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Teachers' Knowledge about Students with Dyslexia and Professional Development

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Abstract

Ensuring a quality educational process requires competent teachers who are able to recognize the individual characteristics of students with dyslexia and provide them with appropriate support. This study on a sample of speech and language therapists (N = 18) and elementary school teachers (N = 431) had the following aims: (1) to determine the content validity of the Teachers' Knowledge about Dyslexia Scale, (2) to explore teachers' knowledge about students with dyslexia, and (3) to determine differences in teachers' knowledge about students with dyslexia according to their participation in different forms of professional development activities (pre-service, in-service, and self-directed learning). The constructed measuring instrument contains 29 statements about etiology, characteristics, and teaching strategies for students with dyslexia. The content validity was verified using the Delphi method in three rounds until a consensus of 90 % was reached by SLT experts. The Teachers' Knowledge about Students with Dyslexia Scale was applied to a sample of Croatian elementary school teachers of first- to eighth-grade students, who had experience in teaching students with dyslexia in the last three years. The results show that most teachers know some specific strategies for teaching students with dyslexia and, to a lesser extent, the causes of dyslexia. Most of the misconceptions regarding students with dyslexia are related to its causes and specific characteristics. A higher level of knowledge about dyslexia is possessed by teachers who have received professional training in teaching students with dyslexia through pre-service, in-service, and self-directed learning. A similar pattern of insufficient deep knowledge of the etiology and symptoms of dyslexia among the teachers was confirmed, clearly indicating the need for significant improvements in teacher competencies in all forms of professional development.

Keywords: knowledge, dyslexia, teachers, elementary school students, Delphi method, teachers' professional development.

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1. Introduction

Dyslexia is a specific disorder in the acquisition of reading and writing skills from the group of neurodevelopmental disorders diagnosed during the elementary school years and includes: "(1) problems with accurate or fluent word recognition, poor decoding and spelling skills, and difficulty with reading comprehension; (2) the presence of difficulties despite proper intellectual abilities, the absence of sensory, other psychological or neurological disorders, psychosocial adverse circumstances, inadequate knowledge of language of academic instruction, or inappropriate instruction; (3) the presence of difficulties for at least six months, despite the use of interventions designed to alleviate those difficulties." ([American Psychiatric Association, 2014: 67](#)).

Systematic reviews and meta-analyses have shown that the prevalence of dyslexia in primary school children is around 7 % worldwide, with significantly higher prevalence in boys than in girls ([Yang et al., 2022](#)). Research conducted in the Republic of Croatia indicates that around 10 % of school-age children have reading and writing difficulties ([Pašiček, Lenček, 1993](#)).

Teachers should have knowledge about etiological factors, characteristics/symptoms, and individualization strategies in order to teach students with dyslexia successfully. Knowledge about etiological factors is crucial for understanding the nature of the difficulties and the impact on the learning and teaching processes of students with dyslexia. There are different theories about the etiology of dyslexia: theory of phonological deficit ([Vellutino et al., 2004](#)), theory of deficit in rapid temporal processing ([Tallal, 1980](#)), visual ([Stein, 2018](#)), cerebellar ([Nicolson et al., 2001](#)), and magnocellular theory ([Ramus, 2003](#)). Equally, significant research has been conducted to clarify the relationship between various genetic risk factors and deficits present in dyslexia ([Francks et al., 2002](#); [Snowling, Melby-Lervåg, 2016](#)).

Within the medical model, the prevailing cognitive theory on the causes of dyslexia, the phonological theory, locates the deficits in the phonological component of language: insufficient phonological representations and problems in phonological processing, storage, retention and retrieval of phonemes ([Tallal, 1980](#); [Annett, 1996](#); [Hatcher, Snowling, 2002](#); [Nicolson, Fawcett, 2008](#)), and problems in the acquisition of phonological skills ([Elliot, Grigorenko, 2014](#)), i.e., the establishment of connections between graphemes and phonemes that are necessary for the acquisition of reading skills in alphabetic systems ([Nicolson et al., 2001](#); [Fletcher et al., 2007](#); [Snowling, Melby-Lervåg, 2016](#)). On the other hand, a more complete picture of dyslexia is obtained when the phonological theory is combined with the magnocellular theory or the double-deficit hypothesis. The double deficit hypothesis assumes the simultaneous presence of a deficit in phonological skills and a slower naming speed ([Wolf, Bowers, 2000](#)), while the magnocellular theory unites the propositions of individual theories of auditory, visual magnocellular, and cerebellar/motor deficits and assumes the existence of two direct causes of dyslexia – phonological and visual ([Stein, 2019](#)).

For the purpose of a more comprehensive explanation of dyslexia, a causal modeling framework, involving three interconnected levels, was proposed: (1) the biological level (e.g., genetic contributions, neuro-anatomical factors), (2) the cognitive level (e.g., impaired processing mechanisms), and (3) the behavioral level, which moves beyond the well-known problems in reading and writing and has significant variability within and between individuals ([Frith, 1999](#)). Within the same model, the influence of environmental factors that can aggravate or ameliorate the condition is also emphasized. From the educational perspective, environmental factors are particularly important because they include quality reading instruction programs, prevention and remediation interventions, trained teachers, and cultural factors, such as differences in the transparency of different orthographies ([Frith, 1999](#); [Fletcher et al., 2007](#)).

Although the problems with mastering pre-reading and writing skills are visible in the preschool years ([Lenček, Ivšac, 2007](#)), dyslexia is diagnosed at the elementary school age when, despite good skills and effort, the child has difficulties in mastering reading and writing skills and is falling behind their peers in terms of educational outcomes and academic success.

In Croatia, the following symptoms of dyslexia in reading/writing were found: difficulties in mastering phonemic awareness, recognizing and naming graphemes and matching them to the corresponding phonemes, insufficiently developed visual vocabulary, persistent spelling while reading, prolonged reading by joining syllables, pausing, repeating what is read, omitting, adding, and substituting graphemes, phonemes, and whole words, substituting syllables, difficulties in decoding pseudowords saturated with sounds/letters specific to the Croatian Latin alphabet, longer reading and writing time, failure to follow orthographic rules, and difficulties in orientation in the

text (Lenček, Ivšac, 2007; Lenček, 2012). Moreover, children understand what they read better if they read the text several times, and they rely on general knowledge and contextual factors when interpreting the text (Dulčić, Pavičić Dokoza, 2014).

