

IMPROVING STUDENT ENGAGEMENT IN CIVIL ENGINEERING STUDIES

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Abstract. Educating Generation Z poses new challenges for academic and administrative staff at universities. As the new generation of students has new ways of learning and paying attention, modern engineering education methods need to be applied. In addition, the general popularity of civil engineering is low, studies are relatively difficult and dropout rate is high. Therefore, student engagement and motivation always require special attention. This paper presents several strategies and methods applied at VILNIUS TECH Faculty of Civil Engineering during the last 5 years. Authors present and analyse how institutional policies and targeted academic support for lecturers can improve student engagement and help build faculty competencies. Paper briefly presents several best practices in engineering education from our teaching experience. Qualitative and quantitative analysis and faculty surveys are used to assess the impact of the implemented policies on student engagement.

1 INTRODUCTION

Engineering education is a constantly changing field. Two recent milestone events – global pandemic and evolution of generative Artificial Intelligence (AI) – made tremendous impact on teaching and learning process. We learned and adapted quickly after the pandemic – successfully tackled the challenges of distant and mixed learning. Yet academia still slow in reacting to the rapidly evolving AI developments [1]. “Generation Z”, “digital natives” and similar terms describing new student generations sometimes sounds too generalized and lacking content, but it undoubtedly indicates that individuals we see in our classrooms are changing. Therefore, it is necessary to adapt to the way of thinking, learning and using information.

As the total number of students in Lithuania are declining (mostly due to demographic problems), VILNIUS TECH civil engineering programs also has historically low number of students. Even more worrying is that general interest in engineering sciences is lower than a decade ago (Fig. 1). Some students avoid engineering because they see it rigid or lacking opportunities for self-development. Poor image and status of engineering careers, as well as societal and peer group influences, can also deter interest. As data shows, attracting more students is as hard as retaining them. As engineering is behind in popularity of other fields of studies, the students our university manages to attract are less academically advanced. This results in a lower academic performance at university. Looking for a quantitative measures, a good indicator of academic performance is the number of students who pass all their exams on

the first attempt - only 51% of students do so. Academic performance is also reflected in the number of students dropping out – in 2024 about 29% of students do not complete their studies on time. 6% of them left to repeat the year, 11% dropped out altogether and 11% took academic leave. Out of those who drop out, 67% do so voluntarily, 17% due to lack of performance, 3% due to failure to sign a study contract and 8% due to failure to arrive after a break in studies. The main reasons for dropping out according to students are: ‘studies incompatible with work’, ‘emigration’, ‘unsatisfactory quality of studies’, ‘did not like the study programme’. Statistically the highest probability to drop out is in the 1st or 2nd year of studies. Correlating this data with academic performance suggests that undergraduate students are most likely to fail in basic science subjects, leading to dropout.

