



Norwegian classroom teachers' and specialized "resource" teachers' dyslexia knowledge

Oddny Judith Solheim^{1,2} · Julie Arntzen¹ · Njål Foldnes¹

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Abstract

Students with reading difficulties such as dyslexia receive most of their instruction in mainstream classrooms, but many teachers feel inadequately prepared to teach students with dyslexia and/or report that dyslexia was inadequately addressed in their training. However, depending on a school's organization, it may be sufficient that classroom teachers know enough to realize when to ask for support with identification and accommodation from specialized teachers with greater knowledge. In the present study we first investigate dyslexia knowledge in a sample of Norwegian upper-elementary-school teachers ($N=269$). Second, we examine whether specialized ("resource") teachers are more knowledgeable about dyslexia than classroom teachers. Finally, we explore whether teaching experience and having encountered reading-related themes in formal training predict dyslexia knowledge. Overall, we find that only a small share of teachers holds misconceptions about dyslexia. However, a notable proportion of them are *uncertain*, especially regarding the role of visual deficits in dyslexia. Somewhat surprisingly, resource teachers have only marginally higher dyslexia knowledge than classroom teachers. Finally, neither experience nor reading-related course content in formal training are substantial predictors of dyslexia knowledge. The large extent of uncertainty concerning dyslexia suggests a need to reconsider teacher training curriculum and opportunities for teacher professional development.

Keywords Teacher knowledge · Dyslexia · In-service teachers · Elementary education · Special education

✉ Oddny Judith Solheim
oddny.j.solheim@uis.no

¹ Norwegian Center for Reading Education and Research, University of Stavanger, Stavanger, Norway

² Present Address: Institute of Education and Sport Science, University of Stavanger, Stavanger, Norway

Introduction

The principle of inclusive education implies that students with learning difficulties, such as dyslexia, should receive most of their instruction in mainstream classrooms (UNESCO, 1994). Still, studies from a wide range of educational contexts have found that many teachers lack knowledge about important aspects of dyslexia, feel inadequately prepared to teach students with dyslexia, and/or report that dyslexia was inadequately addressed in their training. Such findings have been reported, *inter alia*, from China (Yin et al., 2020), England and Wales (Knight, 2018), New Zealand (Dymock & Nicholson, 2022), Norway (Grimsæth & Holgersen, 2015), Peru and Spain (Soriano-Ferrer et al., 2016), South Africa (Geertsema et al., 2022), Saudi Arabia (Abed & Shackelford, 2022), Turkey (Tosun et al., 2021), and the United States (e.g., Gonzalez, 2021; Peltier et al., 2022; Washburn et al., 2017). Although it would be unrealistic to expect all teachers to have in-depth knowledge of dyslexia, it seems reasonable to expect that structures at the school level will ensure that teachers can obtain support from more knowledgeable colleagues. Concretely, although all teachers should possess some basic knowledge about dyslexia, it may be sufficient for more detailed knowledge about assessment, diagnosis, and effective approaches to remediating and compensating for dyslectic difficulties to be held by certain teachers or special-needs teams with a specific responsibility for supporting general teachers in their work with students with dyslexia. This arrangement indeed seems to be common. However, few studies have investigated whether there actually are differences in dyslexia knowledge between teachers serving such different functions within the school structure. In the present article, we investigate dyslexia knowledge in a sample of Norwegian teachers and compare dyslexia knowledge in two different groups of teachers working in the same schools: classroom teachers and teachers with specific responsibility for accommodating for students with special needs and providing guidance for classroom teachers in how they should support those students. We also investigate whether teaching experience and reading-related course content in formal training are related to dyslexia knowledge.

Why do school professionals need to be knowledgeable about reading instruction and reading difficulties?

In recent years, awareness has grown that teachers need to have accurate knowledge of reading instruction and reading difficulties such as dyslexia (see, e.g., Department of Education, 2015; International Dyslexia Association, 2018; Rose, 2009). There are several reasons for this. An accumulating research base shows that early interventions are more effective than later ones for students at risk of reading difficulties (see, e.g., Snowling, 2013). Early intervention presupposes early identification. Virinkoski et al. (2018) found that more knowledgeable teachers were better able to identify first-grade students at risk of reading difficulties, and also better at judging students' reading level. Accurate recognition of a student's reading level is a prerequisite for providing individualized instruction, which experimental studies have

found to positively affect students' reading (Connor et al., 2009, 2013). Also, in a longitudinal study combining teacher reports, classroom observations, and student assessment, Piasta et al. (2009) found that more knowledgeable teachers provided higher-quality literacy instruction, which again was associated with better student outcomes. High-quality, explicit, and individualized instruction is particularly valuable for students who are at risk of, or have been identified as having, dyslexic difficulties (Moats, 2019). Also, Hornstra et al. (2010) argue that dyslexia knowledge is important because it might affect teachers' attitudes toward and expectations of students identified as having dyslexia. Gentrup et al. (2020) investigated the link between teacher expectations and student achievement longitudinally in a sample of 64 first-grade classrooms and found that (inaccurate) low teacher expectations were associated with lower achievement in reading. Regarding other school professionals, Schraeder et al. (2021) found that school principals who had greater knowledge and more correct beliefs about dyslexia provided more appropriate school-based services for students with dyslexia. To our knowledge, no studies have investigated how teachers' levels of dyslexia knowledge specifically affect instruction and student outcomes.