Dyslexia may or may not co-occur with other disorders. Among related difficulties, it is most commonly associated with a writing disorder (dysgraphia), a disorder in the acquisition of mathematical knowledge and skills (dyscalculia), dyspraxia, language, communication, and ADHD disorders, which may alter the course and outcome of the disorder itself (American Psychiatric Association, 2014).

A combination of auditory or visual perceptual difficulties, motor and coordination difficulties, memory difficulties, organizational and sequential difficulties, and difficulties in understanding spatial and temporal concepts may also be present in some individuals with dyslexia (Wadlington et al., 1996; Waterfield, 2002; Alexander-Passe, 2006). Some students with dyslexia can also have difficulties in self-regulatory skills and socio-emotional development, a tendency toward depressive patterns in the self-regulation of learning, a lack of self-control, passivity, low motivation, an increased risk of school failure, a maladaptive attribution style associated with pessimistic attitudes toward future success, and insufficient use of effort (Humphrey, Mullins, 2005; Núñez et al., 2005; Martan et al., 2015a).

On the other hand, students with dyslexia have good cognitive abilities, and some of them develop above-average abilities (Waterfield, 2002). Students with dyslexia face numerous challenges in their daily lives, which are most evident in academic activities at school (Cornoldi et al., 2018). The described diversity and specificity of cognitive functioning points to the existence of strong and weak sides of students with dyslexia. Therefore, one of the fundamental questions of modern education is how teachers can recognize the potential and adapt the educational system to the strengths of different groups of students, including students with dyslexia.

Ensuring the conditions for quality education of all students implies an equal adoption of educational outcomes and realization of potential (Čepić, Kalin, 2017), in which the individualization of the teaching process is extremely important for realizing the maximum potential of students. The application of specific forms of support and adaptations in learning and teaching, evaluation and assessment, as well as an appreciation of difficulties and a consideration of the student's strengths and needs, require a high level of professional competency from teachers. The alignment of teacher competencies with the individual needs and capabilities of students is the basis of a quality educational process (Firth et al., 2013). With timely support from the education system, especially from competent teachers who teach students with dyslexia on a daily basis, the negative consequences of dyslexia can be minimized. These consequences may include socio-emotional difficulties, the risk of dropping out of school, juvenile delinquency problems, unemployment, and social isolation (Frisk, 1999).

In the Croatian educational system, students with dyslexia are taught in inclusive classes in regular schools (Pravilnik o osnovnoškolskom..., 2015) and their teachers have no opportunity to specialize in dyslexia. Teachers are considered insufficiently educated to work with students with dyslexia, while the guidance of speech-and-language therapists is rarely available to them (Martan et al., 2015b). Therefore, there is lack of formal and informal forms of professional development, and it is emphasized that knowledge is acquired mainly through self-directed learning (Martan et al., 2015b; Mullikin et al., 2021). It is important that teachers have knowledge about the cognitive and genetic factors related to dyslexia to understand that visible difficulties in reading, writing, and reading comprehension are related to neurodiversity. Thus, teachers' knowledge of the scientifically based causes of dyslexia affects the understanding of the underlying cognitive processes; it enables the teacher to provide instruction that is focused on the strengths of students with dyslexia and respects their individual learning pace. By contrast, insufficient knowledge about the etiological causes of dyslexia leads teachers to develop their own ideas about the reasons why students with dyslexia are unable to master literacy skills and learning outcomes, which may contradict scientific findings and lead to misconceptions about dyslexia. Indeed, it is well known that teachers in the past have often interpreted students with dyslexia as "lazy" and categorized them among "those who don't try hard enough".

Previous research has shown that there is a wealth of information on the knowledge of teachers related to the causes and symptoms of dyslexia, as well as intervention strategies. For example, the authors Wadlington and Wadlington (2005) created the Dyslexia Belief Index (DBI), which was replicated by Washburn et al., (2013) and Mullikin et al. (2021). The authors Soriano-

Ferrer and Echegaray-Bengoa, (2014) created the Knowledge and Beliefs about Developmental Dyslexia Scale (KBDSS), which was replicated by Soriano-Ferrer et al. (2016), Echegaray-Bengoa et al. (2017), Ramli et al. (2019), Yin et al. (2019), Sümer Dodur, Altındağ Kumaş (2021), and Peltier et al. (2022) created the Dyslexia Knowledge Questionnaire. Teachers' knowledge was most often studied in the form of scales with items that assessed knowledge of various facts about dyslexia or the degree of agreement or disagreement with various claims about dyslexia. The scales most commonly included knowledge of general information about dyslexia, knowledge of the causes and characteristics of dyslexia, and knowledge of the procedures for teaching/treating students with dyslexia and the so-called "myths about dyslexia." (Washburn et al., 2013; Soriano-Ferrer et al., 2016).

The results of recent research show that teachers' knowledge is mainly present in the area of general information about dyslexia, the recognition of the visible features of dyslexia in reading and writing, and basic procedures in teaching students with dyslexia (Wadlington, Wadlington, 2005; Bell et al., 2011; Washburn et al., 2013; Soriano-Ferrer, Echegaray-Bengoa, 2014; Soriano-Ferrer et al., 2016; Echegaray-Bengoa et al., 2017; Washburn et al., 2017; Nadelson et al., 2017; Ramli et al., 2019; Yin et al., 2019; Sümer Dodur, Altındağ Kumaş, 2020; Mullikin et al., 2021; Peltier et al., 2022). Ignorance of the cognitive and genetic factors associated with the causes of dyslexia and the endorsement of beliefs that are inconsistent with contemporary knowledge about dyslexia are indicators of a limitation in the ability to provide quality support to these students (Wadlington, Wadlington, 2005; Washburn et al., 2013; Mullikin et al., 2021).

