The Inclusion of a Sustainability Awareness Indicator in Assessment Tools for High School Buildings

Tatiana Santos Saraiva [1,*] **, Manuela Almeida** [2] **, Luís Bragança** [2] **and Maria Teresa Barbosa** [3]

1   International Doctoral Program in Sustainable Built Environment, School of Engineering, Minho University, 4800058 Guimarães, Portugal
2   Department of Civil Engineering, School of Engineering, Minho University, 4800058 Guimarães, Portugal; malmeida@civil.uminho.pt (M.A.); braganca@civil.uminho.pt (L.B.)
3   Department of Civil Engineering, Federal University of Juiz de Fora, Juiz de Fora 36036, Brazil; teresa.barbosa@engenharia.ufjf.br
*   Correspondence: saraivaus@yahoo.com; Tel.: +55-96-98106-1627

Abstract: The growing debate about global environmental problems is evident in several spheres of society. The concern for the future of the planet is used as a political slogan, inspiring the creation of new laws and encouraging academic research that serves this purpose, as well as increasing the number of government agencies concerned with this matter. The 21st century is considered the "century of sustainable development". Sustainability education in high schools has the potential to make the benefits of civil construction more visible to society and media by showing students, parents, and communities in general how sustainability in the built environment can improve their lives in economic, social, and environmental aspects. This study was applied in three high schools of Juiz de Fora (Brazil) and Guimarães (Portugal). These high schools have similar characteristics regarding teaching patterns and commitment to strengthening sustainability in their respective regions and reflect their socio-economic conditions, governmental strategies, everyday habits, and cultural attributes. The information was collected through questionnaires applied to high school students in 2017. This paper shows the need for including an indicator of sustainability awareness in sustainability assessment tools for high school buildings.

Keywords: sustainability education; high school; sustainability

1. Introduction

Although the topic of sustainability is reaching great popularity, it has also generated doubts in relation to the balance between various factors that involve the coverage of economic, social, and environmental issues [1]. According to Freericks [2], "sustainability is a new type of environmental policy since it is concerned not only with the current economic and social environmental protections but also with the responsibility for future generations".

The construction sector has a major environmental impact. To evaluate this, several methodologies (assessment tools) of sustainability evaluation were created, such as LEED (Leadership in Energy and Environmental Design), BREEAM (Building Research Establishment Environmental Assessment Method), DGNB (Deutsche Gesellschaft für Nachhaltiges Bauen—German Sustainable Building Council), and SBTool (Sustainable Building Tool). In the last few decades, the need to develop specific tools for construction arose, such as tools for residential buildings, hospitals, and schools. This work aims to improve methodologies related to high school performance by adding an indicator of sustainability awareness in assessment tools.

The importance of fostering social awareness of the impacts of sustainability is undeniable [3]. This indicator allows for the use of schools as vehicles to disseminate the importance that the experience of sustainability has on people's lives, using students as tools since they can spread this idea in their families and in society, transforming it as part of their daily lives in a natural way. The objective of this paper is to demonstrate the importance of the addition of a sustainability awareness indicator to the sustainability assessment tool for high schools based on questionnaires applied in schools of different cities and countries where the concept of sustainable development is widespread. These included Juiz de Fora (Brazil) and Guimarães (Portugal).

2. Education and Sustainability Awareness

Schools should prioritize the development of students' skills for several types of work [4]. Therefore, a school should have adequate facilities and infrastructure, aiming to improve the quality of learning [5]. It is also necessary to increase financial investment in education to create critical and prepared professionals and socially aware citizens [6].

History and science should encourage the critical and active involvement of students, respecting the requirements of the educational system, which are aligned with the political and socio-economic interests of the training project into which a school project is inserted [7]. This type of attitude should serve as a basis for environmental education. Education supports sustainable social transformation, since environmental education is a process that promotes knowledge, attitudes, and social values that seek sustainable development alternatives through the community. It is an instrument that promotes conscience formation through knowledge of and reflection on environmental realities [8]. The term "environmental education" (EE) was used for the first time in the Conference of Education of the University of Keele, England (1965), where it was stated that it should become part of the education of all citizens. In 1968, the council for environmental education in the Nordic countries and France introduced this theme into the curriculum of their schools [9].