Dyslexia

Before we look more closely at what previous research has taught us about what teachers know about dyslexia, we will briefly summarize the characteristics and prevalence of dyslexia. Dyslexia is a primarily language-based learning difficulty characterized by unexpected and persistent difficulties in learning to decode and spell (Lyon et al., 2003; Snowling et al., 2020). Secondary problems include the absence of fluent reading, poor reading comprehension, and weak reader self-beliefs (Georgiou et al., 2022; Hanich & Jordan, 2004; Lyon et al., 2003; Pulkkinen et al., 2022; Snowling et al., 2020). Dyslexia is a persistent learning difficulty that cannot be outgrown, but an accumulating research base shows that individuals identified as having dyslexia can improve their reading skills and learn to compensate for their difficulties if they are given the right support (see, e.g., Hall et al., 2022), and larger effect sizes have been reported for early interventions than for later ones (Snowling, 2013). Regarding prevalence, the use of different operationalizations of dyslexia across empirical studies has caused estimates of prevalence to vary. The most common prevalence estimations are in the range of 3–7% of the population (Snowling & Melby-Lervåg, 2016; Yang et al., 2022), but estimates vary from under 5 to 15% (Wagner et al., 2020).

Teachers' knowledge about dyslexia

Descriptive studies of teachers' dyslexia knowledge have been reported from a range of countries and educational contexts. Interestingly, even if the general level of knowledge tends to be lower in contexts where there has been little focus on dyslexia, such as in China (Yin et al., 2020), the pattern is quite similar across contexts. One aspect of this pattern is that many teachers know how dyslexia manifests

behaviorally, namely through problems with decoding, spelling, and fluency (e.g., Echegaray-Bengoa et al., 2017; Gonzalez, 2021; Knight, 2018; Mullikin et al., 2021; Peltier et al., 2022; Soriano-Ferrer et al., 2016). In other words, many teachers seem to possess knowledge that is important for *detecting* students who have dyslexia. By contrast, more teachers are uncertain about foundational aspects of dyslexia, such as whether it is hereditary (e.g., Abed & Shackelford, 2022; Echegaray-Bengoa et al., 2017; Mullikin et al., 2021; Peltier et al., 2020, 2022; Yin et al., 2020), whether it is related to general abilities (Abed & Shackelford, 2022; Peltier et al., 2022), and whether it can be outgrown (e.g., Gonzalez, 2021; Washburn et al., 2014, Yin et al., 2020). Hence, more teachers seem to lack knowledge that is important for *providing appropriate support and interventions*. A further aspect of the above-mentioned pattern is that one particular misconception—the belief that dyslexia is caused by a visual deficit, which is often referred to as “the visual-deficit misconception”—has been found to be highly prevalent across educational contexts, and in samples of both pre-service teachers (e.g., Echegaray-Bengoa et al., 2017; Washburn et al., 2011, 2014; White et al., 2020), in-service teachers (e.g., Abed & Shackelford, 2022; Echegaray-Bengoa et al., 2017; Gonzalez, 2021; Knight, 2018; Macdonald et al., 2017; Mullikin et al., 2021; Peltier et al., 2022; Yin et al., 2020), principals (Schraeder et al., 2021), teacher trainers (Wadlington & Wadlington, 2005), and the general public (Castillo & Gilger, 2018; Macdonald et al., 2017). Misconceptions about the role of visual deficits in dyslexia are evident in questions about the origin of dyslexia (e.g., agreeing that dyslexia is a visually based reading problem), identification (e.g., agreeing that dyslexia should be diagnosed by an eye-doctor), and treatment (e.g., agreeing that colored overlays or eye-tracking exercises are effective in remediating dyslexia). In line with this, several previous studies on teacher knowledge of dyslexia report more misconceptions and uncertainty on items related to the visual component in dyslexia compared to items about other aspects of dyslexia (e.g., Echegaray-Bengoa et al., 2017; Mullikin et al., 2021; Peltier et al., 2022; Yin et al., 2020).

Sources of teacher knowledge about dyslexia: education and experience

Teachers’ knowledge about dyslexia can have different sources, including course content in formal training and experiences during one’s teaching career, such as experience gained from working with children with dyslexia, from in-service training, or even from informal education (such as self-initiated reading). Associations between education and dyslexia knowledge have been investigated in samples of both pre-service and in-service teachers, and from the angle of (i) level of education, (ii) different majors/specializations, and/or (iii) the inclusion of reading- or dyslexia-related course content in formal training.

Several studies have found that level of education is not associated with dyslexia knowledge (e.g., Abed & Shackelford, 2022; Gul et al., 2022; Wadlington & Wadlington, 2005; Washburn et al., 2017; White et al., 2020; Yin et al., 2020). Regarding different majors/specializations, the picture is more mixed. White et al. (2020) examined dyslexia knowledge in a sample of university students, finding

no overall differences in dyslexia knowledge between students with education and non-education majors or between groups with different education majors: special educators, school psychologists, and general educators. Similarly, Washburn et al. (2017) found no differences in dyslexia knowledge between novice teachers in general education and special education. However, both of those studies did report that elementary-school teachers had higher scores on the dyslexia-knowledge scale than secondary-school teachers. Washburn et al. (2017) argue that this difference can be attributed to the types of courses attended by the two groups, with elementary-school teachers being more likely to take courses on literacy instruction and/or assessment (in which reading difficulties are more likely to be addressed) whereas secondary-school teachers are more likely to take courses in content literacy.

However, majors and specializations with similar names may have very different content. In line with this idea, some studies have examined how the presence or absence of dyslexia- or reading-related course content in previous education is associated with dyslexia knowledge, finding significant associations between the inclusion of such content and dyslexia knowledge (Abed & Shackelford, 2022; Peltier et al., 2022; Soriano-Ferrer et al., 2016; and Yin et al., 2020). However, the picture is not consistent: other studies did not find such associations (Gul et al., 2022; Wadlington & Wadlington, 2005; Washburn et al., 2017). It is not easy to draw conclusions from these studies, but it seems that those who found significant associations between course content and dyslexia knowledge tended to use measures that explicitly mentioned "dyslexia." By contrast, Washburn et al. (2017), who did not find significant associations between course content and dyslexia knowledge, used a more general measure of "reading- and literacy-related subjects".