In the Republic of Croatia, teachers' knowledge about teaching students with dyslexia is poorly researched. An examination of the factor structure of existing scales for assessing teachers' knowledge about dyslexia translated into Croatian (Wadlington, Wadlington, 2005), as well as the newly constructed scales (Martan et al., 2015b; Skočić Mihić et al., 2019), did not reveal the construct validity of the measuring instruments, and the internal-consistency coefficients were low. Although the lack of knowledge about dyslexia among teachers is well known and reported in a variety of cultures and educational settings, each national context develops its unique models for supporting these students due to socio-cultural specificities, especially the characteristics of particular languages and local educational regulations. In this paper, a unique approach to defining the corpus of teachers' knowledge about dyslexia is applied to include the opinions of speech-and-language-therapy experts, who provide treatment for students with dyslexia but also support teachers in the implementation of individualized curricula. The specificity of the Croatian educational context is that, of the two regulated professions working with students with dyslexia in education, the speech-and-language therapy (SLT) profession is the one that acquires specific competencies for working with students with dyslexia in initial education. On the other hand, the teaching profession does not have the opportunity to acquire competencies for working with students with dyslexia in the required courses of initial education, and the relevant materials are scarce and inconsistent in elective courses. In addition, in-service training programs do not enable teachers to acquire competencies for teaching students with dyslexia. Precisely because of the specific national context, which distinguishes the role of the SLT in diagnosing and treating students with dyslexia from the role of the teacher in teaching these students in the classroom, the application of the Delphi method in this study aims primarily to evaluate the content validity of the measuring instrument. At the same time, the use of the Delphi method represents a novelty in the research on teachers' knowledge about dyslexia.

Since determining content validity usually requires obtaining expert opinions, a research design was created that utilized the methodology of the Delphi technique by systematically obtaining expert opinions according to specific protocols. Therefore, the research included two samples of experts. The first sample included SLTs, who are experts in the treatment of students with dyslexia, and who evaluated whether the defined set of teacher knowledge about dyslexia was appropriate, meaningful, and useful. The second sample included teachers, who assessed their knowledge about dyslexia.

The unique position of SLT professionals is that they work individually with students with dyslexia and provide professional support to teachers in developing procedures for individualizing instruction. This dual role allows for a "deeper", more comprehensive and complex approach to defining and filtering the corpus of teacher competencies, which was one of the main motivating factors for this research project.

Thus, the purposes of this study were: (1) to determine the content validity of the Teachers' Knowledge about Students with Dyslexia Scale using the Delphi method, (2) to explore teachers'

knowledge about students with dyslexia, and (3) to determine differences in teachers' knowledge about students with dyslexia according to their participation in different forms of professional development activities (pre-service, in-service and self-directed learning).

2. Materials and methods

To determine the content validity of Teachers' Knowledge about Students with Dyslexia Scale, the Delphi method was used in three rounds. This is a qualitative research method designed as a group communication process based on the process of interviewing and discussion in at least two rounds with participants who are mutually anonymous. The collected data are processed after each round of research and presented to the participants again until a consensus is reached among them on the renewed research topic (Visković, 2016).

Participants

In accordance with the aim of this study, two samples were included: (1) experts (SLTs) who participated in the Delphi method, and (2) elementary school teachers.

Sample 1

The Delphi method involved 18 experts who worked with students with dyslexia. All of them had a Master's degree in Speech and Language therapy (SLT) and more than five years of work experience. It should be noted that, in the Republic of Croatia, SLTs are the only profession trained for the assessment and therapy of students with dyslexia, taking into account the assessments of other professions (especially psychologists) and information about the student's functioning in the school and family environment (Lenček, 2012). The snowball technique was used for sampling in 6 regions of the Republic of Croatia (City of Zagreb, Primorsko-Goranska, Istarska, Varaždinska, Međimurska, and Krapinsko-Zagorska counties), including two criteria: (1) experience in working with students with dyslexia and (2) willingness to provide feedback on the characteristics of these students, especially in the school context. The age range of the participants was 28 to 55 years, and their work experience ranged from 5 to 32 years. Of 18 participants, 1 was male. Fifteen participants were employed in public institutions at the time: early childhood education and care (ECEC) (1), elementary schools (11), higher education (1), and health care (2). Three participants were employed in private speech-and-language-therapy practice. All participants willingly accepted their participation in the Delphi method research aimed at improving educational practices for students with dyslexia. We believe that they were intrinsically professionally motivated and not a single participant withdrew from the research. After all three rounds had been completed, all participants were informed about the results of the Delphi method.

Sample 2

The constructed measuring instrument was applied to a sample of elementary school teachers in the second phase. The stratified sample included 431 elementary school teachers ($F = 377(87.5 \%)$) with experience in teaching students with dyslexia. Teachers were employed in 63 schools in six counties of the Republic of Croatia (Primorsko-Goranska, Istarska, Ličko-Senjska, Varaždinska, Međimurska, and Krapinsko-Zagorska counties). The sample included subject teachers (70.8 %) and classroom teachers (29.2 %) who taught students from first to eight grades. The average age of teachers was 42 years ($M(SD) = 42.97(9.24)$, $Min-Max = 25-65$) and the average professional experience was 17 years ($M(SD)=17.20(10.23)$; $Min-Max=1-44$). All teachers worked in inclusive classrooms in regular elementary schools. In the last three years, teachers had taught an average of three students with dyslexia ($M(SD) = 3,23(3,33)$), and about two-thirds of them (73.5 %) had written an individualized curriculum for the students with dyslexia. One-third of the teachers (30.2 %) had topics related to dyslexia during their initial education in various courses, and 44.1 % of them received professional training on dyslexia, most often in individually organized lectures at the school level. Most frequently, teachers acquired competencies about dyslexia through informal learning (65.4 %). Less than one-third of teachers (29.3 %) worked in schools where speech-and-language therapists were also employed.