After the conference in Belgrade in 1975, UNESCO outlined the purposes of environmental education for humanity as follows: "[to] form a world population aware and concerned with the environment and related problems, a population that has knowledge, skills, state of mind, motivation and a sense of commitment that allows them to work individually and collectively to solve the current problems and prevents them from repeating" [10]. According to UNESCO, programs conducted in schools must fulfill four objectives: (i) knowledge, (ii) awareness, (iii) abilities, and (iv) participation. The focus should be on the students and on well-planned courses (with activities, fieldwork, research, and projects) [10]. There are still some problems regarding the adoption of a sustainable lifestyle, mainly due to the lack of specific education on the subject. Therefore, the development of appropriate environmental programs in schools is necessary. These programs should target attitudes and cognitive abilities related to environmental practices, beliefs, values, intentions, and action strategies [11].

Educational programs should also have behavioral and emotional goals to improve cognitive skills and raise awareness of environmental issues. Appropriate teaching techniques should be used according to local legislation or programs of environmental education centers related to sustainable development [11]. During high school, students form their attitudes related to environmental protection and also develop their personal and social values [12]. Therefore, it is important to include environmental education in the current high school curriculum [13]. The main objective of the sustainable school is to promote sustainability, enabling students to follow sustainable practices in their routines, teaching them how to make decisions, set goals, deal with information, and identify how to behave in a critical way in relation to sustainability matters [14]. According to Hassan, high school students have a high level of environmental awareness of the concept of sustainable development. Four components of environmental education were considered in the research: Abilities, values, awareness, and knowledge. Generally, there is a relationship between the level of sustainable practices, attitudes, and values and the sustainability awareness level among students in high school [15]. In this

context, environmental education will inform students about environmental problems related to political, economic, and social issues [16].

The study performed by Kim (2018) with 12,000 students from the University of Washington analyzed the influence of three types of sources: News sources, blogs, and social media sources, and local sources of information related to awareness and attitudes towards sustainability. All sources of communication were successful in increasing awareness among participants; however, there was only a slight impact on their sustainability-related behaviors. To increase behavioral transformation, education should also provide opportunities for involvement and use participatory methods to encourage student involvement [17]. Nowadays, several countries have developed tools that enable the implementation of sustainability assessments of buildings. These tools were created with the goal of being adapted to all types of constructions. Therefore, the need to develop tools for specific buildings, such as residences, offices, shopping centers, and hospitals, was gradually realized by the elaboration of sustainability assessment tools. There are many methods to suit various types of construction; however, few have specific methodologies for school buildings.

The indicator related to education and sustainability awareness exists in specific methodologies, such as the LEED for school and the BREEAM for education. The LEED for school method addresses this question through the innovation of indicators, Design 6, and through the use of the school as a teaching tool [18]. Therefore, it is not a permanent sustainability awareness indicator. BREEAM for education in 2008 reported on this subject with the *MAN 10* indicator, addressing the importance of developing the indicator as a learning resource and aiming to recognize and encourage the use of the site and the learning resources to demonstrate environmental consciousness by analyzing sustainability factors [19]. This BREEAM indicator considers a building as an example of sustainability in order to teach the user. This differs from the proposed indicator addressed in this article, whose function is to evaluate the level of sustainability awareness of the students of a given school.

In the SBTool methodology for K-12 schools, there is no specific indicator related to environmental education, which is part of the education for sustainability category [20]. Therefore, there is no perceived methodology that evaluates and promotes the necessary level of education and awareness related to sustainability. The sustainability certification of the aforementioned methodologies is requested in order to determine whether they meet the prerequisites of the indicators contained in these methodologies. Therefore, the inclusion of the proposed indicator will promote sustainability awareness among students using the school building as an example to be observed and promoting sustainable attitudes in students' daily lives.

3. Materials and Methods

This study aims to analyze the questionnaire applied in Juiz de Fora (Brazil) and Guimarães (Portugal) schools with the objective of verifying the level of sustainability awareness of the student body. The schools analyzed in this study are considered to be traditional in their respective cities and both were built in the 19th century.

