Integration of Exer-Learning Games in School

The Evaluation of HOPSCOTCH as teaching aid in specialised school

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***Abstract* – This paper examines the benefits of the exer-learning game HOPSCOTCH for students with special needs. We give a thematic overview about the theoretical foundations of digital game-based learning and about exercise in connection with learning; then we report on an empirical study in a public development centre comparing the new teaching method HOPSCOTCH and a traditional teaching method (run and write). In addition, the students' mood was examined because it was assumed that this factor should be enhanced by the integration of the exer-learning game in the classroom compared to the traditional teaching method. The results of the study have shown that students achieve the same learning success with the two learning methods; however, mood is increased by learning with HOPSCOTCH.**

Keywords – learning; exercise; specialised school; exer-learning games; learning success; mood; motivation

I. INTRODUCTION

Recently, the potential of digital games to support learning has been increasingly discussed [1] [2] [3]. The underlying assumption of game-based learning is that incentives inherent in games can be used to engage and encourage children and adults alike in learning activities, effectively fostering meaningful learning [4] [5]. HOPSCOTCH is one of a new genre of learning games that not only seeks to combine playing and learning but also introduces exercise as a principal component. This is the genre of exer-learning games. The design concept of HOPSCOTCH requires the learner to enter answers to simple questions or perform simple tasks, such as translating a German word into English, by jumping on a sensor pad. It therefore aims at the joyful and physically active acquisition of factual knowledge according to Bloom's taxonomy [6]. First studies with HOPSCOTCH showed that this exer-learning game could not only serve as an additional tool for private learning, but potentially could be applied in school lessons under special circumstances [7]. The results heralded the use of HOPSCOTCH for the education of students with learning difficulties.

This paper, therefore, focuses on the presentation of a study where HOPSCOTCH was integrated into everyday school life of a school dedicated to persons with disabilities – herein referred specialised school. The presented study was conducted in order to explore the potential of the HOPSCOTCH exer-learning game for students with special needs.

II. HOPSCOTCH: A CONCEPT FOR EXER-LEARNING

In the following chapter a theoretical basis is outlined. Firstly, digital game-based learning is examined more closely; then the connection between learning and exercise is introduced. Putting these components together, exer-learning games in general and HOPSCOTCH as first particular prototype are presented.

A. Digital game-based learning

The terms "serious games", "game-based learning" and "digital educational games" – widely used synonymously – mark the initiative to use the potential of digital games to actively engage and encourage players in learning [1] [2] [3] [8]. One important goal of game-based learning, however, is to foster an increase in intrinsic motivation and knowledge acquisition rather than just to provide an opportunity for enjoyable play [4] [5]. Intrinsic motivation arises from activity-specific incentives that are inherent in games but not necessarily in learning activities [9]. This will not necessarily lead to better achievements as such, but it could result in an increase in learning time. Traditional learning activities are often performed to meet certain external success criteria (to get good marks, to pass an exam, etc.), while game activities are rather focused on fun and flow experiences [10] [11]. Game-based learning tries to create intrinsically motivating learning experiences through integrated game activities that offer activity-specific rewards.

Several studies were conducted on digital educational games as instructional tools in schools – but most of them were not integrated into school lessons [12] [13] [14]. Recently there have also been attempts to integrate educational games within school lessons. Examples include the online multi-user virtual environment "anytown" [15] [16], or the computer game "Quest Atlantis" [17].

B. Learning and exercise

The body is in movement constantly, because even if we sit or lie, activity takes place inside. By the 1990s it had been found that the frontal lobes that are responsible for coordination of thinking are directly connected with the areas of the brain responsible for motor control [18]. As a result of the stimulation of the brain's activity and metabolism by movement, information processing is strengthened. Attention

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increases because the brain is awake and receptive [19]. Therefore this strongly suggests that physical exercises should be increasingly integrated into learning processes. In addition, the brain is „[…] a pattern recognition organ, so engaging students in a movement exercise every 30 - 60 minutes can prevent them from going to sleep and help increase attention span" [20]. Investigations have shown that children are more attentive and concentrate better after ten minutes of exercise than before such physical activity [21]. Consequently learning could be intensified by physical activity because of improved concentration. The connection of mental processes and physical exercises to overcome motor deficits can increase confidence in personal skills [22].