Teachers' Knowledge about Students with Dyslexia Scale

The measuring instrument was developed in the more comprehensive research about teachers' competencies in the teaching of students with dyslexia (Martan, 2022). Its specificity lies in the selection and modification of a set of teacher knowledge about the causes and characteristics of dyslexia (e.g., Wadlington, Wadlington, 2005; Washburn et al., 2013; Soriano-Ferrer, Echegaray-Bengoa, 2014; Echegaray-Bengoa et al., 2017; Soriano-Ferrer et al., 2016) and knowledge about teaching procedures for students with dyslexia, designed in theory and guidelines

for teachers in the Croatian educational context. In the first phase, an instrument describing teachers' knowledge was constructed on a theoretical basis, and, in the second phase, its content validity was assessed using the Delphi method.

The newly constructed measuring instrument contained 29 items describing teachers' knowledge about dyslexia: (1) etiology (6 items), (2) characteristics (14 items), and (3) teaching strategies (9 items). The response format comprised "True (T)," "False (F)," and "I don't know." Examples of true or false items are as follows. (1) For etiology: "Due to hereditary factors, dyslexia is more common in some families" (T), and "One of the causes of dyslexia is intellectual disability" (F). (2) For characteristics: "One of the characteristics of dyslexia is non-fluent reading" (T), and "One of the characteristics of students with dyslexia is excellent working memory skills" (F). (3) For teaching strategies: "When teaching students with dyslexia, frequent repetition of content in different contexts is recommended" (T), and "When testing the knowledge of students with dyslexia, the students' specific errors in reading and writing should be evaluated" (F).

It was intended for an individual participant's score on the scale to be calculated as the total sum of correct responses, with one point assigned to each theoretically correct response and zero points assigned to each theoretically incorrect response and to the "I don't know" response.

Data collection

The research was conducted in two phases according to the set aims. In the first phase, the research was conducted electronically through e-mail correspondence using the e-Delphi method, while in the second phase, a measurement instrument in paper-pencil format was delivered to elementary school teachers.

Data collection from the first sample of experts was conducted according to the following procedure. The experts were contacted through their email addresses to give their consent to participate in the research. Upon the second contact, the experts received a protocol with a detailed cover letter describing the purpose and procedure of the research, measuring instrument, instructions on how to record their responses, and the approximate date for returning the material. The experts were assured of anonymity. They were asked: (1) to read each of the constructed items in detail, (2) to determine whether it was theoretically true or false, (3) to indicate if it described etiology, characteristics, or teaching strategies for students with dyslexia, (4) to provide suggestions for improving the scale, (5) to suggest the addition or elimination of certain proposed items, and (6) to correct errors or suggest language improvements for the understandability of items that were unclear, confusing, or ambiguous. Items on the scale were evaluated according to two criteria: (1) whether the item was true or false; and (2) whether the item belonged to etiology, characteristics, or teaching strategies. The Delphi-method procedure was conducted in three rounds until a consensus of 90 % was reached for both criteria for each item. If the level of consensus was lower than 90 %, the item was reworded or omitted according to the suggestions. After collecting responses and suggestions from participants, items were revised (eliminated, reworded, or added) and sent out for rereading and adaptation. The three rounds of data collection from experts lasted three months and all participants provided input for all three rounds.

In the second phase, data collection on a stratified sample of elementary school teachers was applied. The sampling procedure included three selection criteria, namely, the county, 30 % of randomly selected schools according to the database of the Ministry of Science and Education of the Republic of Croatia, and the experience in working with students with dyslexia in the last three years. The questionnaires were sent by mail to selected schools, whose principals gave consent for the research to be carried out, with information about the research and instructions to the coordinator for conducting the research at the school; the questionnaires were also returned by mail. The survey was conducted for five months. A total of 890 questionnaires were sent; 450 questionnaires (50.5 %) were returned, and 431 questionnaires (48.4 %) were included in further analysis.

Ethical review and approval for the research was obtained from the Ethics committee for scientific research of the University of Rijeka, Faculty of Humanities and Social Studies. The consent of the Ministry of Science and Education of Republic Croatia to conduct research with elementary school teachers was also obtained.

Statistical analysis

Categorical data were described in terms of frequencies and percentages and continuous data in terms of median and interquartile range. The construct validity of the scale was verified by exploratory factor analysis, and reliability by internal consistency type reliability analysis

(Cronbach's alpha). The normality of distribution was tested with Kolmogorov-Smirnov test. As data deviated from the normal distribution, the nonparametric Mann-Whitney U test was used to determine differences in teachers' knowledge about dyslexia according to participation in different types of professional development activities. Data were analysed using the SPSS 25.0 statistical package.

3. Results

3.1. Content validity verification of the Teachers' Knowledge about Students with Dyslexia Scale

The content validity verification process was conducted in three rounds, including the preparatory phase.

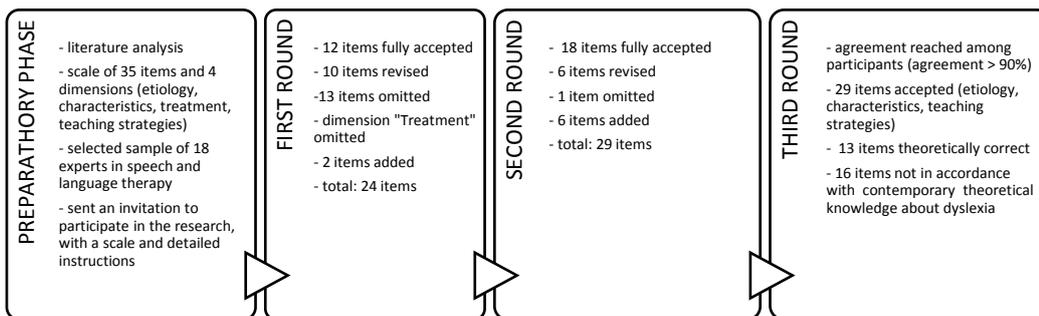


Fig. 1. Phases of the Delphi method implementation

In the preparatory phase, based on an analysis of existing instruments and a review of recent literature, a set of items covering relevant facts about: (1) the causes of dyslexia, (2) the characteristics of dyslexia, (3) the treatment of dyslexia, and (4) the teaching strategies for students with dyslexia was created. The selected items considered the characteristics of dyslexia and scientifically relevant facts about dyslexia and teaching students with dyslexia in the Croatian context. The initial version of the scale contained 35 items.