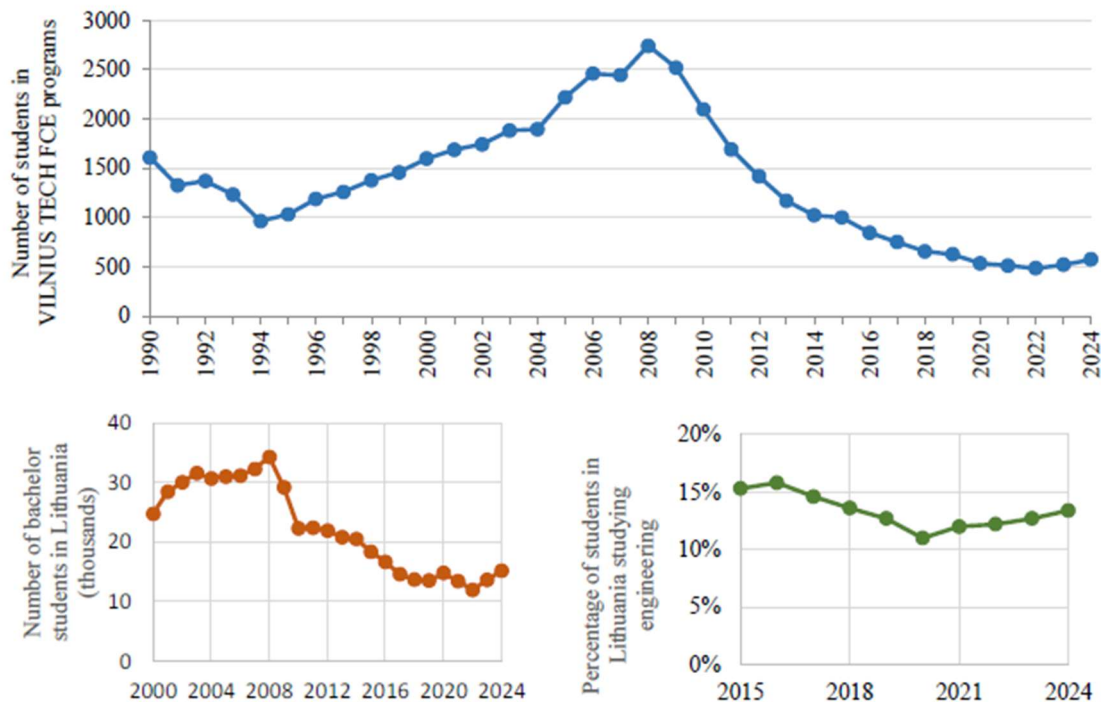


Figure 1: Changes in student numbers and their interest in engineering over the years (source: VILNIUS TECH and <https://osp.stat.gov.lt>)

The aim of the Faculty of Civil Engineering (FCE) is to tackle these problems and gradually improve the public perception of civil engineering and promote it among young people. Smaller number of students might be seen as a good opportunity to make a visible impact. This requires attention and high dedication from all parties involved – administration and academic staff. It is necessary to introduce modern teaching and communication methods that meet students' expectations. Big part of successful studies are active, determined and eager to learn students. Significantly improving student engagement in studies is a long and demanding task. This paper overlooks the steps that has been taken so far and discusses their effectiveness. Efforts are divided into two categories – measures targeting students and incentives for lecturers (Fig. 2). First category involves management actions taken globally at the university and locally in the FCE with the goal of shaping student behaviour. Second category of measures aims to help lecturers to improve their teaching skills. This is expected to result in innovative education

practices having overall positive impact on studies. All subcategories are described in the subsequent sections.

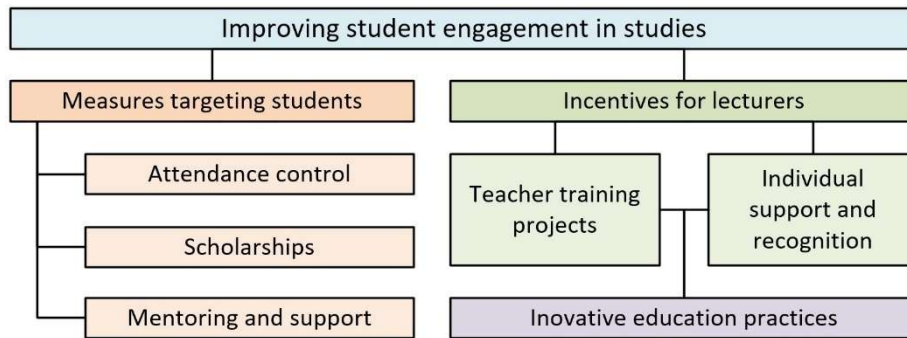


Figure 2: Student engagement methods

2 MEASURES TARGETING STUDENTS

2.1 Attendance control

Poor student academic performance is partly related with non-mandatory attendance of lectures. As study materials are usually available online, some students think they can study individually and do not attend multiple lectures. This often results in failed exams. Therefore, in 2023, a compulsory attendance of lectures has been introduced in order to "bring students back to university" and increase their engagement in the study process. Compulsory means that failing to attend a certain percentage (usually 70-80%) results in subject failure. After one year of compulsory attendance, the academic performance of students in full-time first cycle programs increased by 8% (from 43% in 2022-2023 academic year to 51% in 2023-2024). This is not yet statistically reliable, but the indications are positive. A lecturer survey also shows a modest positive effect (Table 1). In summary, around one third of lecturers see an overall positive impact of attendance control.

