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An international initiative on geosynthetic education

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2 Maria das Graças Gardoni Almeida

3 Federal University of Minas Gerais, Department of Transportation and Geotechnical
4 Engineering, 31.270-901 Belo Horizonte, MG, Brazil, Tel.: 55-31-94645186,

5 E-Mail: mgardoni06@gmail.com

6 ORCID: 0000-0001-6025-0296

7

8 Jorge G. Zornberg, Ph.D., P.E.,

9 The University of Texas at Austin, Austin, Texas, USA

10 E-Mail: zornberg@mail.utexas.edu

11 ORCID: 0000-0002-6307-1047

12 Ennio Marques Palmeira, PhD.

13 University of Brasília, Department of Civil and Environmental Engineering, FT, 70.910-900
14 Brasília, DF, Brazil, Tel.: 55-61-3107 0969, Fax: 55-61-3273 4644,

15 E-Mail: palmeira@unb.br,

16 ORCID: 0000-0003-2620-0708

17

18 Nathalie Touze, PhD, HDR

19 Université Paris-Saclay, INRAE, Département Écosystèmes aquatiques, ressources en eau et
20 risques, Jouy-en-Josas, France

21 E-Mail: nathalie.touze@inrae.fr

22 ORCID: 0000-0002-0696-0091

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29 Abstract: An international educational initiative to facilitate the exposure of geosynthetics to
30 undergraduate civil engineering students has been conducted by the International Geosynthetics Society
31 (IGS) for over a decade. Geosynthetics is a comparatively new topic within geotechnical engineering
32 and, consequently, has only been sporadically introduced into undergraduate Civil Engineering
33 curricula. In particular, geotechnical engineering professors themselves may have not been exposed to
34 the basics of geosynthetics to be able to comfortably transfer such knowledge to their students. As part
35 of this educational program, civil engineering professors are invited to take a course on geosynthetics,
36 for which they receive fellowships covering their expenses. The course also includes complementary
37 components such as a workshop consisting of practical demonstrations, pedagogical material, and
38 technical documents. Implementation of the program involves multiple parties, including the IGS, its
39 national chapters, and geosynthetics industry, who are allotted the responsibilities of supporting the
40 program instructors, offering practical project-oriented input. This paper describes the course structure,
41 the educational tools employed, the impact on the program caused by the pandemic, and results from
42 feedback surveys that assessed how the knowledge on geosynthetics acquired by the participants was
43 transferred to their students in terms of new courses on geosynthetics, inclusion of geosynthetics topics
44 in existing undergraduate disciplines, etc. Emphasis is given on the experience of the Brazilian Chapter
45 of IGS, which has already conducted programs. The educational outcomes of the programs
46 currently offered are being evaluated and they suggest excellent acceptance of the course by
47 participants and undergraduate students at the universities.

48 Keywords: Geosynthetics; Education; Instructor training; Undergraduate education.

49 1. Introduction

50 Civil engineering (CE) programs are currently facing increasing technical challenges in relation
51 to the continuously evolving nature of engineering works, which require knowledge of new
52 materials and technologies. However, while CE curricula need to provide such new knowledge
53 to young engineering graduates, they also need to limit the offerings of disciplines in
54 undergraduate civil engineering courses. Accordingly, to ensure that these courses remain
55 relevant and effective, new materials such as geosynthetics must be included but in a way that
56 become integrated into existing syllabi. In this context, geosynthetics are a comparatively new
57 technology in civil engineering, and therefore introducing them into undergraduate courses is a
58 priority but also a challenge for disseminating such knowledge among future civil engineers.

59 An international training program called "Educate the Educators (EtE)", initiated in 2012 under
60 the auspices of the International Geosynthetics Society (IGS), is addressed to university
61 professors in civil engineering, and aims at providing the content and pedagogical tools
62 necessary for them to teach undergraduate civil engineering students on geosynthetics. An
63 important goal of the EtE program is to provide undergraduate civil engineering students with,
64 at least, a one-hour lesson on geosynthetics. This content should be offered in mandatory
65 disciplines of the fundamental engineering courses, so that every undergraduate engineering
66 student will have received a basic knowledge of geosynthetics before they graduate.

67 The EtE program provides participants with grants to cover their expenses for a typically two-
68 day-long course. Instructional material from theoretical and practical classes and instructional
69 documents are provided to the participants. The EtE program also includes more advanced
70 modules addressing the design of geotechnical systems using geosynthetics, such as retaining
71 walls, embankments, roads, and waste containment facilities. The educational outcomes of the
72 programs currently offered are being evaluated and they suggest excellent acceptance of the
73 course by participants and undergraduate students at the universities.

74 2. Timeline

75 Geosynthetic materials were introduced more than half a century ago and have been widely
76 adopted in engineering applications to fulfill functions such as separation, stabilization,
77 drainage, wastewater and landfill applications (cushions and liners) (Koerner, 1986; Zornberg

78 et al., 2020). Over four decades ago, on November 20th, 1983, the International Geosynthetics
79 Society (IGS) was established (Zornberg 2013) and the first edition of the landmark textbook
80 “Designing with Geosynthetics” (Koerner 1986) was published. The IGS is a learned society
81 dedicated to the scientific and engineering development of geotextiles, geomembranes, related
82 products, and associated technologies. The purpose of the IGS is to provide understanding and
83 promote the appropriate use of geosynthetic technology worldwide.

