UNIVERSITY OF SZEGED


TEACHING AND LEARNING PROGRAM

DOCTORAL SCHOOL OF EDUCATION




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# TECHNOLOGY BASED ASSESSMENT OF PHONOLOGICAL AWARENESS FOR CHILDREN AGED 5-8 YEARS

Theses of a PhD - dissertation




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Szeged,

2018

# INTRODUCTION

Reading is one of the conditions for individuals to be integrated into society. Early reading assessment is essential for successful decoding, fluent reading, furthermore, it is vital to monitor the progress children make with the skills and cognitive factors which lay the foundation for reading comprehension.The early stage of the skill development as well as the future reading success are determined by several components. Several studies have proved that among the linguistic skills phonological awareness plays a crucial part in developing early reading skills; the predictive power of phonological awareness measured at preschool age, during kindergarten years, is determining (Lonigan, Burgess, & Anthony, 2000; Phillips, Gormley, & Anderson, 2016; Stanley, Petscher, & Catts, 2018; Ziegler & Goswami, 2005). With the increase of the numbers of studies revealing the significance of phonological awareness the number of instruments examining that area is increasing too, the methods of research are increasing, they are becoming more child friendly and objective, adapting to the 21st century needs and taking advantage of the innovative opportunities offered by the 21th century. Several fundamental studies and books have been and are published which give details about the increasingly colourful research methodology of this cognitive factor of reading (Chard & Dickson, 1999; Józsa, Steklács, Hódi, Csíkos, Adamikné, Molnár, Nagy & Szenczi, 2012; Muñoz, Valenzuela, & Orellana, 2018; Palmer, Fleming, Horn, Butera, & Lieber, 2018; Rathvon, 2004).

Nowadays survey methods of phonological awareness have been based on face-to-face live voice delivery; during the survey procedure one or two tasks occasionally appear which are attended by audio materials recorded in advance. These audio materials were previously recorded on audio cassettes, thus, their quality has become questionable after a certain amount of time, moreover, during the description of the surveys enhanced by audio cassettes the position of the microphones, the volume of the recordings and the external noise coming from the environment were not described, which would largely affect the success of the recording of the tests. As the technology has advanced the face-to-face live voice delivery has changed, the opportunities provided by ICT (Information and Communications Technology) have come into prominence. Computer -enhanced instruments, computer/software based developmental games have appeared whose objectivity and cost and time saving are significant. It is typical of the 21st century child population that even before learning to write and read, they use ICT tools (McKenney & Voogt, 2012), in addition, it is an increasingly accepted view that children can be banned from these tools. After having reviewed the survey methods of

phonological awareness in and outside Hungary, having taken the advantages of the opportunities provided by ICT, having considered teachers' and pupils' positive approach on this topic and the 21st century children's knowledge in information technology, we have undertaken the task of designing an online phonological test which was recorded in a kindergarten and primary school environment.

## THEORETICAL BACKGROUND

The psychological, linguistic, pedagogical and logopedic approaches of phonological awareness are evenly relevant. According to the views of Bruinsma (2003), Ellis (2009), Göncz (2003), Graves, Juel, & Graves (1998), Kassai (2001), és Lőrik (2006) phonological awareness is a significant metalinguistic skill during which the language appears as the object of thinking and it is dominated by the operations among language elements. This skill is a transition between spontaneous speech acquisition and learning and teaching how to read. Phonological awareness encompasses the conscious skill  to get access to the inner structure of the words and the skill to segment the words into different length units (in the Hungarian language into syllables and sounds) (Csépe, 2006); as well as the access to different linguistic elements as well as the ability to do operations with them (Blomert & Csépe, 2012), moreover, the skills to identify and manipulate phonological units within the words (Hayes & Flanigan, 2014).