Table 1: Lecturer survey results

Has the attendance tracking of lectures been successful as a means of improving study results?	Yes 27%	Rather yes 30%	Rather not 18%	No opinion 25%
Has the attendance tracking of seminars been successful as a means of improving study results?	Yes 37%	Rather yes 29%	Rather not 16%	No opinion 18%
Has the number of exam failures in your subjects decreased since the introduction of attendance tracking?	Yes 22%	No 32%	I did not compare the results 46%	

2.2 Scholarships as motivation

Studies in Lithuania are generally free [2]. Specifically in civil engineering there are usually more state funded places than eligible people willing to study. As a result, there is no financial pressure on students – they make the decision to study with no major commitment and no significant consequences for dropping out. FCE is always open to partnerships with industry

sponsoring scholarships. As a trade-off, companies hope to attract new employees, although most of them declare idealistic incentives. Recently two infamous engineers sponsored 3 scholarships for 1st year bachelor students. Their reasoning was as follows:

"In business, we feel that there is a shortage of talented engineers, project managers and designers for more complex projects. That's why we want to contribute to the motivation of students, because engineers will always be needed."

President of Lithuanian Geotechnical Society, which funded 6 scholarships last year, said:

„The aim of the scholarships is to have more specialists in this field, because there is a shortage of geotechnical engineers. The new generation of Eurocodes introduces a new part - Geotechnical Structures. Our Society members (designers, foundation builders) foresee that this will further increase the demand for these professionals“.

Over the last several years, the number of scholarships for bachelor students from private companies has been visibly growing (Table 2). The size of scholarships is usually around 100-300 EUR/month or 500-5000 EUR as a one-off allowance. Therefore, it is not too significant financially, but the intention is to increase students' engagement and motivation. Recipient feedback supports the claims:

"It is a great honour to receive this scholarship. I am glad that someone on the outside has appreciated our efforts and confirmed that we are on the right career path. It also provided some financial incentive and support to continue to achieve our goals!"

Table 2: Business scholarships

Academic year	2021-2022	2022-2023	2023-2024	2024-2025
Total number of scholarships for bachelor students from private companies	12	18	18	23

2.3 Mentorship and individual support

VILNIUS TECH focuses on mentorship for the first-year students as data shows this is the most challenging time, leading to the highest drop out rates. FCE delegates four lecturers to be student mentors and keep a close eye on their study performance and general well-being. Each of the mentors overview around 50 students. In 2022, after five years of practical experience, the activities of lecturers serving as mentors were revised to focus on a more individualized approach and building the relationships with the students. To support this shift, specialized training sessions and systematic experience-sharing seminars were organized. Meetings between mentors and the coordinators are held twice per semester. Mentors conduct individual conversations with students to understand their needs, goals, motivation, and study challenges, collaboratively seeking solutions.

Since 2018 students are able to access personal psychological support and assistance. Annually, more than 600 individual psychological consultations are provided at VILNIUS TECH. This number grows every year, which indicates that students need such help. This support reduces the chance of them failing or dropping out. Psychologists also organize various special public events, major of which is the Well-being Day. During this event, a group of experts share presentations and insights on mental health, discussing topics such as importance of physical activity for well-being, addictions, neurodiversity, problematic internet use and digital awareness, and other relevant issues. Active participation from faculty members

indicates that academic staff increasingly recognise the importance of their own and student well-being.

3 INCENTIVES FOR LECTURERS

3.1 Teacher training projects

In the 2020-2021 academic year, a group of volunteer lecturers was selected to implement the Flipped Classroom method as part of an initiative led by the Academic Support Center (ASC). The selected lecturers underwent specialized training, received consultations, and participated in regular meetings and experience-sharing sessions. The project spanned three semesters and involved 27 lecturers, including 4 from the FCE. Student surveys conducted during the project revealed positive feedback regarding the Flipped Classroom method – students reported that the method was engaging and motivating. Although it is not a new methodology, its systematic introduction and support for teachers is still necessary and effective.