84 In the early days of geosynthetic use, applications focused primarily on the use of geotextiles
85 for projects involving drainage, filtration and soil reinforcement and of geomembranes for
86 applications requiring a barrier function. Over the past 50 years, these products have evolved
87 significantly and nowadays there is a wide variety of geosynthetic products from an ever-
88 increasing number of manufacturers, as exemplified in the annual Geosynthetics Specifiers
89 Guide (IFAI 2018). The functions and applications of these materials in geotechnical and
90 environmental protection works have also expanded significantly.

91 A of using geosynthetics include their speed of installation, ease of deployment in remote areas,
92 comparatively low construction costs, availability of a wide range of products, reduction or
93 elimination of the use of natural construction materials, uniformity of mechanical and hydraulic
94 properties, increasing number of established design methodologies, and reduced environmental
95 impact of geosynthetic solutions compared to conventional alternatives. Research carried out
96 in recent decades has also shown that engineering solutions using geosynthetics result in more
97 sustainable alternatives, having lower impact on the environment than traditional solutions
98 (Palmeira et al., 2021).

99 According to Zornberg et al. (2020), despite the aforementioned advantages, geosynthetics
100 continue to be regarded as a new product by many practitioners in the civil engineering industry,
101 mostly due to the lack of familiarity with geosynthetics and their benefits. The adequacy of
102 current design approaches involving geosynthetics has been validated certified through the
103 success of a myriad of existing projects, the availability of numerous standards (ASTM, ISO,
104 CEN, ABNT and others), the increasingly effective quality control in testing procedures, as well
105 as the availability of design manuals and training courses.

106 A more plausible explanation for the still insufficient adoption of geosynthetics is the lack of
107 education on geosynthetics, as most undergraduate university programs do not include
108 geosynthetics in their curricula. The IGS Council decided in 2010 to set up a program to educate
109 academics about geosynthetics so that they could introduce geosynthetics into their

110 undergraduate courses and thus train future generations of engineers. The objectives of the
111 "Educating the Educators" program were established to assist the educator in introducing
112 geosynthetics as a relatively new and promising technology within civil engineering.

113 EtE programs result from the initiative of a national chapter IGS, with subsequent involvement
114 from the IGS. The IGS provides financial support to cover travel expenses of the instructors of
115 an EtE event, and also provides educational materials such as a sustainability video, technical
116 handouts, and glossary of geosynthetic terminology. The overall implementation of an EtE
117 event requires a partnership involving the IGS, the local IGS chapter, the local geosynthetics
118 industry, and national civil engineering faculty associations.

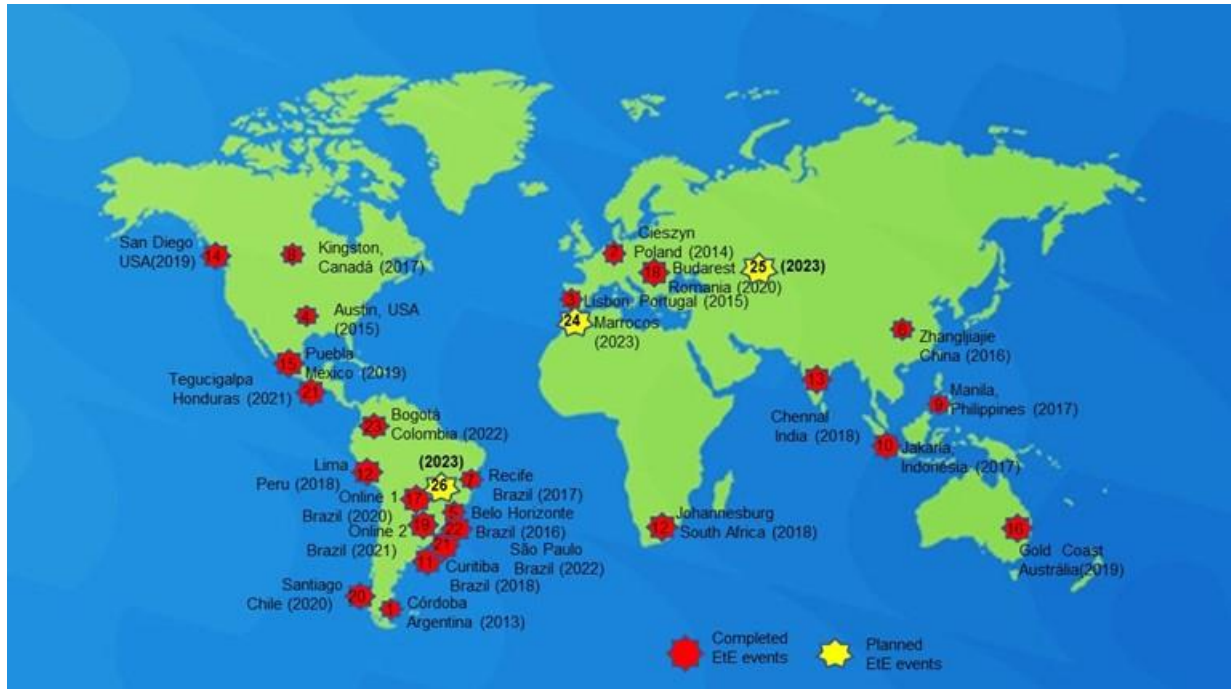
119 To support the IGS mission, an international foundation (the IGS Foundation) was established
120 in 2021 with the objective of collecting donations from different segments of the geosynthetics
121 community for subsequent allocation to important initiatives such as education outreach. For
122 example, a recently supported initiative involved the production of a series of educational
123 videos by two professors from universities in the USA and Brazil. The videos, including basic
124 content on geosynthetics and instructions about practical workshops of the EtE course, were
125 published and are publicly available, for use by undergraduate professors at their universities.

