

The impact of feedback on phonological awareness development

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Abstract. The utilization of Information and Communication Technologies (ICT) in educational practice is indispensable, while it becomes imperative in the education of individuals with special educational needs, as it promotes the application of Individualized Education Programs. Feedback in digital activities aiming at phonological awareness development is the topic under consideration in the present paper. The study has two objectives. On the one hand to study feedback as a differentiating factor for dyslexia intervention through the use of ICT and on the other hand to search for the type of feedback that helps students with dyslexia the most. The two different feedback types are based on behaviorist and constructivist approaches. Results show that constructivism is the theoretical model that feedback has to be based on, in order activities to be fruitful to students with dyslexia.

Keywords: ICT, dyslexia, feedback, behaviorism, constructivism

Introduction

ICT play an important role in the learning process, especially in individuals with dyslexia (Adam & Tatnall, 2008; European Commission, 2000; Lynch, Fawcett, & Nicolson, 2000; Olson & Wise, 2006; Tijms & Hoeks, 2005; Tijms, 2004). However, educational software and digital learning activities often simply transfer traditional activities to digital ones (Rivera & Smith, 1997). Usually, software applications are limited to a relationship of a behaviorist type, based on the correct answer that is rewarded and the wrong one that is frowned upon or just one extra attempt that is encouraging after the wrong one. The question on which the present paper will focus is whether and to what extent interactive digital activities, which will lead the student gradually to the correct answer by explaining to them what is wrong, will help students with dyslexia.

Literature Review

With the aim of designing software with direct feedback we should first clarify the term feedback and define its importance in education of individuals with dyslexia. What is meant by feedback is the knowledge of the outcomes for success or failure of the learning process during the solution of a problem by means of which motives develop for the student (Schunk, 1989). Feedback has its origin in the conclusions of Thorndike's experiments who demonstrated that only practice and repetitive exercises are not sufficient to achieve learning. There should also be the knowledge of the outcome which leads to reinforcement. Reinforcement, in the form of reward as well as in the form of punishment, affects learning. Thus, the law of exercise is incorporated in the law of effect and is a consequence of it (Thorndike, 1913).

In ICT, feedback is the property of the information system to present its response to the user's actions. It presents the user with the outcomes of their actions so that they can adjust them better for a better response of the system. Specifically, behaviorism emphasizes transmission of information and modification of behavior. According to this theory, learning is realized through the modification of human behavior. Reinforcement, positive and negative, is an important factor in learning, in which a behavior develops as a reaction to repeated stimuli which are followed by learning through trial and error (Jonassen, 2000). In behaviorist theories, feedback entails that the student knows the success or failure of the learning process, namely that they learn the outcomes of a behavior while trying to solve a problem with the aim of modifying behavior in the right direction.

According to constructivism, however, knowledge is either constructed or reconstructed by the student (Jonassen, 2000). The student plays an active role in forming its cognitive structures, crucially affecting the learning process. Learning is considered to be the outcome of organizing and adapting new information to already existing knowledge. The student is guided by the teacher towards structuring knowledge and in this case, the teacher is a collaborator and intermediary in this structuring.

Bruner suggests that all topics can be taught effectively to all students and at all levels of knowledge acquisition, in simple form and in accordance with the mental capacities of the students. What is more, according to him, learning depends on and is defined by factors such as learning speed, resistance to oblivion, ability of generalization, etc. (Jonassen, 2000; Bruner, 1970). This view is fundamental if it is considered in the realm of special education, where students vary cognitively to a considerable degree, as long as the teacher is in a position to adapt the learning material to the capacities and needs of the students. Moreover, feedback as a means of support plays an important role in constructivist learning environments. The teacher should be in a position to provide additional material which is essential for the student in order to construct knowledge. The teacher, therefore, should, on the one hand, base the knowledge provided on prior experience and, on the other hand, adjust the steps constantly so that the student can end up succeeding (Sherman & Kursan, 2005; Soulis, 2009). To that end, the teacher should use supplementary aids which will reinforce the teaching process. Teaching machines are mentioned among these aids. These machines present the student with a carefully programmed series of problems/exercises step by step. In every step the student reacts by selecting one of the options presented and the machine in turn reacts to show if the chosen option is right or wrong. The aim is to have an increasing difficulty so that student failure and disillusionment can be prevented. An important feature of teaching machines, although they do not replace the teacher in any case, according to Bruner, is that they provide feedback, that is, they correct the student while they are learning (Bruner, 1970).

