“We are the same, we are equal”: Plant diversity knowledge in Indonesian elementary special school textbooks

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Education

Abstract

Background: Education for students with disabilities continues to develop to meet the demands of changing times so that students with disabilities can receive learning in an inclusive environment and their talents and interests continue to develop. The research aims to determine plant diversity in Indonesian textbooks based on class, disability specifics, and book themes at the elementary school level.

Methods: The data was collected from 190 books from six grades and five disability categories (blind, deaf, autistic, physically disabled, and mentally disabled).

Results: The results found 172 plant species from 61 families. The total frequency was 3642 from all textbooks, and the species that had the highest relative frequency levels was *Cocos nucifera* (8.79%). The book with the highest species frequency was fifth grade autistic, with 387. Based on content analysis in each chapter, it was found that the cultural score in first grade and instrumental in sixth grade was the highest, with 80 chapters. The dominant plant type was herbaceous at 63.95%. Plants were also categorized into several different types. Several types of threatened species were also found in the textbook. Most of the plants discussed were in the horticultural category.

Conclusions: The results of this research can be a reference regarding plant content to better explore threatened species as a conservation education effort. Apart from that, the low level of introduction of plants in textbooks could be reviewed for more effective methods for introduction.

Keywords: disability, diversity, plant, special school, textbook

Abstrak

Latar belakang: Pendidikan untuk siswa dengan disabilitas terus berkembang untuk memenuhi tuntutan perubahan zaman agar siswa dengan disabilitas dapat menerima pembelajaran di lingkungan yang inklusif serta bakat dan minatnya terus berkembang. Penelitian ini bertujuan untuk mengetahui keanekaragaman tumbuhan pada buku teks pelajaran di Indonesia berdasarkan kelas, disabilitas, dan tema buku di tingkat sekolah dasar.

Metode: Data dikumpulkan dari 190 buku dari enam kelas dan lima kategori disabilitas (tunanetra, tunarungu, autis, tunadaksa, dan tunagrahita).

Hasil: Hasil menunjukkan terdapat 172 spesies tumbuhan dari 61 famili. Total frekuensi adalah 3642 dari semua buku teks, dan spesies yang memiliki tingkat frekuensi relatif tertinggi adalah *Cocos nucifera* (8,79%). Buku dengan frekuensi spesies tertinggi adalah Kelas lima Autis, dengan 387 spesies. Berdasarkan analisis konten pada setiap bab, ditemukan bahwa skor kultural pada kelas satu dan instrumental pada kelas lima adalah yang tertinggi, dengan 80 bab. Jenis tanaman yang dominan adalah herba sebesar 63,95%. Tumbuhan juga dikategorikan ke dalam beberapa jenis yang berbeda. Beberapa jenis spesies yang terancam punah juga ditemukan di dalam buku teks. Sebagian besar tanaman yang dibahas termasuk dalam kategori hortikultura.

Kesimpulan: Hasil penelitian ini dapat menjadi referensi mengenai konten tanaman untuk lebih mengeksplorasi spesies yang terancam punah sebagai upaya pendidikan konservasi. Selain itu, rendahnya tingkat pengenalan tumbuhan pada buku teks dapat menjadi bahan kajian untuk mencari metode pengenalan yang lebih efektif.

Kata kunci: disabilitas, keanekaragaman, tumbuhan, sekolah luar biasa, buku pelajaran

Background

In the Indonesian context, students with disabilities receive learning in inclusive and special schools to develop their children's talents and interests. Even though inclusive schools are more supported because they prioritize human rights (Kolstrein et al. 2019, Cho & Hong 2022, Qu 2022). Not all students with disabilities can benefit from inclusive classes (Kauffman 2021, Bernardo 2022). Special schools prioritize pragmatic, individualized learning adjustments to the child's character and are vocationally based so that they are seen as more contextual to the child's needs (Hornby 2021, Maher & Fitzgerald 2022, Lee & Cho 2023, WonHo et al. 2023). For this reason, special schools are still developing in Indonesia and is becoming an alternative educational service for students with disabilities.

The curriculum plays an essential role in self-development, internalization of character, determining learning goals, materials, processes, and accessible evaluation for students with disabilities. In special schools, students with disabilities receive material study in stages and learning specifically designed based on the child's type of disability (Waddington & Reed 2017, Lee & Cho 2023, Zakai–Mashiach 2023). When linked to the K21 curriculum, the special school curriculum prioritizes interdisciplinary, collaborative, and holistic student learning experiences (Beld *et al*. 2021, Cipriano & Barnes 2022, Sebothoma *et al*. 2022). By presenting thematic learning, students with disabilities are encouraged to make connections and apply their knowledge in real-life contexts. This approach not only fosters a deep understanding of the subject matter but also fosters activeness, critical thinking skills, creativity, and environmental connectivity.

Regarding learning resources, one of the sources used by students with disabilities is textbooks, which should contain various contextual illustrations related to conservation education. Apart from aiming to increase ecological awareness, illustrations and drawings play a decisive role in improving the learning outcomes of students with disabilities (Ma 2023). Integrating conservation education with learning can be achieved in various ways (Iliopoulou 2018; da Silva Caixeta *et al*. 2021, Pany *et al*. 2022, Borsos *et al*. 2023). Another study states that integration can also be done by displaying biodiversity through pictures and illustrations (Brownlee *et al*. 2023). Photographs and illustrations will help students understand the concept of biodiversity, help students recognize plant species, help students understand the context of the material, and help increase motivation in learning. By including conservation education in the curriculum, schools open up access for students to understand environmental conservation's importance.

Understanding to know plants will foster empathy and enthusiasm for conservation (Balding & Williams, 2016). The diversity of plants displayed make students with disabilities more involved in learning because the images included in textbooks will increase activity and promote sustainability education. Knowing the types of plants is important because children have

minimal interest in plants and experience plant blindness (Balas & Momsen 2014, Amprazis *et al*. 2021). Usually, children are more enthusiastic about studying animals, so their memory of plant types becomes poor and forgotten. Worse, young children do not know that plants are also living creatures and consider them to be part of the natural landscape (Martínez-Losada *et al*. 2014). The lack of diversity of plant types in the subject matter taught in schools is said to be one of the causes of the plant blindness phenomenon (Amprazis & Papadopoulou 2018). This plant blindness disrupts conservation efforts and sustainable environmental education (Parsley 2020, Thomas *et al*. 2022).

As content matures, research into image analysis and textbook illustrations has begun to emerge. Previous research states that the more graphics displayed, the more familiar students will be with the plants (Ahi *et al*. 2018). Images and drawings can create meaning in human relationships with nature, whose purposes can be both pedagogical and non-pedagogical (Lemoni *et al*. 2013, Bel Martínez 2017, Hartt 2018, Ghoushchi *et al*. 2021, Brownlee *et al*. 2023). Images and illustrations in textbooks must support student learning activities, use a variety of images and illustrations, and pay attention to differences in national traditions, pedagogical culture, and social structures (Wermke *et al*. 2015, Martínez & Rubio 2018, Tawalbeh *et al*. 2019, Kwon 2021). Previous studies on plant species diversity in Korean elementary school textbooks showed 232 plant species (Kwon 2021). In Turkish elementary schools, at least 62.5% were associated with plant photography (Ahi *et al.* 2018). In Greek elementary schools, knowledge about plants is most commonly found in the subject study of the environment (Amprazis & Papadopoulou 2018). Beneficial plants are most often found in Manchurian textbooks used by Japanese students (Ikeda & Yamamoto 2021). Among the research trends in plant analysis in textbooks, research into illustrations of plant images in special school textbooks has never been carried out. The research aims to determine plant diversity in Indonesian textbooks based on grade, disability specifics, and book themes at the elementary school level. This research can be the foundation for further refinement of textbooks so that they are contextually appropriate to the characteristics of children with special needs.

Materials and Methods

Data collection protocols

This research analysis was carried out on 190 special school textbooks from first and second semesters of first-sixth grades of elementary school by the Indonesia Ministry of Education. In special schools, children with special needs were divided into deaf, blind, mentally disabled, physically disabled, and autistic. Table 1 shows the classification of books and the number used in this study. All books were obtained from the website https://pmpk.kemdikbud.go.id/bukudigital/ and accessed from January to August 2023. The number 0 indicated that a book was excluded because it did not contain information related to plants. All books used were based on the 2013 curriculum.

Table 1. Category of basic level special school textbook subjects based on type of special needs and grades

Categories	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	Total
Deaf	6	13	4	7	8	0	34
Blind	3	8	7	7	16	10	51
Intellectually disabled	6	8	8	8	0	0	30
Physically disabled	7	0	7	0	0	10	24
Autistic	6	9	8	8	13	7	51
Total	**28**	**38**	**33**	**30**	**34**	**27**	**190**

Identification of plant species in textbooks was done by classifying them based on mosses, pteridophytes, gymnosperms and angiosperms. Plants were recorded using specific plant name information, illustrations, and photos. This study did not include unclear plant images or patterns, non-regenerative forms such as unidentifiable plants, and unclear metaphors. If the book only mentions plant parts, for example, flowers, seeds, stems, and fruit, then the name was considered a botanical name and analyzed further. The same species but written with different names was adjusted to the local name recognized by the large Indonesian dictionary. Besides local names, scientific names were also written based on the World Flora Online source (https://www.worldfloraonline.org/), previously known as the Plant List (http://www.theplantlist.org/). The diversity and frequency of plant species in textbooks based on grade classes and special needs categories were also examined to discover which class contained the most plants. The IUCN red list classification (https://www.iucnredlist.org/) was used to determine conservation status.