126 According to Zornberg et al. (2020), The inaugural "Educate the Educators" program was held
127 in May 2013, in Carlos Paz, Cordoba Province, Argentina. This first event was organized by
128 the Argentinian chapter of the IGS, with the support of the International Geosynthetics Society
129 and in cooperation with the Argentinian Society of Geotechnical Engineering. The event
130 brought together 40 professors from 18 different Argentinian universities, representing 19
131 different cities across the country and the selection criteria involved the professor's stage in the
132 academic career, experience, maximum academic degree reached and geographic diversity. At
133 least one professor was selected from each university.

134 From the inaugural program in 2013 to April 2023, a total of 22 additional EtE programs have
135 been conducted. Figure 1 shows the locations of the EtE programs completed to date. As the
136 figure illustrates, 23 EtE programs have already been conducted (Zornberg et al., 2020; IGS
137 2023). Three more EtE are planned to be held in 2023, reaching 26 events in 15 countries, with
138 over 700 educators trained. Demand for implementation of additional programs has continued
139 to increase. The broad geographical implementation of the EtE program illustrates the
140 significant interest in geosynthetics education worldwide and the motivation of IGS chapters.

141 However, Figure 1 shows a comparatively higher concentration of EtE in the American
142 continent.

143



144

145 Figure 1. Geographic distribution of Educate the Educators programs conducted up to April 2023 and planned
146 within a 12-month period.

147

148 Table 1 presents results from the IGS evaluation of EtE programs conducted from 2015 to 2020
149 (IGS, 2023). The results show that 17% of the participants from have been able to include
150 geosynthetics in existing disciplines and have created disciplines on geosynthetics.

151 3. Structure of the EtE Program

152 3.1. Objectives

153 As previously mentioned, the overall goal of the EtE program is to provide basic knowledge
154 about geosynthetics to all undergraduate civil engineering students.

155 The consensus is that the focus on education should involve providing basic information about
156 geosynthetics, even if only a one-hour course within a four-year program, but to all
157 undergraduate civil engineering students. Since they share the same curriculum as civil

158 engineering, geotechnical, structural, environmental, transportation, construction, and
 159 hydraulic engineers will also benefit from at least this basic knowledge of geosynthetics before
 160 they graduate.

161 Table 1. Outcomes of the EtE programs conducted from 2015 to 2020 in the world (IGS 2023).

| Year | Country | Number of students | Included GSY in existing disciplines (%) | Created a discipline on GSY (%) |
|------|-----------|--------------------|------------------------------------------|---------------------------------|
| 2013 | ARGENTINA | 25 - 50 | NA | NA |
| 2015 | USA | 0 – 24 | 20 | 20 |
| | | 25 – 50 | 0 | 20 |
| | | 51– 100 | 0 | 0 |
| | | 100 - 150 | 10 | 0 |
| 2017 | CANADA | 0 – 24 | 17 | 0 |
| | | 25 – 50 | 0 | 8.3 |
| | | 51– 100 | 17 | 0 |
| | | 100 - 150 | 17 | 17 |
| 2019 | USA | 0 – 24 | 8,3 | 0 |
| | USA | 25 – 50 | 17 | 0 |
| | AUSTRÁLIA | 25 – 50 | 17 | 17 |
| | PERÚ | 25 - 50 | 17 | 17 |
| | AUSTRÁLIA | 51– 100 | 17 | 7 |
| | MÉXICO | 25 -50 | NA | NA |
| 2020 | TAIWAN | 0 – 24 | 10 | 0 |
| | | 25 – 50 | 0 | 0 |
| | | 51– 100 | 0 | 0 |
| | | 100 - 150 | 0 | 0 |

162 Note: NA = not available; Data on Brazilian EtE’s to be presented later in this
 163 paper.

164 Achieving the goal of the EtE initiative may be especially challenging since civil engineering
165 programs are facing increasing challenges from a vastly expanded curriculum base and the need
166 to limit the entry of new disciplines.

167

168 With the ultimate beneficiary of the EtE program being the undergraduate student, the effort of
169 this initiative focuses on training the university professor, who will thereafter provide this basic
170 knowledge of geosynthetics to their students. The specific objectives of each EtE course are as
171 follows:

- 172 • Provide material for immediate implementation in at least one class on geosynthetics
173 offered to all civil engineering students at the undergraduate level.
- 174 • Provide additional information on geosynthetic applications for implementation in up-
175 per-level undergraduate courses.
- 176 • Offer information that can also be used for advanced classes or graduate courses.
- 177 • Offer information that can also be used for advanced classes or graduate courses.
- 178 • Evaluate ways to implement the educational material provided in the classroom.
- 179 • Outline the basis for curriculum changes that include geosynthetics teaching.

180

181 The specific objectives of each EtE program were often tailored to address needs of the country
182 or region of the event.