The factors that should be taken into consideration in programming and designing the learning process are common in traditional as well as in more modern forms of teaching. What is important in the case of modern forms of teaching, where technology is involved to a great extent, is that these factors should be adapted in such a way that the learning process leads to successful outcomes (Adam & Tatnall, 2008; Chang & Wang, 2009). The objective of this paper is that the fundamental learning principles that are useful in the learning process are exploited in the design of educational software for the needs arising in the field of special education.

It should be noted that encouragement which emerges from feedback is of paramount importance in special education. The parent and the teacher in traditional forms of teaching, as well as the computer in modern forms, should show and by way of extension prove to the student that they are not so weak or as incompetent as they could possibly believe. Given

that students with special educational needs experience constant disappointments and frustrations every day which stem them from the educational and learning process, results in falling self-esteem and discrediting of self-image (Chang & Wang 2009; Marsh & Singleton, 2009). In traditional forms of teaching, encouragement occurs directly, easily and many times spontaneously: a pat on the back, a gesture of approval and acceptance, a pat on the head and a smile achieve the aim easily. What happens, however, in the case where the computer undertakes to complete the teacher's role? In this case, all of the above should be taken into account and adapted accordingly in the design of software that will complete the traditional forms of teaching.

Additionally, the computer provides the student with an interactive environment increasing active participation and involvement with the learning process. Communication through the user's feedback ensures the most active way of learning. The student ceases to be a mere spectator in the framework of the traditional classroom and undertakes an active role. They feel responsible for operating the computer as a tool and they are thus given the possibility to act and to accept the direct feedback of their action, which increases the level of self-acting and self-concentration on a task and releases them from fruitless and passive attendance. What is of great significance is that direct feedback ensures constant control of student learning and performance. This fact enables children with dyslexia to check their knowledge by themselves and to understand their weak points. Direct feedback does not leave them with questions concerning their wrong answers while on the other hand, direct positive reinforcement and reward foster learning motives. In this way, the personal factor between the teacher and the student, which can sometimes be negative for the student, is avoided. For example, the psychological consequences of a negative or/and ironic comment/remark on the part of the teacher for possible faulty answers of the student are avoided. Through the computer the blame is taken off the error and the effort is rewarded. The students appreciate the patience and the objectivity of the computer and do not hesitate or are ashamed to try, because they know in advance that even the wrong answer is not going to "cost" them a lot. Their interest and attention are heightened contributing in this way to their progress. Moreover, by means of communication and interaction between student and computer, individualization is put in practice, resulting in the student handling knowledge following the way and pace that they wish. Thus, technology appears to function in a reinforcing and supportive way in the context of dealing with school failure (Hartley, 2007; Lynch et al., 2000; Marsh & Singleton, 2009; Nicolson et al., 2000; Morfidi et al., 2012; Olson & Wise, 2006; Singleton, 1991; Torgesen, 1986).

Furthermore, a teacher should configure the educational process starting from the positive characteristics of students, their abilities and potentials. In the same way educational software needs to be designed in such a way that it is based on existing, acquired knowledge of the students. As a result, it can reinforce and develop the learning process (Soulis, 2009). In this case, it is essential that feedback leads gradually to small and successful steps, whereas in the case of failure, it should not be stressed, but rather instructions/guidelines should be provided based on prior knowledge which will reconstruct the student's knowledge. User-friendliness, the pedagogical principles on which it is based, and its forms of interaction with the user play an important role in forming the quality of software. Communication with the user should include direct feedback. Reinforcement of the correct answer should be direct. Presentation of information should depend on the student's answer in the previous step. The question is not just to confirm whether the answer is correct or not, but to provide suggestions towards the correct answer (supplementary or/and prior knowledge, alternative solutions and information). Therefore, regarding wrong answers, they should be justified and a rationale should appear for the solution and the required knowledge for it should also be given. The student should be guided to the correct answer.