In the first round of the application of the Delphi method, participants were sent a protocol with 35 items by e-mail. Twelve items were accepted in full, while 10 items were linguistically reworded and then included in further analysis. Thirteen items were excluded. Of the thirteen excluded items, six fell into the "Treatment" category, three of which the participants suggested should be excluded entirely because they were not relevant to the domains of specific teachers' knowledge. Therefore, all the items from this category were excluded from further analysis, even though most of them individually met the acceptability criteria. Two items were added according to the participants' suggestions. The revised form of the Teachers' Knowledge about Students with Dyslexia Scale after the first round of the Delphi survey consisted of 24 items.

In the second round of the Delphi method, of the total of 24 items proposed, 18 were fully accepted (agreement > 90%). Considering the agreement of less than 90%, six items were reformulated, while one item was excluded. According to the participants' suggestions, six more items were added (four about the characteristics of dyslexia and two about teaching students with dyslexia).

In the third round of the Delphi method, the participants were sent a protocol with a total of 29 items, also by e-mail. After the third round of research, all the participants agreed with the proposed items in terms of truth/falsity and the particular categories to which they belonged. There was a 100% agreement for 24 items for truth/falsity of statements, while for five items, agreement was 94%. For category membership, agreement was 100% for 23 items and 94% for six items. In the third round, there were no additional comments, and the participants reached a consensus.

As a result of the application of the Delphi method, the Teachers' Knowledge about Students with Dyslexia Scale contained 29 items based on current theoretical knowledge about dyslexia. Regarding the items about etiology, the theoretically correct statements included the cognitive and neurobiological causes of dyslexia, while misconceptions were related to the perception of external factors or intellectual disabilities as causes of dyslexia. The items about dyslexia characteristics included theoretically correct statements about symptoms and the strengths of students with dyslexia in the educational process, while misconceptions included characteristics that do not relate to students with dyslexia. The teaching-strategy items included theoretically correct statements aligned

with the difficulties and strengths of students in the teaching process, whereas the misconceptions described various instructional strategies not appropriate for students with dyslexia.

After obtaining the results of the Delphi method, a factor analysis was performed to determine the construct validity of the scale. All 29 items on the scale explained 18.6 % of the variance of the factor of teachers' knowledge about dyslexia, with a characteristic root of 5.393. The reliability-coefficient Cronbach alpha was 0.66.

3.2. Teachers' Knowledge about Students with Dyslexia Scale (descriptive data)

Table 1 presents descriptive data on the number of participants and the percentage of responses for the 29 items of the constructed Teachers' Knowledge of about Students with Dyslexia Scale.

Table 1. Teachers' Knowledge about Students with Dyslexia Scale

Teachers' Knowledge about Students with Dyslexia Scale	%		
	True	False	Do not know
One of the causes of dyslexia is poor methods of teaching reading. (F)	7.5	77.2	15.4
Deficits in the phonological component of language at the level of phonological processing are one of the causes of dyslexia. (T)	35.4	20.4	44.3
Dyslexia is based on neurological differences. (T)	69.6	5.9	24.6
One of the causes of dyslexia is insufficient student effort. (F)	5.1	87.4	7.5
Due to hereditary factors, dyslexia is more common in some families. (T)	45.8	11.4	42.8
One of the causes of dyslexia is intellectual disability. (F)	19.5	59.8	20.7
Some characteristics that may indicate dyslexia can be observed before the reading automation stage. (T)	74.1	4.0	21.9
One of the characteristics of dyslexia is non-fluent reading. (T)	85.5	10.5	4.0
Signs of dyslexia are expressed exclusively in the substitution of the graphemes <i>b</i> and <i>d</i> in reading. (F)	9.3	81.4	9.3
One of the characteristics of dyslexia is prolonged "spelling" in reading after the acquisition phase of initial reading. (T)	57.5	12.9	29.7
One of the characteristics of dyslexia is difficulty in reading comprehension. (T)	86.2	7.5	6.3
One of the characteristics of dyslexia is difficulty in logical reasoning. (F)	27.4	58.1	14.5
One of the characteristics of students with dyslexia is good time-management skills. (F)	6.6	40.5	52.9
One of the characteristics of students with dyslexia is good visual and imaginative ability. (T)	24.8	37.9	37.2
One of the characteristics of students with dyslexia is above-average ability in some areas of creative expression (e.g., visual expression, music, dance, or acting). (T)	57.7	14.2	28.1
One of the characteristics of students with dyslexia is excellent working-memory skills. (F)	24.7	27.0	48.4
One of the characteristics of dyslexia is a lower ability to achieve all educational outcomes. (F)	23.8	61.2	15.0
Students with dyslexia have a disparity between scores on written and oral knowledge tests. (T)	94.7	3.2	2.1
Difficulties in acquiring basic academic skills are the same in form and degree for all students with dyslexia. (F)	3.3	88.4	8.4
The symptoms of dyslexia disappear in adulthood. (F)	4.4	76.0	19.5

For most students with dyslexia, the curriculum content of subjects should be reduced. (F)	34.6	55.8	9.6
When adapting teaching and testing materials for students with dyslexia, it is sufficient to use an appropriate font and increase the font size. (F)	12.1	79.8	8.1
When teaching students with dyslexia, it is recommended to use mind maps, schematic diagrams, and pictures to make the lesson content visually clear. (T)	94.9	1.2	3.9
When teaching students with dyslexia, it is important to additionally check that the student has understood the written instructions or the task. (T)	97.7	0.2	2.1
When teaching students with dyslexia, frequent repetition of content in different contexts is recommended. (T)	83.7	5.3	10.9
When testing the knowledge of students with dyslexia, the students' specific errors in reading and writing should be evaluated. (F)	12.5	78.4	9.0
Impaired reading speed and accuracy should be practiced by reading aloud in class. (F)	11.7	78.0	10.3
When testing the knowledge of students with dyslexia, oral tests should be preferred along with written tests. (T)	96.5	1.9	1.6
It is desirable to correct specific errors in the written work of students with dyslexia with red ink. (F)	14.0	70.2	15.8

Notes: T = true; F = false

The first part of the descriptive analysis contained items which the largest percentage of participants answered correctly, according to the descriptive indicators. This was followed by items which the majority of participants answered either incorrectly or with "I do not know". A similar model of descriptive analysis can be found in other papers on this topic (Wadlington, Wadlington, 2005; Washburn et al., 2013; Mullikin et al., 2021). The teacher-response accuracy ranged from 35 to 87 % for the etiology items, from 25 to 95 % for the characteristic items, and from 57 to 97 % for the teaching-strategies items.

