

## SpellLit: A Collaborative Body- and Space-Related Interactive Learning Game for School Children to Acquire Reading and Writing Skills

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**Abstract:** SpellLit 4.0 is a collaborative body- and space-related learning experience for elementary school children, which facilitates to acquire reading and writing skills in a playful way. SpellLit allows teachers to edit and change the game by themselves. In this contribution, we introduce this new didactic concept for regular school lessons. Additionally, we present studies employing a semi-structured survey based on cultural-historical activity theory (CHAT) enriched by the System Usability Scale (SUS) and the Affinity for Technology Scale (ATI-Scale) questionnaires. We gained insight into questions and potential contradictions in the teacher's perception of this didactic and technology-assisted concept for their lessons. The results reveal that even teachers with a weak technical affinity show a high degree of willingness to use this novel configurable learning game in regular lessons. In addition to a high degree of usability, we conclude that this is due to the fact that there are no barriers between the pedagogical demands of the educators and the application of the learning game.

### Introduction

Introducing educational software into primary education is an ongoing and complex process that largely depends on the technology, the users, the environment and the interactions between them. Many learning applications offered by educational publishers or meanwhile app stores for Android and iOS devices are predominantly based on classical pedagogical-didactic concepts of teaching designed without the use of digital technologies in mind. As a result, schools often use digital learning applications to support traditional teaching activities, such as fact-finding or individual information gathering, as Cuban (Cuban, 2013), Player-Koro (Player-Koro, 2013), and Selwyn (Selwyn, 2016) describe.

In this contribution, we present the latest version of our learning game *SpellLit* for children in elementary schools. It facilitates to acquire reading and writing skills as outlined in more detail below. *SpellLit 4.0*, the most recent iteration in development, features *GameCreator*, which enables teachers to construct and edit the game played by schoolchildren.

The research question of this contribution focusses an approach of evaluation and evaluation results from four primary school teachers. The evaluation is based on a questionnaire which consists of elements of the *Cultural-History Activity Theory (CHAT)*. With this theoretical framework, the evaluation focuses on expectations and concerns of the educators as well as the experience and the opinions of educators with regard to the use of *SpellLit* together with *GameCreator*. The questionnaire is about finding out, what teachers think and feel about the learning application, and if and why they are ultimately willing to use it based on the understanding of their work as pedagogues in the education at school. This semi-structured survey is enriched with two more questionnaires to better understand and clarify the results: the *Systems Usability Scale (SUS)* and the *Affinity for Technology Scale (ATI)*.

## Related Work

We found only very few projects that are scientifically close to the concept of SpellLit 4.0. Collaborative learning games to learn how to read and write in a way that involves the physical learning environment are *Read-It*, *Spelling Bee* or the recently *Words*.

*Read-It* seeks to combine the benefits of analog games and computer exercises (Weevers, Sluis-Thiescheffer, et al., 2004). The aim of the game is to find terms with the same start or end letter depending on the type of game. The game is played in pairs of two: similar to the traditional memory game, a card is revealed by each player, which depicts a concept. Together it must then be decided whether the two terms match the rules of the game (Sluis, Weevers, et al., 2007). This approach addresses the same target audience as SpellLit, but it does not involve any physical movement in space. In addition, the number of players is limited to two.

*Spelling Bee* is the digital variant of the well-known *ABC Cubes* (Dekel, Yavane, et al., 2007). These are small dice on which a term is shown on one side and the corresponding initial letter on the opposite side. Thus, each cube has three letters with which words can be formed. Through the illustrations, even children who have not yet mastered the alphabet can put together first words based on phonetics. The cubes in *Spelling Bee* are enriched with sensors and actuators, which serve to communicate with the players in the form of visual feedback in the composition of words and, secondly, to enable the evaluation of the games (green and red LEDs). Even though the educational game can be played together, there is no need in the game to do so.

*Words* by Osmo (Broda, Frank, 2015) is only available as a native application for Apple's iPad and iPhone. In addition, a special stand and words tiles are required for each device. *Words* itself is very colorful and learning is aligned in stories and competitions. The words tiles are recognized by the camera of the mobile device. It is possible to reach a solution via trial and error. As a motivation not to try further, there are only points of failure that should be avoided. In many cases, the structure of the educational game grounds on extrinsic motivation and as well the ultimately punitive approach does not correspond to the pedagogical demands of modern primary school education. In some cases, the learning applications offered are based on the current curricula of federal states, which (like in Germany) call for joint, creative problem solving of the students or even far-reaching pedagogical concepts are important, such as the inclusion of gross motor physical activity in the classroom (Winkler et al, 2014).