Knowledge should be organized hierarchically so that it is easy to retrieve the necessary information. Prerequisite knowledge should be incorporated and utilized in the presentation of information. Information should be presented in many different ways covering the different way in which each student is led to the acquisition of knowledge (learning styles) (Day, 1995; Mayer, 2002).

In the software that is addressed to students with special educational needs until now –as has already been mentioned- there is widespread use of methods that are based on the theory of behaviorism. Thus, in their majority they apply feedback of the type “well done”, in the case of a correct answer and “try again” in the case of a wrong answer.

The study: The activities

The present paper aims to study the forms that feedback can take depending on the theoretical framework on which it is based. Specifically, what is pursued is to search for the type of feedback that helps students with dyslexia in the learning process. Moreover, the paper aims to investigate whether feedback in a digital environment forms a differentiating factor in dyslexia intervention.

Based on the constructivist principles, a software application was designed which is addressed to students with dyslexia. The application provides direct and constant feedback, aiming at restructuring the student’s knowledge using the users’ existing knowledge and scaffolding them on a more effective basis (Kazakou et al., 2011; Mory, 1992; 1995; 2004). Besides, feedback in the learning process generally and specifically in the education of individuals with special educational needs, is considered to be an inextricable part of the process not only for assessment, but also for the educational process in general, as it promotes and facilitates the learning route (Geoff, 2004; Lerner, 2002; Lundberg, 1995). Feedback contributes to the construction of knowledge, since it allows students not only to evaluate the level of learning, but also even more to pinpoint possible misunderstandings or even incomplete comprehension. In this way, teachers can define the performance level at which they aim, reinforcing at the same time the students’ metacognitive level (MacBeath, 1999). Besides, from a psychological perspective, feedback, as it aims not only at recognizing the error but also leading to the correct answer, boosts the self-image and the self-confidence of the students, heightening the feeling of security and confidence in them. Especially for students with dyslexia, this is considered to be very important, as they generally experience frustration with their performance in the school environment.

In the above framework, a tool was constructed for dyslexia intervention aiming at developing phonological awareness. The tool includes five digital activities structured upon two different theories of learning. In the first case, communication with the user is achieved through feedback of a behaviorist type. In the second case, the same activities are provided, with the feedback following constructivist principles. Digital activities are organized and structured in such a way that allows the student to structure anew their knowledge so as to improve reading as well as writing. The same activities could be used in the evaluation of phonological awareness depending on the case, helping the teacher to locate those fields in which the child encounters difficulties (Kazakou et al., 2011). The activities focus on specific phonemes and graphemes which constitute common mistakes and standard difficulty of students with dyslexia such as /f/, /v/, /θ/, /ð/. The software application consists of five activities which are of graded difficulty and cover all structural parts of speech: phoneme, grapheme, syllable, word, sentence, text.

Each activity is designed in two phases. Each phase is based on a different feedback type: the first activity phase is based on behaviorism and the second on constructivism, as they were analyzed above. In the first case, when the student makes a wrong choice, the application simply indicates that the choice was wrong and urges a second attempt. On the contrary, in the second case, various types of feedback are employed which are graded depending on the wrong choices. The aim of feedback each time is not to pinpoint the error but to utilize prior knowledge to scaffold or/and reconstruct knowledge and to lead the student to the correct answer. Two of the activities together with their different types of feedback are presented below.

Activity 1 designed with the behaviorist type of feedback

Activity 1 has to do with the recognition, distinction and connection of a phoneme with its respective grapheme. The students are asked to select the grapheme that corresponds to the phoneme they will hear from a multitude of graphemes, in this case /f/ (Figure 1). The application reinforces positively the students after their correct answer (Figure 2).

In case of a wrong answer, the error is indicated and the students are urged to make another attempt (Figure 3). In this case, the students return to the previous, first screen of the activity (Figure 1).



Figure 1. 'Find the grapheme that corresponds to the phoneme /f/'



Figure 2. Positive reinforcement (bravo!)