The application of this questionnaire was carried out by one of the authors of this article and was administered to high school students ranging from 14 to 18 years old. These questionnaires were applied in the classroom in the presence of the teacher. Students were asked to identify themselves in the questionnaire only by placing the age, grade, and the school in which they studied. The reasons for the application of the questionnaire and the explanations for each question were clarified before the application. Juiz de Fora is considered to be the seventh best city in life quality ratings in the state of Minas Gerais, Brazil (out of a total of 853 cities in the state). The objects of this study, the Cristo Redentor and Santa Catarina schools, were built in 1891 and 1900, respectively. These schools are considered to be the best and most traditional private schools in the city, both being in operation for over 100 years [21]. Guimarães is considered the ninth-best city in quality of life ratings in Portugal (out of 338 cities), and has a good education system. Francisco de Holanda high school, an object of

this study, was built in 1864, and in 2011 it went through a major modernizing rehabilitation. Currently, the school holds the title of "standard school" in Portugal [22].

In this study, the adapted survey (multiple choice answers—Appendix A) was used for high school students to evaluate how the students behave regarding sustainability awareness issues in their schools. The questionnaire was elaborated based on the opinion poll of the Federal University of Uberlandia [23], with the number of questions applied being reduced in order not to disturb the progress of the classes. The number of students that received the questionnaire was determined using a sample calculator, and the choice of the high school students was made at random. The questionnaire evaluates the level of environmental interest of the students, the frequency of environmental issues mentioned in class, and the frequency with which the students acted to protect the environment in their daily lives. Other issues address environmental practices in their homes and how students feel environmental issues should be addressed in high schools. Then, a statistical analysis was performed using the Microsoft Excel software ANOVA, with a level of probability equal to 0.05 to evaluate the performance of the responses.

This questionnaire consists of eight questions related to environmental attitudes and sustainable awareness, and Tables 1 and 2 demonstrate the level of the students' awareness of each aspect of sustainability defined in the questions. With this data, using the ANOVA software, an analysis of variance is conducted, verifying to what extent the average of each measured variable is related to the global average. Through the statistical analysis performed with ANOVA, it is possible to test hypotheses about the differences between the means of a variable (response variable) in relation to treatment with two or more categorical levels.

Table 1. Percentages (%) of Students' sustainability awareness level in Brazilian high schools.

Questions	Level 1	Level 2	Level 3	Level 4
	Good	Average	Bad	Terrible
Question 1—Environmental quality	29	49	16	6
Question 2—Environmental issues	28	53	18	1
Question 3—Environmental protection	64	23	13	0
Question 4—Environmental practices	22	51	22	5
Question 5—Water consumption	75	21	3	1
Question 6—Energy consumption	50	28	10	12
Question 7—Recyclable waste	38	8	5	55
Question 8—Sustainable debate in class	19	21	11	49

Table 2. Percentages (%) of students' sustainability awareness level in a Portuguese high school.

Questions	Level 1	Level 2	Level 3	Level 4
	Good	Average	Bad	Terrible
Question 1—Environmental quality	26	55	17	2
Question 2—Environmental issues	32	51	16	1
Question 3—Environmental protection	63	25	10	2
Question 4—Environmental practices	32	55	7	6
Question 5—Water consumption	73	23	2	2
Question 6—Energy consumption	55	39	6	0
Question 7—Recyclable waste	40	15	7	38
Question 8—Sustainable debate in class	38	11	7	44

Therefore, the Microsoft Excel software ANOVA statistically verifies the effect of the influence of the level of consciousness factor related to sustainability awareness of high schools in Juiz de Fora and Guimarães. It is verified that the value of the factor ($F_{calculated}$) provided by the statistical analysis is greater than the factor ($F_{tabulated}$). The factor's effect was found to be significant. The analysis of variance (ANOVA) is a method used to test the equality of three or more averages from different groups. In mathematical terms, the value of F is calculated by the division among average squares of

the model ($F_{tabulated}$) and the residual average squares ($F_{calculated}$). The best result is achieved when F is larger, demonstrating that the average squares of the model are larger than the residual average squares, indicating that there is a difference between these groups.