According to Goswami (2002) and Barbour, Keafer, & Scott (2003) in the development of phonological awareness two different levels can be identified: the phonological and the phonemic level. The phonological level consists of making up rhymes, segmenting syllables as well as separating the beginning of the syllables and the rhymes. The phonemic awareness includes manipulating skills as well, decomposing (segmenting) the words into sounds, blending words from sounds (synthesis), the identification of the position of individual phonemes in the words (isolation), the substitution or omission of the sounds within a word (deletion). Based on the approach presented by Farrall (2012) the phonemic level awareness develops by the final period of kindergarten. Several theories agree that in the early period of reading development phonological awareness is one of the most determining factors (Carson, Gillon, & Boustead, 2013; Wackerle-Hollman, Schmitt, Bradfield, Rodriguez, & McConell, 2013), moreover, within phonological awareness phonemic awareness measured in preschool age becomes prominent (Duff, Hulme, Grainger, Hardwick, Miles, & Snowling, 2012).

The investigation of phonological awareness has become increasingly important since 1970s. Investigation and survey tendencies on national and international levels show a great diversity; nevertheless, the innovative survey opportunities provided by the 21st century have not been or have been utilized to a small extent. Rathvon (2004) examines phonological awareness based on (1) the lack of standardization among tasks, (2) the relative predictive utility of various tasks during different periods of reading development, and (3) examiner and scorer variance. It has been found that during the tests the order of the recordings of the task types has not been determined in every case, the context of the tasks, their level of difficulty, complexity, the person who supervises the survey and the method of giving answers show differences. The predictive value of the tasks is not clear; it shows differences by languages and instruments as well. In our country the recordings based on face to face, live voice delivery are typical; however, similarly to the international tendency tasks with previously recorded audio materials (with sample materials) as well as the manual aids to help solve the tasks and graphics appear. Among our national tests there are proprietary tests (e.g. Gósy 1995/2006; Nagy, Józsa, Vidákovich, & Fazekasné, 2004) and adopted instruments for example (Jordanidisz, 2009).

## THE CONCEPT OF THE EMPIRICAL RESEARCH

**The purpose, the importance of the research, and the antecedent of the research**

The empirical research took place involving state education institutions, in the upper kindergarten group, among children who were ready for school according to their age, and in the first grade of the primary school. There was a significant difference between the survey methods of the two scenes since the methodology of online surveys for primary schools has already been worked out at the beginning of the surveys, nevertheless, the online methodology for kindergartens has not been worked out; there was a hiatus in the field of kindergarten surveys at that time, consequently, we designed and applied a test for kindergarten during the first survey in 2014. The first kindergarten investigations consisted of working out a phonological test as well as the partial adaptation of the Token test's children version to an online interface (Kiss, 2015; Kiss & Patai, 2015a, 2015b). The examinations were aimed not just to map children's abilities but to observe how the tests work in a new environment and state the grounds for further research since the altered medium and the innovative form replacing face-to-face testing required the reconsideration of the tasks from the designers of the tests. A further step of the test development was the calibration of the

Difer test to an online interface in kindergarten and the third unit was working out a new type of school maturity test battery and its application on a kindergarten sample, which included an online phonological awareness test as well.

Our work aims to examine some subskills of phonological awareness through online tests, take the advantage of the opportunities and meet the challenges of online examinations, as well as it focuses on the description of the online testing and on the steps of the test development involving kindergarten age and first grade students.

## GENERAL OVERVIEW OF THE EMPIRICAL STUDIES

Children in the upper kindergarten group and first graders at primary school were tested. The kindergarten sample consisted of only kindergartens of the chief town of Csongrad county on a volunteer basis. The first graders of the primary school during the sampling both in 2015 and 2016 belonged to the network of partner institutions of Teaching and Learning Research Group. The sample in 2015 consisted of 1291 pupils, the sample in 2016 included 4386 pupils. Children themselves answered the question built in the tests referring to their gender; data from the kindergarten were recorded based on the information given by the kindergarten. There were no missing data regarding the children's gender based on the information received from the kindergarten. There are no other variables regarding the sample.