The connection of learning and exercise could be preventive as well as therapeutic for children with special needs. In particular children and youngsters with dyslexia and dyscalculia can exploit their natural ability to move to overcome their inner restlessness that might be a factor that amplifies their learning difficulty. Cognitive performance of children with learning difficulties can be improved by active perception, specific action and personal experience [23]. Therefore, it seems that physical exercise should be increasingly integrated into schools. The initiative "Moving School" contains relevant aspects and developed different possibilities for lessons in specialised schools. The aim of this initiative is to integrate (1) physical learning, (2) physical breaks, (3) physical organisational structures and (4) physical thinking into schools [24]. The "Moving School" integrates exercise into everyday life of schools; however exercise and learning are still divided: Either the children do exercise or they learn. In this setting, exercise is an element that might promotes faster learning, but it costs learning time. It would be better if children could exercise while they learn.

C. HOPSCOTCH: A prototype of an Exer-Learning Game

Hopscotch is a children's game where the challenge is to hop on a series of numbered squares in the sequence of their numbers. The course is drawn with chalk on pavement (see Figure 1).

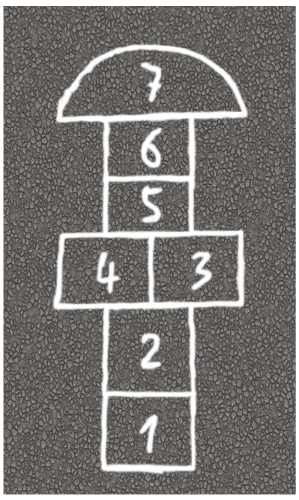

Figure 1. Hopscotch playing field

It is one of the world's most popular outdoor games for children, often played in the schoolyard. The idea of the children's game "hopscotch" has been adopted for the concept HOPSCOTCH, to create exer-learning games that can be applied for different learning tasks.

The concept of HOPSCOTCH was developed at the Fraunhofer Institute for Digital Media Technology IDMT, Germany. Instead of drawing numbered squares on the pavement, a dance pad with nine sensor fields is provided as an input device. The nine sensor fields resemble the keyboard of a mobile phone with numbers and letters for writing short messages (SMS). The sensor fields are multidimensional in the sense that tapping on a field once, twice or three times results in a different letter (e.g., A, B, or C when tapping the field "2"). The dance pad can therefore be used as an input device for letters and numbers by single or multiple taps on a certain field. These letters can then be arranged into words by jumping another pattern for the second letter and so on. Only the correct input is accepted by the system, so the player/learner always gets immediate feedback on his input. If he does not know the answer, he can find it out by jumping on the pad until all the correct letters are logged in.

Figure 2. HOPSCOTCH exer-learning game

The players can use their hands and feet to enter numbers or letters: they can either tap or jump on the sensor pad. Further, HOPSCOTCH can be played in single- and multiplayer mode. In the multiplayer mode, players can work in groups, either jumping words one after the other with the hints of their team members or jumping a word together by jumping one letter each in order to achieve a faster answering time (higher score).

When playing the game, the player receives questions that are presented on a monitor and is then asked to enter the solution by jumping on the sensor mat (see Figure 2). The game presents one question at a time. The player receives

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game points as a function of the time taken to enter the correct letters or numbers. The playing component of HOPSCOTCH is, therefore, to move the body as quickly as possible on the sensor pad, touching the correct fields in a given order as fast as possible. In the case of a vocabulary game, the player may be asked, for example, to translate the German word for plum into English and therefore hop the word 'plum' on the sensor pad.

Up to now the HOPSCOTCH concept has been applied for different learning contents including mathematics (multiplication table), history (historical dates, events and names) and languages (English vocabulary words, learning letters and numbers). The levels of difficulty can be varied either by presenting hints (such as the dashes indicating the word length in the vocabulary game) or by asking for a free input (not providing any hints for the length of the word to be entered). Further, the high scores in the game can be based on the scores of either different players (norm-referenced feedback) or on the current player showing his or her improvements within the game (self-referenced feedback).

D. Empiric results with HOPSCOTCH

Since 2009 HOPSCOTCH has been tested and evaluated at fairs and in schools. The purpose was to get feedback on the application and to get input for further developments [7]. In the following paragraph we report major outcomes from these tests and studies.