Local utilization of plants refers to ecosystem services from the previous research of Suwardi *et al.* (2023), such as food, medicine, fiber, dye, agricultural tools, construction and building materials, firewood, fodder, fishing, poison and pesticide, commercial uses, fencing, shade, ornament, ritual, and handicrafts. Contents about plants were classified into seven, namely: instrumental (calculations, examples and content material, comparison of forms); cultural (story material, song lyrics, contents of poetry and letters, as well as proverbs), symbolic (seasons: spring, summer, autumn, winter, countries and regions including trade, cities, provinces), botany (physiology, characteristics, structure, classification and processes of plant growth, habitat and cultivation), linguistic (sound speech, text, listening, writing, speaking), artistic (drawing, artistic activities, musical instruments), and environmental (local environment, natural environment and its protection, climate environment and ecosystem) (Park 2003, Kwon 2021). Plants were also classified based on plant characteristics, mostly herbaceous and woody. Herbaceous plants were divided into foliage, bulbs and tubers, cacti and succulents, aquatic plants, and carnivorous plants. After that, it was divided into annual or biannual. Meanwhile, woody plants are divided into trees, shrubs, vines, and evergreen and deciduous.

Based on crop categories, they are divided into food, horticultural, industrial, medicinal and other crops. Food crops were then divided into grain, pulse, and root and tuber crops. Horticultural crops were divided into fruit, ornamental, and vegetable crops. Industrial crops were divided into dye, fiber, oil and sugar. Medicinal crops were divided into medicinal and spice crops. Meanwhile, others were divided into forest tree, weed, and wild flower.

Analysis data

Kruskal-Walli's test was used to compare species distribution and content distribution in each book text, and continued Dwass-Steel-Critchlow-Fligner (DSCF) Test for pairwise comparisons. A generalized linear mixed model (GLMM) with Poisson distribution was used to assess the relationship between species distribution and content in each book text. A Non-metric Multidimensional Scaling (NMDS) ordination diagram was generated based on the similarity matrix. The NMDS ordination results were tested for significance using one-way analysis of similarity (ANOSIM). iNEXT Online software was used for interpolation and extrapolating species diversity (Chao *et al*. 2014; Chao *et al*. 2016). The dendrogram was analyzed to determine species clusters based on their distribution. All tests and modeling analyses were analyzed using JAMOVI, RStudio and Srplot (Tang *et al*. 2023).

Results and Discussion

Species diversity and frequencies of plants

Analyzing 190 national textbooks for special schools in all classes showed 172 plant species found (Table 2). Based on the diversity of plant species in the book, fifth grade deaf was the highest, with 83 species, while the lowest was third grade blind, with only 2 species (Fig. 1). Based on rarefaction and extrapolation analysis, it depicted that the values for each estimator of the sample coverage of the reference sample (SC) were autistic (0.95), intellectually disabled (0.94), physically disabled (0.93), deaf (0.92), and blind (0.86) (Fig. 2). Katayama and Baba (2020) also used this analysis to identify several families that mentioned plants in children's songs in Japan. This result was lower than that of research by Kwon (2021), which found 232 plant species in elementary school textbooks in South Korea. This contrasted with the much lower number of books studied, namely 94 textbooks. This can certainly lead to attention being able to add natural elements to teaching materials. The number of species in different curriculum systems also influences the number of plant species discovered (Park 2003, Chun, 2014).

The five species with the highest relative frequency levels were *C. nucifera* (8.79%), followed by *O. sativa* (6.04%), *D. carota* (6.95%), *Musa × paradisiaca* (4.17%), and *M. indica* (4.01%). Most plant topics in elementary school science textbooks usually explain plant parts (Schussler *et al*. 2010). The high value of FR of *C. nucifera* was influenced by its benefits as food, medicine, agricultural tools, firewood, construction and building materials, shade, ornament, ritual, and handicrafts (Tuhumuri *et al*. 2020; Afrianto*et al*. 2023; Suwardi *et al*. 2023) (Table 2). *C. nucifera* is a common species found in Indonesian home gardens (Suwardi *et al*. 2023). *C. nucifera* appeared in all types of books except for first-grade books for blind students. In addition, *O. sativa* (6.04%), *D. carota*, *Musa × paradisiaca*, and *M. indica* are food plants often consumed by Indonesians (Afrianto *et al*. 2023). On the other hand, species that have low FR were affected by limited distribution area, utilization, and cultivation.

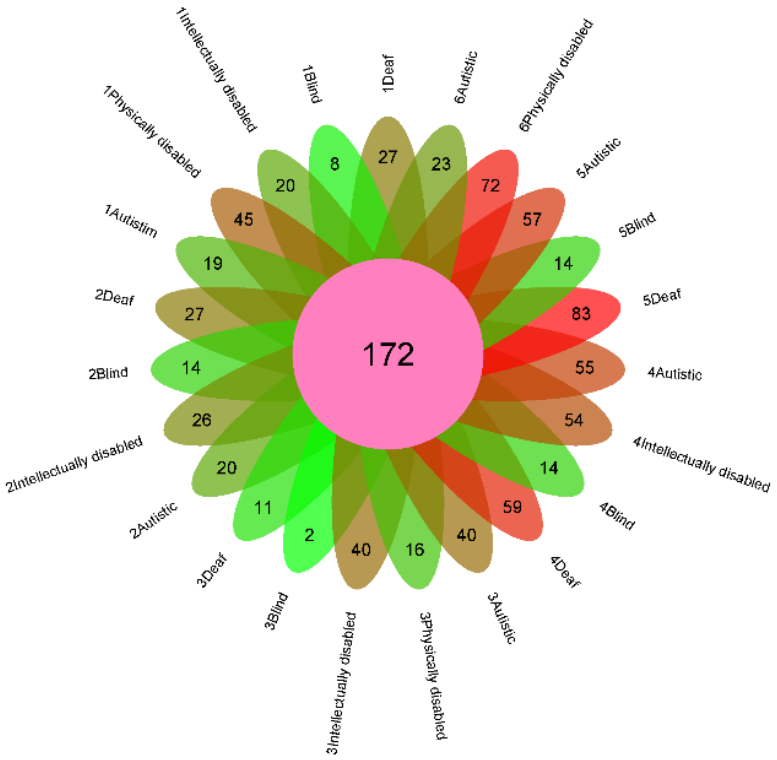

Figure 1. Plant species found in special elementary school textbooks in Indonesia

The Venn diagram show the similarities in plant diversity in each textbook (Figure 3a-b). Fig. 3a shows a slice of plant species at different grades. The results showed that species such as *Amaranthus hybridus*, *Daucus carota*, *Helianthus annuus*, *Ipomoea batatas*, *Solanum melongena*, *Capsicum annuum*, *Zea mays* appeared in all grades. Meanwhile, the species section in the textbook based on disability categories explained that *Bambusa spp.*, *Solanum tuberosum*, *Citrus sinensis*, *Brassica oleracea*, *Ptychosperma macarthurii*, *Musa × paradisiaca*, *Mangifera indica*, *D. carota*, *Manihot esculenta*, *Ananas comosus*, *Rosa spp.*, *I. batatas*, *Vitis vinifera*, *Persea americana*, *Solanum melongena*, *Malus domestica*, *Cocos nucifera*, *Oryza sativa*, *Carica papaya*, *Ficus benjamina*, *Solanum lycopersicum*, and *Zea mays* (Fig. 3b). The heatmap (Table 2) reveals that the total frequencies were 3642. In the heatmap, green means a species with a relatively high frequency, yellow means medium, and red means low. According to Link-Pérez *et al*. (2010), the content of science elementary school books about plants was lower than that on animal topics.

The book with the highest species frequency was fifth grade autistic, with 387, while the lowest was third grade blind, with two. This finding differed from the findings of Kwon (2021), who stated that third class had the highest frequency. The frequency value in blind students' books was low due to their limitations. The Kruskal-Wallis H-test results revealed that plant frequencies no significantly differed among book based on grades ($\chi^2 = 10.4$, df = 5, $p = 0.065$) with a relatively moderate effect size ($\varepsilon^2 = 0.0145$) (Fig 4a). The Kruskal-Wallis H-test results revealed that plant frequencies no significantly differed among book based on grades ($\chi^2 = 34.0$, df = 5, $p < 0.001$) with a relatively moderate effect size ($\varepsilon^2 = 0.0473$) (Fig 4a). The significance different in posterior Wilcoxon pairwise showed that autistic and blind, intellectually disabled, physically disabled $p < 0.005$, and with deaf $p < 0.001$. Using GLMM, the results showed that there was a significant relationship between the independent variable disability book type and the frequency of species occurrence ($p < 0.001$, $F = 6.80$, df = 5, df (res) = 73.6). This showed significant differences in the distribution of species occurrence between different groups in the type of disability book used as a textbook.