4. Results and Discussion

4.1. Santa Catarina and Cristo Redentor Schools, Brazil

This section presents the results of the survey in two high schools in Juiz de Fora. The total number of students in high school is 1980, and the number of students who responded to the questionnaires is 303 (57% of Santa Catarina school, 43% of Cristo Redentor school). The questionnaires were applied on July 19, 2017. The results of the level of awareness and sustainable behaviors of students in both high schools in Juiz de Fora city are shown in Table 1, considering 100% of the interviewed students. The statistical analysis of the sustainability awareness level observed in the students of the schools in Juiz de Fora, according to Table 1, was performed using the Microsoft Excel software ANOVA, referring to the results of sustainability awareness for high schools in Brazil. It was verified that $F_{calculated}$ = 15.43 > $F_{tabulated}$ = 2.61 (probability equal to 0.05 (reliability coefficient)), i.e., there is a significant variable among the data.

Table 1 shows that the sustainability awareness levels of students in Brazilian schools are suitable (good + average), namely:

(i)　78% (29% + 49%) of the students stated that they are very or reasonably interested in issues related to environmental concerns (Question 1);

(ii)　81% of the students stated that they always, or with some frequency, mention subjects related to the environment in the classroom. In this aspect, the results seem quite appropriate, since the worldwide trend is to increase the concern with sustainability (Question 2);

(iii)　87% of the students stated that they always, or with some frequency, protect the environment in their daily lives. This is a good result, considering that the majority of students are involved in saving the environment (Question 3);

(iv)　73% of the students stated that they always, or with some frequency, take environmental attitudes in their own home and try to teach them to their family. The students adopt sustainable attitudes at home, so this is part of their daily lives (Question 4);

(v)　96% of the students stated that they always or with some frequency close the tap after use. Only one percent declares that they do not close it. This low result related to the number of students who do not close the tap after use is good, which means that the majority of the students are aware of the impact that careless use of water can cause (Question 5);

(vi)　78% of the students stated that they always or with some frequency turn off the lights and fans when they leave the room. Twelve percent of the students declare that they do not turn off the light. Therefore, the majority of the students are aware of the impact that irresponsible use of electricity consumption can cause (Question 6);

(vii)　46% of the students always or with some frequency participate in selective waste collection, and 55% of the students do not. In Brazil, concern with recycling began in schools only a short time ago. Therefore, there are still few recycling collection places (Question 7);

(viii)　40% of the students stated that environmental issues should be addressed through events and other academic projects. Therefore, the students want to learn about sustainability, but only eventually, and without including it as part of the school curriculum (Question 8).

4.2. Francisco de Holanda High School, Portugal

The school used for data collection in Guimarães, Portugal, was built in 1864 as an industrial school and was rehabilitated by the "Parque Escolar" in 2011. This school represents the current pattern of school construction in Portugal [22]. In 2016, the environmental education reference for

sustainability was developed in Portugal by the Directorate-General for Education (DGE) with the goal of supporting students in learning to critically assess the effects of human activities related to environmental impacts in political, social, and economic contexts.

The survey answers were analyzed with the objective of verifying the sustainability awareness level. The research was conducted in nine classes, three of each grade, with a total of 269 students. The results of the research are shown in Table 2, considering 100% of the interviewed students and reflecting on how students deal with sustainability awareness.

According to Table 2, a statistical analysis of the sustainability awareness level observed in the questionnaire applied to the students of Francisco de Holanda High school was performed using Microsoft Excel software with analysis of variance (ANOVA). It appeared that the Fcalculated = 14.17 > Ftabulated = 3.23 (probability of 0.05 (reliability coefficient)), i.e., there is significant variability among the data. Table 2 shows that the sustainability awareness level of the students in Portugal's high school is very high (good + average), namely:

(i)   81% of the students stated that they are very or reasonably interested in issues related to environmental concerns. The students indicated that they have much or reasonable interest in issues related to environmental concerns (Question 1);

(ii)   84% of the students stated that they always, or with some frequency, mention subjects related to the environment in the classroom. In this aspect, the results are adequate, since the global trend is to increase concerns about sustainability (Question 2);

(iii)   88% of the students stated that they always, or with some frequency, separate recyclable waste and save water and/or save electricity, and just two percent do nothing to protect the environment. Therefore, most students are supporting the environment (Question 3);

(iv)   87% of the students stated that they always, or with some frequency, take environmental attitudes into their homes and try to teach them to their families (Question 4);

(v)   96% of the students stated that they always or with some frequency close the sink after use. Just two percent declare that they do not close the sink. This shows that most students are aware of the impact that careless use of water can cause (Question 5);

(vi)   94% of the students stated that they always or with some frequency turn off lights and fans when leaving a place. None of the students declared that they do not turn off the light. This result, related to the number of students who care about the impact of irresponsible use of energy consumed by light, demonstrates that most students are aware of the impact that irresponsible energy use can cause (Question 6);

(vii)   55% of the students stated that they always or with some frequency participate in the selective collection of recyclable waste. This result shows that most students are concerned about this aspect, but it is still necessary to do something to promote students' attitudes about recycling (Question 7);

(viii) 49% of the students declared that subjects related to the environment should be communicated through events and other academic projects, but, for 56%, this subject should be part of the assessment of their high school grade (Question 8).