## The Collaborative Game SpellLit

SpellLit 4.0 is a mobile, body- and space-related learning game for three to six children at the end of preschool or children in the first year of primary school. It enables them to read and write collaboratively. At the same time the game promotes gross motor and social activities. All versions of SpellLit have been developed in co-design processes with children and teachers from several primary schools. While SpellLit 1.0 needed a purpose-built square multi-touch table, already four children learned collaboratively, but were not yet engaged in gross motor movement in the room (Scharf, Günther, Winkler, Herczeg, 2010), SpellLit 2.0 was played with the Sifteo Cubes and a group of three to five children, where running was a conceptual part of the educational game (Winkler, Scharf, Herczeg, 2013). Favre (2009) stated that instructional strategies should include movement in a game-like format, so he suggested designing kinesthetic games. According to Högger (2013), people of all ages learn faster, if different learning channels

are addressed. This way, content is better understood and kept in memory. The concrete action via additional perceptions facilitates a better analysis of the content and offers multiple reminders. It should be noted that purely visual concentration is volatile. Learners who are not yet able to solve the cognitive task on their own are guided by classmates and are equally involved in acting with their own perceptions. These introductory images contain information from which knowledge is derived. Consequently, they are more informative than purely verbal descriptions. Therefore, didactically meaningful is the inclusion of self-executed actions in the learning process in school lessons. Based on this, the teaching content is coded motorically and cognitively and can be remembered more quickly. The movement should only be conducive to concentration and motivation. Thus, the kinesthetic sense helps in generating inner images and well-founded holistic experiences. These assumptions are reinforced by the research area of Neuroscience. McMorris (2015) reports on the neuroscientific correlation between exercise and cognitive functioning. He describes how gross motor movement affects neurochemical and psychophysiological changes in the brain that, in turn, affect cognitive functioning. Since version 2 of SpellLit, the movement fosters concentration and motivation. Thus, the kinesthetic sense, which is addressed when standing together and running, helps to generate inner images and sound holistic experiences. In addition to the movement component, the design of SpellLit also promotes the component of learning together in heterogeneous groups. For instance, learners who are not yet able to solve the cognitive task on their own are guided by classmates and are equally involved in acting with their own perceptions. By embodying the position of the children's bodies in relation to the order of sounds in real physical space, this order can be experienced physically. In addition, facilitating autonomous, independent learning within the group also plays an important role.

The children work independently with teaching materials and work together. The entire lesson is to be described as open, for example, because no postures are imposed and children can move freely in or outside the classroom. With SpellLit 3.0, which for the first time was web-based and played on a browser-compatible device (Winkler et al., 2015), the children used the Tangicon-Cubes (first named ELBlocks) or standard mobile devices with touch screens (Bouck-Standen et al., 2016). However, the teachers teaching the children wished that many more variants and spelling exceptions were taken into account. Based on their feedback and requirements, SpellLit 4.0 has been developed and extended the system for playing a learning game by a module for game creation. Through this GameCreator new games can be created for SpellLit 4.0 through a browser-based drag-and-drop user interface. Although SpellLit is based on Reichen's "*Reading through Writing*" method with a table of initial and final phonemes (Reichen, 1988), SpellLit prevents learning errors by learning to listen to the phonemes and choosing the right ones for writing. Also, SpellLit differs from similar learning games based on the method of Reichen in that several children are learning together in a problem-oriented way. Another difference to Reichen's method is that children are not seated while learning, and have to run in-between.

## **Scenario**

The following scenario illustrates the use of SpellLit 4.0: Heidi Mueller teaches the children of their first grade in "learning circles". A group of four children, Anne, Kaya, Leon and Maria, are sent out of the classroom with five iPods to play SpellLit in front of a multitouch-screen in the hallway. Having arrived outside the classroom in the hallway, Kaya selects the icon

of SpellLit on the screen. Together, the children choose what they want to start playing the educational game, and therefore they choose four players, which Leon selects by pointing on the icon with the four kids on the screen. Then he clicks in the green field, to choose the difficulty level “easy” and there on the top row the subject “animals”, for the four pictures of animals whose names are to be written in the game round. Now, this row is highlighted as well as the green little button with the white hook. The process of selection ends when Leon clicks on the green little button. The four kids are now starting all five iPods and select the icon of SpellLit on the start screen. The educational game opens and the children each select the Player icon to join the game on their four devices.