Figure 3. Negative reinforcement (try again)



Figure 4. Constructivist type of feedback using video



Figure 5. Constructivist type of feedback using enunciation

Activity 1 designed with the constructivist type of feedback

The reaction of the application in case of a correct answer is the same as above. The activity is differentiated when the students make wrong choices. In the first wrong choice, the requested phoneme is highlighted. The students have the opportunity to watch a short video showing the way the phoneme is articulated and have the possibility to repeat it as many times as they wish (Figure 4). In case of a wrong choice for a second time, then the students listen to the enunciation of the phoneme /f/ and some words which begin with this phoneme that will probably lead them towards the correct answer (Figure 5).



Figure 6. Constructivist type of feedback using animation



Figure 7. 'Match the syllables with the letters'

In case of a third consecutive wrong answer, the students watch an animation with the grapheme /f/ magnified which suggests not just the phoneme but also the way of writing it by using a moving ball (Figure 6).

Activity 2 designed with the behaviorist type of feedback

Next example has to do with recognition and distinction of syllables in phonemes and graphemes that are usually confused with each other. On the computer screen syllables appear with the structure consonant-vowel (CV). The students are firstly asked to read the syllables and then to put each syllable in the correct box, according to its initial consonant (Figure 7). The application reinforces positively the students after their correct answer, with verbal reward (exclamations). In case of a wrong answer, then the wrong answer is indicated verbally and the students are urged to try again (Figure 7).

Activity 2 designed with the constructivist type of feedback

The reaction of the computer in this activity, in case of a correct answer, is the same as above. When the students, however, choose a wrong box to put a syllable in, then the first feedback type appears. Specifically, the chosen syllable as well as the wrong box in which they put it are visually highlighted in yellow (Figure 8). At the same time, there is verbal indication that a wrong choice has been made, they are reminded of the chosen phoneme, and words starting with this phoneme are enunciated. The aim is to indicate and stress the difference of the chosen phoneme from the requested one, so that the students can realize their mistake and proceed to the correct answer.



Figure 8. Constructivist type of feedback using yellow signs

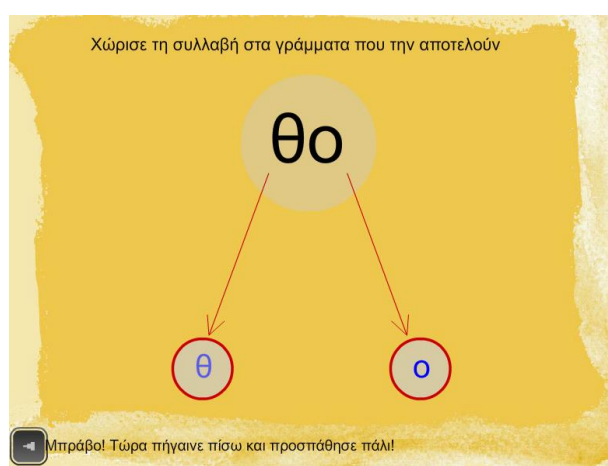


Figure 9. Constructivist type of feedback using syllable deconstruction

In case there is a second consecutive wrong answer, then the emphasis is given to the requested syllable. The students are asked to deconstruct the syllable, namely to separate it in the graphemes that it is consisted of. At the same time, the graphemes are followed by enunciation of their phonemes (Figure 9). The aim of this type of feedback is to focus the user's attention on the requested syllable, reminding them of its features with an emphasis on the initial phoneme and with the aim of choosing the correct box.

Research methodology

Hypotheses

Based on the literature review, the aim of the study was to find out which of the two types of feedback is more effective for students with difficulties in phonological awareness.

The hypotheses of the study were the following:

H1: Students with phonological deficit achieve more correct answers when they deal with activities with the constructivist type of feedback.

H2: Students with phonological deficit answer faster after the feedback when they deal with activities with the constructivist type of feedback.

H3: Students with phonological deficit need more attempts in order to achieve correct answers when they deal with activities with the behaviorist type of feedback.

The sample

The sample consisted of 30 elementary school pupils, 6 – 8 years old. Two groups of students were formed, which demonstrated common symptoms, as they had been defined from the beginning, that is, symptoms related to phonological deficit. Namely, all the students had difficulty in the following graphemes and phonemes: /f/, /v/, /θ/, /ð/. Regarding the phonological deficit of the students, it was estimated at first by the students' teachers and – in the cases that they were available – from their evaluations / diagnoses and then through evaluation by the researchers.