183 3.2. Educational Content

184 The EtE educational program is delivered by geosynthetic engineering experts (usually 3
185 professors), from universities in the country where the course takes place or invited from other
186 countries. The content of each EtE program is adapted according to the needs of the local
187 chapter in order to facilitate conveying the experience on geosynthetic by the actual experts
188 delivering the program.

189 The philosophy of the program has been to offer it only as in-person forums to facilitate the
190 experiential nature of the technical content. Such an approach has allowed EtE faculty
191 delivering the course to interact with attendees, facilitating discussion on teaching

192 methodologies and curriculum issues beyond the technical geosynthetics content. However,
193 during the pandemic period, years 2020 and 2021, continuity of the program required that its
194 delivery be conducted. For example, two of the EtE programs implemented by the Brazilian
195 chapter were conducted online. The Chilean chapter has also conducted its EtE program during
196 the Pandemic using an online format.

197 The duration of EtE programs is usually two days, with at least 16 hours of instructor contact
198 time. Other durations, such as 2.5 days and 3 days, have been implemented, at least by the
199 Brazilian Chapter, but a duration of two days is deemed the best suited. Each EtE event involves
200 a partnership between the international society and its national chapter, the local geosynthetics
201 industry, and national associations of civil engineering professors.

202 IGS provides funds to cover travel expenses for program instructors. The responsibilities of the
203 local IGS Chapter are to coordinate activities and funding related to the venue, compilation of
204 educational material (e.g., geosynthetic samples), promotion of the event, and design and
205 execution of the application process and selection of event attendees. The local IGS Chapter,
206 along with industry sponsors, fund local travel expenses (e.g., hotels, meals) for the attending
207 university professors, with only the transportation costs being paid by the participants.

208 The structure of the different EtE programs has been reasonably similar. For example, the
209 program conducted in Austin, Texas (USA), in 2015, consisted of four modules, which
210 considered four typical undergraduate CE courses (Zornberg, 2020). Table 2 presents the
211 structure of EtE 2015, Austin, Texas, USA (Zornberg, 2020).

- 212 • Module 1: A typical “Geotechnical Engineering I” core class
- 213 • Module 2: A typical “Geotechnical Design” technical elective class
- 214 • Module 3: A typical “Pavement Design” technical elective class
- 215 • Module 4: A typical “Environmental Design” technical elective class

216

217 In the EtE programs, introductory topics were presented to illustrate the didactics and level of
218 detail expected in undergraduate civil engineering courses. The advanced topics were presented
219 at a higher level with a focus on technical content and should illustrate the level of complexity
220 that designers of systems using geosynthetics must achieve. Discussions were focused on the
221 theoretical content delivered and the implementation of basic and advanced topics in
222 undergraduate courses.

223

Table 2. Typical structure of an EtE program

| | |
|---------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Introductory Topics | <ol style="list-style-type: none"> 1. Introductory class on types and functions of geosynthetics materials 2. Introductory class on geosynthetics in soil reinforcement applications 3. Introductory class on geosynthetics in roadway systems 4. Introductory class on geosynthetics for environmental protection |
| Topics | <ol style="list-style-type: none"> 1. Fundamental properties and related tests on geosynthetics materials 2. Advanced topics on geosynthetics-reinforced soil walls 3. Geosynthetics-reinforced steep slopes 4. Geosynthetics for stabilization of unpaved roads 5. Geosynthetics for stabilization of paved roads 6. Prediction of leakage through geosynthetic liners 7. Factors affecting the service life of geosynthetic liners |
| Support Activities | <p>Workshops</p> <p>Case histories</p> <p>Discussions</p> |

225 EtE Brazil introduced several innovations, such as an initial class on pedagogical tools for
 226 participants to use in their disciplines; two practical workshops presenting different engineering
 227 projects to be analyzed using geosynthetics; and the development of the Pedagogical Plan for
 228 the discipline of geosynthetics, which was developed during EtE and delivered at the last class
 229 by each of the participants. Another interesting innovation introduced by EtE Brasil was the
 230 creation of a Mutual Support Network (MSN), with the aim of integrating the participants with
 231 each other, with the teachers, and with the IGS Brasil secretariat, during and after the course.

