Implementing Storytelling, Gamification and Implicit Learning into Digital Learning Environments – The Case of Brainix

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Abstract

Designing digital learning environments that are engaging for learners and based on neuroscientific evidence is an underrepresented and mostly unrecognized art in the field of education. Based on an innovative textbook architecture that is rooted on the three pillars of storytelling, gamification and implicit learning, the digital learning environment Brainix [1] offers one such recently designed artwork. Yet, how does this software implement these three cornerstones? To answer this question, a qualitative research design was chosen to categorize the ways in which these are implemented in eight completed Brainix learning units for 6th grade in Bavarian high schools. Units analyzed include both subjects covered by the software, Math and English. Results reveal key realizations for storytelling in authentic and emotional storylines, for gamification in playful and personalized learning paths and for implicit learning in multisensory and difficulty increasing exercises. In conclusion, this textbook architecture and its concrete realization approaches offer an innovative, promising pathway to designing digital learning environments and possibly lays the groundwork for a new teaching epoch of the 21st century.

Keywords: *textbook architecture, digital learning environments, storytelling, gamification, implicit learning*

1 Educational Neuroscience and the Three Pillars

With the beginning of the pandemic, information and communication technologies have become a vital force for online education around the world. Various digital learning environments (DLEs) have found their way into education and research has proven its effectiveness already [2]. Creators of DLEs should, however, consider findings from educational neuroscience to guarantee its effectiveness. The aim of this paper is to connect this scientific background on the three pillars of a textbook architecture for DLEs established by Böttger [3] with concrete realization approaches utilized in the digital learning environment *Brainix* [1].

The first pillar, storytelling – a culturally universal and most likely, the oldest form of teaching – is seen as one of the most valuable ways to share knowledge [4]. According to Green [5], stories' purpose in the teaching context is to "(a) create interest, (b) provide a structure for remembering course material, (c) share information in a familiar and accessible form, and (d) create a more personal student–teacher connection." ([4], p. 248). Neuroscientific research has shown that brains react similarly to stories as they do to experiences in real life (cf. [4]). Furthermore, stories allow experiences independent of space and time, giving opportunities to connect old with new experiences and establish new neuronal networks (e.g. [6]). In a recent meta-analysis, a strong positive effect of digital stories on academic achievement in all school levels was found [7].

The second pillar, gamification, has repeatedly been found beneficial for student motivation, engagement [8] and learning achievement (e.g. [9]). More recent studies also highlight stress reduction as positive influence [10]. It can be defined as "the use of game elements […in non-]game contexts" [11]. Reasons for its success in learning situations can be found in neurological processes. For instance, in case of success or rewards, dopamine – the so-called happiness hormone – is released. Since gamified learning often evokes a sense of achievement and offers a non-restrictive context, positive associations of learning contents can be fostered.

The third and last pillar is implicit learning, which according to Reber [12] is defined as a process in which learners acquire knowledge about a rule-governed subject area without explicitly intending to do so. Stoffer [13] suggests it to be based on the following four characteristics (transl., p. 220): (a) complexity of stimulus structures, (b) casualness of learning, (c) novelty of stimulus material, and (d) almost exclusively nonconscious learning. Although there is an ongoing debate about the superiority of implicit learning to explicit learning in terms of learning performance, various studies have found posi-

tive effects of implicit learning on aspects indirectly linked to it. Firstly, implicitly acquired knowledge remains in memory longer than if explicitly acquired [14]. Secondly, a study by Rathus and colleagues [15] showed that learning implicitly is less likely to be influenced by learners' affective state, like test anxiety, than when learning explicitly. Thirdly, successful implicit learning seems to be possible even with low cognitive ability [16].
In sum, these three pillars show great positive impacts on learning.