Teachers also have opportunities for acquiring knowledge about dyslexia after completing their formal training, such as from teaching students with dyslexia, professional development, or self-initiated reading. Most previous research on associations between experience and dyslexia knowledge has investigated associations between the number of years spent teaching and dyslexia knowledge. The results have been mixed both within and across educational contexts. As regards U.S. samples (including teachers from pre-K to 6th grade), Gonzalez (2021), Gul et al. (2022), and Mullikin et al. (2021) have all reported positive associations, but Washburn et al. (2011) and Peltier et al. (2022) did not find significant associations between years of teaching experience and dyslexia knowledge. As regards other countries, Soriano-Ferrer et al. (2016) reported a significant correlation for Spanish and Peruvian preschool, elementary-school, and high-school teachers. Confirming these results, Echegaray-Bengoia et al. (2017) reported a significant correlation for Peruvian elementary-school teachers and Giménez et al. (2023) for Spanish preschool and primary-school teachers. From a Saudi Arabian context, Abed and Shackelford (2022) reported that elementary-school teachers with 11–20 years of experience had higher dyslexia scores than teachers with either more or less experience. By contrast, studies from Turkey (Tosun et al., 2021), South Africa (Geertsema et al., 2022), and China (Yin et al., 2020) have all reported non-significant associations between years of teaching experience and dyslexia knowledge.

Varying results across countries are not surprising, because the factors likely to lie behind an association between teaching experience and dyslexia knowledge

(such as general attention toward dyslexia and opportunities for in-service training in dyslexia) are likely to vary across contexts. Consequently, a measure of “years of teaching experience” might mask very different learning opportunities for teachers. In line with this, several of the studies that do find significant associations between teaching experience and dyslexia knowledge report that teachers in their samples had had opportunities for professional development on reading difficulties (e.g., Echegaray-Bengoa et al., 2017; Gonzalez, 2021; Soriano-Ferrer et al., 2016). Still, even studies that have looked in greater detail into associations between dyslexia knowledge and experience teaching students with dyslexia (Abed & Shackelford, 2022; Gonzalez, 2021; Gul et al., 2022; Soriano-Ferrer et al., 2016; Tosun et al., 2021; Yin et al., 2020), in-service training (Soriano-Ferrer et al., 2016; Tosun et al., 2021; Yin et al., 2020), and informal education (Mullikin et al., 2021; Tosun et al., 2021) have found mixed results. On a related note, opportunities to learn from experience may also vary as a function of a person’s position within the school system. For example, someone who holds a position with specific responsibility for students with learning difficulties might have more opportunities for learning (such as counseling, collaboration with school psychologists, etc.).

We are aware only of a single study that has investigated associations between the professional roles played by teachers within a school and their dyslexia knowledge. In a stepwise hierarchical multiple regression, Gonzalez (2021) found that adding educational position significantly increased the explained variance in dyslexia scores over and above experience (teaching students with dyslexia and years of experience). Teachers holding a “reading-specialist role” within the school had more dyslexia knowledge than other teachers.

The present study

The present study was undertaken as part of an innovation project, “Engage”, in which we develop resources for teacher professional development and intervention material for struggling readers in upper-elementary school. To accommodate this material to actual knowledge needs of teachers, we searched for previous research on what Norwegian teachers typically know (and not) about reading difficulties. However, besides a study that investigated knowledge about literacy instruction and reading difficulties among 10 newly qualified teachers (Grimsæth & Holgersen, 2015), we were unable to locate any studies about Norwegian teachers’ dyslexia knowledge.

We thus set out to investigate dyslexia knowledge among upper-elementary-school teachers in the municipality that served as a partner in the project. The policy applied in that municipality is to assign specific teachers the tasks of making accommodations for students with special needs and of providing guidance for general teachers in how they should support such students. In this article, we refer to such teachers as “resource teachers”. Our sample includes both classroom teachers, meaning teachers with principal responsibility for teaching one or several subjects to a whole class of students, and resource teachers. We ask the following research questions:

1. What do upper-elementary-school teachers in a large Norwegian municipality know about dyslexia?
Based on the reviewed research from other countries we expected that teachers in our sample would know less about the role of visual deficits in dyslexia compared to other aspects of dyslexia.
2. Are resource teachers more knowledgeable about dyslexia than classroom teachers?
As the resource teachers in our sample had an extended responsibility for students with special needs (including dyslexia) and that prior research has found that teachers with such a role tend to know more about dyslexia (Gonzalez, 2021), we expected our resource teachers to know more about dyslexia than the classroom teachers.
3. Does teaching experience or reading-related course content in formal training predict dyslexia knowledge?
Given that previous research has found the "visual-deficit misconception" to be resistant and prevalent even in samples of teacher trainers (see, e.g., Wadlington & Wadlington, 2005) we wanted to explore whether knowledge related to the role of visual deficits in dyslexia would be less affected by education and training than other aspects of dyslexia knowledge.

Method

Context

The Norwegian educational system is founded on the principle of a unified system that provides equal and adapted instruction in an inclusive environment (Norwegian Ministry of Education & Research, 2017). Approximately 8% of students receive special-needs education (SNE). Most SNE is provided in ordinary schools; less than 0.3% of the total population attend special schools (Norwegian Directorate for Education and Training, 2022). All students are to receive differentiated, research-based classroom instruction (Act relating to primary and secondary education and training, 1998, §1–3). Students who do not benefit from ordinary classroom instruction are entitled to supplemental interventions (§1–4). Students who require even more intense, explicit, and individualized instruction should receive SNE (§5–1). The right to SNE is evaluated by a municipal agency called the Educational Psychological Counseling Service (PPT). SNE is provided as additional help in or outside of mainstream classrooms; around 50% of those receiving it do so in mainstream classrooms (Norwegian Directorate for Education and Training, 2022). According to a White Paper from 2019/2020, principal responsibility for helping students with highly frequent learning difficulties such as reading difficulties is vested in the municipality (Ministry of Education and Research, 2019/2020). Schools can receive guidance from the PPT if needed.