232 The MSN would grow with each EtE held and interconnect participants from all regions of
233 Brazil.

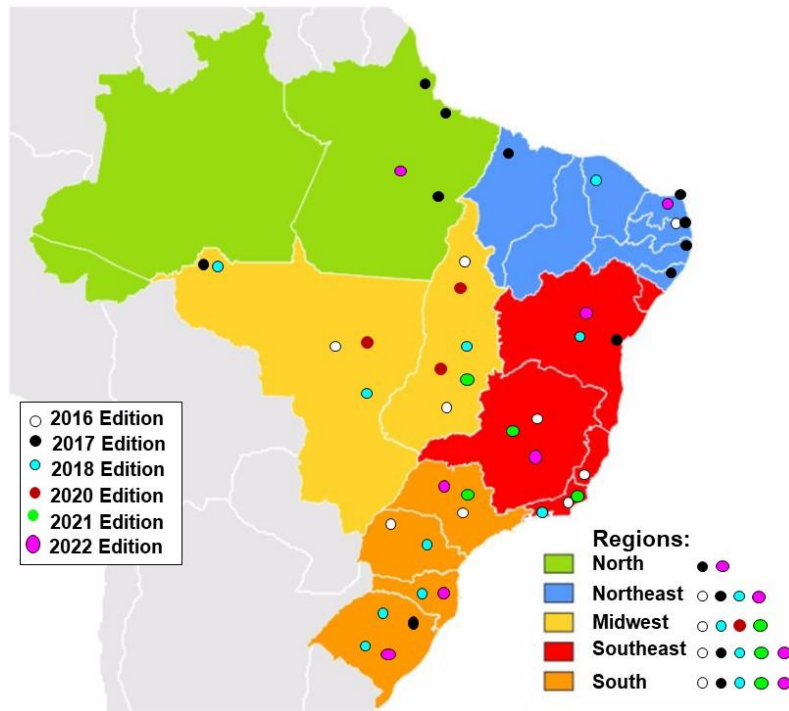
234 4. EtE Programs in Brazil

235 4.1. General description

236 To satisfy the demand for the program, a total of six EtE courses were implemented in Brazil
237 (2016, 2017, 2018, 2020, 2021 and 2022). Figure 2 illustrates the origin of the attendees
238 throughout the Brazilian territory (modified from Zornberg et al., 2020). The events
239 implemented by the Brazilian Chapter of the IGS are described in this paper as a case study to
240 explain the metrics collected from the participants and the overall outcomes of the EtE
241 programs. The first EtE event in Brazil was held in 2016 in the city of Belo Horizonte
242 (southeastern region of Brazil) and included participants from the entire country. Considering
243 the vast territorial extension of Brazil, it was decided to organize the subsequent EtE's courses
244 in different geographic regions to facilitate outreach to a high number of professors. The
245 regional events included: North and Northeast, Midwest, Southeast, and South. Specifically,
246 the 2017 event was held in the city of Recife (north and northeastern regions); the 2018 edition
247 took place in the city of Curitiba (southern region); the 2020 event, which was the first online
248 EtE (due to the COVID 19 pandemics), aimed at participation from the Midwest region; the
249 2021, which was also an online event, aimed at participation from the Southeast region. The
250 most recent (2022) event was held in São Paulo and included participants from the entire
251 country. Table 3 summarizes information from the six Brazilian EtE courses, the regions where
252 they were held, and the number of participants in each one.

253 Despite the country's significant size and the wide distribution of its population, a relatively
254 diverse distribution of participants' origins can be observed in Figure 2, with a greater number
255 of attendees coming from the southeastern and southern regions of Brazil. The organization of
256 such courses has had a major impact on the dissemination of geosynthetics among
257 undergraduate students in Brazil, as will be detailed below.

258



259

260

Figure 2. Origin of the attendees to the EtE programs implemented in Brazil.

261

262

Table 3. EtE held by region in Brazil and number of attendees.

| EtE date | Region | City | Number of attendees |
|----------|----------------|----------------|---------------------|
| 2016 | All regions | Belo Horizonte | 27 |
| 2017 | Noth/Northeast | Recife | 27 |
| 2018 | South | Curitiba | 30 |
| 2020 | Midwest | Online | 34 |
| 2021 | Southeast | Online | 28 |
| 2022 | All regions | São Paulo | 24 |

263

264 Consistent with the technical content previously described for the EtE program, the EtE courses
 265 given in Brazil examined different aspects of geosynthetics applications in civil and
 266 environmental engineering works. Overall, the following topics were addressed:

- 267 • Introduction to the teaching of geosynthetics at the undergraduate level; objectives of
 268 the “Educating the Educators” program; course methodology, pedagogical techniques.

- 269 • Geosynthetic types and functions.
- 270 • Geosynthetic properties and testing.
- 271 • Geosynthetics in filtration and drainage.
- 272 • Geosynthetic-reinforced walls.
- 273 • Geosynthetic-reinforced steep slopes.
- 274 • Reinforced embankments on soft soils.
- 275 • Geosynthetics in roadway applications.
- 276 • Environmental applications of geosynthetics.
- 277 • Hydraulic applications of geosynthetics.

278

279 Following core sessions on a given theme, sessions focusing on case histories of engineering
280 works involving geosynthetics were presented to provide additional context involving recent
281 projects. Pedagogical workshops with groups of activities were also conducted, including
282 integrated panels, workshops on recognition of geosynthetic samples, customer and supplier
283 exercises, and a pedagogical workshop for the preparation of the geosynthetics course plan
284 (Masetto, 2003, Coelho, 2012, Coelho, 2016 and Gardoni & Coelho, 2016).

285

286 The workshops involve the application of teaching techniques and group dynamics, followed
287 by a discussion of the pedagogical knowledge that underpins class planning, learning
288 evaluation, and the relationship between the teacher, the students, and knowledge. This
289 pedagogical setup is better aligned with the practical learning outcomes associated with
290 geosynthetic materials in engineering, such as the selection of types and functions that the
291 geosynthetics can fulfill, as well as their properties. Participants are also exposed to project
292 challenges during the course to better prepare their undergraduate students for the project
293 challenges they will encounter during their careers.

294

295 The Pedagogical Workshop reviews the pedagogical techniques experienced during the course
296 (Integrated Panel, Client and Supplier), the pre-planning of teaching for the subject based on
297 the knowledge acquired in the course, and the Mutual Support Network proposal for continued
298 interaction among attendees, instructors and manufacturers.