1) General feedback: HOPSCOTCH was evaluated between 2009 and 2011 at an annual trade show focused on children entertainment to get first results about user acceptance and fun factor. The survey involved scholars (N = 276) aged between seven and twenty years (M = 11.41; SD = 1.31). The sample consisted of young visitors to the fair and school classes which were invited to hold English lessons with HOPSCOTCH. Children and adolescents who played at least ten minutes were requested to answer a questionnaire.

On a scale from 1 ("very good") to 5 ("poor") HOPSCOTCH was valued as "good" (31.3%) or "very good" (64.3%). The vast majority (87.2%) associated HOPSCOTCH as a learning game (11.2% sports game; 1.6% both). So, 62.5 % would use it for learning. More than a half of the respondents (56.1 %) would renounce on another present for getting HOPSCOTCH (e.g., their mobile phone, clothes, wii).

In addition to students the accompanying teachers (N = 33) were asked to fill out an additional questionnaire to get information about HOPSCOTCH as a possible teaching method. Rated on a scale from 1 ("very good") to 5 ("poor") the first impression of HOPSCOTCH was "very good" (75%) or "good" (25%). Almost all of the questioned teachers see the potential for learning as "high" (68.8%) or "very high" (18.8%). They (58.1%) could very well imagine using HOPSCOTCH for their classes as a teaching method.

2) English lessons in Elementary School: In two exploratory studies at a German elementary school, we investigated the potential of HOPSCOTCH to engage students as well as to facilitate the acquisition of factual knowledge (English vocabulary) and to improve the attitudes of students towards learning English as a second language.

In both studies a comparison of lessons was conducted, where new vocabulary words were learned and practiced via HOPSCOTCH in contrast to "traditional" teacher-centred lessons that also aimed at introducing and practicing new vocabulary words.

In the first study, 55 students of a 4th grade learned 13 vocabularies in "traditional" teacher-centred lesson and another 13 vocabularies in HOPSCOTCH-lessons. According to the results, playing HOPSCOTCH did at least not impair the performance of the students on cued recall tasks compared to a teacher-centred lesson. This was true although the vocabulary words were put into context within the teacher-centred lesson which was not the case when playing HOPSCOTCH. Further, even on the first encounter with the game, the additional exercise component - that may require cognitive resources to perform the "dance steps" – did not seem to impair learning.

In the second study we reduced the number of vocabularies to be learned. This was due to the fact that in the first study the children did not get the whole 45 minutes of a usual German school lesson, because the game and the rules were introduced by the teacher before starting. 58 students of the 3rd grade learned 10 vocabularies in a "traditional" lesson and another 10 in a HOPSCOTCH lesson. In contrast to the first study, the second study showed advantages of HOPSCOTCH on cued recall compared to a teacher-centred lesson. After playing the exer-learning game, the students were better able to remember and correctly spell the new vocabulary words. Lowering the number of words to be learned in the given time from the first to the second study allowed for higher repetition rates per word in the HOPSCOTCH lesson. This may then have led to the advantage of HOPSCOTCH in the second study suggesting that the students need enough time to repeat each word to be learned more than five times.

This result, however, needs further examination. In summary, the conducted studies yielded preliminary results that HOPSCOTCH, as teaching aid within school lessons, may be a fruitful approach to facilitate both active engagement and learning. Further, the application of digital learning games does not exclusively aim at fostering learning in terms of efficiency (learning as much as possible in a given time). Rather, it focuses on motivating people to engage in effective learning activities. The results of both studies showed that students who were below-average in the teacher-centred lesson have learned most with HOPSCOTCH. Therefore we assumed that weaker students benefit more from HOPSCOTCH. These results led to the idea that HOPSCOTCH could well be used for the education of children with special needs.

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III. EDUCATIONAL SUPPORT FOR CHILDREN WITH SPECIAL NEEDS

There are special schools for gifted and talented learners as well as for those with learning difficulties. In this paper we only refer to children with learning difficulties when we address special schools. For a clear demarcation in this context we refer to specialised school.

Since 2009 the *UN Convention on the Rights of Persons with Disabilities* requires a reduction of specialised schools and integration of impaired students into regular schools [25]. Therefore, new innovative teaching methods are needed. The following section gives an insight into structural conditions and didactic concepts of specialised school.