The measuring tools - the procedure

The study was carried out in two phases. The pilot phase was carried out in parallel with the design and the development of the digital activities. Specifically, when each activity was completed, it was tested on five students and a first evaluation aimed at possible corrections, additions, and alterations during the process of design and development of the application. At this pilot phase, the instructions and the rubrics provided by the application were also checked in order to be certified that there were clear for the children and the level of the activities corresponded to the learning level and the needs of the pupils consisted the specific age group.

At the second phase, the main study, two groups of 15 pupils each interacted with the activities. The 15 pupils who interacted with the activities of the behaviorist type feedback, was the control group. The researchers utilized open-ended (observation, interview and logs) as well as closed-ended techniques (questionnaires) for data collection. The teacher's log was used especially during the first pilot phase, where the objective was to check to what extent the activities have been designed and developed properly. The researchers recorded the comments and remarks of the pupils that were raised either by their spontaneous reactions during their interaction with the activities, or by focused questions asked by the researchers.

In the second phase of the study, a questionnaire was used which the researchers completed after their observation and interviews. The questionnaire had to do with registering the behavior of the students during the interaction with the digital activities. For each activity the trials of the pupils until the correct answer as well as the time needed were recorded. Table 1 presents the questionnaire used for the activities of the constructivist type feedback. Questions for the activities of the behaviorist type feedback are in parentheses.

Table 1. Questionnaire of the constructivist (behaviorist) type

-
1. School:
 2. Age:
 3. Class:
 4. Symptoms:
 5. Activity 1: the pupil found the correct answer:
 - i. immediately, without the help of feedback (immediately)
 - ii. after the first feedback (after the first attempt)
 - iii. after the second feedback (after the second attempt)
 - iv. after the third feedback (after the third attempt)
 - v. the pupil did not find the correct answer
 6. Activity 2: the pupil found the correct answer:
 - i. immediately, without the help of feedback (immediately)
-

-
- ii. after the first feedback (after the first attempt)
 - iii. after the second feedback (after the second attempt)
 - iv. after the third feedback (after the third attempt)
 - v. the pupil did not find the correct answer
7. Activity 3: the pupil found the correct answer:
- i. immediately, without the help of feedback (immediately)
 - ii. after the first feedback (after the first attempt)
 - iii. after the second feedback (after the second attempt)
 - iv. after the third feedback (after the third attempt)
 - v. the pupil did not find the correct answer
8. Activity 4: the student found the correct answer:
- i. immediately, without the help of feedback (immediately)
 - ii. after the first feedback (after the first attempt)
 - iii. after the second feedback (after the second attempt)
 - iv. after the third feedback (after the third attempt)
 - v. the pupil did not find the correct answer
9. Activity 5: the pupil found the correct answer:
- i. immediately, without the help of feedback (immediately)
 - ii. after the first feedback (after the first attempt)
 - iii. after the second feedback (after the second attempt)
 - iv. after the third feedback (after the third attempt)
 - v. the pupil did not find the correct answer
10. The pupil's speed, initially in his answers is judged to be:
- i. very slow
 - ii. slow
 - iii. normal
 - iv. fast
 - v. very fast
11. The pupil's speed after a wrong answer and after the help of the 1st feedback is judged to be:
- i. very slow
 - ii. slow
 - iii. normal
 - iv. fast
 - v. very fast
12. The pupil asked for supplementary explanations (besides those provided by feedback)
- i. no
 - ii. yes
- If Yes, what type of explanations?
13. According to the researchers, feedback helped the pupil find the correct answer and why?
- i. No, because.....
 - ii. Yes, because
14. According to the pupil, feedback helped him find the correct answer and why?
- i. No, because.....
 - ii. Yes, because
-

Results

The results so far indicate that students with dyslexia and especially those that appear to have intense difficulty on the phonological level need feedback of the constructivist type in order to achieve the correct answer. The use of help, which in this case constitutes feedback, even of the third level (3rd feedback) in some questions, shows that the activities with the constructivist type feedback are more effective as they helped the pupil to find the correct answer.