In 2023-2024 academic year, the ASC implemented the "Digital Transformation in Education" project [3]. This initiative was part of the economic recovery and resilience plan "New Generation Lithuania," funded by the European Union's NextGenerationEU recovery and resilience facility. The primary goal of the project was to promote the integration of educational innovations based on digital technologies within the education sector. This involved creating and testing innovative solutions in educational institutions, providing consultations, and leveraging the expertise of tech-savvy teachers, innovators, and experts. These professionals offered support to educational institutions and educators facing challenges in utilizing technology and digital resources.

In 2023, the ASC team organized a specialized digital pedagogical competencies development program, providing 66 hours of training to 72 university lecturers. As a result, these lecturers developed 90 digital teaching and learning resources (8 in the FCE) within the Moodle environment. Additionally, 18 hybrid work classrooms were established at the university, funded by the project. Continuing the project into 2024, lecturers prepared and submitted for approval 30 interactive digital books (7 in FCE), 16 self-study courses (3 in FCE), and 15 digital teaching and learning resources (1 in FCE) within the Moodle environment. This ongoing effort aims to enhance the digital competencies of educators and improve the quality of education through innovative digital tools and resources.

3.2 Individual support and recognition

Each year, VILNIUS TECH organizes awards for outstanding achievements in teaching. Award winners are presented with uniquely designed badge that reads "I Teach at VILNIUS TECH" and a recognition certificate. An award ceremony includes greetings from administration and ASC with presentation of detailed merits of the award recipients. This award specifically recognizes achievements related to teaching, relationships with students, and study-related activities. The nominations reflect the faculty's didactic, digital, and psychological competencies. The awards are held since 2022. Over this period, 30 faculty members have been honoured, including 5 from the FCE.

ASC organizes regular training and individual consultations for lecturers to help them

improve their didactical competencies. All training sessions are designed to implement student-centered learning. Both novice and experienced lecturers encounter questions about how to organize lectures, what teaching and assessment methods to apply, how to motivate students, what technologies to use for effective and engaging teaching, and how to adapt materials for students with special needs. Annually, around 40-45 different training topics are offered to lecturers, attracting approximately 1500 participants. It must be stressed that in order to be certified, lecturers must accumulate the specified number of hours of pedagogical training. In the last two years significant emphasis was put on AI training for lecturers.

A noteworthy new initiative is "FAQ: Innovative Teaching at VILNIUS TECH – Answers and Examples from Lecturers," which brings together lecturers once a month to discuss innovative teaching methods, student engagement, and collaboration in their subjects. These meetings have received a very good feedback from participants. Often live meetings are followed by discussions in the virtual chat groups, fostering ongoing dialogue and mutual support among lecturers.

4 STUDENT CENTERED TEACHING METHODS

This section describes selected teaching methods from VILNIUS TECH FCE. These methods were well conceived by students, faculty staff and ASC. Their impact on academic performance is hard to measure, but they clearly have positive influence on student engagement in studies, which generally leads to overall better student achievements.

4.1 Gamification of lectures to improve participation and engagement

Students from generation Z are very fond of computer games. Hence, it makes sense to involve some sort of gamification approach to lectures. Education research claims that games in a class can promote development of creativity, innovation, participation, leadership, goal management and motivation. Furthermore, compared to the traditional class, games can significantly improve academic performance in engineering students [4]. A relatively simple method applicable in engineering is a game of Jeopardy. It is based on a television game and adapted for studies [5]. It is most suitable for textual questions, but it may also include problem solving. Fig. 3 demonstrates an example from structural analysis course: a presentation slide starting with brief explanations and a question board (Fig 3, left). Students are divided into groups (1-4 are recommended) and each group takes it in turn to choose a question (Fig 3, right). Time to solve the problem is limited to 2-8 min. If students answer correctly, they receive corresponding amount of "money". If they are incorrect, other student groups take turn to answer. Finally, lecturer or students should briefly explain the solution. When the game is finished winning group is awarded with extra credit of just acknowledgement from the lecturer. This method works well for smaller academic groups (6-25 students) and can easily take up an entire lecture (1-2 hours).

