Article

Interpretative Signs as a Tool Supporting Informal Environmental Education on the Example of Warsaw's Urban Forests

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Abstract: The article presents the results of research conducted in order to determine the comprehensibility (intelligibility) of the text of signs on educational paths in Warsaw's city forests. This evaluation was carried out with the use of an online IT tool—Promovolt. The obtained results were confronted with the assessment of users of educational paths and the opinion of an expert group, which consisted of people involved in the design of educational materials. The results indicate that the majority of the analyzed interpretative signs are dedicated to secondary school students because of the level of text comprehensibility. At the same time, 20% of the text is understandable only to recipients with higher education. This means that the educational paths in the urban forests of Warsaw, with interpretative signs allowing independent learning, do not sufficiently support the ecological education of children and youth from primary schools up to 15 years of age, as well as people with basic or vocational education.

Keywords: recreational infrastructure; forest education; forest didactic paths; Promovolt

1. Introduction

In recent decades, many cities have started to change towards a greener, more sustainable and more resilient model of urban development. They are investing in forests, wetlands and other green spaces—"green infrastructure" [1]. Urban forests can be broadly defined as the natural and planted trees in urban areas [2]. Forest resources can significantly improve the quality of the urban environment and the wellbeing of its inhabitants [3]. Properly planned and managed urban and per urban forests provide important positive externalities through ecosystem services. These services and values include, as McPherson et al. [4], Bolund and Hunhammar [5] and Ordóñez and Duinker [2] claim: clean air and water, energy conservation, carbon storage and sequestration, cooler and more regulated air temperatures, wildlife habitat, recreational opportunities, social, physical and psychological wellbeing, aesthetic quality, emotional and spiritual benefits and economic values (increased real-estate values, savings due to carbon dioxide sequestration and air pollutant removal, among others). Sustainable urban forests may be broadly defined as the persistence or continuation of a system over time. A review of useful definitions of this term can be found in the publication of Ordóñez and Duinker [2]. Sustainable urban forests cannot be separated from the activities of humans. Such activity can be both positive and negative. Wide-ranging activities of people are among the major forces for change in the health and character of the urban forest and ultimately determine its sustainability, more so than with any other forest resource [3,6]. The adverse impacts of humans can be mitigated by positive actions such as planning, planting and management; all occurring with common commitment and shared vision. Managers of urban green spaces (both

public and private), as Clark, Matheny, Cross and Wake [7] note, must involve the surrounding community in decisions and actions regarding urban forests. The use of urban forests provides opportunities for citizens to appreciate and learn about natural resources. According to Sondergaard [8], nature interpretation is considered to be an essential part of both recreation and tourism. The importance of urban forests and green spaces is increasing, because the number of people living in towns is growing. The experiences that urban residents have with trees and associated resources in the urban environment are likely to influence their perceptions, expectations and use of more distant natural resource areas, such as national forests, parks and monuments [3]. The results of Eaton's [9] study demonstrate that outdoor education programs are effective for promoting cognitive changes in students. Lindemann-Matthies' [10,11] research on promoting opportunities for children to experience nature directly on their way to school suggests that teachers should make greater use of educational approaches that focus on direct experiences in children's local environments. Ecological education conducted in forests is aimed at passing on the knowledge about the natural environment and the functions of forests, as well as shaping a pro-ecological system of values and triggering activities for the protection of the natural world. Environmental education programs can enhance the recreational services of urban forests for visitors [12]. According to Ja-Choon et al. [12] environmental education programs in urban forests can be categorized into two types by the presence of signs or interpreters. Without interpreters, a self-guided environmental education program can be provided through signs located along the trail. The occurrence of recreational infrastructure in forests, which includes interpretive signs, has strong links to public use of the forest environment [13]. Roads or marked trails will attract and concentrate visitors to particular areas. Such infrastructure, however, can negatively affect those seeking wilderness areas without signs of human activity [14,15]. According to Wielgus [16], the relationship of an engineering facility to the landscape is not widely appreciated, meaning that many emerging facilities are disconnected from their environment, lacking a synergistic display of value along with landscape assets. Vidiella [17] points out that with the introduction of the concept of sustainability into the design of buildings, an increase has been noticed in the number of buildings that meet or seek to meet the principles of green building, being environmentally friendly but also creating harmony with the surrounding landscape.