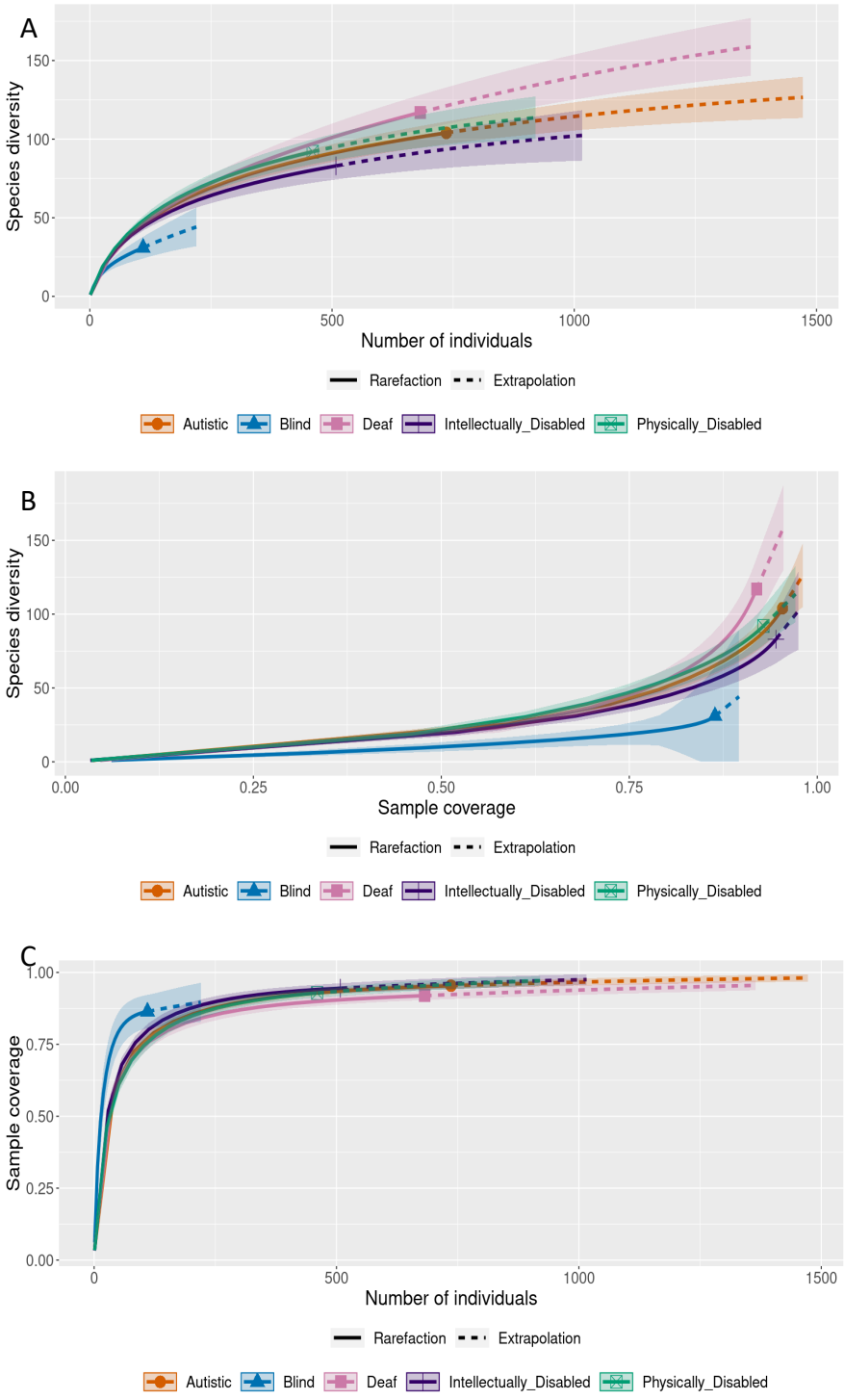

Figure 2. (a) Individual- and (b) coverage-based rarefaction and extrapolation curves with 95% confidence intervals (shaded areas, based on a bootstrap method with 200 replications) comparing plant abundance. Curves are drawn to (a) a base sample size, (b) a base coverage, and (c) sample completeness curves linking curves in (a) and (b).

Table 2. Heatmap of plant species diversity by special elementary school in textbooks in Indonesia.

Local name	Scientific name	Family	Uses	FR
Agave	*Agave sp*.	Asparagaceae	Fo, Me, Fi, Orn	0.10
Alpukat	*Persea americana* Mill	Lauraceae	Fo, Me, Comu, Sha	0.37
Amarilis	*Hippeastrum puniceum* subsp. *Puniceum*	Amaryllidaceae	Comu, Orn	0.07

Local name	Scientific name	Family	Uses	FR
Anggrek asem	*Aerides odorata* Lour.	Orchidaceae	Comu, Orn	0.03
Anggrek bulan	*Phalaenopsis amabilis* (L.) Blume	Orchidaceae	Comu, Orn	0.30
Anggrek hitam	*Coelogyne pandurata* Lindl	Orchidaceae	Comu, Orn	0.03
Anggrek tebu	*Grammatophyllum speciosum* Blume	Orchidaceae	Comu, Orn	0.10
Anggur	*Vitis vinifera* L.	Vitaceae	Fo, Comu	1.22
Apel	*Malus domestica* Borkh.	Rosaceae	Fo, Comu	2.77
Apu-apu	*Pistia stratiotes* L.	Araceae	Comu, Orn	0.03
Asparagus	*Asparagus officinalis* L.	Asparagaceae	Fo, Comu	0.03
Aster	*Aster sp*.	Asteraceae	Comu, Orn	0.07
Bambu	*Bambusa sp*.	Poaceae	Fo, Conbu, Comu, Fe, Orn, Han	0.71
Bambu kuning	*Bambusa vulgaris* Schrad	Poaceae	Conbu, Comu, Fe, Orn, Han	0.03
Bawang bombay	*Allium cepa* L.	Amaryllidaceae	Fo, Comu	0.19
Bawang merah	*Allium cepa* L.	Amaryllidaceae	Fo, Me, Comu	0.55
Bawang putih	*Allium sativum* L.	Amaryllidaceae	Fo, Me, Comu	0.27
Bayam	*Amaranhus sp*.	Amaranthaceae	Fo, Comu	1.57
Belimbing	*Averrhoa carambola* L.	Oxalidaceae	Fo, Comu	0.41
Bengkuang	*Pachyrhizus erosus* (L.) Urb.	Fabaceae	Fo, Comu	0.03
Beringin	*Ficus benjamina* L.	Moraceae	Fir, Sha	1.67
Brokoli	*Brassica oleracea* L.	Brassicaceae	Fo, Comu	0.49
Bromeliad	*Bromelia karatas* L.	Bromeliaceae	Comu, Orn	0.03
Buah naga	*Hylocereus sp*.	Cactaceae	Fo, Comu	0.08
Bugenfil	*Bougainvillea glabra* Choisy	Nyctaginaceae	Me, Orn	0.08
Buncis	*Phaseolus vulgaris* L.	Leguminosae	Fo, Comu	0.16
Bunga alamanda	*Allamanda cathartica* L.	Apocynaceae	Me, Orn	0.03
Bunga asoka	*Saraca asoca* (Roxb.) W.J.de Wilde	Fabaceae	Me, Orn	0.03
Bunga bangkai	*Amorphophallus titanum* (Becc.) Becc	Araceae	Me, Orn	0.03
Bunga dahlia	*Dahlia sp*.	Asteraceae	Me, Orn	0.05
Bunga daisy	*Bellis perennis* L.	Compositae	Me, Orn	0.05
Bunga kamboja	*Plumeria alba* L.	Apocynaceae	Me, Orn	0.03
Bunga kecubung	*Datura metel* L.	Solanaceae	Pope, Orn	0.03
Bunga kupu-kupu	*Oxalis triangularis* A.St.-Hil.	Oxalidaceae	Comu, Sha, Orn	0.19
Bunga lily	*Lilium regale* E.H.Wilson	Liliaceae	Comu, Orn	1.07
Bunga matahari	*Helianthus annuus* L.	Compositae	Fo, Comu, Orn	0.08
Bunga pisang-pisangan	*Heliconia densiflora* Verl.	Heliconiaceae	Orn	0.16
Bunga sakura	*Prunus serrulata* Lindl	Rosaceae	Orn	0.03
Cabai	*Capsicum annuum* L.	Solanaceae	Fo, Comu	2.50
Cempaka	*Magnolia champaca* (L.) Baill. ex Pierre	Magnoliaceae	Orn	0.05
Cempedak	*Artocarpus integer* (Thunb.) Merr	Moraceae	Fo, Comu	0.03
Cendana	*Santalum album* L.	Santalaceae	Me, Comu, Ri	0.03
Cengkeh	*Syzygium aromaticum* (L.) Merr. & L.M.Perr	Myrtaceae	Fo, Me, Comu	0.11
Cherry	*Prunus sp*.	Rosaceae	Fo, Comu	0.16
Ciplukan	*Physalis angulata* L.	Solanaceae	Fo, Me, Comu	0.03
Coklat	*Theobroma cacao* L.	Malvaceae	Fo, Me, Dy, Comu	0.03