Sample and procedure

We investigated dyslexia knowledge by administering an online survey to all upper-primary-school (grades 5–7, ages 10–12) teachers ($N=350$) in the 26 elementary schools of a large Norwegian municipality. The participants received a link to the survey by email. Our final sample ($N=269$) consists of the teachers who answered all questions in the dyslexia questionnaire (80%).¹ We have no information about the teachers who chose not to open the survey (13%) or only responded to a couple of items (7%), and consequently don't know whether they systematically differ from participants in the final sample. Most of the respondents ($n=207$) worked as classroom teachers and taught one or several text-based courses, including L1, mathematics, and science. The remaining 62 teachers self-reported to work as resource teachers. Information about the two teacher groups is given in Table 1.

Measures

Teachers' dyslexia knowledge

The teachers' dyslexia knowledge was assessed by means of items adapted from Peltier et al. (2020) and Washburn et al. (2014) which were both inspired by the Dyslexia Belief Index (DBI, Wadlington & Wadlington, 2005). The participants were presented with 15 statements about dyslexia (see Table 2). As suggested by Peltier et al. (2020, 2022), to target knowledge rather than personal beliefs, each statement was introduced by the phrase "To what extent do you think an expert in dyslexia would agree with the following statement?" That introductory phrase was followed by statements such as "Dyslexia is primarily a visual-based disability" and "Dyslexia is not hereditary." The participants were asked to rate each statement on a Likert scale ranging from 1 to 6 (1 = *strongly agree* to 6 = *strongly disagree*). Items containing a scientifically correct statement were reverse-scored, so that all scores consistently measured the degree of agreement with scientifically correct ideas (e.g., for "Students with dyslexic difficulties have difficulties with word reading," *strongly agree* was recoded to 6, *strongly disagree* was recoded to 1). Higher scores thus indicate knowledge levels that are more aligned with the scientific knowledge of dyslexia. In Table 2 the first four items, V1–V4, pertain to dyslexia as a visual deficit, while the remaining items D1–D11 relate to other aspects of dyslexia.

Reading-related course content in formal training

Participants were asked whether they had encountered any of three themes relating to reading instruction and reading difficulties as part of their formal training: (i) assessment methods in reading, (ii) literacy instruction for upper-elementary students, and (iii) reading difficulties. Specifically, they were asked to judge whether each theme had been "a topic of emphasis," whether they had been given an

¹ We excluded those teachers who taught only practical/aesthetic subjects (i.e., P.E., music, and art) ($n=17$).

Table 1 Descriptive information about the two groups of teachers

		Classroom teachers <i>n</i> = 207	Resource teachers <i>n</i> = 62
Sex*	Female	65%	90%
	Male	35%	10%
Age (years)*	25–29	19%	8%
	30–39	29%	19%
	40–49	29%	32%
	50–59	15%	21%
	Above 60	7%	19%
Educational level	No bachelor	1%	2%
	Bachelor	81%	71%
	Master	17%	26%
Teaching experience in years, mean (standard deviation)*		12.8 (9.9)	16.1 (11.1)
Number of reading-related themes encountered in formal training*		1.6 (1.2)	2.2 (1.1)
Special-needs education encountered as a theme in formal training*		37%	68%

*Significant difference between classroom teachers and resource teachers

“overview of or introduction to” a topic, or whether that topic had “not been taught at all.” Owing to small group sizes in some cells, the first and second options were merged for the purposes of the analysis. This yielded one variable for each theme, indicating whether the teacher had encountered that theme in formal training (1) or not (0). Finally, we merged the three reading-related subjects into a single reading-related course content variable, indicating how many of the themes a teacher had encountered (ranging from 0 to 3). Of all teachers, 23% had encountered none of the themes, 20% had encountered one, 22% had encountered two, and 35% had encountered all three.

Teaching experience

Participants were asked an open question about the number of years that they had spent teaching in school. Years of teaching experience was treated as a continuous variable in the analysis.

Analytic strategy

To answer the first research question, the responses for each item on the dyslexia-knowledge questionnaire were collapsed into three categories. Category I represents incorrect answers (1–2), category C represents correct answer (5–6), and category

Table 2 Percentages of incorrect, uncertain, and correct answers to items involving dyslexia statements, for classroom teachers (CT) and resource teachers (RT)
 «To what extent do you think an expert in dyslexia would agree with the following statement?»

		CT			RT		
		I	U	C	I	U	C
V1	Dyslexia is primarily a visual-based reading disability	17	55	28	23	39	39
V2	Eye-tracking exercises are effective in remediating dyslexia*	18	56	26	15	45	40
V3	Colored lenses and/or colored overlays are research-based accommodations to help students with dyslexic difficulties*	12	55	33	11	50	39
V4	Dyslexia should be diagnosed by an eye-doctor*	4	18	78	3	16	81
D1	Students with dyslexic difficulties have difficulties with word reading	1	17	82	2	21	77
D2	Dyslexia is not hereditary*	6	26	69	8	15	77
D3	Children with dyslexic difficulties need more systematic and explicit reading instruction than their typically developing peers	3	21	76	5	13	82
D4	Students can outgrow dyslexia*	5	39	56	5	24	71
D5	Dyslexia can be caused by a literacy-poor home environment (e.g., parents not reading to their children)*	3	25	72	3	19	77
D6	Children with dyslexic difficulties have problems with spelling	5	30	64	5	26	69
D7	Dyslexia can have negative consequences for the student's reading comprehension	4	14	82	5	10	85
D8	Students with dyslexic difficulties will not be able to improve their reading skills despite targeted and systematic measures	3	14	83	2	16	82
D9	Children with dyslexic difficulties tend to have lower IQ scores than children that don't have dyslexia*	4	14	83	3	5	92
D10	Certain medications have been found to be effective in treating dyslexia*	2	14	84	2	8	90
D11	Students with dyslexic difficulties can do well on school-related tasks that do not involve reading and writing	2	11	87	0	5	95