Ballantyne and Hughes [18] point out that the number of visitors to nature sites has increased in recent years, which also means an increase in the demands put on workers working in nature sites. Site managers have responded to this pressure by installing in situ visitor signs to inform visitors about the features, events and/or facilities they encounter. Well-designed interpretative signs can play a key role in developing positive environmental attitudes and behaviors [19,20] and foster attachment to the site and identification with the area [21]. There is a large number of publications showing how to design interpretation panels and signs in closed spaces such as museums and visitor centers [22–25]. Much smaller is the number of guides for designing interpretative signs outdoors, in national parks and forests, including urban forests [21,26]. According to Wolf, Stricker and Hagenloh [27], guidelines for the design of closed spaces cannot be always used outdoors. In the open air, interpretative media have to be particularly effective in communication because of the presence of many random sensory stimuli that are not conducive to concentration [18]. Moscardo et al. [26] note that another issue related to signs interpreting nature is that a sign is always static, while nature, including animal behavior, is dynamic. The effectiveness of information communication depends on how it is presented, how much and how well it is arranged and how many images it contains [19,28,29]. Graphic techniques make it possible to give a visual image to interpretative content in order to better illustrate the information. Whatever the subject matter, signs should be written in conversational tone with limited use of jargon and technical terms [30] or those borrowed from the professional language of foresters, as well as abbreviations of tree species, forest habitat types without explanation and Latin names of organisms and plant communities [31]. Professor Mike Wingfield, IUFRO ex-President, during his speech at the last IUFRO World Congress in

Brazil, in Curitiba, said that the risks identified by scientists and the solutions and sustainable options for the future of the world's forests should be used by decision makers and the broader public to reduce global crises such as climate change. He expressed the opinion that "it is crucial to present the best possible science in an accessible language and to engage with policy makers and political processes. This will allow the world's decision makers to 'unite behind the science and then take real action', as Greta Thunberg has recently demanded" he added [32]. Seretny [33] points out that difficult texts in which new words are piled up on top of each other may significantly reduce the level of motivation of the learners. A material too difficult is often counterproductive. Instead of stimulating the learning process, acquiring new information, it extinguishes involvement, causes reluctance or a feeling of failure. Ballantyne et al. [30] and Serrell [34] show that interpretative signs for the general public are most accessible when they are written in a language understood by 10–12-year-olds. The level of intelligibility of the text is tested with the use of a variety of tools. The handbook "Nova Scotia. Outdoor interpretive signage. Tourism development guideline" recommends using Gunning's (Fog Index) or Flesch's (reading ease scale) legibility tests for this purpose. According to Łopacińska and Wnuk [35], public studies in particular should be characterized by the use of readability indexes. In Poland, apart from pointing out general deficiencies concerning the educational message of interpretive signs, no research has been conducted in the outdoors to determine the degree of readability of educational texts. Our research was aimed at determining the groups to whom interpretive signs in urban forests are addressed, and thus assessing the level of comprehensibility of their contents. Planning the research, a hypothesis was posed that a large part of society may have a problem with interpretation of the content presented on didactic paths in the city forests of Warsaw, because it is transmitted in a language that is too difficult to understand.

2. Materials and Methods

2.1. Participants

Two groups participated in the research: educational pathway users and an expert group. The first group consisted of educational pathway users. Two hundred and fifty participants living in the city of Warsaw were recruited for this study. Persons recruited for this study were random walkers in urban forests, encountered in the vicinity of educational trails, who agreed to participate in the study. An optimal sample size was used to balance the need for quick testing and the need to obtain reliable results. Only adults over 18 participated in this study (demographics of the participants are presented in Table 1).

Table 1. Demographic information of study participants "didactic paths users".

Gender	**Female**	**Male**	**Title**	**Title**	**Title**
	51.2%	48.8%			
Age	18–30	31–40	41–50	>50	
	16.7%	33.1%	29.3%	20.9%	
Educational level	Primary school	Secondary school	Technical school	High school	University
	4%	17.4%	6%	32.5%	40.1%
Childhood	Without children	One child	Two children	Three children	More than three
	35.5%	22%	27.5%	10.5%	4.5%

The second group of participants were experts. The expert group consisted of two graphic designers, three forest educators and two landscape architects. Participants were selected using both social networks and university contacts. In order to ensure that participants were professionals with great experience, two selection criteria were used: (a) to this group were invited people with over 20 years of professional experience, and

(b) they were persons who published or designed educational materials. Participation in the experiment was non-commercial. All participants, including both the didactic path user and expert groups, were informed about the nature and purpose of the study and informed consent was obtained from each participant.