A. Structural conditions

For many years school reform has been a controversial subject in Germany. The existing system excludes children with learning difficulties and puts them in specialised schools. Nearly half a million children and youngsters need special education. Only 15.7% of them are taught together with all other students in regular schools – in contrast to 90% in the Scandinavian countries [26]. Once again Germany limps behind in the European comparison. For example, Italy has abolished the specialised schools in the 1970s; the Scandinavian countries generally teach all children, whether handicapped or not, together; Austria and the Netherlands have been gradually ending the separation of regular and specialised schools since 2007 [27].

In the discussion about integration of students with special needs, politicians have to find a solution by weighing the advantages against the disadvantages. On the one hand, intellectually disadvantaged children should have same chances as others [28]; on the other hand a drop in performance is expected by integrating slower learners [25].

A proper education system needs to offer integrated education to all students. So, special requirements have to be met by innovative teaching and learning methods whenever the need arises. For children for whom the traditional teacher-centred approach is not adequate HOPSCOTCH theoretically complies with these conditions by integrating new media as well as connecting learning with exercise and enjoyment. Therefore the concept of exer-learning could offer a certain adaptivity which allows an individual support within the class. Due to physical exercise an increase in success is expected for children with special needs as mentioned in chapter II.

B. Didactic concepts

From developing-psychological point of view *support* encloses (1) promoting intra-individual changes of people for a certain period (for example: learning to swim); (2) reducing inter-individual differences between people of different ages (for example: learn to read and write) and (3) lower inter-individual differences in intra-individual changes (for example: individual support to relieve development gaps) [28]. Support for all three areas is always adjusted to educational aims which should be reached by promotion, suggestion and care [29]. The aims of the special-educational support are the dismantling of developing problems and therefore enabling integration in society [28]. According to this discipline, children and youngsters with special needs should be encouraged by reducing the differences in achievement – not by repressing the achievement more able children but by raising the achievement of the less able. They should be able to integrate themselves in the existing education system and later into the labour market.

In this area of research there are different fields which should be strengthened by certain measures. Besides the support of learning there is the strengthening of linguistic, intellectual, social-emotional, and motor aspects to be supported. The present paper deals with academic success. This is defined by two components: (1) ability and (2) motivation [30]. With reference to the theoretical outlines of chapter II we assume that HOPSCOTCH could support the two major components ability and motivation relating to academic success.

Furthermore studies empirically confirmed the effects of psychomotor support, showing that the best results are observed with slower learners. In particular the long-term support shows positive effects concerning the increase in output as well as the strengthening of motivational and emotional aspects with four to 12 year old children [22]. Therefore a specialised school was selected for the present study, particularly children of grades three and four.

IV. EMPIRIC EXAMINATION

As in the aforementioned studies in chapter II, a comparison of learning methods – HOPSCOTCH and a traditional teaching method – was conducted, to see which teaching aid leads to better outcomes in terms of ability.

Therefore a superior teaching aim had to be determined, to which both learning strategies could be adjusted. This aim defines a certain qualification which should be provided by the teaching-learning process [31]. For the present study the chosen aim was to improve the abilities in the field of orthography. Spelling is a skill needed in most tasks and for problem solutions. In essence, an improvement in a child's ability to spell could strengthen their performance level in school.

The objective of the investigation was that students should learn the correct spelling of a defined number of words. Half of the words were to be taught with a traditional method, the other half by using HOPSCOTCH.

Also mood was appraised to make some initial statements about the multidimensional construct of motivation. On the one hand, mood can determine action choice; on the other hand the intensity of action could be influenced [32]. Both could implicitly lead to a strengthening of academic success. Within the scope of this investigation it was assumed that cognitive learning and mood is positively influenced by HOPSCOTCH.

A. Two learning methods

Because HOSCOTCH has already been introduced in detail in the theoretical section of the paper, merely the description of the traditional teaching method – *run and write* – will now be discussed. This learning method is

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traditionally used in the selected school to teach students the spelling of new words.

Different words are hung on the wall of the classroom. Then the children walk through the classroom, look at a word, memorise it, go back to their seat and write it down. After writing, they start with the next word. This process is repeated until all of the words are recorded and written. At the end the students have to look over their words again, to find and to try to correct their mistakes.