Concerning all parts of the scale, the most frequent correct answers were found on the items that explore specific teaching procedures and the characteristics of students with dyslexia that are visible in the teaching process at different educational levels (e.g., the importance of additional checks on the comprehension of written tasks, oral knowledge tests, the visually clear presentation of teaching content, discrepancies in written- and oral-knowledge-test scores). More than 90 % of the teachers answered the above items correctly. In addition, it was found that a high percentage (with an accuracy of answers of about 80 %) of teachers answered correctly the items describing difficulties in the reading mastery of students with dyslexia (e.g., early signs of dyslexia, reading fluency and comprehension problems, symptoms of dyslexia not expressed exclusively in the substitution of graphically similar phonemes).

Marking the "I do not know" response to certain items reflects the teacher's uncertainty about the accuracy or inaccuracy of a particular statement and/or lack of knowledge. The highest percentage of "don't know" responses was recorded on the items describing the causes and characteristics of dyslexia (e.g., deficits in the phonological component of language, hereditary factors associated with dyslexia, poor time-management skills, working-memory problems and strong visual skills).

The teachers' most frequent incorrect responses were found on items describing various characteristics that may be present in students with dyslexia (e.g., the strengths of students with dyslexia and working-memory problems). Furthermore, one-third of teachers believe it is true that students with dyslexia have difficulties with reasoning, need reduced curriculum content, and are less able to achieve all educational goals.

An individual participant's score on the scale was calculated as the total sum of correct answers, with 1 point assigned to each theoretically correct answer and 0 points assigned to each theoretically incorrect answer and to the answer marked "I do not know." It was found that out of the total 29 items of the Teachers' Knowledge about Students with Dyslexia Scale, the teachers

answered 20 items correctly, i.e., 68.9%, on average. The obtained composite variable ($M = 20.13$; $SD = 3.707$) deviated statistically significantly from the normal distribution ($z = 0.114$; $p < .001$).

3.3. Differences in teachers' knowledge about students with dyslexia according to participation in various forms of professional development activities

To determine whether there were statistically significant differences in the teachers' knowledge about students with dyslexia according to their participation in different forms of professional development activities (pre-service, in-service, and self-directed learning), the Mann–Whitney U test was conducted (Table 2).

Table 2. Differences in the teachers' knowledge about students with dyslexia according to their participation in different forms of professional development activities

		Pre-service training		In-service training		Self-directed learning	
		Yes	No	Yes	No	Yes	No
Teachers' knowledge about students with dyslexia	N	129	282	186	229	276	135
	C(Q ₃₋₁)	21(5)	20(4)	22(5)	20(4)	21(4)	19(5)
	U	14673.000**		13589.000***		11570.500***	
	z	-3.160		-6.370***		-6.269	
	r	0.16		0.31		0.31	

Notes: U = Mann–Whitney U test; N = number of teachers; C = median; Q₃₋₁ = interquartile range; r = effect size; Yes = participated in professional development; No = did not participated in professional development; ** $p < .01$; *** $p < .001$.

The results indicated that statistically significant differences were found in the teachers' knowledge about teaching students with dyslexia in relation to the teachers' participation in professional development. The teachers who covered at least one topic about teaching students with dyslexia on various courses during their initial training, and who had participated in in-service training and self-directed learning in the previous three years, showed higher levels of knowledge about teaching students with dyslexia. The effect-size coefficients indicate a small effect of pre-service training and a medium effect of in-service training and self-directed learning on teachers' knowledge about students with dyslexia.

4. Discussion

In accordance with the first research aim, the content validity of the newly constructed Teachers' Knowledge about Students with Dyslexia Scale was confirmed as unidimensional construct. One of the priority tasks of this study was to focus on the Delphi method due to the objectivity of the assessment, the understanding of the process, the generation of ideas, and the achievement of consensus among the experts involved. For the purpose of this study, the SLTs were selected for their expertise in diagnosing and treating students with dyslexia, and some of them were employed in educational institutions. With the consensus reached, the experts modified and confirmed the necessary set of dyslexia knowledge that included 29 statements on the etiology and characteristics of dyslexia and on appropriate instructional strategies for students with dyslexia.

According to the second aim, insufficient teachers' knowledge about students with dyslexia was established, similar to other findings (Wadlington, Wadlington, 2005; Soriano-Ferrer, Echegaray-Bengoa, 2014; Soriano-Ferrer et al., 2016; Echegaray-Bengoa et al., 2017; Washburn et al., 2017; Ramli et al., 2019; Yin et al., 2019; Sümer Dodur, Altındağ Kumaş, 2020; Mullikin et al., 2021; Peltier et al., 2022). Knowledge about dyslexia varies widely among Croatian teachers (25-97 %) in degrees and types of information. The majority of teachers know that appropriate accommodations in classroom for students with dyslexia are needed, such as the use of oral testing, the use of additional oral verification for the written instructions and the use of mind maps, schematic diagrams, and pictures to visually clarify the lesson content. In addition, teachers know that dyslexia is not caused by insufficient student effort neither inappropriate teaching methods.

The stereotypical statements to students that they just need to try a little harder in order to overcome the disorder are less common compared to the past. The finding that teachers know that difficulties in reading and writing do not depend on students' insufficient effort or teaching methods sheds light on the true nature of the disorder, that students with dyslexia have difficulties in reading fluency and reading comprehension. The role and responsibility of teachers, who are in a unique position of daily interaction with students with dyslexia, is of immeasurable importance in identifying the characteristics of dyslexia that are most visible at school age (Ramli et al., 2019). In today's classroom practice, the early identification of students with dyslexia and appropriate support increases the likelihood of their success (Dyson, Skidmore, 2003; Carvalhais, da Silva, 2010). Because of the characteristics of dyslexia that are sometimes not immediately apparent, some of which even overlap with the characteristics of other learning difficulties, teachers may sometimes ignore dyslexia in students or confuse it with other difficulties, lack of motivation and effort, or with an unfavorable family situation (Dockrell, Lindsay, 2001).