Table 2. Pupils' answers in the constructivist type feedback activities

Results/activity	Number of pupils per activity				
	1 st	2 nd	3 rd	4 th	5 th
The pupil found the correct answer immediately, without the help of feedback	3	5	4	2	2
The pupil found the correct answer after the 1 st feedback	3	7	7	4	5
The pupil found the correct answer after the 2 nd feedback	5	3	3	3	3
The pupil found the correct answer after the 3 rd feedback	4	0	0	4	3
The pupil didn't find the correct answer	0	0	1	2	2

Table 3. Pupils' answers in the behaviorist type feedback activities

Results/activity	Number of pupils per activity				
	1 st	2 nd	3 rd	4 th	5 th
The pupil found immediately the correct answer	3	5	3	2	1
The pupil found the correct answer after the 2 nd attempt	3	4	3	3	2
The pupil found the correct after the 3 rd attempt	3	3	4	2	3
The pupil found the correct after the 4 th attempt	4	2	2	4	5
The pupil didn't find the correct answer	2	1	3	4	4

Table 2 shows that most of the students found the correct answer after the second feedback of the constructivist type. In the 1st and 2nd activities there were no pupils who failed, whereas only one pupil in the 3rd and two in the 4th and 5th activities did not find the correct answer. These findings show that the first hypothesis was confirmed. Concerning the time for the pupils' answers it was considerably decreased when the pupils completed the activities with the help of the first feedback. This shows that the second hypothesis was confirmed.

Table 3 shows that students used all the attempts in all the activities in order to find the correct answer in the behaviorist type activities. Besides, few of the students did not find the correct answer at all. The findings of both types of feedback show that the third hypothesis is confirmed.

Therefore, activities designed with feedback of a constructivist type are recommended for the specific students. Pupils seem to feel secure to give an answer without the fear of failure each time there is extra guidance that helps them reach the correct answer (Morfidi et al., 2012). At the same time this fact reduces the hesitation in answering and functions in a positive and encouraging way. It is also worth mentioning that in the cases of wrong answers and after the behaviorist urge "try again" the subjects' answer was given immediately, without considerable thought and rather randomly until the correct one was achieved. The factor of the time does not seem to be affected in the behaviorist type of activities. As for the pupils who although they had a phonological deficit, did not encounter great difficulty with the phonemes/graphemes that were included in the activities, they appeared not to have any problem with the activities that use feedback of a behaviorist type, since on most occasions the correct answer was given immediately.

Conclusion

The aim of this study was to investigate the impact of the feedback on students with phonological deficit through digital activities. For that purpose the activities were designed with two different types of feedback, behaviorist and constructivist. The activities of the behaviorist type feedback simply informed students about the correct or wrong answer whereas the activities of the constructivist type feedback offered supplementary guidance in order to help students find the right answer. A first attempt was made to check to what extent the feedback factor, in activities that develop phonological awareness and contribute to effective dyslexia intervention affects the learning process positively

Results showed that digital activities should be designed and developed based on the theory which seems to be more effective for the relevant target group. In this case, when the software is addressed to students with special educational needs and specifically students with dyslexia, it should be based on constructivism theory. Digital activities based on this theory help students find more easily (H1 and H3 confirmed) and faster the correct answer (H2 confirmed). In this way, on the one hand the students' potential will be exploited and on the other hand their abilities will be developed and their feeling of self-esteem will be fostered contributing to the facilitation and the successful completion of the learning process.

The computer seems to be an especially useful tool in the hands of the teacher as well as the learner, which promotes and reinforces differentiated instruction. The use of feedback of a constructivist type, for which an alternative way of presenting knowledge was used, shows additionally the need for differentiated instruction to students with dyslexia.

Undoubtedly, this study has a number of limitations that need to be taken into account. Firstly, the study should be made with a larger amount of participants in order to reach more secure conclusions. However, research continues so that safer conclusions can be drawn. Additionally, we could study the impact of feedback on students with dyslexia, together with their age and/or sex. Moreover, it would be interesting if software included activities concerned not only with the phonological deficit but also with other difficulties that children with dyslexia encounter such as memory, orientation, and arithmetic. Future work aiming to improve those aspects can lead in studying the factor of feedback in children with dyslexia in depth.

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