CT classroom teachers, RT resource teachers, I incorrect, U uncertain, C correct

*Reverse-scored items

U represents uncertainty (3–4). For each item, we report the percentages of teachers in each teacher group (classroom teachers and resource teachers) who answered that item correctly or incorrectly as well as the percentage who were uncertain.

For the analyses relating to research questions two and three, we created two subscales. All items in these scales were analyzed using the original full scale range of 1–6. The first subscale (VIS) included the four items V1-V4 and the second subscale (DYS) included the remaining eleven items D1-D11. Reliability for the VIS subscale was low (Cronbach's $\alpha = .59$, McDonald's $\omega = .65$) (Cronbach, 1951; McDonald, 1999). Although reliability measures may be downward biased owing to the small number of items and to the violation of tau-equivalence (Raykov, 2001), we acknowledge that VIS has poor internal-consistency reliability. However, as will be reported in the results section, a latent-factor VIS provided good fit to the data, and we therefore deem the VIS subscale to be of adequate psychometric quality for our purposes. Reliability for the DYS subscale was deemed satisfactory, with $\alpha = .76$ and $\omega = .79$.

We adopted a latent-variable modeling approach and the subscales VIS and DYS were treated as latent factors in confirmatory-factor and structural-equation-modeling analyses. This approach allows explicit representation of measurement error, allows nonparallel measurement, and facilitates investigation of measurement invariance, which is why it is considered superior to the popular approach of representing constructs by simple sum scores.

If indicator variables are ordinal and categorical in nature, it is recommended to use statistical procedures suitable for ordinal data (Foldnes & Grønneberg, 2021). However, such procedures require the ordinal data to be consistent with an underlying assumption of normality (Foldnes & Grønneberg, 2020). We therefore conducted tests for underlying normality implemented in the *discnorm* R package (Foldnes & Grønneberg, 2020). For both the VIS and the DYS indicators, we found strong support for underlying nonnormality. We therefore proceeded by conducting the analysis as if the items were roughly continuous, with robust standard errors and model-fit statistic. Latent-variable analyses were conducted using the *lavaan* R package (Rosseel, 2012) with the *estimator* = "MLM" option. The tests of model fit relied on mean-scaled chi-square statistics (Satorra & Bentler, 1988, 2001), which are more robust to nonnormality than the conventional normal-theory chi-square statistic. In addition to the chi-square test of correct model specification, we also calculated the following approximate goodness-of-fit indices: root mean square error of approximation (RMSEA), comparative-fit index (CFI), and standardized root mean square residual (SRMR). The rule-of-thumb cutoffs for acceptable model fit are $RMSEA < 0.08$, $CFI > 0.95$, and $SRMR < 0.08$ (Mair, 2018).

To answer the second research question, whether the resource teachers exhibit more knowledge than classroom teachers, we estimated the latent mean levels of VIS and DYS in both groups. This was done by fixing the latent mean of the classroom-teacher group to zero, and freely estimating the latent mean of the resource-teacher group. The variances of the VIS and DYS were freely estimated, and used to calculate the pooled variance to obtain Cohen's *d*, i.e., an effect size of the difference in knowledge between resource- and classroom teachers. The analyses were separately conducted for VIS and for DYS.

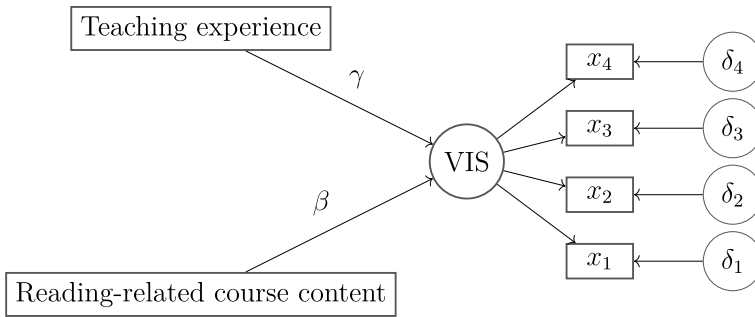


Fig. 1 Structural equation model explaining variance in the latent variable VIS

For our third research question, we estimated separate structural equation models explaining variance in VIS (exemplified in Fig. 1) and in DYS. The regression coefficients γ and β are the main parameters of interest, and we investigate using nested-model testing (Satorra & Bentler, 2001) whether they differ in the two groups, with the constrained model imposing equality of regression coefficients across groups while the unconstrained model allows regression coefficients to be freely estimated.

The proposed analyses for our second and third research question assume that the VIS and DYS factors have similar measurement properties in both teacher groups. For that reason, scalar measurement invariance—that is, the equality of factor loadings and indicator intercepts across the classroom-teacher and resource-teacher groups—was assessed for both VIS and DYS using a scaled-difference chi-square test (Satorra & Bentler, 2001).

Results

Research question 1: what do upper-elementary-school teachers in a large Norwegian municipality know about dyslexia?