2 Methodology

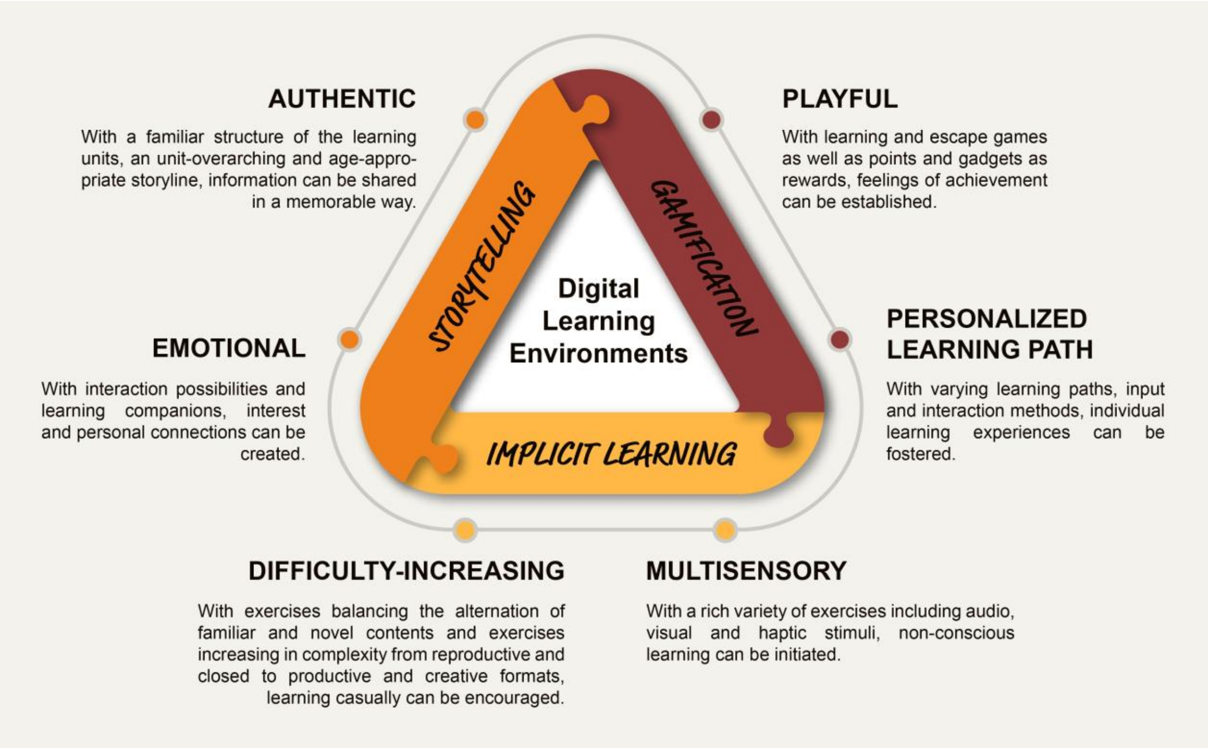
To answer the research question on how the software *Brainix* implements storytelling, gamification and implicit learning, a qualitative content analysis of eight learning units for 6th grade in Bavarian secondary schools in the subjects Math and English is conducted. The categorization followed the approach by Kuckartz and Rädiker [17]. For the two major limitations – possible biases and restricted (time) resources – suitable adaptions were made: For one, a review cycle by the authors of this paper was added to minimize biases. For another, analysis was stopped only after content saturation was reached, which reasons the number eight of investigated units, all of which were extracted by random sampling.

3 Results and Discussion

Analyses concerning storytelling show that stories in the learning units can be characterized by two aspects: firstly, the stories analyzed are authentic. In Math, for example, students are part of a birthday party and need to split cakes into equal pieces, which introduces the concept of fractures. In English, an exchange trip to New York City is organized to sustain geographic knowledge. These age-appropriate storylines span over several learning units and maintain a recurring structure. That way, as suggested by Green [5], the learning content tends to be remembered more easily. Secondly, by means of interaction possibilities and learning companions, connections on a personal level can be established. These, however, could be further improved. In some cases, immersion into the story is interrupted due to insufficiently working AI responses in conversations.
Gamification is implemented in various ways. To offer individualization, the units repeatedly allow students to choose their learning order. Also, distinct inputs options and interaction methods are available – e.g. choice between voice message, keyboard or pen input for replying. *Brainix* has further implemented multiple learning games, such as connecting domino pieces with decimal numbers to those of equaling fractions. Escape games in which students need to solve exercises to identify, for instance, the thief of a missing lunch, is included. Rewards for filling out questions or reading texts can be gained in form of experience points and gadgets, such as clothes for students' own avatars. In sum, the analyses show that gamification has been implemented by playful exercises as well as rewards and learning experiences that can be personalized. Learning games focus, however, as analyses reveal, mainly on reproductive exercises. This lack of complexity should be avoided in digital learning environments.
Implicit learning seems to be realized within the eight learning units in mainly two ways: By including audio, visual, and haptic input, multisensory learning is ensured. Further, units are structured in a way which guides students from easier to more complex tasks. This is achieved by an alternation of familiar and novel contents as well as exercises. The order of introducing new contents with reproductive exercises first and only then moving on to more open and creative exercises is stringently followed. These two ways allow students to experience their learning process casually and non-consciously, as proposed by Stoffer [13]. However, improvement proposals are again in order. For one, more (interactive) video materials should be included, aimed at heightening students' multisensory acquisition of contents by incorporating learning media of their generation. For another, more learning paths should be available since implicit learning depends strongly on individual students' prior knowledge and personal preferences.
The three pillars storytelling, gamification and implicit learning are each individually implemented in the DLE *Brainix*. By analyzing eight learning units, it was found, however, that these are highly interlinked and interdependent. Telling stories to teach learning contents means to implicitly introduce new concepts. To learn implicitly means to not be directly aware of learning, but to learn through play Gamified learning entails the feeling of success, which implies emotional involvement. Taken together, this shows that learning environments should create situations in which students can feel, listen, observe and interact in a way that makes learning easy, playful, enjoyable and engaging. These findings, results from the literature review for this paper as well as guiding considerations derived from concrete implementations in *Brainix* are visualized in figure 1. It captures that engaging and motivating DLEs

should base on authentic and emotional storylines, playful and personalized learning paths as well as multisensory and difficulty-increasing inputs or exercises.

Fig. 1. Framework of Digital Learning Environments and Realization Approaches (based on Green [5], Stoffer [13], and Böttger [3])



4 Conclusion

This paper analyzed eight exemplary units of the digital learning environment *Brainix* to find out how the three pillars of Böttger’s [3] textbook architecture – storytelling, gamification and implicit learning – are implemented. The findings collate concrete realization approaches of authentic and emotional storytelling, playful and personalized learning paths as well as multisensory and difficulty-increasing inputs or exercises. Further, the analysis highlights the interlinkage and interdependence of the three pillars and their concreate realizations, compiled in a visual framework. This framework can be used by researchers and practitioners to create engaging and motivating digital learning environments. Further research should focus on how interaction can be enhanced further for the three pillars to gain more insights on what makes digital learning environments motivating and engaging.

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