299

300 4.2. Analysis and results

301 The benefits derived from the various courses implemented in Brazil were assessed by
302 interviewing attendees at the end of the event and two years thereafter to evaluate if the major
303 course objectives had been achieved. Figures 3(a) to 3(f) present evaluations at the end of the
304 event by the attendees of the six events in Brazil (from 2016 to 2022) (Zornberg et al., 2020).
305 Specifically, the attendees evaluated the courses by assigning a grade ranging from zero (poor)
306 to 5 (excellent) regarding quality of learning, quality of course content and overall satisfaction.
307 As indicated by the ratings shown in Figure 3, the attendees thought very highly of the course
308 in the different categories and in the various events. The evaluations of the three types show
309 increasing scores for EtE 2022 compared with previous years. However, for "Quality of
310 learning" and "Satisfaction with the course", the rating reached 100% compared to the last
311 years.

312

313 As part of the evaluation process of the benefits brought by the EtE program, the participants
314 were also interviewed two years after course completion to assess if the main course objectives
315 were accomplished. Approximately 60% of the participants in the 2016 to 2022 courses
316 responded to a questionnaire aimed at evaluating the influence of the course on encouraging
317 them to disseminate the knowledge acquired.

318 Figure 4 shows that geosynthetics topics had been incorporated to existing disciplines in
319 undergraduate courses by 62% of the 2016 course attendees; elective disciplines on
320 geosynthetics had been created by 15% of them; geosynthetics were included in routine
321 academic events at their institutions by 54% of the attendees. In addition to coursework
322 activities, 15% of the attendees indicated having delivered keynote addresses; and 15%
323 indicated having participated in the offering of geosynthetics short courses. Inspection of the
324 information in Figure 4 reveals some notable highlights, including the fact that geosynthetics
325 topics were included in existing disciplines in undergraduate courses by 90% of the 2017 course
326 attendees (See Figure 4(b)); 54% included geosynthetics in academic events; 10% created a
327 discipline on geosynthetics; 11% delivered keynote addresses and 6% offered geosynthetics
328 short courses.

329

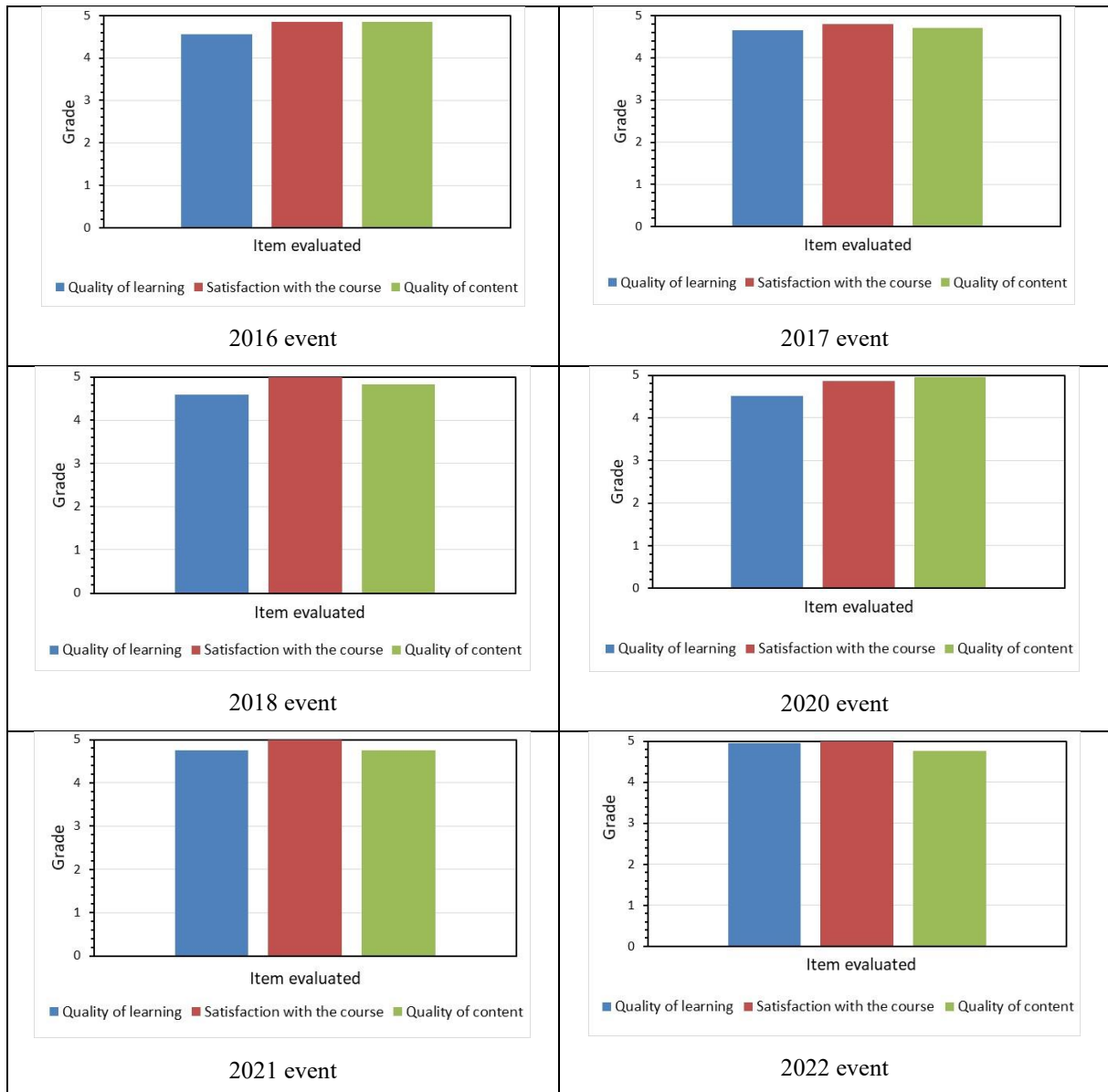


Figure 3. Evaluation of EtE course by attendees.