Table 3 and Figure 1 reveal the differences and similarities between the percentages of sustainability awareness among the students of Juiz de Fora (Brazil) and Guimarães (Portugal) schools. The ANOVA between the groups, referring to the results of sustainability awareness in the Brazilian and Portuguese high schools, established that:

(i)   For each of the countries, $F_{calculated} = 0.001 < F_{tabulated} = 2.20$ (probability equal to 0.05), i.e., there is no significant variability in the data among the countries. Brazilian and Portuguese students have the same parameters regarding school framing of sustainability issues.

(ii)   For the comparative sustainability awareness of students from both countries, $F_{calculated} = 5.19 > F_{tabulated} = 2.20$ (probability equal to 0.05), i.e., there is significant variability in the sustainability awareness of students among the countries.

Table 3. Percentages (%) of students' sustainability awareness level in Brazilian and Portuguese high schools.

Questions	Level 1		Level 2		Level 3		Level 4	
	(BR)	**(PT)**	**(BR)**	**(PT)**	**(BR)**	**(PT)**	**(BR)**	**(PT)**
Question 1—Environmental quality	29	26	49	55	16	17	6	2
Question 2—Environmental issues	28	32	53	51	18	16	1	1
Question 3—Environmental protection	64	63	23	25	13	10	0	2
Question 4—Environmental practices	22	32	51	55	22	7	5	6
Question 5—Water consumption	75	73	21	23	3	2	1	2
Question 6—Energy consumption	50	55	28	39	10	6	12	0
Question 7—Recyclable waste	38	40	8	15	5	7	55	38
Question 8—Sustainable debate in class	19	38	21	11	11	7	49	44

BR, Brazil; PT, Portugal.
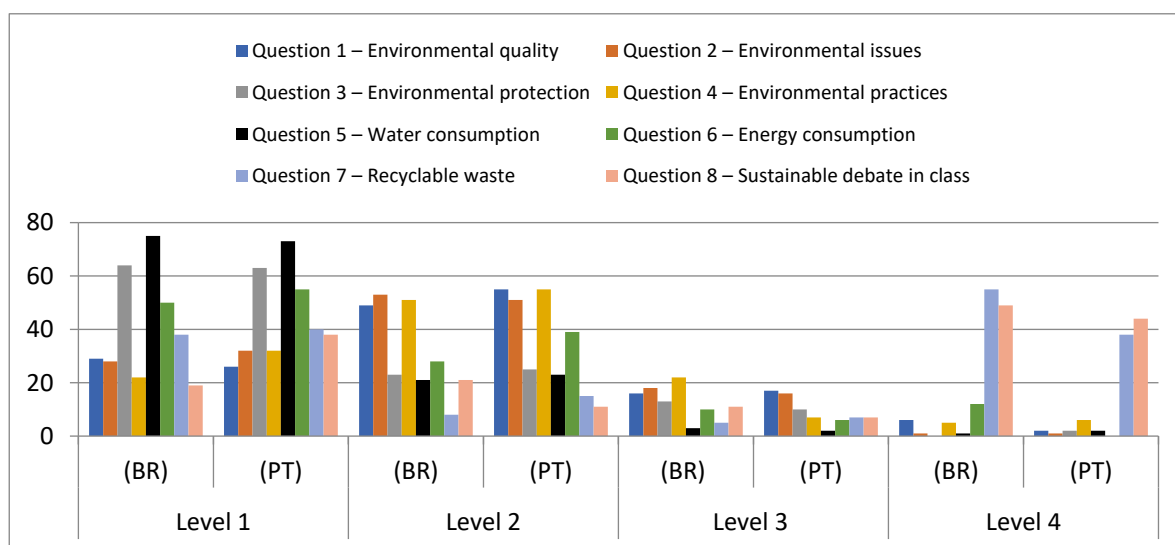
Figure 1. The results of the sustainability awareness level in Brazilian and Portuguese high school.