Anne also joins the game with the fifth iPod and selects the symbol of the key. Then she places the device on a window sill about 10 meters away from the screen. Now, on the large screen, the image of a donkey appears. Below four empty blue-rimmed fields appear into which Anne, Kaya, Leon and Maria have to collaboratively insert the four sounds of the word “Esel” (donkey). At the same time, the image of the donkey appears on the four iPods of the children. When the image is touched on the mobile device, the word “Esel” is read aloud by the digital system. This is especially helpful if German is not the mother tongue of the child. Thereafter, on their mobile devices, each child selects a letter from another blue bordered field, which represents the corresponding arrival or final sound. Some sounds are represented by more than one letter, but for readability purposes, we will refer to them simply as “letter”. The field offers multiple selections, so the players each have to choose one of the right ones. It will also be read when the small blue bordered field with the image and the letter is touched. Every child is now looking for the right sound. In a mutual conversation, the children help each other to find the appropriate letter, which is to be transferred to the placeholder under the picture of the donkey on the large multi-touch screen.

In the discussion phase, they also consider in which order the letters should appear to form the word. To do this, the children stand in front of the large screen in the right order and then confirm their letter one after the other. SpellLit praises the children if they work together without errors. If one or more letters are reversed in their order, they are marked with a yellow border and SpellLit tells them that they now have the option to correct the order. However, if they have selected a wrong letter, it will be marked with a red border and SpellLit asks them to unlock the lock, which now appears on their mobile devices. Now, the children run to the fifth iPod placed 10 meters away and touch both devices in order to unlock the pause. They click on the key of their device first and then on their lock of the fifth device. Running improves the concentration and at the same time prevents the children from solving a level via trial and error. After unlocking their device, they see that they have the option of picking letters again on their mobile devices, so they run back to the large screen. Together they now think about which sound to choose, so they do not have to walk again. After four words, a round of the game is finished. After finishing a round, the children are also requested to unlock the lock appearing on their mobile devices with the key on the remote device for playing the next round.

## **GameCreator**

In this 4<sup>th</sup> generation of the collaborative learning game SpellLit with the GameCreator, for the first time teachers are now able to create new game sequences assigned to different levels of difficulty as well as change these game sequences. Once the GameCreator is opened in the browser and SpellLit is selected, a new game round can be created. This opens another view

where the game round can be assigned a name, the difficulty level is set and the number of phonemes and the number of children who participate in a game, that is 2 to 6, is selected. In the subsequent dialogue, educators can enter new words into the system. Each word has to be accompanied by a meaningful icon or picture as well as a sound file and the corresponding phonemes. For example, the names of children that are not written literally along with their picture can be entered.

## **Evaluation**

The use of SpellLit in regular education leads to some challenges for teachers compared to traditional forms of teaching. For this reason, our evaluation design uses mainly evaluation approaches of *Cultural-Historical Activity Theory (CHAT)* for the context of school. In order to evaluate the statements also in quantitatively much larger evaluations in the near future, our design is also accompanied by the validated *System Usability Scale (SUS)* questionnaire on the usability of the GameCreator and the *Affinity for Technology Scale (ATI-Scale)* questionnaire to reflect the technical affinity of teachers in elementary school. Since learning does not consist in the mere accumulation of information, but rather in the actual change in the learner's environment and their life references, it is necessary to discover, understand, or exclude potential contradictions that teachers may encounter when developing novel learning software developed and provided for the school. Should it come to clear contradictions, it is also about possible strategies on how to overcome them. For the theoretical substantiation of the evaluation of the acceptance of the use of GameCreator by teachers in regular education, we refer back to the cultural-historical activity theory (CHAT), as used today by the educator Engeström (2010) in similar contexts. According to the theory of activity, the relationship between man and the environment is a social relationship characterized by the development of cultural tools and signs. In activity theory, the basic unit of analysis is activity. Engeström (2014) describes activity in the form of a triangular relationship of subject, tool, and object, as described by Vygotsky (2012) in the 1920s, and in the 1930s by Leontjev (1978) in the context of the beginnings of the development of an activity theory used.