On the other hand, only one third of teachers know about the cognitive and neurobiological causes and characteristics of dyslexia. For example, that the cause of dyslexia is a deficit in the phonological component of language at the level of phonological processing and that dyslexia is more common in some families due to hereditary factors, which is similar to the findings of Soriano-Ferrer et al. (2016). Teachers should have knowledge about the causes of dyslexia in order to understand the cognitive processes of students with dyslexia, which are invisible to them but are extremely important in shaping the teaching process. When teachers do not know what causes dyslexia, they form their own interpretations, which may be incorrect. For example, the fact that the student performs worse on reading and writing tasks compared to other educational outcomes may lead to the conclusion that only more practice can remedy the difficulty in mastering a literacy skill. This may influence the negative consequences of such teacher attitudes, which are rooted in insufficient knowledge. Ignorance of the causes and neurobiological factors of dyslexia can lead to inappropriate teaching, whereas specific knowledge of the etiology of dyslexia ensures quality teaching that is responsive to the needs of students (Dockrell, Lindsay, 2001). Only a quarter of teachers know that students with dyslexia have potential strengths in visual and imaginative ability, visual capacity, and imagination. Some individuals with dyslexia show above-average results on tests of general creativity and originality in thinking (LaFrance, 1997; Tafti et al., 2009; Cancer et al., 2016), global spatial abilities (Von Károlyi, Winner, 2004), and visual spatial memory (Tafti et al., 2009). Empirical research on areas of the potential talents of students with dyslexia related to visual skills and creativity is also sparse and inconsistent (LaFrance, 1997; Winner et al., 2001; Von Károlyi, Winner, 2004). Teachers should focus on students' strengths, which primarily means knowing how to recognize them. Teaching based on the strengths and potentials of students with dyslexia enables improvements in their basic academic skills, self-confidence, and confidence in their academic abilities (Singer, 2008). When teachers understand a student's strengths (Dyson, Skidmore, 2003), they are more able to provide appropriate accommodations to ensure the maximum development of students' potential (Singer, 2008; Antoniazzi et al., 2010).

If we focus on what teachers say they do not know, it is evident that almost half of teachers do not know that students with dyslexia can have deficits in working memory (48 %), in time-management skills (53 %), in the phonological component of language at the level of phonological processing (44 %), and that dyslexia is more common in some families due to hereditary factors (42 %). Insufficient knowledge about dyslexia could lead teachers to apply inappropriate accommodations (Lenček, 2012). The facts about dyslexia about which teachers consider they have no knowledge indicate their real educational needs and this finding is critical in the context of teachers' professional development.

Similar to previous findings (e.g., Wadlington, Wadlington, 2005; Soriano-Ferrer et al., 2016; Echegaray-Bengoa et al., 2017), teachers' misconceptions about dyslexia were also noted. More than a third of teachers believe that students with dyslexia do not have good visual or imaginative abilities and that the curriculum content of subjects should be reduced, and a quarter of teachers believe that dyslexia is a difficulty in reasoning and that students with dyslexia have a lower ability to achieve all educational outcomes. This is compounded by the fact that around 40 % of teachers do not know or have a misconception surrounding the fact that dyslexia is caused by intellectual and reasoning difficulties, which is consistent with studies in Ghana, Spain, and Peru (Soriano-Ferrer et al., 2016; Acheampong et al., 2019). By contrast, in most studies in Anglo-Saxon countries, teachers do not associate dyslexia with intellectual disabilities (Bell et al., 2011;

Washburn et al., 2017). Knowledge of the cognitive abilities of students with dyslexia is essential. Based on this, teachers can make appropriate accommodations without reducing the curriculum.

Obviously, seems that misconceptions about dyslexia are rooted among teachers. Knowledge about dyslexia is the basis for teachers to ensure high quality teaching. Teaching students with dyslexia in classrooms using standard teaching materials and strategies is not aligned with their educational needs (Skočić Mihić et al., 2021). In order for teachers to provide quality education for students with dyslexia, they need to know (1) the characteristics of students that are strongly influenced by cognitive and neurobiological differences due to etiological causes, (2) how they manifest in the learning process, and (3) which teaching strategies are needed in classroom. Only accommodations that are scientifically and theoretically grounded, consider the strengths of students with dyslexia, and respect their individual learning pace to progress.

Taking into account the above findings about teachers' insufficient knowledge and misconceptions, it becomes clear how important teachers' professional development is for developing competencies for teaching students with dyslexia. Questions arise about how teachers can provide appropriate instructions for students with dyslexia if they do not have adequate professional development, through which they can acquire the necessary competencies.

According to the third aim of this study, differences in teachers' knowledge about students with dyslexia are established according to participation in different forms of professional development (pre-service, in-service, and self-directed learning). The planning, organization, and development of various professional development programs should be based on an objective assessment of needs, conditions, and opportunities, and should lead to improvements in teachers' knowledge and skills or competencies. Teachers' professional development is a lifelong learning process. It is important for teachers to be able to assess their competencies and know how to evaluate their professional development activities (Čepić et al., 2017; Čepić et al., 2019; Čepić, 2020). The complex relationship between educational needs, conditions, and opportunities offers guidelines for reflecting on and improving curriculum planning in the context of teachers' professional development (Čepić, 2020). The same author points out that despite the recognition of the importance of professional development and the pressures arising from current educational needs, most professional development opportunities remain fragmented, insufficiently linked to curricula, and inadequately adapted to teachers' needs, conditions, and opportunities. Due to the adaptation to individual needs, the purpose of professional development should be to enable teachers to strive for and apply new knowledge in the profession, share interdisciplinary experiences, and acquire the highest level of professional competency (Čepić, Kalin, 2017; Kalin, Čepić, 2019).