2.2. Study Sites

The field experiment was conducted in the forests in the borders of Warsaw city—Figure 1. The forests in Warsaw occupy about 8 thousand hectares, which constitutes almost 15% of the city's area. Private forests occupy 3200 hectares, whereas other forests belong to the State Treasury. The entire forest management system is supervised by the organization "Municipal Forests-Warsaw", established especially for this purpose in 2007. There are 27 forest complexes in Warsaw. In seven of them, educational paths equipped with interpretive signs have been marked out. On the basis of the field vision, it was decided that the research would concern the paths located within three forest complexes: Bemowo Forest (two educational paths: 4.5 and 0.8 km long), Bródno Forest (one educational path: 1.5 km long) and Kabaty Forest (two educational paths: 3.5 and 4.0 km long). The other paths are poorly accessible or are currently undergoing modernization works. A total of 49 interpretive signs (20 in Kabaty Forest, 15 in Bemowo Forest and 14 in Bródno Forest) were selected for the study, characterized by good technical condition, without traces of vandalism. An example of a random interpretative sign is shown in Figure 2.

The indoor experiment was conducted in the didactic hall at the Faculty of Forestry of the Warsaw University of Life Sciences (WULS).
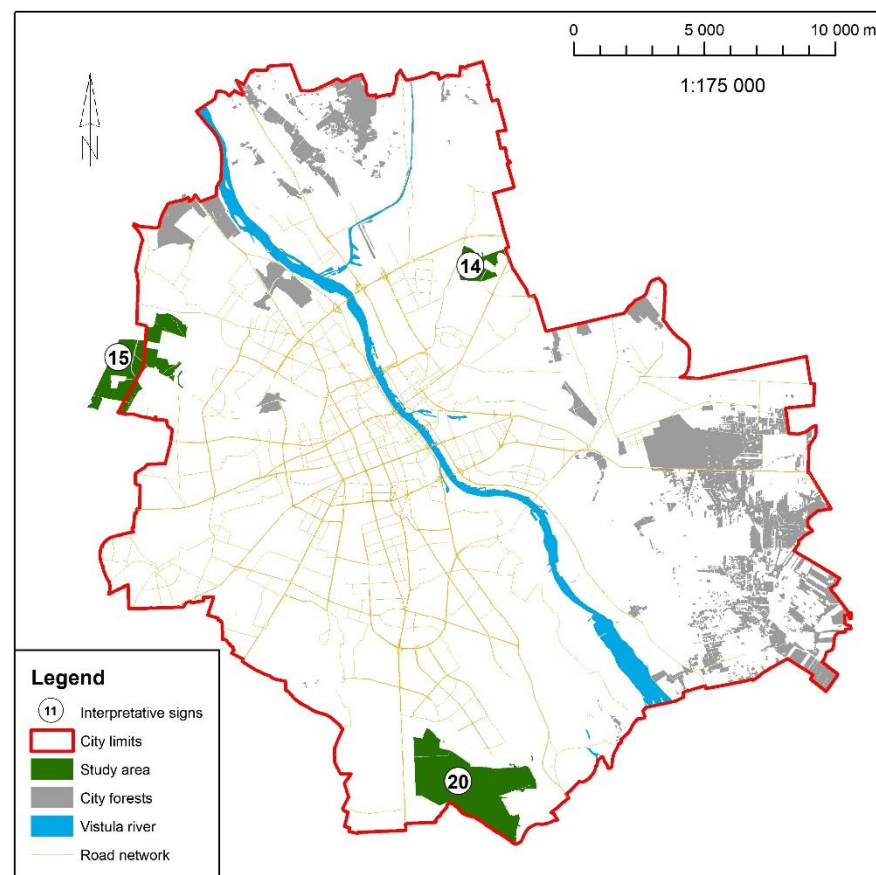

Figure 1. The forests in the borders of Warsaw city.

Figure 2. The interpretative signs in Warsaw forests.

2.3. Procedure

All the interpretative signs on the didactic paths were inventoried in the field and documented with photographs. The path user surveys were carried out from 10 to 14 September 2018. In the field, a total of 250 interviews were conducted with randomly selected adult users of the didactic paths. Each survey participant, after walking through the path, received a set of laminated photographs (10 cm × 15 cm) showing the content of interpretive signs on the path. Five researchers, at the same time, from 10.00 a.m. to 4.00 p.m., conducted interviews on five selected paths (50 interviews per one path). Meteorological data on the field study survey were collected from the meteorological station in Warsaw—Table 2. Interviews had an average duration of 19 min (the minimum duration was 15 and the maximum 29 min). Indoor interviews with each of experts had an average duration of 45 min (the minimum duration was 26 and the maximum 55 min). The indoor interview was conducted on 15 September (Saturday). Each of the experts evaluated all the interpretative signs, as did the users of the paths presented with laminated photographs.