Local name	Scientific name	Family	Uses	FR
Damar	*Agathis dammara* (Lamb.) Rich. & A. Rich.	Araucariaceae	Fi, Agr, Conbu, Comu, Sha	0.03
Dandeloin	*Taraxacum sect. Taraxacum* F.H.Wigg.	Asteraceae	Orn	0.03
Daun bawang	*Allium fistulosum* L.	Amaryllidaceae	Fo, Me, Comu	0.11
Daun payung/daun salo	*Johannesteijsmannia altifrons* (Rchb.f. & Zoll.) H.E.Moore is	Arecaceae	Comu, Orn	0.03
Daun suji	*Dracaena angustifolia* (Medik.) Roxb.	Asparagaceae	Fo, Me, Comu	0.03
Delima	*Punica granatum* L.	Lythraceae	Fo, Me, Comu	0.08
Durian	*Durio zibethinus* L.	Malvaceae	Fo, Me, Comu	0.25
Eboni	*Diospyros celebica* Bakh.	Ebenaceae	Conbu, Comu, Sha	0.03
Edelweis	*Anaphalis javanica* (DC.) Sch.Bip.	Asteraceae	Comu, Orn	0.08
Enceng gondok	*Eichhornia crassipes* (Mart.) Solms	Pontederiaceae	Orn, Han	0.08
Ephorbia	*Euphorbia sp*.	Euphorbiaceae	Comu, Orn	0.08
Gadung	*Dioscorea hispida* Dennst.	Dioscoreaceae	Fo, Pope	0.03
Gambas	*Luffa acutangula* (L.) Roxb.	Cucurbitaceae	Fo, Comu	0.11
Ganja	*Cannabis sativa* L.	Cannabaceae	Fo, Me, Pope	0.05
Gembili	*Dioscorea esculenta* (Lour.) Burkill	Dioscoreaceae	Fo, Comu	0.03
Glodokan tiang	*Monoon longifolium* (Sonn.) B.Xue & R.M.K.Saunders	Annonaceae	Comu, Orn	0.05
Jagung	*Zea mays* L.	Poaceae	Fo, Fod, Fish, Comu	2.83
Jahe	*Zingiber officinale* Roscoe	Zingiberaceae	Fo, Me, Comu	0.27
Jambu air	*Syzygium aqueum* (Burm.f.) Alston	Myrtaceae	Fo, Comu	0.66
Jambu biji	*Psidium guajava* L.	Myrtaceae	Fo, Me, Comu	0.30
Jambu mete	*Anacardium occidentale* L.	Anacardiaceae	Fo, Comu	0.03
Janda bolong	*Monstera adansonii* Schott	Araceae	Comu, Orn	0.03
Jati	*Tectona grandis* L.	Lamiaceae	Agr, Conbu, Comu, Sha	0.11
Jeruk	*Citrus sinensis* (L.) Osbeck	Rutaceae	Fo, Me, Comu	2.33
Jeruk nipis	*Citrus aurantiifolia* (Christm.) Swingle i	Rutaceae	Fo, Me, Comu	0.03
Jintan	*Cuminum cyminum* L.	Apiaceae	Fo, Me, Comu	0.03
Kacang hijau	*Vigna radiata* (L.) R.Wilczek	Leguminosae	Fo, Comu	0.30
Kacang kapri	*Pisum sativum* L.	Leguminosae	Fo, Comu	0.08
Kacang merah	*Phaseolus vulgaris* L.	Leguminosae	Fo, Comu	0.03
Kacang panjang	*Vigna unguiculata* (L.) Walp.	Leguminosae	Fo, Comu	0.74
Kacang tanah	*Arachis hypogaea* L.	Leguminosae	Fo, Comu	0.05
Kaktus koboi	*Cereus repandus* (L.) Mill.	Cactaceae	Comu, Orn	0.11
Kangkung	*Ipomoea aquatica* Forssk.	Convolvulaceae	Fo, Comu	1.10
Kantung semar	*Nepenthes sp*.	Nepenthaceae	Orn	0.05
Kapas	Gossypium sp.	Malvaceae	Fi, Comu	0.38
Kapulaga	*Amomum compactum* Sol. ex Maton is an	Zingiberaceae	Fo, Me, Comu	0.05
Karet kebo	*Ficus elastica* Roxb. ex Hornem.	Moraceae	Conbu, Comu, Orn	0.05
Kayu manis	*Cinnamomum burmanni* (Nees & T.Nees) Blume	Lauraceae	Fo, Me, Comu	0.11
Kecipir	*Psophocarpus tetragonolobus* (L.) DC.	Leguminosae	Fo, Comu	0.05
Kedelai	*Glycine max* (L.) Merr.	Leguminosae	Fo, Comu	0.44
Kelapa	*Cocos nucifera* L.	Arecaceae	Fo, Me, Conbu, Comu	8.79
Kembang kol	*Brassica oleracea* L.	Brassicaceae	Fo, Comu	0.58

Local name	Scientific name	Family	Uses	FR
Kembang sepatu	*Hibiscus rosa-sinensis* L.	Malvaceae	Orn	0.27
Kemiri	*Aleurites moluccanus* (L.) Willd	Euphorbiaceae	Fo, Me, Comu	0.03
Kemuning	*Murraya paniculata* (L.) Jack	Rutaceae	Orn	0.03
Kencur	*Kaempferia galanga* L.	Zingiberaceae	Fo, Me, Comu	0.03
Kentang	*Solanum tuberosum* L.	Solanaceae	Fo, Comu	0.88
Ketela pohon	*Manihot esculenta* Crantz	Euphorbiaceae	Fo, Comu	0.85
Kopi	*Coffea sp*.	Rubiaceae	Fo, Me, Comu	0.03
Krisan	*Chrysanthemum indicum* L	Compositae	Comu, Orn	0.14
Kubis	*Brassica oleracea var. capitata*	Brassicaceae	Fo, Comu	1.07
Kunyit	*Curcuma longa* L.	Zingiberaceae	Fo, Me, Dy, Comu	0.19
Labu Kuning	*Cucurbita moschata* Duchesne	Cucurbitaceae	Fo, Comu	0.74
Labu siam	*Sechium edule* (Jacq.) Sw.	Cucurbitaceae	Fo, Comu	0.22
Lada	*Piper nigrum* L.	Piperaceae	Fo, Me, Comu	0.05
Lemon	*Citrus limon* (L.) Osbeck	Rutaceae	Fo, Me, Comu	0.14
Lengkuas	*Alpinia galanga* (L.) Willd.	Zingiberaceae	Fo, Me, Comu	0.03
Lidah buaya	*Aloe vera* (L.) Burm.f.	Xanthorrhoeaceae	Fo, Me, Comu	0.11
Lobak	*Raphanus raphanistrum* L.	Brassicaceae	Fo, Comu	0.30
Mahoni	*Swietenia mahagoni* (L.) Jacq.	Meliaceae	Conbu, Fir, Comu, Sha	0.05
Mangga	*Mangifera indica* L.	Anacardiaceae	Fo, Me, Fir, Comu, Sha	4.01
Manggis	*Garcinia mangostana* L.	Clusiaceae	Fo, Me, Fir, Comu, Sha	0.08
Markisa	*Passiflora foetida* L.	Passifloraceae	Fo, Comu	0.05
Matoa	*Allophylus cobbe* (L.) Raeusch.	Sapindaceae	Fo, Me, Fir, Comu, Sha	0.03
Mawar	*Rosa sp*.	Rosaceae	Comu, Orn, Ri	2.64
Melati	*Jasminum sambac* (L.) Aiton	Oleaceae	Comu, Orn, Ri	0.38
Melon	*Cucumis melo* L.	Cucurbitaceae	Fo, Comu	0.36
Mengkudu	*Morinda citrifolia* L.	Rubiaceae	Fo, Me, Comu	0.03
Murbei	*Morus nigra* L.	Moraceae	Fo, Comu	0.03
Nanas	*Ananas comosus* (L.) Merr.	Bromeliaceae	Fo, Comu	0.52
Nangka	*Artocarpus heterophyllus* Lam.	Moraceae	Fo, Me, Comu	0.05
Okra	*Abelmoschus esculentus* (L.) Moench	Malvaceae	Fo, Comu	0.11
Padi	*Oryza sativa* L.	Poaceae	Fo, Fish, Comu	6.07
Paku	*Diplazium esculentum* (Retz.) Sw.	Aspleniaceae	Fo	0.03
Pala	*Myristica fragrans* Houtt.	Myristicaceae	Fo, Me, Comu	0.11
Palem hijau	Ptychosperma macarthurii (H.Wendl. ex H.J.Veitch) H.Wendl. ex Hook.f.	Arecaceae	Comu, Orn	0.77
Palem kipas	*Livistona saribus* (Lour.) Merr. ex A.Chev.	Arecaceae	Comu, Orn	0.05
Palem merah	*Cyrtostachys renda* Blume	Arecaceae	Comu, Orn	0.03
Paprika	*Capsicum annuum* var. *grossum* (Willd.) Sendtn.	Solanaceae	Fo, Comu	0.30
Papyrus payung	*Cyperus papyrus* L.	Cyperaceae	Comu, Orn	0.03
Pare	*Momordica charantia* L.	Cucurbitaceae	Fo, Me, Comu	0.08
Pegagan	*Centella asiatica* (L.) Urb.	Apiaceae	Fo, Me, Comu	0.03
Pepaya	*Carica papaya* L.	Caricaceae	Fo, Me, Comu	2.80
Petai	*Parkia speciosa* Hassk.	Fabaceae	Fo, Me, Comu	0.03
Philodendron gergaji	*Philodendron sp*.	Araceae	Comu, Orn	0.03