The percentages of (classroom and resource) teachers who answered each item in the questionnaire incorrectly, expressing uncertainty, or correctly, respectively, are presented in Table 2.² More than 80% of teachers knew that dyslexia can have negative consequences for a student's reading comprehension (item D7), that students can improve with targeted and systematic help (item D8), that students with dyslexia do not tend to have lower IQ scores than students without dyslexia (item D9), that medication is not effective in treating dyslexia (item D10), and that students with dyslexia can do well on school-related tasks that do not involve reading and writing (item D11). The lowest percentages of correct answers were observed for three items pertaining to the visual component of dyslexia (items V1, V2, and V3, which were answered correctly by $\leq 40\%$)

² For summary descriptives of the item raw scores, see Table 2 in the only supplementary material.

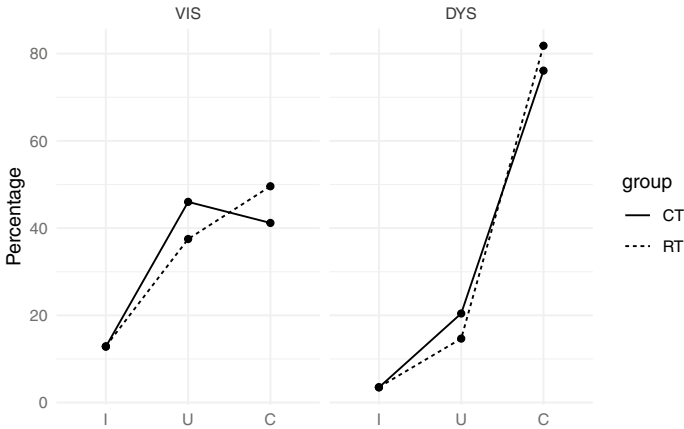


Fig. 2 Aggregated percentages across the VIS and DYS items in each category of incorrect (I), uncertain (U), and correct (C) for classroom teachers (CT) and resource teachers (RT)

and for one item on whether students can outgrow dyslexia (item D4, answered correctly by 56% of classroom teachers and 71% of resource teachers). For all items, more teachers were uncertain than were incorrect. In Fig. 2 the aggregated percentages across the VIS and DYS items in each category of incorrect, uncertain, and correct, are plotted for each teacher groups. It is seen that uncertainty overall is more prevalent for VIS items compared to DYS items.

Research question 2: are resource teachers more knowledgeable about dyslexia than classroom teachers?

The models used to answer our remaining research questions employed latent variables for VIS and DYS. The preliminary analyses first involved assessing the fit of one-factor models for VIS and DYS, as reported in Table 3. Although VIS has lower reliability than DYS, as a one-factor model it clearly has acceptable fit. For DYS, RMSEA indicated acceptable fit, but both CFI and SRMR indicated poor fit. The invariance tests for DYS and VIS are presented in Table 4. The scalar invariance is tenable for both the VIS and DYS subscales.

To test whether there were differences across groups in knowledge as measured by VIS and DYS, we estimated latent mean models. We constrained the classroom teachers to have latent mean zero while freely estimating the latent mean in the resource-teacher group. Model results are shown in Table 5, which also contain effect sizes. Resource teachers have higher scores than classroom teachers. The effect size for VIS (Cohen's d is 0.30) and statistically significant. For DYS, the effect size is 0.2 and not significant. Thus, a knowledge difference in favor of resource teachers was supported for the VIS scale, but not for the DYS scale.

Table 3 Model-fit statistics for one-factor models

	<i>df</i>	χ^2	<i>p</i>	RMSEA	CFI	SRMR
VIS	2	3.88	.14	0.06	.98	.03
DYS	44	120.73	.00	0.08	.78	.10

RMSEA root mean square error of approximation, *CFI* conditional fit index, *SRMR* standardized root mean residual

Table 4 Tests of scalar invariance across teacher groups for the latent constructs VIS and DYS

Model	<i>df</i>	AIC	BIC	χ^2	χ^2 diff	<i>df</i> diff	<i>p</i>
<i>VIS</i>							
Restricted	4	3443.27	3529.55	6.33	NA	NA	NA
Unrestricted	14	3435.59	3485.92	18.65	12.16	10	.27
<i>DYS</i>							
Restricted	88	8284.77	8522.02	262.49	NA	NA	NA
Unrestricted	119	8283.41	8409.23	323.13	38.03	31	.18

AIC akaike information criterion, *BIC* Bayesian information criterion

Research question 3: does teaching experience or reading-related course content in formal training predict dyslexia knowledge?

Two separate models were fitted for each endogenous variable (VIS and DYS), with years of teaching experience and exposure to reading-related themes in formal training as exogenous variables (see Fig. 1). For VIS, we first tested whether its regression on experience was different in the two teacher groups, finding no support for this ($\chi^2(1) = 0.36, p = .55$). We therefore constrained γ in Fig. 1 to be equal across teacher groups. Next, we tested whether the regression of number of reading related courses on VIS differed across groups, which we found it did not ($\chi^2(1) = 2.57, p = .11$). Hence, we also constrained the regression coefficient β to be equal across teacher groups. The estimated regression coefficients are presented in Table 6. Neither experience nor number of reading-related themes statistically significantly predicted VIS knowledge.

For DYS, we first tested whether its regression on experience was different in the two groups, which was not supported ($\chi^2(1) = 0.08, p = .78$). The regression of number of reading-related themes on DYS was also not found to differ between the groups ($\chi^2(1) = 2.62, p = .11$). Hence, we constrained γ and β to be equal across teacher groups. The estimated regression coefficients are presented in Table 6. Number of reading-related themes was positively and statistically significantly related to DYS knowledge, but experience had no significant association with DYS.