The students' sustainability awareness level in Francisco de Holanda High School is significant, since "Parque Escolar" promotes sustainable construction in all schools for which it is responsible. Furthermore, teachers motivate students to take sustainable attitudes supported by the Environmental Education Reference for Sustainability, among other actions with the same objective.

Through the results shown in Table 3 and Figure 1, it is noted that students do not perform sustainable practices in their homes very often, and do not have the desire to teach these practices to their families; only 22% of students in Brazil and 32% in Portugal (Question 4) expressed this desire. The level of selective collection of recyclable waste participation by students is low in Brazil at 38%, and at 40% in Portugal (Question 7).

Another aspect perceived in both schools was that the students wanted to learn about sustainability without adding it to the school curriculum (Brazil, 19%, and Portugal, 38% (Question 8)), indicating a lack of commitment to the subject. Since these methodologies should be applied in several countries, including developed countries where the simple concern of turning off a tap and switching off a light is not common, it is necessary to include an indicator of sustainability awareness in school environments in sustainability assessment tools in order to increase awareness. It is impossible to build a sustainable school if the students do not identify how and why they can use existing sustainability mechanisms properly and consciously.

5. Conclusions

In Brazilian and Portuguese schools, the level of the students' sustainability awareness is considered to be appropriate, as observed in Tables 1 and 2. The results are well-balanced, and Portuguese schools show slightly better performance in most of the results. This can be attributed to the fact that the environmental education reference for sustainability was developed in Portugal in 2016 by the DGE with the goal of supporting students in learning this knowledge. This happens because concern with student motivation for sustainability in European countries is further encouraged and also because the "Parque Escolar" always has the concern of building schools with sustainable environments using equipment that decreases energy and water consumption. Portugal also has environmental education incentives.

In Brazil, the incentives started a little later, but the results were good because in this country (especially in schools) there is high motivation for activities related to the reduction of the environmental impact, in addition to the environmental education imparted by means of lectures and teachers. It is necessary for students to perform according to environmental issues, and thus there is a need for practices of environmental awareness since the relationship regarding the level of desired sustainability and the awareness of the inhabitants of a region is significant. Therefore, there must be motivation for learning sustainable attitudes in schools through environmental education to achieve social, environmental, and economic sustainability in a country.

This work demonstrates the need to include a sustainability indicator in specific methodologies for sustainability assessment in the school environment. The inclusion of this indicator in the methodologies of sustainability for school buildings promotes awareness of sustainability among students, encouraging sustainable attitudes in the students' daily lives. Therefore, future studies related to this subject should be made with the purpose of the inclusion of a sustainability awareness indicator in several assessment tools for high school buildings. There should also be studies on the adaptation of this indicator to each region, taking into account cultural, social, financial, political, and educational aspects specific to the study region or country.

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Conflicts of Interest: The authors declare that there is no conflict of interest.

Appendix A

Questionnaires—Sustainability Awareness
Grade: Date:

1.   Qualify your environmental interest.

    A)   Very interested
    B)   Reasonably interested
    C)   Little interested
    D)   No interest

2.   How often the environmental issues are mentioned in class?

      A)   Always
      B)   With some frequency
      C)   Rarely
      D)   Never

3.   How often do you do something to protect the environment in your daily life?

      A)   Always
      B)   With some frequency
      C)   Rarely
      D)   Nothing

4.   Do you have environmental practices at home and try to teach it to your family?

      A)   Always
      B)   With some frequency
      C)   Rarely
      D)   Never

5.   How often do you close the tap after use?

      A)   Always
      B)   With some frequency
      C)   Rarely
      D)   Never

6.   How often do you turn off the lights and fans when leaving a room?

      A)   Always
      B)   With some frequency
      C)   Rarely
      D)   Never

7.   Do you usually do the selective collection of recyclable waste?

      A)   Always
      B)   With some frequency
      C)   Rarely
      D)   Never

8.   How the environmental issues should be addressed in high schools?

      A)   As a mandatory course
      B)   As an elective course
      C)   In specific courses
      D)   In events and other academic projects

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