The instruments exclusively measured phonological awareness and its subskills. The original instrument consisted of 55 items, which were altered during the test developing procedure. The tasks included two linguistic levels (phoneme and syllable) and four operation levels (identification, synthesis, segmentation and deletion) were covered. In the case of syllable level exercises we did not consider the identification tasks important because children in the upper kindergarten years can manipulate on a phoneme level. The tasks were designed for online interface, and kindergarten teachers and developmental teachers helped us to design the final version of the exercises. While designing the tasks we preferred the simple, concise, however, child friendly instructions and forms (e.g. robot, worm), at the same time we paid attention to avoid that the colourful images would draw children's attention from the task to be solved. Every exercise exclusively contained sound instructions, which children listened to by two- moment delay. Our aim with the two- moment delay was to provide some time for the children/pupils to process the images they could see on the screen, hereby not to strain the visual and audio perception at the same time.

Although as a result of the test development there was a change between the two first-graders' test, which was related to the structure of the tests and the visual appearance of one task type,   the beginning and the closing slides of the tests have remained the same during the testing. The opening page is for entering the identification number, while on the closing page not only the child's/pupil's performance is displayed using percentages, but also the number of balloons held by Piglet indicates the child/pupil performance. It is also common among the three data collections that slides giving instructions appear. The aim of the instructional slides is to call the attention to the procession of moving between exercises, that is, there are three steps to be followed: listening to the task, giving an answer and clicking on the arrow. The first instructional slide is to test whether the pupil can hear the exercise on a proper value, since both tasks for the children in kindergarten and the pupils studying at primary school are built on voice instructions; text instructions do not appear at all. The second instructional slide calls the attention to the orange stripe which shows the orientation and the tempo of the progress in the test, which is useful for pupils with attention deficit and the ones who have problems concentrating on the task when filling out the test.

During the recording of the test there are differences. In the case of the primary school pupils the data were collected in the computer lab with the guidance of the teachers, the transmitting media were desktop computers, while in kindergarten university students recorded the test in small groups (about five children) and the transmitting media were tablet computers with a touch screen.

All in all, within the framework of the present study can be divided into two parts built on each other:

1)      Pilot tests to examine some subskills of phonological awareness through online tests, to use the opportunities and meet the challenges of online examinations within the kindergarten age group

2)      Online testing of phonological awareness and the description of the online test development involving kindergarten age and first grade pupils.

**Research questions**

The research questions can be grouped around the testing of children's phonological awareness.

I.      Questions regarding the construct of phonological awareness:

Are the tests suitable for the measurement of the subskills in the given age groups?

Are the psychometric features of the tests appropriate?

How much does the difficulty of the tests suit the level of the students' skills?

Is the construct validity of the tests acceptable?

What relationships can be found between the subskills?

II.     Questions regarding the development of the phonological awareness within the examined age group and between the age groups:

How does the development of the phonological change within the examined age groups and between the age groups?

Which examined subskills affect most the development of phonological awareness?

III.    Questions relating to the measurement of phonological awareness and the background variables:

Does the ability to use the transmitting medium influence the results reached in the phonological test both at primary school and in the kindergarten age groups?

What relationships and differences appear with regard to the background variables?

**Hypotheses**

I.     Hypotheses referring to the instruments and the construct of phonological awareness:

H1: The tests reliably estimate the development of the primary school pupils' phonological awareness, and the psychometric features of the tests are appropriate.

H2: Based on the examination of the inner structure of the test (CFA) the size of the examined linguistic unit and the operation performed with the linguistic element jointly determine the performance given on the tests.

II.    Hypotheses applying to the development of phonological awareness:

H3: Despite the overlaps between the age groups the first grade pupils' performance in phonological awareness is higher.

H4: Within the different age groups of the samples including kindergarten children and first graders children show differences in the development of phonological awareness.

III.    Questions concerning phonological awareness and the background variables:

H5: The ability of using the transmitting medium (a PC or a tablet computer) does not influence the performance given on the tests either in the kindergarten or in the primary school sample.