This traditional learning method can be compared with HOPSCOTCH very well. First, the systematic repetition of words provides the base for both strategies. Second, both methods include exercise (walking in the classroom vs. tapping on a sensor pad). Nevertheless, there are also differences between these learning strategies. One aspect is the (immediate) correction. With HOPSCOTCH only correct input is accepted by the software. Thus the students do not memorise wrong words, because these are indicated always correctly. In contrast, in *run and write*, students sometimes memorise a word wrongly and reinforce their mistakes before correcting themselves. A second difference between these methods is the input that is either hopped or handwritten. HOPSCOTCH fosters a connection of each word with a special body movement or dance. In contrast, the writing process of the words from *run and write* is made without body movement. On the one hand the permanent exercise could affect the learning process positively. On the other hand the transfer between the HOPSCOTCH way (reading and hopping) and the later process of writing on paper could be difficult because the kinaesthetic memory of hand movements has not been developed. However, as outlined in chapter II we suppose that exercise is supporting the process of memorization, the dance steps could even serve as memory aid to support the recall process. By contrast in organisation HOPSCOTCH needs less effort for preparation and observation.

B. *Execution and stimulus material*

All together the investigation in school took five weeks. In the first week HOPSCOTCH was introduced to teach participants the handling of HOPSCOTCH itself, and to reduce the novelty value of the exer-learning game. During the following four weeks the students practiced twice a week using both learning methods for a period of 20 minutes each. The observation units were carried out one day on a weekly basis. In addition, each learning method was observed to get information about the technical handling as well as to get an impression about the learning process.

The content arrangement of the learning methods was carried out in close co-operation with the teachers. So, 68 words (20 adjectives, 20 verbs and 28 nouns) were selected.

Within those four weeks 34 words should be learned by *run and write* and another 34 by using HOPSCOTCH. Adjectives and verbs were given in written notation and could be copied by the students (see Figure 3: Type the following word! ‘grumble’), while nouns were shown as pictures and had to be written by the participants (see Figure 4: What do you see in this picture?). Two learning units were set up. The first learning unit run the first two weeks, whereas the second unit run the third and forth week. During the first learning unit 34 words were taught (17 words per method), in the second unit the remaining words were practiced.

Figure 3. Words which were given in written notation

Figure 4. Words which were shown as pictures

Vocabulary tests were set up at the end of each practice week. These tests consisted of 20 words – ten words of the practice with HOPSCOTCH and the other ten taken from the *run and write* lessons. Participants’ previous knowledge of spelling was not raised.

C. *Analysis*

For the evaluation of the learning success the vocabulary tests were analysed by counting the number of correct letter sequences. According to this method, the participant gets an achievement point when two correct letters follow each other. In addition, an achievement point was given for the correct initial letter and last letter in each case [33]. Consequently a student would get four points for a correctly spelt word "cat" (+c+a+t+) whereas he would get just two points for the wrong spelling of "dog" - "dok" (+d+ok).

To visualise an increasing in learning success an evaluation standard is needed. A comparison of learning success over time used the *individual relation norm.* Thus this relation norm was used to be able to measure the changes in spelling ability of the students over the period of four weeks. The comparison of the two methods (*run and write* vs. HOPSCOTCH) in terms of learning success was assessed by using the *objective relation norm.* Using this objective relation norm learning success could be set against a predefined educational objective [34].

Mood was evaluated by a short questionnaire after every learning unit with HOPSCOTCH and *run and write* (see Figure 5: How do you feel? Mark one smiley!). Therefore

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the participants had to specify which learning method they had used (questionnaire: I learned with () HOPSCOTCH () *run and write*.) With the help of nine different smileys current feelings were be given by the pupils.

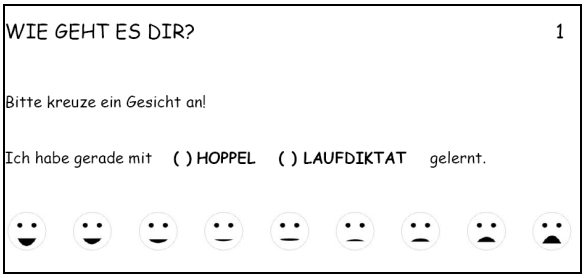


Figure 5. Questionnaire about mood

Due to the small sample (N = 30), the significance level was fixed to $p = .10$.