Local name	Scientific name	Family	Uses	FR
Pinang	*Areca catechu* L.	Arecaceae	Fo, Me, Comu	0.03
Pinus	*Pinus merkusii* Jungh. & de Vriese	Pinaceae	Conbu, Comu, Sha	0.91
Pir	*Pyrus sp*.	Rosaceae	Fo, Comu	0.11
Pisang	*Musa × paradisiaca* L.	Musaceae	Fo, Comu	4.12
Pohon bodhi	*Ficus religiosa* L.	Moraceae	Ri	0.82
Pucuk merah	*Syzygium myrtifolium* Walp.	Myrtaceae	Comu, Orn	0.05
Putri malu	*Mimosa pudica* L.	Fabaceae	Me	0.03
Rafflesia alrnordi	*Rafflesia arnoldii* R.Br.	Rafflesiaceae	None	0.19
Rambutan	*Nephelium lappaceum* L.	Sapindaceae	Fo, Me, Comu	0.47
Rotan	*Calamus rotang* L.	Arecaceae	Fo, Me, Agr, Conbu, Comu	0.03
Rumput kipas	*Selaginella doederleinii* Hieron.	Selaginellaceae	Orn	0.03
Rumput teki	*Cyperus brevifolius* (Rottb.) Hassk.	Cyperaceae	Fod, Comu	0.03
Sagu	*Metroxylon sagu* Rottb.	Arecaceae	Fo, Me, Comu	0.03
Salak	*Salacca zalacca* (Gaertn.) Voss	Arecaceae	Fo, Comu	0.22
Sawi hijau	*Brassica rapa* L.	Brassicaceae	Fo, Comu	1.21
Sawi putih	*Brassica rapa* subsp. *pekinensis*	Brassicaceae	Fo, Comu	0.25
Sawo	*Manilkara zapota* (L.) P.Royen	Sapotaceae	Fo, Me, Comu, Sha	0.08
Sedap malam	*Polianthes tuberosa* L.	Asparagaceae	Comu, Orn	0.08
Selada	*Lactuca sativa* L.	Compositae	Fo, Comu	0.27
Seledri	*Apium graveolens* L	Apiaceae	Fo, Comu	0.16
Semangka	*Citrullus lanatus* (Thunb.) Matsum. & Nakai	Cucurbitaceae	Fo, Comu	0.69
Sirih	*Piper betle* L.	Piperaceae	Me, Comu	0.27
Sirsak	*Annona muricata* L.	Annonaceae	Fo, Me, Comu	0.33
Sogo tunteng/sogo telik	*Adenanthera pavonina* L.	Leguminosae	Me, Sha	0.08
Soka	*Ixora sp*.	Rubiaceae	Comu, Fe, Orn	0.27
Strawberi	*Fragaria sp*.	Rosaceae	Fo, Comu	0.41
Talas	*Colocasia esculenta* (L.) Schott	Araceae	Fo, Dy, Comu	0.08
Tali putri	*Rhipsalis baccifera* subsp. *Baccifera*	Cactaceae	Me	0.11
Tapak dara	*Catharanthus roseus* (L.) G.Don	Apocynaceae	Me, Comu, Orn	0.03
Tebu	*Saccharum officinarum* L.	Poaceae	Fo, Comu	0.05
Teh	*Camellia sinensis* (L.) Kuntze	Theaceae	Fo, Comu	0.14
Teh-tehan	*Acalypha siamensis* Oliv. ex Gage	Euphorbiaceae	Comu, Orn	0.05
Tempuyung	*Sonchus arvensis* L.	Compositae	Me, Comu	0.03
Temu lawak	*Curcuma zanthorrhiza* Roxb.	Zingiberaceae	Fo, Me, Comu	0.08
Teratai	*Nymphaea sp*.	Nymphaeaceae	Me, Comu, Orn	0.36
Terong	*Solanum melongena* L.	Solanaceae	Fo, Comu	1.04
Timun	*Cucumis sativus* L.	Cucurbitaceae	Fo, Comu	0.47
Tomat	*Solanum lycopersicum* L.	Solanaceae	Fo, Comu	3.19
Tulip	*Tulipa sp*.	Liliaceae	Comu, Orn	0.33
Ubi jalar merah	*Ipomoea batatas* (L.) Lam.	Convolvulaceae	Fo, Dy, Comu	0.58
Wortel	*Daucus carota* L.	Apiaceae	Fo, Dy, Comu	4.12

Note: FR (Frequency Relative), Fo (Food), Medicine (Me), Fibre (Fi), Dye (Dy), Agricultural tools (Agr), Construction and building material (Conbu), Firewood (Fir), Fodder (Fod), Fishing (Fish), Poison and pesticide (Pope), Commercial uses (Comu), Fencing (Fe), Shade (Sha), Ornament (Orn), Ritual (Ri), Handicrafts (Han).

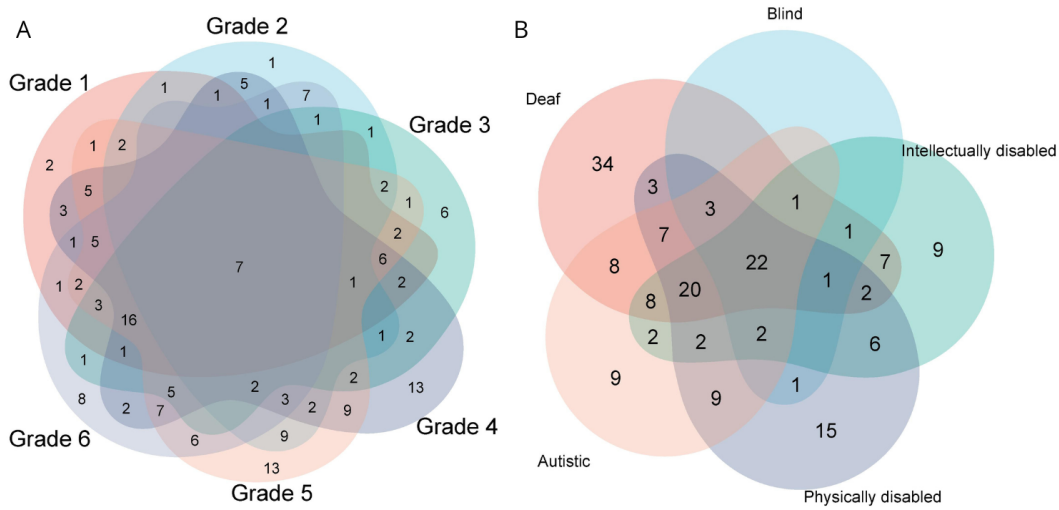

Figure 3. Ven diagrams of plant diversity plant species diversity by special elementary school in textbooks in Indonesia, (A) based on grades and (B) disability categories.

Fig. 5 shows NMDS and ANOSIM results of species composition based on Indonesia's special elementary school textbooks. NMDS of the Bray-Curtis species similarity of 23 book categories determined that the distribution of species composition preferred not to cluster and spread apart. The similarity analysis showed that at a significance level of $p < 0.5\%$ and a global R-value of 0.1729, there were significant differences in Bray-Curti's species similarity between the book categories. Dendrogram analysis shows that plant species were categorized into four groups (Fig. 6). Three groups consisted of only one species: *Cocos nucifera*, *Musa × paradisiaca*, and *Oryza sativa*. The remaining group consisted of 169 other species. Ikeda and Yamamoto (2021) revealed that beneficial plants will have a higher frequency.

Family diversity

The diversity of families found was quite diverse, namely 61 families. The dominant family was Arecaceae, which consists of 9 species (5%). The Arecaceae and Leguminosae family was dominated with 10 species (5%). The next families were Leguminosae with eight species (5%), Cucurbitaceae, and Solanaceae, with seven species each (4%). The Arecaceae family was often called the palm family (Dransfield *et al*. 2005). This family has been reported to be rich in bioactive compounds with potential health benefits (Morais *et al*. 2022). The families with the highest FR values were Solanaceae and Poaceae, which are marked green (Table 1). These families are widely used as fooders, medicinal products, foods, and rituals/ceremonies in Indonesia (Amrul *et al*. 2019; Cita *et al*. 2020; Jadid *et al*. 2020; Elfrida *et al*. 2021; Ratnani *et al*. 2021). Plants in these families are also cultivated in almost all regions of Indonesia.

Content analysis

Content analysis showed that at grade level, the cultural score in first grade and instrumental in fifth grade was the highest, with the same score, namely 80 chapters. Meanwhile, in the disability category, the highest score was instrumental on autism, with 144 chapters (Table 3). According to Titeca *et al*. (2015), children with autism spectrum disorder showed strength in word/language problems in the second and fourth grades. It was also because children with autism often need learning media that emphasizes calculations, examples and material content, as well as shape comparison because they tended to have a different learning style than neurotypical children. They often responded better to a concrete, structured approach. The Kruskal-Wallis H-test results revealed that plant frequencies significantly differed among book categories ($\chi^2 = 20$, df = 6, $p < 0.003$) with a relatively moderate effect size ($\varepsilon^2 = 0.115$) (Fig. 8). Post hoc Wilcoxon pairwise analysis showed that grades artistic and instrumental and artistic, symbolic and linguistic, and artistic were significantly different ($p < 0.05$) (Fig. 8). The content disability interaction analysis in the GLMM model showed no significant interaction between the two regarding the observed response ($F = 0.642$, df = 24, df (res) = 136, $p = 0.897$).