Table 2. Meteorological parameters during the field interviews.

Date	Parameter (Average Value between 10:00 a.m. and 4:00 p.m.)		
	Temperature (°C)	Cloudiness	Wind Speed (km/h)
10 September 2018 (Monday)	21.0	clear sky	7.4
11 September 2018 (Tuesday)	20.0	cloudy	10.2
12 September 2018 (Wednesday)	24.0	clear sky	15.6
13 September 2018 (Thursday)	19.0	partly cloudy	13.0
14 September 2018 (Friday)	17.0	cloudy	8.5

2.4. Measurements

The text of each sign was loaded using the Ocr Service computer application and then verified from the linguistic point of view. The analysis of the text was based on determining whether there were any specialist, unexplained words, Latin names and units of measurement.

The interpretive signs were also analyzed from a graphical point of view, determining the occurrence of a leitmotif (one large graphic, distinguishing itself from the others). Using the generally available Promovolt information system (www.promovolt.com, accessed on 4 March 2019), the color composition of the table contents and number of sentences and words, including polysyllable words, were determined, and the value of the Fog Index was calculated. The value of the Fog Index indicates the number of years of education necessary to understand the text. The Fog Index is one of the most popular and at the

same time one of the most readable indexes, adjusted to the Polish language. Its value is determined by the formula:

$$Fog = 0.4 \times (ASL + PDW) \tag{1}$$

where ASL (average sentence length) means the average length of a sentence in words, and PDW (percentage of difficult words) means the percentage of polysyllabic words (4 and more for the Polish language).

The value of the Fog Index can be interpreted as follows:

- 1–6: A text very simple and comprehensible to primary school students;
- 7–12: Simple text, understandable to gymnasium or high school students;
- 13–17: A text quite difficult, understandable for students;
- 18 and more: Difficult text, understandable for people with higher education, over 24 years of age.

The evaluation of the readability of the educational texts using the Fog Index was then confronted with the evaluation of the users of the educational pathways and the evaluation of the expert group. The text and graphics of each of the interpretive signs were assessed by the respondents (both groups: didactic path users and experts) on a scale from 1 to 4, meaning:

- Text/graphics are understandable for primary school students (7–13 years old);
- Text/graphics are understandable for gymnasium or high school students (13–19 years old);
- Text/graphics are understandable for students of first cycle studies (19–22 years);
- Text/graphics are understandable for students and graduates of higher education (over 22 years old).

2.5. Data Analysis

Raw data from interviews with experts and pathway users were used for statistical analyses. Statistical analyses were conducted using SPSS Statistics Version 24 (IBM, Armonk, NY, USA). The next step in the statistical analysis was to investigate the correlation between the assessments made by the users of the pathways and experts for the analyzed features of the message content, such as the number of graphics, colors, the occurrence of a leading theme, specialist vocabulary, the presence of Latin names, units of measurement, the number of sentences and the number of polysyllabic words. A measure of the strength of the relationship between the studied features was the Spearman rank correlation coefficient [36].

3. Results

The Fog Index of the analyzed texts, established by the Promovolt system, was between 5 and 19. Only two signs (4.1%) can be considered as dedicated to primary school students because of the value of the Fog Index. The vast majority of the texts (65.3%) are intended for gymnasium or high school students, 18.4% for students of first cycle studies and 12.2% for people with higher education. Taking into account the opinion of users of educational paths, it can be concluded that the text of 12.2% of interpretative signs is legible for primary school pupils, 67.3% for gymnasium or high school students, 16.3% for first-degree students and 4.1% for students or graduates of second-level studies. On the other hand, the evaluation of the level of comprehensibility of the texts determined on the basis of expert opinions indicates that 22.4% of the analyzed texts were very simple and understandable to primary school students, 42.9% of texts were assessed as dedicated to gymnasium or high school students and 24.5% to students of first-cycle studies. In the opinion of experts, 10.2% of the texts were addressed to students and graduates of second-cycle studies.

The statistical analysis showed that there were statistically significant differences be-tween the assessment generated by the Promovolt system and the assessment made by the didactic path users—Table 3. The path users more often indicated that a lower level

of education/knowledge is sufficient to understand the content of a given interpretative signs than that which resulted from the value of the Fog Index.