Table 5 Difference in latent mean dyslexia-knowledge scores and associated effect size between resource teachers (RT) and classroom teachers (CT) on VIS and DYS subscales

	Variance RT	Variance CT	Variance pooled	Mean difference RT-CT	<i>p</i> value of difference	Cohen's <i>d</i>
VIS	0.53	0.28	0.44	0.20	.04	0.30
DYS	0.03	0.03	0.04	0.04	.11	0.20

One-sided hypothesis test

Table 6 Standardized regression coefficients for number of reading-related themes in formal training (β) and experience (γ) on VIS and DYS in structural equation models

Predictor	Estimate	<i>SE</i>	<i>p</i>	95% <i>CI</i>
<i>VIS</i>				
Number of reading-related themes	0.039	0.038	.30	−0.035 to 0.114
Experience	−0.001	0.004	.11	−0.014 to 0.001
<i>DYS</i>				
Number of reading-related themes	0.035	0.013	.01	0.009 to 0.060
Experience	0.001	0.001	.27	−0.001 to 0.003

Discussion

In the present study we set out to investigate dyslexia knowledge in a sample of Norwegian in-service upper-elementary-school teachers, to examine whether there were any differences in dyslexia knowledge between resource teachers and classroom teachers, and to explore whether reading-related themes encountered in formal training and teaching experience predicted dyslexia knowledge. Overall, we find that many teachers in our sample know a good deal about dyslexia. Aside from the “visual deficit” items, most items were answered correctly by at least 70% of the teachers.

What do teachers know about dyslexia?

In line with previous research, we find that teachers know less about visual components of dyslexia than about other aspects of dyslexia. Previous studies have found the proportion of teachers holding the “visual-deficit misconception” to vary between 21 and 75%, depending on the specific questions asked (Gonzalez, 2021; Macdonald et al., 2017; Peltier et al., 2022; Soriano-Ferrer et al., 2016; Washburn et al., 2011). In the present study, the uncertain teachers outnumbered those who gave an incorrect response. In fact, “only” between 3 and 23% of teachers gave

incorrect answers to the various visual-deficit statements. Our results are in line with Mullikin et al. (2021), Soriano-Ferrer et al. (2016), and Yin et al. (2020), who also report a high proportion of teachers being unsure on items related to the role of visual deficits in dyslexia. Our results thus indicate that, rather than there being a widespread “visual-deficit misconception” among Norwegian teachers, there seems to be a great deal of uncertainty about the role of visual deficiencies in dyslexia.

The other items of the dyslexia-knowledge questionnaire were correctly answered by between 56 and 95% of the teachers. This indicates that the teachers in our sample know quite a lot about dyslexia. Still, we were surprised that between 18 and 35% of teachers did not know that (or were uncertain whether) dyslexia is characterized by difficulties with word reading and spelling. This result differs from e.g., Peltier et al. (2022) who found that 96% of U.S. teachers in their sample knew that students with dyslexia “have difficulty with reading and spelling words”. Part of the reason for conflicting findings could be that the terms “word reading” and “spelling” are unfamiliar to, or too specialized for, teachers who teach upper-elementary students and/or have not received any training in the literacy field. In line with this, some previous studies have found that pre-service teachers training to teach in elementary school are more knowledgeable about dyslexia than pre-service teachers training to teach in secondary school (Wadlington & Wadlington, 2005; Washburn et al., 2017). The teachers in our sample all taught upper-elementary students (grades 5–7, ages 10–12), and the instruction provided to such students is less likely to focus on concepts such as “word reading” and “spelling.” In contrast, teachers in the study by Peltier et al. (2022) also included lower-elementary-school teachers. Still, most of the teachers in our sample were trained at a time when Norwegian teacher training did not differentiate its course content as between future upper-elementary-school and lower-elementary-school teachers. Response rate might be another reason for conflicting findings in the two studies. According to several meta-analyses, the salience or interest of a topic is one of the most important factors influencing response rates in both mail and web surveys (Cook et al., 2000; Edwards et al., 2002; Sheehan, 2001; Yammarino et al., 1991). There is a huge difference in response rate between the Peltier-study (5.25%) versus our study (80%). It might be that those U.S. elementary school teachers who chose to respond to the questionnaire also were more interested in, and thus more knowledgeable about, dyslexia than the upper-elementary grade teachers in the more unselected Norwegian sample.

Second, the finding that 29% of resource teachers and 44% of classroom teachers either believe that, or are uncertain whether, children can outgrow dyslexia is worrying, because we know that students with reading difficulties need explicit instruction and that they benefit more from early interventions (see, e.g., Snowling, 2013). Uncertainty about the persistence of reading difficulties might prompt a “wait to fail” approach causing appropriate help to be given too late. On a related note, a recent report found that 49% of Norwegian students with a dyslexia diagnosis received their diagnosis in lower-secondary school (grades 8–10, ages 13–15) or later (Seglem, 2021).

Third, it is also cause for concern that 18% of classroom teachers and 8% of resource teachers either believe that students with dyslexia tend to have lower IQ scores than other children or are uncertain whether that is the case. Although this

share is lower than for comparable questions in previous studies (e.g., Gonzalez, 2021; Peltier et al., 2022), we find this result nonreassuring, especially because recent reports from the Norwegian context have noted that students receiving special-needs education³ claim that their teachers have low expectations of what they are able to achieve (Barneombudet, 2017; Nordahl et al., 2018).

Dyslexia knowledge across teacher groups

Given that the resource teachers in our sample have an extended responsibility for students with dyslexia and that prior research has found that teachers with such a role tend to know more about dyslexia (Gonzalez, 2021), we expected our resource teachers to possess more in-depth knowledge about dyslexia than the classroom teachers. In line with this we found a significant difference in favor of resource teachers on items related to the visual component of dyslexia ($p=0.04$, Cohen's $d=0.3$). On items pertaining to other aspects of dyslexia however, the difference was non-significant ($p=0.11$, Cohen's $d=0.2$). As can be seen in Table 1, resource teachers reported having encountered more reading-related themes as part of their formal training. Also, a higher proportion of resource teachers than classroom teachers had special educational needs education. These factors might in part explain the observed differences. Even if we didn't find an association between experience (as measured in years) and dyslexia knowledge in our analysis pertaining to research question 3, other aspects related to experience could also contribute to knowledge differences e.g. participation in professional development and/or collaboration with school psychologists.