## **Carrying out a Preliminary Study**

As part of the preliminary study, two teachers from a primary school in the Hanseatic city of Lübeck, who already integrate iPads with learning software in their lessons from the entry level (mixed first and second years), were introduced to the use of another body- and space-related learning game *AlgoFrogs 4.0* (Winkler, Bouck-Standen, et al, 2018). Like SpellLit 4.0, it is used by children for collaborative independent learning using small mobile devices in front of a large screen. It serves to promote logical-abstract thinking. With AlgoFrogs the GameCreator was used for the first time, to create new game sequences or edit existing games. Eventually, the two teachers followed the given task of creating more game sequences over the course of a week. Then, each teacher showed in their class the children AlgoFrogs and let this play in small groups of three to five children. After several days of using AlgoFrogs, the two teachers answered a questionnaire based on CHAT, which structured the recording of the verbal response of an about 20-minutes-long verbal interview. The subjects then completed the SUS for the usability of the GameCreator (Winkler, Bouck-Standen, et al., 2017), and the 9-item ATI scale questionnaire for capturing the technique affinity.

The results obtained in the preliminary study were very promising. The preliminary study showed, inter alia, that the questioned teachers are not very tech savvy, but open to new didactic concepts. Since they, from their point of view, can use AlgoFrogs without problems in the classroom, they have apparently overcome the hurdle for the use of novel body- and space-related learning games in the classroom.

### **The Main Study with SpellLit 4.0**

The study regarding the use of SpellLit 4.0 and the part of the GameCreator for SpellLit by two times two teachers from two Primary schools followed the structure of a preliminary study, which was carried out with the also body- and space-related collaborative learning software AlgoFrogs (Winkler, Bouck-Standen, et al., 2018). The nine questions about the use of SpellLit covered two areas.

The first part with five questions refers to the expectations and concerns of the educators:

1. *What motivates you to use SpellLit in the classroom?*
2. *What is interesting for you about the software in the context of learning processes?*
3. *To what extent is it relevant for you that the children learn together and not alone?*
4. *How important is it to you that children do not sit but stand and walk while learning with SpellLit?*
5. *How do you feel about giving the children a sneeze of unobserved learning during class time?*

The second part with six questions relates to questions about the experience and opinions of educators:

6. *What challenges and opportunities have you encountered in dealing with SpellLit and GameCreator? Is the didactic approach associated with SpellLit in conflict with the way you teach on a daily basis?*
7. *Is the didactic approach associated with SpellLit in conflict with the way you teach?*
8. *Were your expectations for SpellLit fulfilled?*
9. *Will you continue to use SpellLit in your lessons? Why or why not?*
10. *Do you want to create new game sequences for SpellLit yourself with the GameCreator or are you just using pre-made game sequences?*
11. *How important is it for you that the digital system SpellLit measures the performance of children and what information would be important to you?*

The answers clearly showed that the teachers would like to use SpellLit in class. The main reason for this is that the software meets the requirements of a contemporary open pedagogical teaching concept.

The SUS-Score shows the perceived usability of the GameCreator. The SUS scores of the four educators (80.0; 85.0; 75.0; 87.5) show an average of 81.75. The average score of the GameCreator is between good (from 70) and excellent, see the interpretation of SUS values by Bangor et al. (2009).

The 9-item affinity for technology interaction (ATI) scale is designed to assess a person's tendency to actively engage in intensive technology interaction – or to avoid it. ATI can be seen as a core personal resource for users' successful coping with technology (Franke, Attig, et al., 2018). The four scores of the teachers (2.11; 3.44; 3.44; 2.77) suggest a rather weak technical affinity.

## **Summary**

The evaluation clearly shows that there are no contradictions between the current and sophisticated pedagogical approach by the teachers and the enrichment of the learning space with SpellLit. Our study indicates that for elementary school pedagogical settings including digital media can imply children not just sitting around, but integrating fine and furthermore gross motor elements, body- and space-related interactions in or outside the classroom. The survey shows that this is already desired by the teachers. The diversity of children should be used to learn together and from each other.

The teachers' weak affinity with technology, which became clear in the preliminary study and is also evident in the main study, does not contradict their willingness to make general use of digital technologies in the classroom. It moreover highlights that traditional digital learning applications do not meet the requirements of a contemporary open pedagogical teaching concept, as is generally the case today in elementary schools in Schleswig-Holstein (Germany), as well as in the two schools where the study was conducted, and that SpellLit together with the GameCreator can meet the teacher's requirements. Although a low affinity for the technology of the respondents can be recorded, the previous observations do not appear to be due to the usability of the learning applications, but rather to the pedagogical background with regard to the subject's previous experience with other learning games.

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