H6: In line with the previous research a difference can be found in the performance between the genders (Price-Mohr & Mohr, 2017)

**The results of the phonological awareness test recorded in the primary school age group**

The test, which was developed for measuring phonological awareness at primary school involved 1301 pupils, proved to be a reliable instrument for the first graders of the primary school (Cronbach-$\alpha$=0,90). Although it is visible from the results that it is not possible to omit the tasks aiming phoneme identification during the measurement of the construct, the reliability of the tasks does not reach the desirable level (Cronbach-$\alpha$=0,63). On the basis of the person- item map it has been found that the tasks are separated along the given operational components independently from the size of the language element. The exercises of segmentation operational level seemed to be the most difficult for the children; they were followed by the exercises requiring identification, deletion and synthesis. The separation of phonological awareness construct by operations was supported even by the CFA model, which can be regarded to be fit ($\chi^2$= 2286, 649; p<0,01; CFI=0,910; TLI= 0,905; RMSEA=0,030). It has been found on the basis of the performance of the pupils on the test that the test is psychometrically appropriate since it is a little bit behind the desirable 50 % with regard to the sum test. However this fact also calls the attention to the differentiating power of subtests. Moreover, it can also be seen that the children who were 6.11 years old gave the best performance, in addition, the exercises differentiated their performance the best of all. The media effect appearing in innovative exercises was the strongest in the case of drag and drop items, therefore, these exercises need reconsideration.

**The results of the phonological awareness test recorded in the primary school age group**

In the second survey in which the first year children were tested, having used the experiences of the first test we were working only with phoneme level exercises, as well as the exercise requiring drag and drop was changed too. With this change the extent of the explained variance between the use of the computer and phonological awareness decreased. The test was recorded on 4342 pupils, 37 items seemed to be reliable, therefore, the test was reliable (Cronbach-$\alpha$=0,91). The average performance the pupils gave was 53, 87 %, which meets our requirements. In the case of phonemic level exercises the separation by operations is not significant, based on the personal item-map the segmentation and identification as well as synthesis deletion exercises are mixed on the item difficulty list. Furthermore, the strongest correlation can be observed between the synthesis and deletion exercises (r=0,59, p<0,01).

**The results of the phonological awareness test in the kindergarten group**

The kindergarten sample consisted of 311 children attending the kindergarten of the chief town of the county. Testing was different in methodology and style from the pattern applied at primary school, however, the tasks implemented were identical to the test items used at the first graders' phonological awareness test recorded at primary school. The test can be regarded to be reliable (Cronbach-α=0,84). Rasch analysis drew the attention to the fact that the tasks were separated on the level of operations, this fact was also supported by CFA model ($\chi^2$= 1088,160; p<0,01; CFI=0,905; TLI= 0,901; RMSEA=0,027), however, the factor weight of latent component of segmentation dissevers from the other three components. The children's average performance is acceptable on the level of the whole test, standard deviation of the segmentation exercises are high.

**The interpretation of the research results**

All the three tests delineated in the dissertation reliably measured the children's ability.

On the whole the test applied for the kindergarten group showed the lowest reliability index, however, it is worth mentioning that the sample was of a different size at the three testing points, in addition, after the examination of the test- item correlations and after omitting the syllable level exercises different number items were deleted. Regarding the whole test the lowest Cronbach- α value was found in kindergarten age group which had the lowest sample size. In the case of the subtests we can find lower reliability values which result in reconsideration of the given groups of items.