Table 3. Accessibility of the text determined by the Promovolt system and on the basis of assessments by didactic path users and experts.

Assessment	Mean	SD	Skewness	r-Spearman	*p*-Value
Expert group	2.22	0.92	0.37		
				0.284	0.3162
Promovolt IT system	2.39	0.76	0.99		
				0.423	**0.0258**
Didactic path users	2.12	0.67	0.74		

The statistical analysis showed that there is a correlation between the number of specialist phrases and the number of polysyllabic words and the level of legibility of the text, regardless of whether the accessibility of the text was assessed by an IT system, didactic path users or experts. The legibility assessment generated by the Promovolt system showed a negative correlation with the number of sentences in the text and a strong positive correlation with the average number of words in the sentence, the number of polysyllabic words and the occurrence of specialist vocabulary (Table 4). This relationship was derived from the construction of the formula used to calculate the Fog Index. The higher the average number of words in a sentence, the higher the value of this index. The statistically significant negative correlation between the number of Latin names and the level of legibility of the text observed in the group of experts is surprising. This means that Latin names were not treated by experts as an element making it difficult to understand the texts.

Table 4. Analysis of the correlation between the level of assessment and the examined features of the text.

Variable	Promovolt IT System	Didactic Path Users	Experts
Specialist vocabulary	0.509	0.437	0.464
Latin names	−0.211	−0.076	−0.293
Numerical data	−0.127	−0.094	−0.236
Number of sentences	−0.,416	−0.170	−0.052
Number of words	−0.035	0.042	0.099
Average number of words in a sentence	0.703	0.281	0.222
Number of polysyllabic words	0.434	0.426	0.352

In the opinion of didactic pathway users, the majority of interpretative signs (59.2%) were characterized by the presence of engravings readable for gymnasium or high school students, 34.7% of interpretative signs were characterized by graphics clear to primary school students, while 6.1% of them were dedicated to students of the second level of studies. According to experts, 14 interpretative signs (28.6%) were distinguished by graphics that were understandable to primary school students. The graphic design of twenty interpretative signs (40.8%) was assessed as appropriate for the level of knowledge of gymnasium or high school students, while 30.6% of them were assessed by experts as comprehensible to first-degree students. Average scores for the graphic design of interpretative signs awarded by the group of experts were higher than the scores of didactic path users. These differences were statistically significant—see Table 5.

The statistical analysis, similarly to the case of the text, showed several significant correlations between the assessment made by experts and didactic path users and the analyzed features of the graphic design (presence of the main theme, number of graphics (e.g., photographs, charts, drawings) and their colors)—Table 6. In the case of expert assessments, a significant positive correlation with the value of the variable determining the occurrence of the main theme was found. This means that interpretative signs without

the main theme were considered more difficult to perceive. The ratings of didactic path users were negatively correlated with the color scheme. Interpretative signs whose color scheme was more diversified were assessed as easier to understand.

Table 5. Legibility of graphic aspect on interpretative signs in the opinion of didactic pathway users and experts.

Assessment	Average	SD	Skewness	r-Spearman	*p*-Value
Expert group	**2.02**	**0.78**	−**0.04**		
Didactic path users	1.71	0.58	0.10	0.532	**0.0039**

Table 6. Comparison of the assessment of the legibility of the graphic aspect on interpretative signs based on the opinions of didactic pathway users and experts.

Variable	Didactic Path Users	Expert Group
Main theme	0.239	0.346
Number of graphics	−0.085	0.018
Color composition	−0.333	−0.270

4. Discussion

One of the key principles of creating educational messages should be the use of simple text, elimination of unnecessary words and replacement of scientific terms with commonly used words, avoiding complex sentences. In Poland, the global social movement Plain Language, whose supporters promote the idea of writing in a style called "simple language" and whose most important features are comprehensibility and effectiveness, is currently gaining more and more supporters [37]. Promoters of the concept of simple language assume that public information does not reach the majority of society because it is conveyed in a language that is exclusive, the language of few and well-educated elites, too difficult for the average person to understand. This hypothesis was also confirmed by the results of our research. Most of the interpretative signs (65%) were addressed to people with secondary education, including gymnasium and high school students. More than 30% of the interpretative signs were understandable only by people with at least a bachelor's degree. This means that an important group of recipients of educational activities in forests, children from primary schools, may have problems with acquiring the educational content presented on didactic paths in the forests of Warsaw. Less than 5% of all interpretative signs were adapted to their level of knowledge. Among the Polish society as a whole, 19% of Poles have higher education. For this relatively small group, the interpretation of the issues presented on the educational boards located in the urban forests of Warsaw should not be a problem.