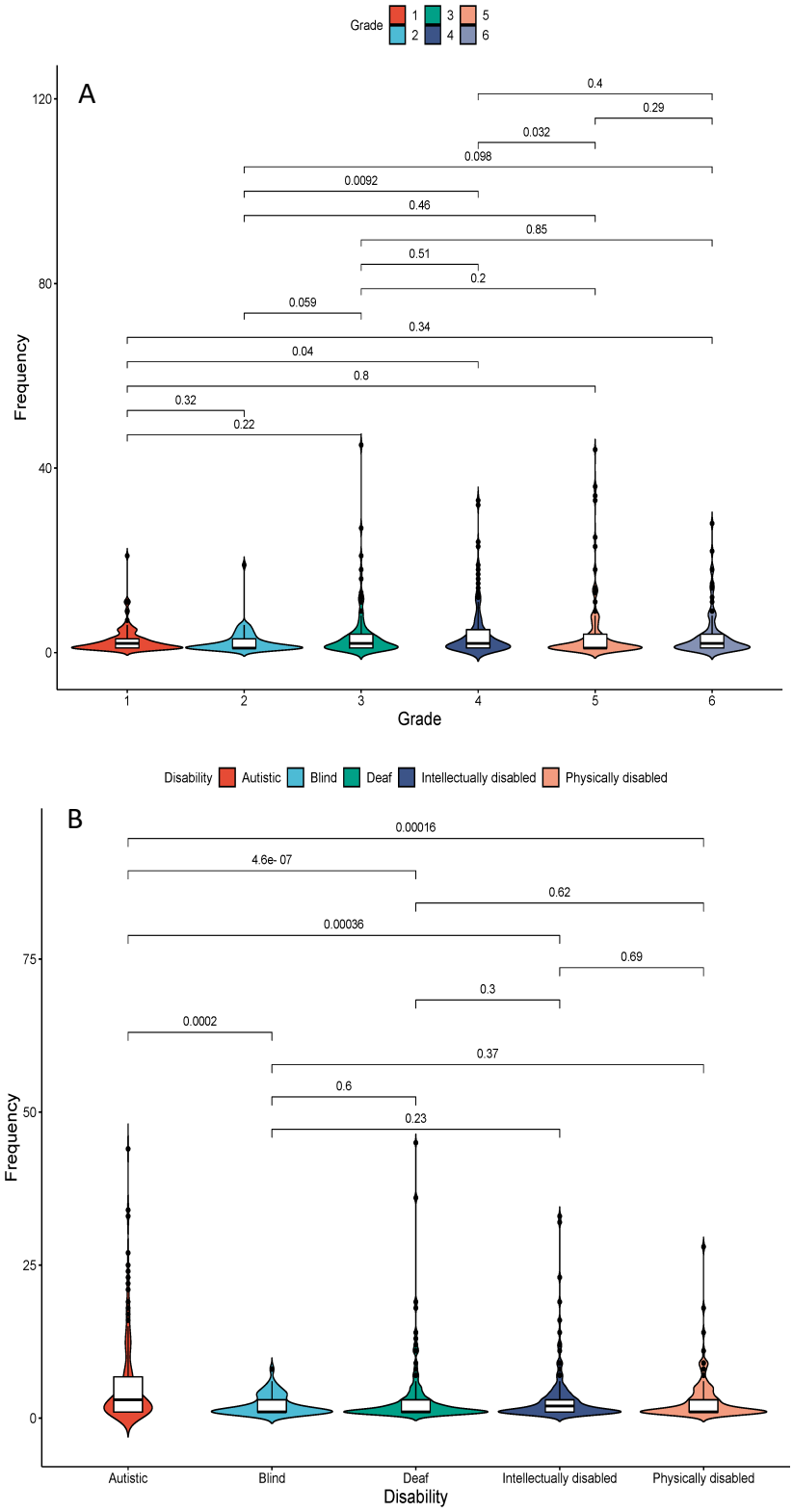

Figure 4. Violin boxplots for significant Kruskal–Wallis tests in frequency of plant species diversity by special elementary school in textbooks in Indonesia based on (A) grade and (B) disability, Significance in posterior Wilcoxon pairwise.

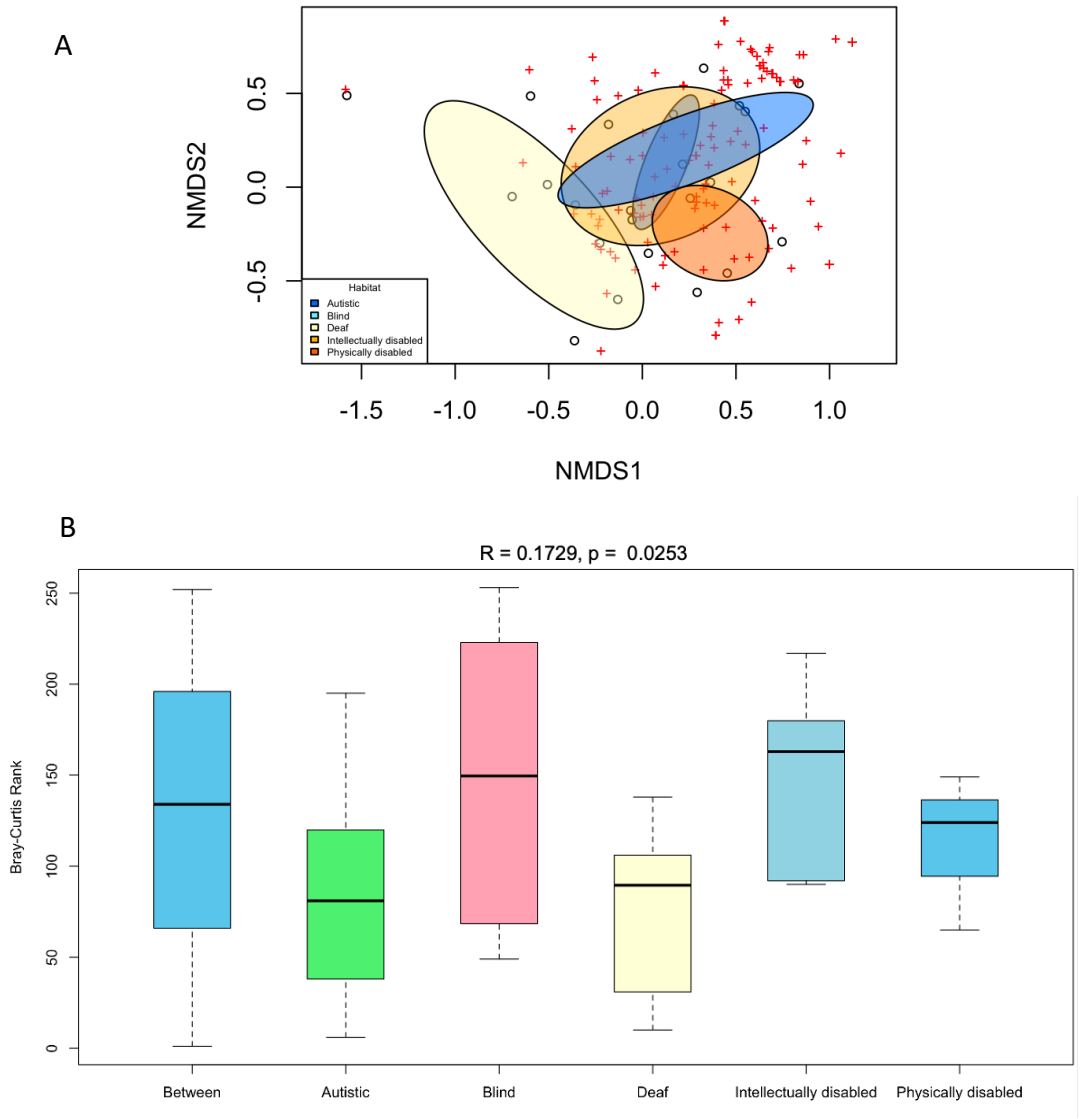

Figure 5. (A) NMDS ordination analysis of sampled sites based on Bray-Curti's similarity (species presence-absence), (B) ANOSIM statistic 0.1729, p = 0.253

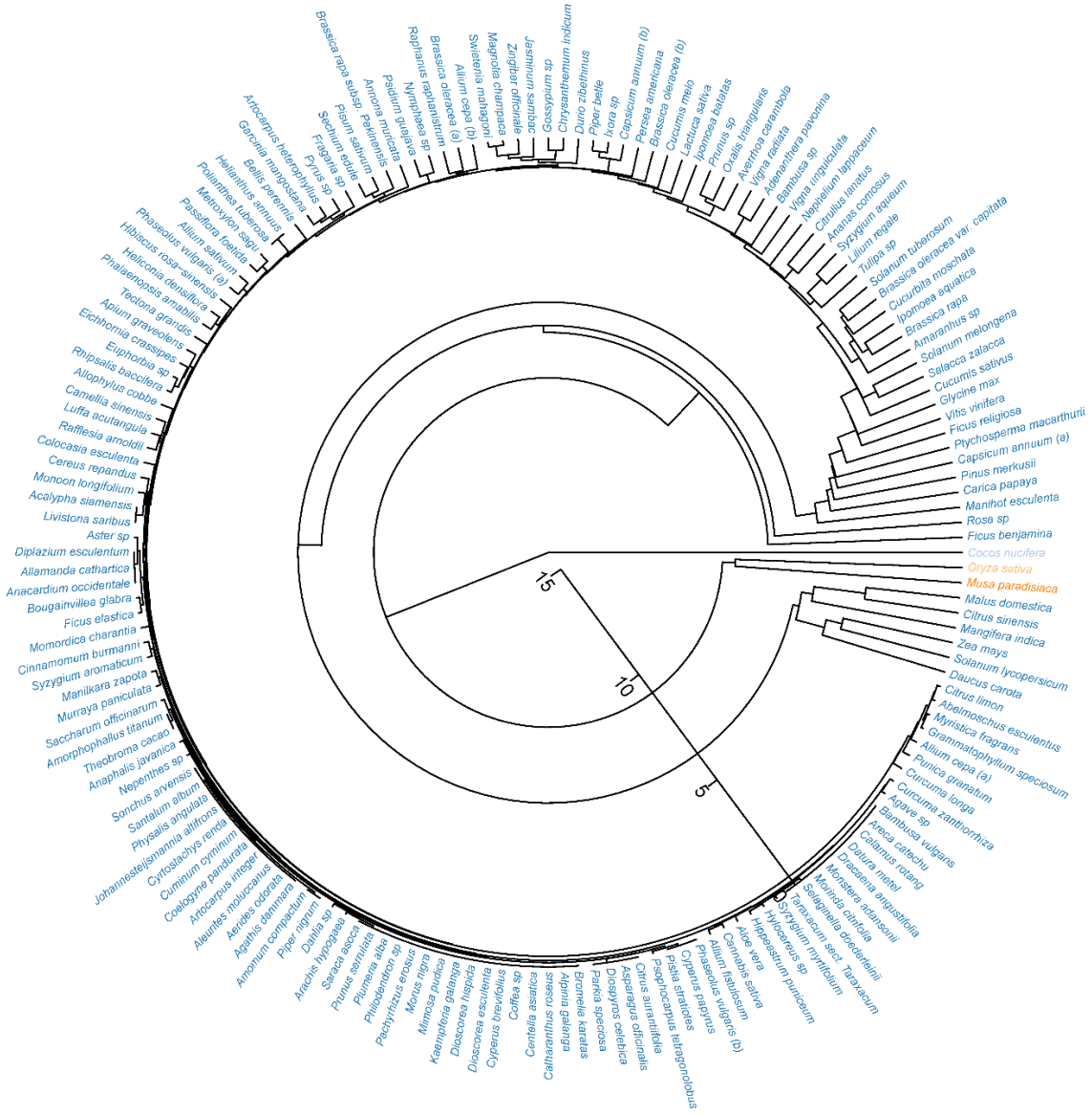

Figure 6. Fan dendrogram of diversity and distribution of species occurrence records by special elementary school in textbooks in Indonesia