Improving the quality of teaching during initial training can contribute to relevant knowledge about dyslexia and teaching students with dyslexia. A question may be raised as to how realistic it is to expect teacher-training programs to be adjusted to provide specialized knowledge in dyslexia in an already crowded curriculum. It is necessary for student teachers to gain at least a minimum amount of experience with students with dyslexia during their student practice or volunteering, which can have a positive impact on their attitudes and sensibilization to the needs of students with dyslexia in the early phases of their professional development. Certainly, post-graduate programs and/or professional development opportunities for early-career teachers seem to be more realistic. One example is to offer micro-qualifications (so-called micro-credentials/minors) that enable the acquisition of relevant skills necessary for inclusion in the work process. In the Croatian educational context, most dominant forms of professional training for teachers about dyslexia is organized by the Education and Teacher Training Agency, in the form of short lectures at the request of schools that express a need for this type of education. It is necessary to develop modular programs for teachers' professional development, lifelong-learning programs, and specialized postgraduate programs on dyslexia to arrange conditions and opportunities that can contribute to additional training and professional development, particularly concerning teaching students with dyslexia. The contribution of this work is its shedding of light on teachers' knowledge of teaching students with dyslexia in the Republic of Croatia, which could be useful in creating professional development programs for subject and classroom teachers.

The results of this study are valuable in several key respects. First, in this research, a measuring instrument was created to assess teachers' knowledge about dyslexia based on dyslexia theory and previous research. According to the information available to the authors, this is the first study in which the content validity of the Teachers' Knowledge about Dyslexia Scale was determined using the

Delphi method. Thus, the contribution of this study is the application of the Delphi method, which proved to be useful in the creation of the Teachers' Knowledge about Students with Dyslexia Scale and can be used for the development of other instruments on this topic.

The second specific contribution of this study lies in its unique research design, in which experts in the field of SLT examined the validity, modified and added items that examined teachers' basic theoretical knowledge about the etiology, symptoms, and strategies for teaching students with dyslexia. The research was based on the principles of inclusive education and the social model, and teachers' knowledge about dyslexia is considered a resource for ensuring quality learning and teaching. The opinions of professionals who are involved in the treatment of students with dyslexia enabled particularly valuable insights about what teachers need to know about the etiology, the basic characteristics of students with dyslexia, and teaching and assessment accommodations. On the other hand, according to their opinion, knowledge about the therapeutic procedures (treatment) for students with dyslexia performed by SLTs is not one of teachers' key areas of knowledge because Croatian teachers do not use it in classrooms. Expertise is the path to a scientific and professional interdisciplinary contribution to the progress and well-being of students.

Third, the created set of items is relevant worldwide because they refer to basic knowledge about dyslexia, which is part of the diagnostic criteria of the DSM-5. At the same time, it is adapted to the specificities of the national educational context. Thus, this study makes a valuable contribution to the understanding of teachers' generic knowledge about dyslexia, which is related to the neurodiversity of this group of students and is not conditioned by specific sociocultural factors, such as language transparency, educational context, support, or others. On the other hand, the items of the measuring instrument examine teachers' knowledge about dyslexia as determined by the national context, i.e., educational policies describing the form of schooling and professional support for students with dyslexia.

The limitations are related to the narrowly defined aim of this study, which focuses deliberately on the content validity of the scale, which was chosen to provide a deeper insight into teachers' knowledge. There is also a need to include other methods of investigating teachers' knowledge about dyslexia, such as open-ended questions or guided interviews.

5. Conclusion

Ensuring a high-quality educational process requires competent teachers who are able to recognize the individual characteristics of students with dyslexia and provide them with appropriate support. Teachers play an important role in the identification and referral of students suspected to have dyslexia, and this process can only be improved if teachers have accurate knowledge about dyslexia and effective teaching accommodations, so that any student with reading difficulties can be supported in the classroom.

Although the lack of knowledge about dyslexia among teachers is well-documented in studies, this study is based on what experts consider necessary knowledge that teachers should possess to ensure the maximum development of the potential of students with dyslexia. The assessment of relevant teachers' knowledge about dyslexia in order to respond professionally and qualitatively to the educational needs of students with dyslexia from the perspective of experts is a methodological strategy rarely used in research. Therefore, in order to provide important insights into teachers' necessary knowledge from the perspective of experts working with students with dyslexia, a newly constructed instrument was developed with content thematically adapted to the area that covers causes, characteristics, and teaching procedures. Content validity was verified using the Delphi method in three rounds in which 18 experts (SLTs) agreed on their assessments of teachers' necessary knowledge about dyslexia.

The obtained results indicate a similar pattern of inadequate teacher knowledge of dyslexia's causes and symptoms. Teachers need different types of knowledge about dyslexia, primarily about its etiology and the strengths of students, which is the basis for understanding the visible and manifest problems associated with it, as well as accommodations based on scientific and theoretical expertise and examples of good practice. This clearly indicates the essential role of teachers' professional development. That is, teachers who have received professional training in teaching students with dyslexia through pre-service, in-service, and self-directed learning have higher levels of knowledge about dyslexia. Professional development programs are often unsuccessful because they do not anticipate the competencies that teachers need in practice. It is important to point out that the teaching of students with dyslexia should be based on knowledge about dyslexia to provide

appropriate teaching accommodations. This is in line with the social inclusion model, which supports the rights of people with dyslexia and the recognition of their potential.

This study can contribute to the exploration of knowledge about dyslexia in a national and international research context with an approach based on (1) a theoretical body of knowledge about what teachers should know about dyslexia, (2) a scientific research approach that includes a review of relevant research on teachers' knowledge about dyslexia, and (3) expert opinions from professionals who have unique insights into the educational needs of students with dyslexia and the competencies of teachers in supporting these students through accommodations of learning and instruction. In addition, the implications of this study show the possibilities of an interdisciplinary approach, which involves experts specialized in the treatment of students with dyslexia in defining relevant teacher knowledge, as well as teachers themselves. This would contribute to success in creating teacher professional development programs that respond to the educational needs of teachers and their students.

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