On the other hand, studies conducted so far on the recreational function of Warsaw's urban forests [38] show that the share of people with higher education among visitors to forests for leisure purposes is higher than among the general public. This is related to the fact that within Warsaw there is a concentration of academic centers, universities and a great diversity of educational offers. The basic function of educational infrastructure, including educational paths, is to transfer knowledge about the environment and to create pro-environmental attitudes among society. One of the leading groups of participants in various forms of education is children. According to a report on the educational activities of the State Forests [39], in 2017 the total number of participants in all forms of forest education conducted in Polish forests amounted to over 2.3 million people, including the largest number of children and youth from primary schools (aged 7–12)—734,102—which constituted 31.4% of the total number of participants. An only slightly smaller group was adults (over 19 years of age)—731,237 (31.3% of participants). Among the participants in forestry education in the State Forests, preschoolers constituted 18.5% (433,029), gymnasium students (13–15 years) 12% (279,898) and secondary school students 6.8% (159,331). Urban forests, as noted by Ja-Choon et al. [12], provide natural education for children with

fewer opportunities to experience nature in everyday life. Didactic paths allow children to learn about the functioning of the forest environment and interact with nature. Ecological education conducted in urban forests helps children to develop into people who can think about the environment on their own and take action to protect it in the future [3]. Experiencing nature is important for the effective cognitive and evaluative development of children [40,41]. Ballantyne and Uzzell [42] point out that adults and children perceive the world in a completely different way. Thus, if the interpretative materials are targeted at a wide range of visitors and are not focused on the educational needs of young students, they may not have the intended educational effect.

This research has shown similarity between the level of readability of the educational texts generated by the Promovolt system and that established by the experts. According to Taylor [43], the Fog Index tool can be used to measure the level of simplicity of language in most types of documents. The Fog Index is calculated using the number of long words. Thus, statistical analysis has shown, among other things, a significant correlation between the ratings generated by Promovolt and the number of polysyllabic words and the average number of words in a sentence. In the Polish language, specialist terms are in many cases more than four-syllable words [43], which may also explain the correlation between the number of professional vocabulary terms and the value of the assessment generated by the Promovolt system.

Assessments of didactic pathway users and experts were also correlated with the number of polysyllabic words and the occurrence of specialist vocabulary. The more polysyllabic words there were in the text, the higher the level of education required to understand them. Similarly, the occurrence of specialized vocabulary raised the level of education required to understand the texts. It is interesting that only expert evaluations showed a negative correlation between the level of understanding of the text and the Latin names it contains. For experts, the importance of Latin names could be so obvious that they ignored them in their assessment of the legibility of the text. Moreover, the use of Latin names could be seen by them as a means to simplify the structure and shorten the length of the text. This thread requires additional research, given that only seven of the analyzed texts contained Latin names.

An important factor influencing the assessment of didactic path users, as the statistical analysis showed, was the coloring. Multicolored signs were perceived as more understandable. On the other hand, the experts' assessments depended on the graphic composition. When there was one main theme in the graphic, the level of comprehensibility of the sign increased. The importance of graphic design as a medium of environmental interpretation was highlighted, among others, by Sitko [44]. Among the most common mistakes, Sitko [44] indicated: the use of diagrams that were incomprehensible to laymen, copied from scientific studies, random selection of photographs, often of unsatisfactory quality, and too bright colors causing landscape dissonance. Snopek [45] adds that a common mistake encountered in interpretative signs is the placement of photographs that have no direct connection with the text or suggest a connection that does not exist. These are photographs of species or ecosystems other than those described in the text, or photographs of proper species, but without the necessary signature due to their poor recognition.

5. Conclusions

The analyses carried out and the results obtained allow us to draw the following conclusions:

- Educational paths in the city forests of Warsaw, equipped with interpretative signs, are an insufficiently supportive tool for informal ecological education, especially for children and youth from primary schools up to 15 years of age, as well as adults with low educational competences, with primary or vocational education.
- The Promovolt computer system allows the verification of educational texts for their level of understanding. The ratings generated by the system are more in agreement with the views of experts than with those of the average user of educational pathways.

- The level of accessibility of educational texts is correlated with the number of polysyllable words and the presence of specialized vocabulary. An important element determining the legibility of educational content is the coloring and the presence of a leitmotif in the graphics.

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