V. RESULTS

30 students at the age of nine to eleven years (M = 10.40, SD = .62) participated in the study – 77% boys, 23% girls. The participants attended grade three (n = 16) and grade four (n = 14) in the specialised school. This average age corresponds with the average age of students in fourth and fifth grade in a German regular school.

In each class HOPSCOTCH was played on average for 16 minutes (M = 16.34, SD = 2.62). As shown in Figure 6, the students of the fourth grade (M = 16.05, SD = 2.78) spent as much time practicing as the third graders (M = 16.19, SD = 2.54).

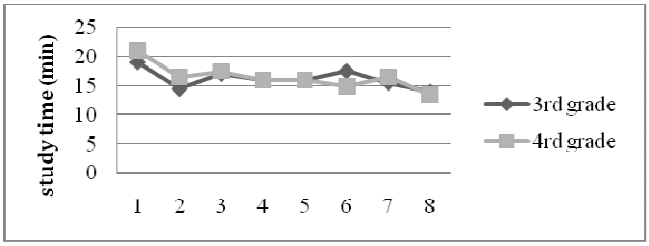
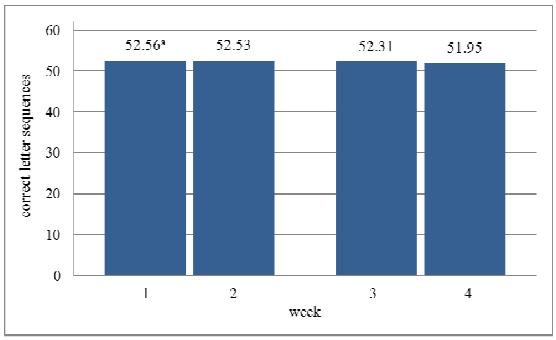


Figure 6. Study time of the eight HOPSCOTCH units

A. *Improvement of spelling ability*

In a first stage learning success was analysed, to check whether students of a specialised school could achieve individual improvements with HOPSCOTCH. The variable consists of the numbers of words which were learned during four weeks. Paired sample t-tests were calculated for the comparison of the results of vocabulary tests within each unit.

Contrary to expectations no significant differences were found for the learning success within units. The comparison of vocabulary tests one (N = 26, M = 52.56, SD = 8.21) and two (N = 26, M = 52.31, SD = 9.93) showed no changes (t(26) = .14, p = .44, d = .03) as with the tests of week three (N = 19, M = 52.53, SD = 10.39) and four (N = 19, M = 51.95, SD = 13.82) (t(19) .30, p = .38, d = .05). The achieved mean values in the vocabulary tests for the words learned with HOPSCOTCH are shown in Figure 7.



a. 62 points could be reached maximum.

Figure 7. Mean values of correct letter sequences learned with HOPSCOTCH

B. *Comparison of learning methods*

For the examination of learning methods (*run and write* vs. HOPSCOTCH) the students' results were compared. Table I presents the comparison of the percentage averages in performance level which were reached by the two different learning methods.

TABLE I. MEAN VALUES OF PERFORMANCE LEVEL FOR BOTH UNITS

	learning method	N	M	SD
Performance level[b]	HOPSCOTCH	30	84.31	14.77
	run and write	30	85.34	13.98

b. The data are percent values.

In order to compare the learning success in terms of orthographic results towards different methods, paired-sample t-tests were calculated. As expected no difference appears in the learning success with HOPSCOTCH and the method *run and write* (t(30) = -1.12, p = .28, d = .07). For teaching German spelling, the use of HOPSCOTCH in specialised schools is as good as the use of *run and write*, but needs less effort for preparation as mentioned in chapter IV.

C. *Exploratory data analysis*

During the first two days of introducing HOPSCOTCH in school lessons it became obvious that the students were particularly open-minded towards the new learning method. The children quickly understood the principle of the game and had no problems with providing the required input. This fact shows that there was no excessive demand on the students in contrast to the supposed doubts which were expressed by the class teachers before the tests. The students got used to the new learning strategy very well and, besides, had a lot of fun while testing it out. However, there were also few students who were critical and showed little desire in interacting with the exer-learning game HOPSCOTCH.