330

331

332 Figure 4 shows that geosynthetics topics had been incorporated to existing disciplines in
 333 undergraduate courses by 62% of the 2016 course attendees; elective disciplines on
 334 geosynthetics had been created by 15% of them; geosynthetics were included in routine
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 340 attendees (See Figure 4(b)); 54% included geosynthetics in academic events; 10% created a

341 discipline on geosynthetics; 11% delivered keynote addresses and 6% offered geosynthetics
342 short courses. Figure 4 (c) depicts that geosynthetic was included in existing disciplines by all
343 the 2018 course attendees; geosynthetics was included in academic events by 35% of them;
344 discipline on geosynthetics was created by 10% of the attendees; 11% of them delivered
345 keynote addresses; and 6% offered short courses on geosynthetics. Figure 4 (d) shows that all
346 2020 course attendees stated that they included geosynthetics in existing disciplines; 36%
347 included geosynthetics in academic events; 6% created a discipline on geosynthetics; 18%
348 delivered keynote addresses; and 6% offered geosynthetics short courses.

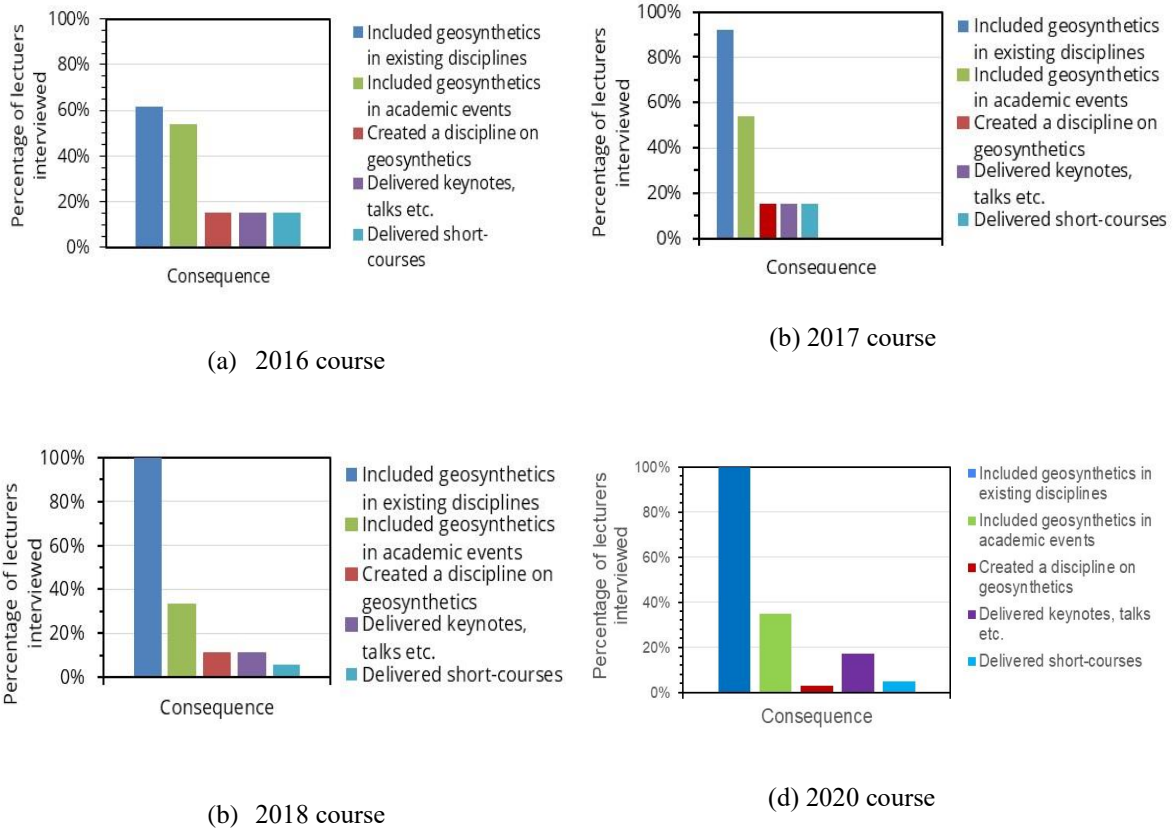
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350 An important achievement regarding the percentage of lecturers who successfully introduced
351 the subject of geosynthetics into existing disciplines was observed. While the 2016 EtE showed
352 62% of the course attendees having this initiative, for 2018 and 2020 EtE that percentage
353 reached 100%. While the objective of the EtE program was not necessarily to support the
354 creation of a new discipline, it was interesting to observe that 15% of the attendees to the 2016
355 and 2017 events reported affirmatively to the question "have you created a discipline on
356 geosynthetics?". However, some decrease in this specific outcome was observed in the
357 outcomes of the subsequent EtE events. Yet, the reason for such decrease in this ambitious
358 outcome may have been the determination of the Brazilian Ministry of Education to reduce the
359 number of disciplines in undergraduate courses. In fact, the results of the EtE program in Brazil
360 so far can be clearly qualified as a huge success since a survey pre-dating the EtE program (of
361 the year 2000) had shown that only two universities in the country with disciplines on or
362 incorporating geosynthetics in the curricula of undergraduate courses (Palmeira 2000).