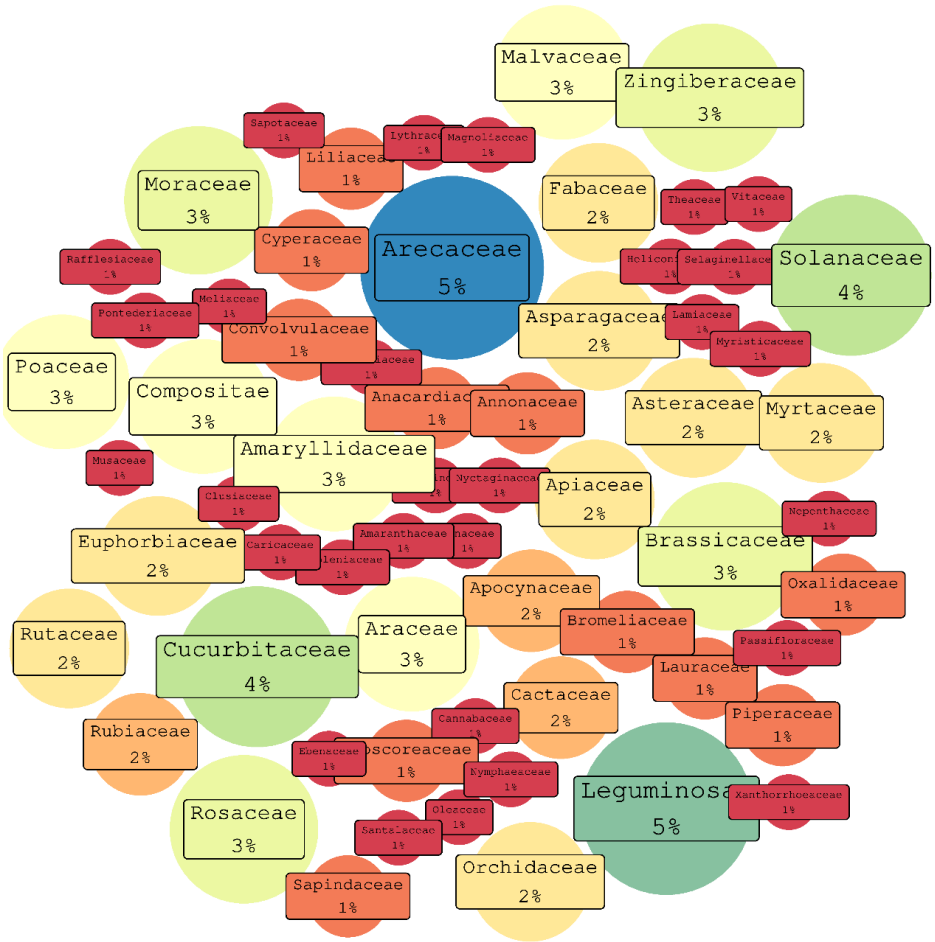

Figure 7. Bubble diagram of family diversity by special elementary school in textbooks in Indonesia

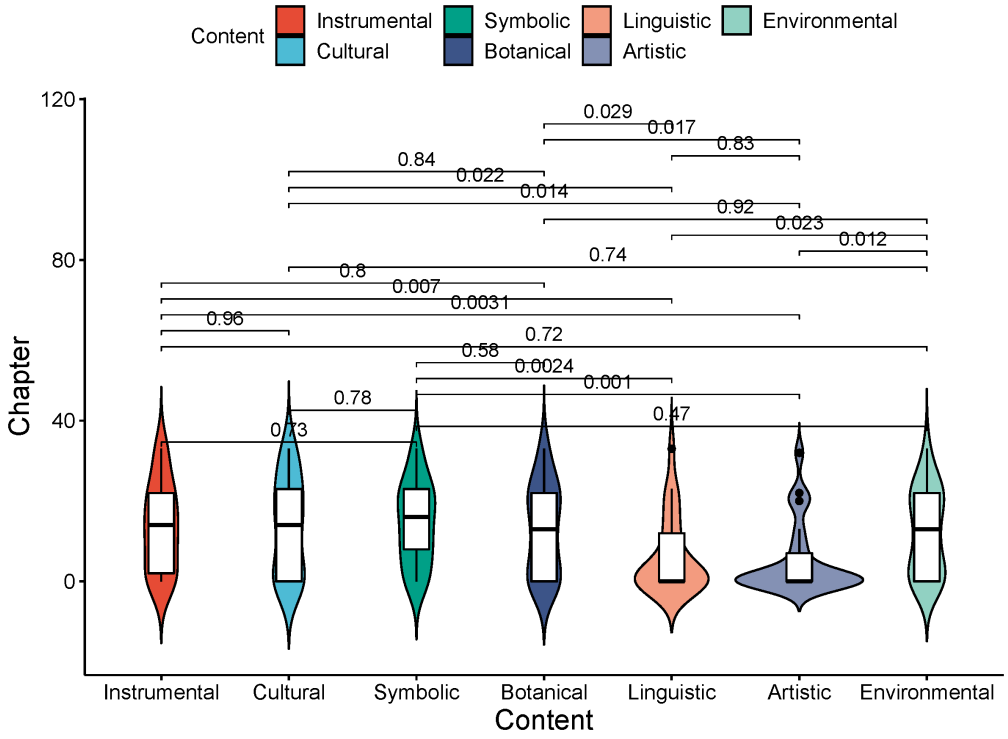

Figure 8. Violin boxplots for significant Kruskal–Wallis tests in content types by special elementary school in textbooks in Indonesia, Significance in posterior Wilcoxon pairwise.

The lack of pictures and illustrations in textbooks for children with visual impairments can be caused by a focus on different sensory experiences, where children with visual impairments rely more on auditory or tactile experiences than visual experiences (Hornby 2021, Kauffman *et al*. 2021). It gives rise to a preference for detailed verbal descriptions, braille writing, and other media with universal designs as alternatives to facilitate understanding and accessibility (Miyauchi 2020, Nahar *et al*. 2021). Additionally, technical obstacles in creating images that can be felt tactilely or presenting images accessible through assistive technology also influence this decision (Alabi & Mutula 2020, Senjam *et al*. 2020).

On the other hand, analysis of illustrations in textbooks for children with special needs showed that the instrumental and cultural categories were the highest. These two categories were more relevant to the learning material for children with special needs. Cognitive and constructivist theories support this phenomenon, underlining the importance of real and contextual experiences in learning (Jafari & Davatgari 2015), as well as the close relationship between subject matter and student experiences (Santrock 2017, Santrock 2019). By prominently illustrating instrumental and cultural categories, textbooks can more effectively support understanding and learning for children with special needs.

Plant classifications

Figure 9 shows the comparison of plant types was herbaceous at 63.95%, while woody at 36.05%. The plant division categories were as follows: foliage 79 species, tree 45 species; flower 19 species, shrub 12 species; bulb and tuber seven species, vine five species; aquatic four species; and carnivorous one species. Perennial types, with 73 species, dominated the plant types. Several plant species were also found in the threatened category in textbooks, such as VU = five species, EN = two species, and DD = 13 species. Learning about plants is important for children because it provides opportunities to increase plant knowledge and awareness (Brownlee *et al*. 2023). These activities also provide diverse sensory stimulation, support inclusive education, and help children with disabilities appreciate biodiversity, broaden their insight into the natural world, and develop empathy for other living creatures.