It can be argued that the potential consequences of a teacher holding a misconception or being uncertain about aspects related to dyslexia can be more severe if held by a resource teacher with specific responsibility for supporting dyslexic students and their teachers. One such example pertains to whether teachers believe that students with dyslexia can improve their reading skills or not. In our sample, 17–18% of the teachers in the two groups were either uncertain or wrong about whether students identified with dyslexia can improve their reading skills. Such a belief is potentially problematic for a student even if it is only held by his or her classroom teacher but matters probably becomes worse if it is held by a resource teacher to whom the classroom teacher might turn for support and guidance after concluding that his or her own competence is no longer sufficient.

For other dimensions of dyslexia, a lack of knowledge may have consequences for individual students no matter whose knowledge is inadequate. For example, if teachers are unsure about how dyslexia manifests behaviorally or have misconceptions about the relation between dyslexia and general intellectual functioning, this might influence those students' opportunities to thrive and progress (Gentrup et al., 2020; Hornstra et al., 2010). Here it does not matter whether it is the classroom teacher or resource teacher whose beliefs are incorrect. In fact, the situation might even be

³ Specific learning difficulties is the most frequent ground for special-needs education in Norway (Nordahl et al., 2018).

especially problematic if the classroom teacher is the one who has misconceptions, considering that students spend most of their time in the mainstream classroom.

Teaching experience and course content

In our final research question, we asked whether years of teaching experience and having encountered reading-related course content in formal training were related to a teacher's dyslexia knowledge. Although previous studies into the association between education/experience and dyslexia knowledge have typically used a composite measure, we chose to perform separate analyses for the items pertaining to a visual component in dyslexia (VIS) and the remaining items (DYS). Our reason for choosing this approach was that the visual-deficit misconception seems to be more resistant to, and hence potentially less affected by, education and experience (see also Gul et al., 2022). The use of a composite measure could therefore mask a potential association between experience/education and knowledge not related to a visual component in dyslexia. In line with this hypothesis, we found no significant associations between previous reading-related course content and knowledge about the visual component of dyslexia. For the remaining items, by contrast, we did find a statistically significant association with course content. However, the effect was small and most likely of little practical significance. To this should be noted that having teachers self-report on which reading-related themes they encountered in formal training retrospectively, has limitations. Also, quantity rather than the quality or depth with which reading-related content was taught is emphasized in our measure. To understand associations between course content and teacher dyslexia knowledge more fully, future research need to develop more nuanced measures.

Previous research into associations between years of teaching experience and dyslexia knowledge has yielded mixed findings. In our study, there were no significant associations. As previously noted, teaching experience is a broad proxy for in-service learning opportunities. Future research might also need to ask more nuanced questions about in-service learning opportunities e.g., participation in professional development, counseling of students, and collaboration with school psychologists to identify meaningful associations with dyslexia knowledge.

Limitations

Our study has several limitations that should be mentioned. First, our study is correlational and cannot support any causal claims. Second, the survey design with closed-ended options limits our results to the specific questions asked and the response options provided. Teachers might have known more than they were able to demonstrate through the questionnaire. Through interviews we may have obtained richer data on teacher's knowledge of dyslexia. Third, our questionnaire did not include the word "uncertain" or "unsure" as a response option, even though we chose to interpret the "slightly agree" and "slightly disagree" responses as expressions of uncertainty. We did this because several teachers who had answered the

questionnaire had commented that they missed an “uncertain” option. Against that background, we assumed that teachers who were in doubt would probably choose one of the two middle categories. However, we cannot rule out the possibility that teachers who were in doubt chose other response options and that the “uncertain” proportion was thus larger than our results indicate. Nor can we rule out the opposite, namely that reasons other than uncertainty made teachers select the “slightly agree” or “slightly disagree” options. Forth, our sample of resource teachers was small, with only 62 individuals. Consequently, there may have been limited statistical power to detect effects. Finally, scientific knowledge on dyslexia has evolved since the scales adapted for the present study were first developed. As Protopapas (2019) puts it: “A crucial development is evident in understanding dyslexia, moving from its conceptualization as a discrete identifiable condition toward the realization of continuity with the general population with no clear boundaries and no qualitative differences” (p.1). Even if it takes time before new conceptualization reach the educational field, it is probably timely that scales used to assess teacher knowledge about dyslexia are reviewed and updated.

Educational implications

Our results show that many Norwegian classroom and resource teachers are uncertain about important aspects of dyslexia. This indicates that improved and clarified descriptions of the teacher-training curriculum regarding reading difficulties are needed. Also, there is a need to reconsider *which* teacher-training subjects or majors should teach dyslexia. In Norway today, reading difficulties are taught within “Norwegian”/L1 (for general educators) and special-needs education (optional). This means that teachers who do not train for these subjects will probably learn nothing about reading difficulties as part of their formal teacher training. As regards opportunities for teacher professional development, the Norwegian educational system now favors sustained site-base whole-school approaches, often in partnerships with local universities (OECD, 2019). Many schools choose to work with themes they consider relevant to most or all teachers. Reading difficulties is not very likely to be chosen as the theme for such a whole-school approach, suggesting that teachers may need access to other forms of professional development to learn more about dyslexia.

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Declarations

Conflict of interest We have no known conflict of interest to disclose.

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