363

364 Table 4 shows the number of students enrolled in courses including geosynthetics that the
365 participants in the four EtE programs had delivered by year 2021 in their institutions.
366 Differences between the results of the EtE courses are likely a consequence of differences in
367 academic conditions, curricula, and facilities of the host institutions in different regions of the
368 country.

369



370 Figure 4. Percentage of Respondents of EtE programs conducted in Brazil, after two years.

371 Analysing the results obtained in the online EtE's in relation to the face-to-face EtE's, immediately after the end of
 372 the course, they remained practically the same for both, with an increase in "Satisfaction with the course and
 373 "Quality of the content. However, in relation to "Inclusion of geosynthetics in existing subjects" there was a
 374 significant increase in EtE2020 online compared to the previous in-person courses, but the other items evaluated
 375 showed decreasing results. This can be explained by the pandemic that occurred in Brazil in 2020 and 2021.

376 Table 4. Number of students enrolled in classes on geosynthetics because of EtE programs in Brazil.

| Number of Students | 2016 (%) | 2017 (%) | 2018 (%) | 2020 (%) | 2021 (%) |
|--------------------|----------|----------|----------|----------|----------|
| 5 – 20 | 8 | 8 | 6 | 17 | 33 |
| 20 – 70 | 31 | 38 | 50 | 58 | 34 |
| 70 – 150 | 23 | 23 | 28 | 17 | 33 |
| Over 150 | 15 | 8 | 17 | 8 | 0 |

377 5. Conclusion.

378 An international educational program to facilitate the exposure of geosynthetics to
379 undergraduate civil engineering students, Educate the Educator has been introduced by the
380 International Geosynthetics Society (IGS). Some conclusions that can be reached from the
381 evaluations on this initiative are:

382 - The EtE initiative has been successfully implemented throughout the world, as evidenced by
383 the 23 EtE events conducted so far, which took place in 14 countries, providing access to
384 geosynthetics knowledge to a geographically diverse number of undergraduate students

385 - The demand for EtE worldwide has been continuously increasing, which attests to the
386 program's effectiveness.

387 - Brazil has conducted 6 EtE with 161 participants from various universities from all regions
388 of the country. The evaluations carried out after the course and two years after its completion
389 show that teaching activities such as introduction of the subject in existing disciplines, creation
390 of optional subjects, academic events, lectures and mini courses were implemented in all the
391 universities that attended the program,

392 - The participants of EtE Brazil have been continuously interacting through the Internet in a
393 Mutual Support Network, helping each other with materials, suggestions for classes, practical
394 workshops etc.

395 - Regarding the online EtE, IGS Brazil adapted the online version of the practical classes so
396 that could be reproduced online. Several adaptations were necessary for the course to work.
397 One of them was the sending of geosynthetics samples by mail one week before the start of the
398 course and the students received the photos of the samples that they were supposed to separate
399 from the box before the practical class.

400 - Despite the excellent evaluations received from the online EtE participants, the course
401 coordinators and instructors have concluded that the in-person format is the most suitable and
402 that it best meets the EtE's objectives. There are several reasons for this, such as: the dedication
403 of the participants is much greater in the in-person EtE, since they are totally immersed in the
404 course, while in the online version they continue to carry out their university activities.
405 The participant's contact with the instructors is so important as is the student's contact with the
406 teacher in the classroom. The practical activities were greatly affected in the online version

407 since there was no connection between the students during the project discussions. In
408 conclusion, the Brazilian experience has shown that for a course with the philosophy of EtE, th
409 in-person version is essential.

410 Bearing in mind the significant size of the Brazilian territory, it may be concluded that the EtE
411 program in Brazil has been a great success for dissemination of the geosynthetics knowledge
412 in the country, serving as example for successful implementation of similar initiatives by other
413 countries.

414

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419

420 Declaration of interest

421 The authors have no conflicts of interest to declare. All co-authors have observed and affirmed
422 the contents of the paper and there is no financial interest to report.

423 Authors' contributions

424 Maria das Graças Gardoni Almeida: Conceptualization, Data curation, Formal Analysis,
425 Methodology, Visualization, Writing – original draft. Jorge G. Zornberg: Conceptualization,
426 Data curation, Supervision, Validation, Writing – original draft. Ennio Marques Palmeira:
427 Formal Analysis, Conceptualization, Data curation, Supervision, Validation, Writing – original
428 draft. Nathalie Touze Foltz: Data curation, Supervision, Validation, Writing – original draft.

429 6. Data availability

430 The datasets generated analyzed in the course of the current study are available from the
431 corresponding author upon request.

432 Abbreviations

| | | |
|-----|------------|--------------------------------------------------------------|
| 433 | ABNT | Brazilian Association of Technical Standards |
| 434 | ASTM | American Society of Testing Materials |
| 435 | CE | civil engineering |
| 436 | EtE | educate the educator |
| 437 | IFAI | Industrial Fabrics Association |
| 438 | IGS | International Geosynthetics Society |
| 439 | IGS-Brazil | Brazilian Chapter of the International Geosynthetics Society |
| 440 | ISO | International Standards Organization |
| 441 | NA | not available |

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