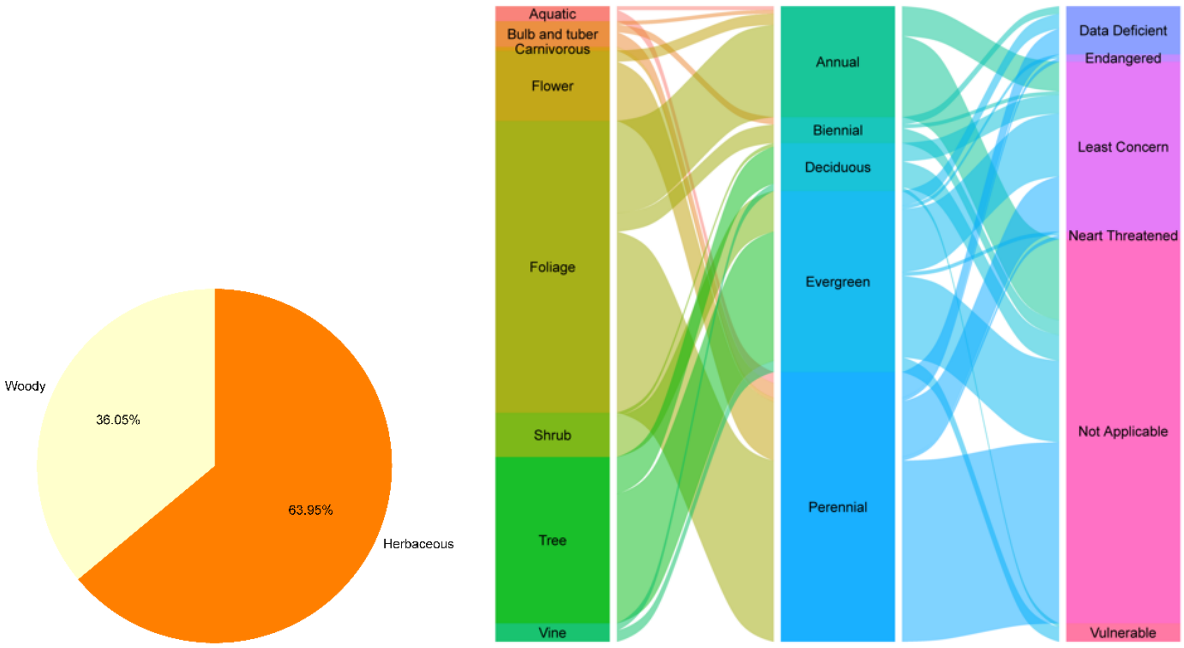

Figure 9. Pie chart and alluvial diagram of plant type categorized in school textbooks

The rare plants taught in the textbook were *Amorphophallus titanum* and *Tectona grandis. T. grandis* was a plant that, since the 19th century, has experienced a decline in pollution due to human activity and pressure in Indonesia. Several reasons were cultivating this species on plantations and stricter government regulations regarding logging, so the rate of decline in the future was likely to be smaller than the current decline rate. In Indonesia, *T. grandis* is closely related to its people, including the Javanese tribe, who associate it with glory. Meanwhile, *A. titanum*, which is an endemic plant to Sumatra, also continues to face various challenges, such as unsustainable harvesting, rapidly changing land cover, and global climate change, which has resulted in its population continuing to decline in natural habitats (Yudaputra *et al*. 2022). In Indonesia, *A. titanum* is known as a corpse flower because of its unpleasant aroma (Latifah *et al*. 2015).

Figure 10 shows the classification based on crop type was divided into five categories: food, medicinal, horticultural, industrial, and other crops. Horticultural types dominated plant types. This type is divided into three: fruit, vegetable, and ornament. The results showed that the composition of plants was 40 fruit species, 40 species of ornaments, and 31 species of vegetables. In food crops, the composition was grain two species, pulse four species, and root and tuber seven species. Medicinal crops were divided into two: medicinal, 14 species, and spice, four species. Apart from that, although the numbers were not large, several types of industrial plants were also found, such as eight species of fiber, three species of oil, one species of dye, and one species of sugar. The final category was not included in the previous four categories: weed nine species, wildflower six species, and forest tree two species.

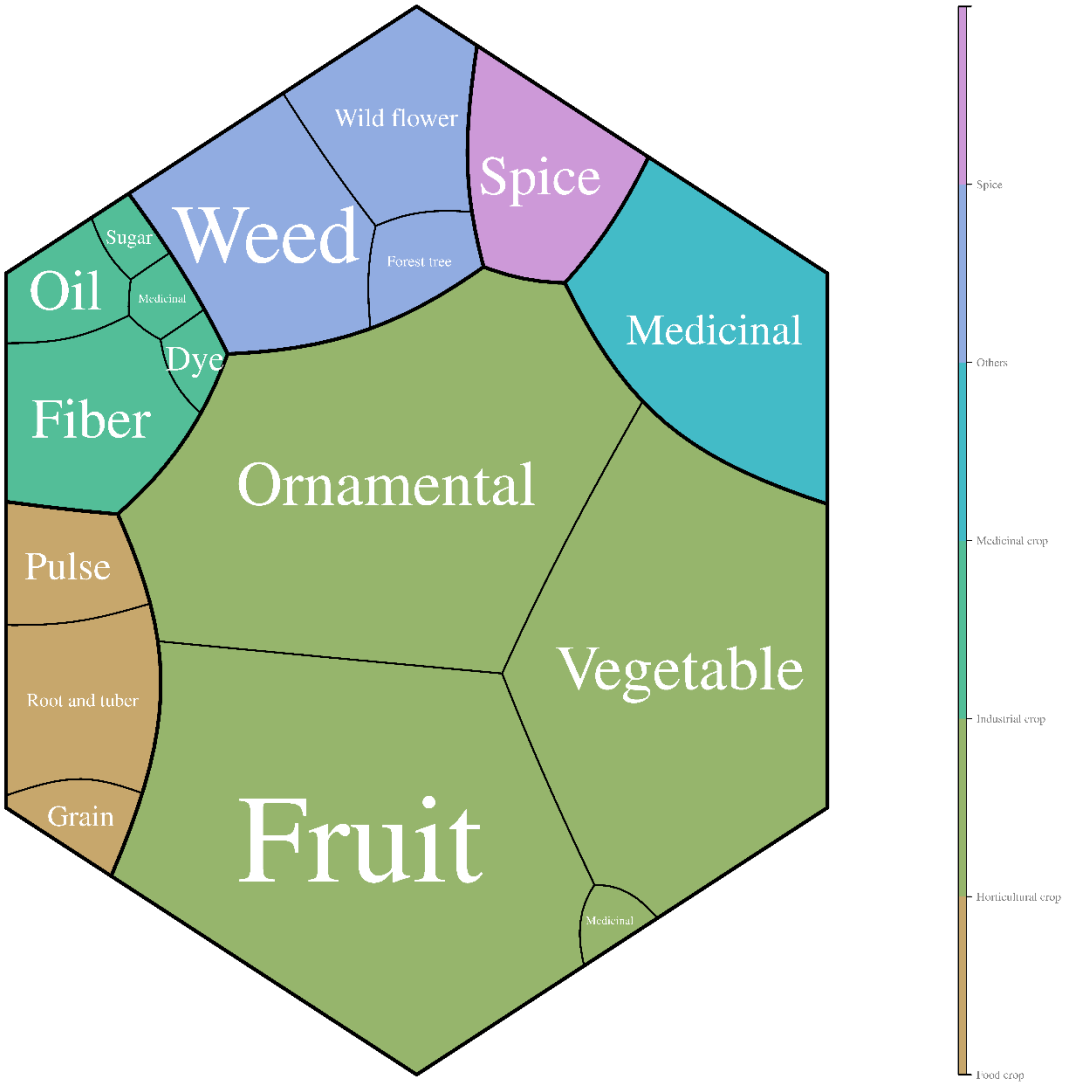

Figure 10. Voronoi tree maps classification of plants in elementary school textbooks by crop type

Conclusion

The diversity of plants in Indonesian textbooks for the primary school level varies based on class, specific disability, and book theme. From an analysis of 190 national textbooks for special schools in all classes, 172 plant species were found. The highest plant diversity was in fifth grade deaf students, with 83 species, while the lowest was in third grade blind students, with only two species. The results of the analysis showed that there are significant differences in plant frequencies between book categories, as well as a significant relationship between disability book types and the frequency of occurrence of plant species.

Understanding of plant diversity in textbooks was also affected by disability factors, with books for students with visual disabilities tending to have fewer pictorial representations, but focus on more detailed verbal descriptions. However, the

analysis showed that the instrumental and cultural categories had a higher number of illustrations, which can support better understanding and learning for children with special needs.

In terms of plant types, woody and herbaceous plants had a ratio of around 36.05% and 63.95%, respectively. Horticultural plants dominate the plant types, with fruit, vegetables and ornamental plants being the categories that appear most frequently. In addition, several plants were also classified as threatened, showing the importance of learning about conservation and biodiversity. This research provides a better understanding of the representation of plants in Indonesian textbooks for elementary school students with special needs. These results can be used as a basis for further improvements in creating textbooks that are more appropriate to the context and needs of children with disabilities, as well as to improve their understanding of biodiversity.

Recommendations for future research could focus on several key areas to deepen the understanding of plant diversity in special education textbooks. First, evaluation research on the integration of plant species can enhance special needs students' knowledge of local biodiversity and promote environmental stewardship. Second, exploring the socio-cultural implications of endemic plants in textbooks could provide insights into how these materials reflect regional biodiversity and cultural values. Longitudinal studies that track changes in plant representations over time can reveal trends and support the development of dynamic educational resources. Finally, integrating qualitative research methods can deepen students' understanding and engagement with plant-based educational content, thus enriching effective teaching practices. These recommendations promote a holistic approach to incorporating botanical knowledge into special education materials, thereby increasing environmental awareness among children with special needs.

Declarations

List of abbreviations: IUCN (The International Union for Conservation of Nature), DSCF (Dwass-Steel-Critchlow-Fligner), GLMM (generalized linear mixed model), NMDS (Non-metric Multidimensional Scaling), ANOSIM (Analysis of Similarity), DD (Data Deficient), LC (Least Concern), NT (Near Threatened), VU (Vulnerable), EN (Endangered), NA (Not Applicable)
Ethics approval and consent to participate: Not applicable
Consent for publication: Not applicable
Availability of data and materials: Not applicable
Competing interests: The authors declare no conflicting interests.
Funding: Not applicable
Author contributions: WFA conducted the research idea, data collection, analyzed and interpreted the data, drafted the initial manuscript, revised and improved the manuscript. AAM, ADS, and RJT analyzed and interpreted the data. MI and SIW revised and improved the manuscript. All the authors read, reviewed, and approved the final version of the manuscript.

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