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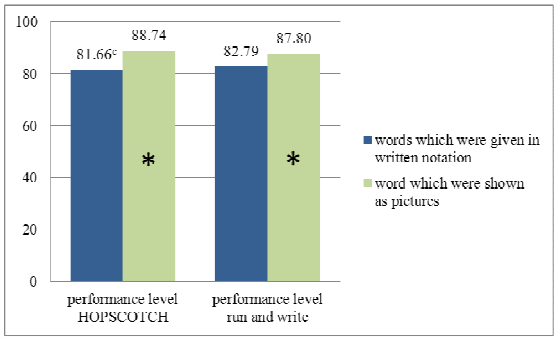
Regarding the material's degree of difficulty, the observations during the four weeks showed that students were insufficiently challenged. In particular the fourth graders assessed the degree of difficulty as too simple. This is supported by the achieved percentages for both types of words in the vocabulary tests which were reached with HOPSCOTCH. Paired-sample t-tests were calculated to compare words to be copied (copy words; see Figure 3) and words to be recognized (word pictures; see Figure 4) towards the learning success. Words that were learned on the basis of pictures (N = 30, M = 88.74, SD = 11.80) were significantly more correct (t(30) = -3.86, p = .00, d = .48) than words that were written (N = 30, M = 81.66, SD = 11.79). Figure 8 shows the achieved learning success.



* significant c. The data are percent values.

Figure 8. Mean Values of correct letter sequences

Also the comparison of the percentages which were reached with the *run and write* shows a significant difference with small effects (t(30) = -2.565, p = .00, d = .35) between the learning of the transcribed words (N = 30, M = 82.79, SD = 16.90) and the word pictures (N = 30, M = 87.80, SD = 11.92). We assume that the results of the comparison of methods could differ if the tasks were more difficult. However, the observations and log file data indicate that students get much faster in typing the words and make fewer mistakes. Especially highly underachieving students showed an enormous increase in handling the words. Because of the high number of correctly given answers by the many fast-learning children at the beginning of the evaluation, an additional increase over the time was hardly possible.

D. Mood after learning

For the examination of *mood* the feelings after learning with HOPSCOTCH and *run and write* were compared. Table II shows the mean values of the variable mood in comparison. A lower score signals a better mood.

TABLE II. MEAN VALUES OF MOOD

	learning method	**N**	**M**	**SD**
Mood[d]	HOPSCOTCH	30	2.00	1.70
	run and write	30	2.44	2.19

d. A lower value shows a better mood.

To compare the mood of the students after learning towards the two different methods, non-parametric tests were performed As excepted, a significant difference was found (Z(30) = -1.65, p = .05, d = .23). The mood after learning with HOPSCOTCH was better than by practicing *run and write*. Another interesting point was that pupils love to learn generally. Worst moods were mentioned rarely.

VI. SUMMARY AND CONCLUSION

In this paper we introduced exer-learning games that not only combine playing and learning but also integrate exercise as principal component of a digital learning game. Physical activities may constitute incentives within playing that facilitate engagement. Research from different disciplines suggests that physical activities may be positively related to cognitive performance.

We reported on a study with HOPSCOTCH over a period of four weeks where we compared two learning methods based on exercise in school everyday life. The comparison results of both learning methods indicate that students can learn with HOPSCOTCH as well as with the traditional teaching method *run and write* – but the former with more pleasure in learning..

The explorative data analysis has shown that words with a higher degree of difficulty were significantly better remembered irrespective of the learning method. So the students seemed to be under-challenged with the degree of difficulty of the requirements imposed on them.

Furthermore the difficulty level of the method *run and write* was obviously higher than HOPSCOTCH, because students had to memorise the exact spelling of the word before writing it down. In contrast, they could copy each letter individually when playing HOPSCOTCH and were not forced to memorise the word. Therefore, the assumption is made that students would have reached better results with HOPSCOTCH if the content had been more demanding. It seems that the degree of difficulty had to be defined individually for each student before the training starts. Additional investigations should be done with more difficult problems or more comprehensive content of educational workload to verify this hypothesis.

As HOPSCOTCH is based on a digital platform, it offers numerous new advantages. The option to integrate adaptive elements and individual levels as well as to run it without the immediate help of a teacher could support the integration of special students in regular schools. Therefore, HOPSCOTCH could become part of the new integration reform of students with special needs into regular school.

Slow learners could be supported individually in regard to their special needs within a large class. Nonetheless, further research is needed to provide more evidence in order to confirm this assumption and to optimise the relevant applications.

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