get lost in the labyrinth of scientific education with mental overload, frustration and demotivation being possible consequences. Thus, educational settings should shift towards more participation by the learner.

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2. Perspective, research method and didactic concept

In this chapter, we are going to introduce our research method based on a pilot project, before presenting and discussing the components of our concept as key findings of our research in progress.

2.1 Knowledge management perspective

Scientific teaching has to provide students with new didactic approaches to break down the subject's complexity and abstraction level by making use of emotions, creativity and lively teaching methods. However, higher education in particular lacks this focus for supporting memorability and accessibility in learning. Our didactic concept aims to fill this void by applying a knowledge management perspective. From such a perspective, we hope to gain new insight into *abstract* learning processes and how to improve their didactic design. At this point, we perceive learning as a circle of intertwined knowledge processes such as acquisition, preservation, usage, sharing and development by referring to the *Wheel of Knowledge* by Bettoni & Schneider 2002 (see Figure 1).

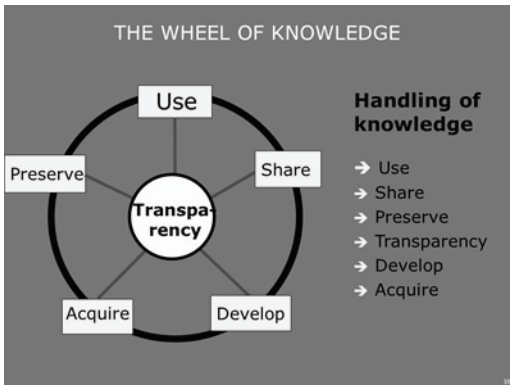

Figure 1: Wheel of knowledge (Bettoni et al. 2002, p.7).

Assuming that learning is a dynamic interplay of continuous knowledge activities with social components, storytelling turns out to be a proven method for the didactic design of such processes. Stories have always been a powerful tool *for* and *in* human communication. Hence, creating stories and sharing them with an audience is an 'old skill' and something that is a *fundamental* part of human life, rather than a new or additional extra (see Snowden 2005a). With the help of symbols and metaphors, stories create simple and memorable access to our emotions, relationships and cognitive structures (Snowden 2005b). Thus, stories become an omnipresent tool for a wide range of learning purposes such as understanding, creating or reflecting.

The concept makes use of this power of story(telling) to support learning in online higher education settings by breaking down abstract science-related knowledge. As such, the concept fills another void by using storytelling in higher education – particularly with scientific subjects. Zazki and Liljedahl (2009) should be mentioned here as pioneers.

2.2 Research method

The concept has been developed as part of a Campus Open Online Course (COOC) for mathematics at the Swiss Distance University of Applied Sciences (FFHS). What we have here as research method is a combination of a pilot experiment with prototyping. The course takes place at a non-mandatory level and aims to serve as an additional support, repetition or reference offer for current and future students of business administration, informatics, business information or industrial engineering. However, taking into account that a considerable number of students face difficulties in learning mathematics at a higher education level, there was a need for a new didactic approach, supporting online learning. This approach is being implemented in the second course edition in spring 2014. Its core components are described below.

2.3 The components

Our understanding of learning as a wheel of knowledge processes has enabled us to design the full learning process as a set of four interwoven sub-processes: storytelling, story writing, story sharing and story storing

(see Figure 2). However, the concept does not aim to replace traditional ways of teaching science but rather to enrich them.

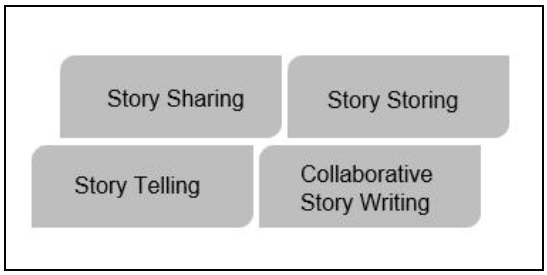

Figure 2: Components of 'learning maths with stories'

Telling stories: Teachers choose those units they want to teach with the help of storytelling. To this end, they can rely on a pool of existing stories on various topics written by other teachers or write their own stories. In the latter case, the writer has to consider some guidelines for creating a (good) story (Balakrishnan 2008):

- Intended audience: the plot of a story has to vary according to the target group.
- Learning purpose. A story can *explain* a concept or theory, *formulate* a learning task, *introduce* or *accompany* a topic. The teacher has to be aware of what the learning purpose of the story is expected to be.
- Learning goal: Will the learners be able to *understand*, *reflect on*, *explain* or *apply* the story?
- Story structure: stories typically consist of a beginning, an action (including conflict and its resolution) and an end.

Once a story has been written, it is integrated into the curriculum and made available as a learning resource. By working through the story alone or in groups, students profit from its simple and memorable structure to acquire or develop new knowledge at an individual speed. Throughout our pilot project, three stories have been created on the topics of *Calculating Percentages*, *Functions* and *Exponential Equations*.

Writing stories collaboratively: As seen above, mathematics etc. often lack opportunities to link learning content to the learner's everyday life. With this in mind, stories become a precious bridge towards a higher level of applicability by designing concrete images. Thus, by writing their own stories, students are able to assess and develop their level of understanding and their capability in handling complexity. Furthermore, by writing stories collaboratively in teams, students profit from their *complementary* skills and competencies. For instance, while one student is good at mathematics, another brings writing skills and a third creativity. In the pilot project, students work collaboratively on the teacher's story about Exponential Equations to test their personal learning progress.

Activating and making use of such synergies among students is the innovative core of the concept to support the preservation and sharing of new learning content.

Sharing stories: Assuming with Snowden (2005) that we only know what we know when it is needed to be known, tacit knowledge requires contexts to be applied and verbalised. Our concept therefore aims to enhance the communication among learners by going *beyond* storytelling and writing as genuinely communicative activities. To this end, an online forum is provided where students and teachers can exchange ideas about stories and the mathematical concepts, theories and challenges in them. The forum also serves as a kind of help desk where questions can be posted to receive answers, feedback and comments by the community. Furthermore, finished student stories are shared in this forum. The concept therefore underlines the importance of social exchange and interaction in knowledge accessibility and memorability.

Storing stories: Finally, all stories developed throughout the course are stored in a wiki and kept available so that other or later learners can benefit from these stories and their rich images, symbols and metaphors for an easier, more tangible and better memorable learning. The wiki can therefore serve as a kind of reference book: where a student is limited in his/her learning when using the traditional ways of teaching, he/she can look for a story to explain the learning content at a less abstract level. At the same time, existing stories can provide the learner with ideas for new narratives. Hence, the wiki becomes a dynamic and open learning resource.

3. Summary and outlook

Our concept aims to bridge the gap evident in tangible didactic approaches to accessing and memorising tacit, scientific knowledge in higher education. It defines four core components for promoting and enhancing mathematical learning as an interwoven circle of acquiring, developing and sharing abstract knowledge. To this end, storytelling is applied in various shapes: teachers tell mathematical stories to provide a more lively access to learning content, students write their own stories in teams to assess their learning progress and benefit from each other's complementary skills and knowledge levels before these stories are then discussed in a forum to support a higher level of understanding and reflection and finally stored in a wiki as learning sources for reuse by classmates or later students.

The pilot project is still in the implementation phase. Right now, the teacher's stories are being integrated into the course curriculum and communicated to the students as an alternative learning path. Evaluation results are expected to be available by end of 2014.

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