During the examination of the test construct as a first step we decided to examine the correlations, and then we applied confirmatory factor analysis. In the sample of the first graders we found a weak or moderate correlation. During the examination of the relationship of the whole test and the operations and tasks types it was found that the most determining operation was identification whereas the most determining item types were the identification of phonemes and the identification of the phonemes with the determination of the position of the sound type exercises. Since the correlation values were heterogeneous we utilized confirmatory factor analysis and we deployed five models from which we finally decided to create a nine-dimension model, which could be regarded to be fit according to its indicators. After having built the three model type it was possible to state that operations determined the inner construct of the test independently from the size of the linguistic unit. In the case of the kindergarten sample we worked with the same test. In the case of the test recorded in

kindergarten the correlation values are slightly weaker. During the CFA examinations we built five models, as a result we decided on creating a 9-dimension model. The structure of the 2015 phonological awareness test and the structure of the model of the kindergarten testing are identical. During the survey in 2016 the syllable level exercises were deleted from the test therefore the examination of the relationships focused only on phonemic level tasks. The whole test and the operations as well as the whole test and the item types mostly showed moderate, in some cases, high correlation values. Among the operations there are moderate correlations; the highest correlations can be observed between the phoneme identification and the phoneme identification with the position of the calling sound type exercises similarly to the 2015 sample. The present online test construct calls the attention to the role of the operations independently from the size of the language element both in the first grade of primary school and in the case of preschool aged children.

The hypotheses referring to the testing of phonological awareness and its background variables are to reveal the extent of the media effect as well as the differences in the performances between the genders. In order to examine the media effect we applied regression analysis to disclose the explained variance which determines relationship between the use of computers and phonological awareness tests. In the case of the kindergarten sample recorded in 2015 the tasks requiring clicking and drag and drop appear too, therefore, these operations were examined separately. The primary school sampling recorded in 2015 took place using desktop computers. The explained variance between the entire use of the computers and the phonological test results was a bit higher than the explained variance between the two tasks requiring drag and drop. The smallest explained variance was detected between the tasks requiring clicking and the phonological test items. In the case of the test recorded in the kindergarten the transmitting medium was a touchscreen tablet computer, therefore the mouse as an output device attached to the computer was not applied. During the testing in kindergarten 4 % smaller explained variance was detected between the use of the computer and the phonological test results, nevertheless, in the case of the clicking there was a bigger explained variance between the exercises. In the kindergarten medium between the tasks requiring drag and drop we could not discover significant correlations. In 2016 during the testing of phonological awareness only the exercises requiring clicking appeared and the transmitting media were desktop computers. The entire computer use test explains the overall performance given during the test to a smaller extent than in the case of 2015 sampling, thus, the deletion of drag and drop exercises could be regarded to be an effective step. The explained variance between the exercises requiring clicking was 1.5% larger than in the case

of the above mentioned sampling. On the whole it can be stated regarding the sum tests the smallest explained variance was shown in the case of the kindergarten testing where tablet computers were used (5,3%). We cannot make such a statement in the case of drag and drop exercises since the relationship in the case of the kindergarten sampling the correlation is not significant, whereas in the case of the exercises requiring clicking we experienced the smallest explained variance (2,9%).

The differences between genders became conspicuous in connection with the reading abilities (Price-Mohr & Price, 2017). In our country the research on preschool children (Nagy, 1980) and on primary school pupils (Józsa, 2004) brought the attention to the fact that there are approximately 1.5 month differences between the development of the two genders in favour of the girls, however, pedagogically it cannot be regarded as a significant developmental difference. Our results show the girls' advantage in all the three samples, nevertheless, the relationship can be considered to be significant only in the case of the 2016 sample.

**The theoretical and practical significance of the research**

The results of the research indicate several new trends. By the innovative test development, reconsiderations of the instruments a new opportunity opens not only for the researchers of the topic but for the people implementing the examinations, educators who represent the practical side. The innovative testing accelerates the survey procedure and gives objective results to the children about their performance, and in the case of a longitudinal examination it gives objective data about their development giving foundation, supplement to the intervention plan of the children/pupils. Literal assessments could be attached to the results, the children's results can be compared to the national, regional, county or municipal level results, additional data can be retrieved from the system, in terms of the time spent on the tasks, as well as we can get data about how many times the child listened to the instructions of the exercises and which distractor he/she chose when giving the wrong answer. These data can contribute to the foundation of successful, coordinated innovative work.

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