Another simple way to involve games into lectures is using online quiz apps (e.g. Mentimeter). Lecturer creates quiz slides, which involves text or figure questions, answer options and defines time limit for answering (Fig 4, left). Students use smartphones to connect to the game and choose one of the provided answers. The slides are simultaneously presented on the classroom screen. After dedicated time (usually 20-120 seconds) question is closed. Students that answer correctly receive points. The quicker they answer, the more points they

receive. Next slide should be the “Leaderboard” (automated in the app) which shows the results (Fig 4, right) and usually receives cheering from the audience.

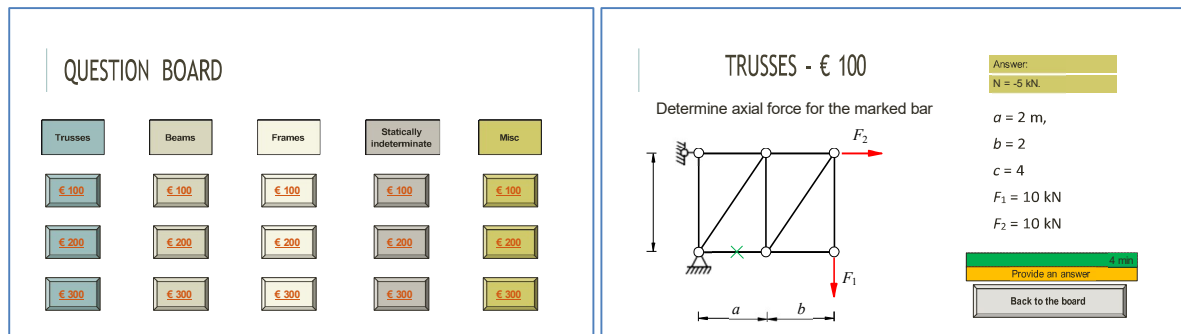


Figure 3: Jeopardy game slides. Question board (left) and a question slide (right), which would initially appear without answers.

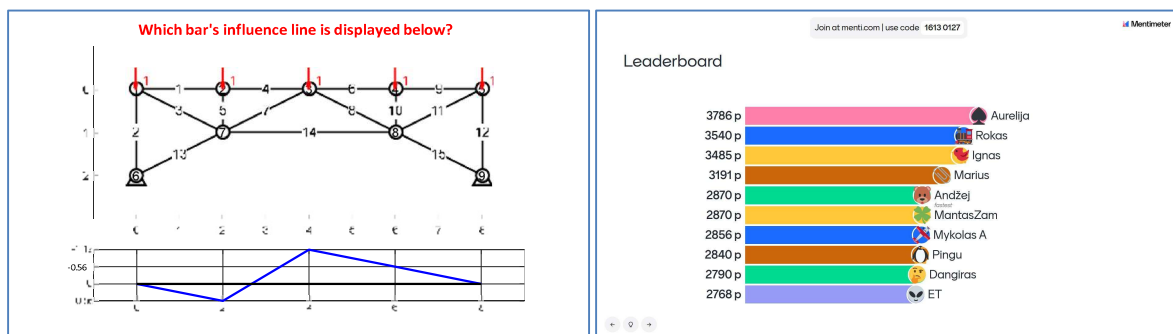


Figure 4: Mentimeter based quiz slides. Question slide (left) and a leader board slide (right)

After all the questions, students that collected most points are declared winners. These applications are best suited for short text questions, but an engineering figure works fine as well. Fig. 4 demonstrates an example from structural analysis lecture dedicated to the influence lines. Student would need to pick the number of a truss bar for which the influence line is shown below the structure. This method works equally well for small and large audiences (also for distant and hybrid learning). It is well suited for a quick review session (beginning, mid or end of a lecture) and can take only 5-15 minutes (3-10 quick questions).

Including hands-on assignments improves student engagement in lectures even more than virtual quizzes. Various commercially produced structural models are useful for engineering education. FCE uses several as well. A good example is from the course of steel design, where students are divided into small study groups (2-6 persons) for the entire semester. Final lecture of this course is dedicated to the “Building championship”. The assignment for the study group is to build a two story building in such way that it would support as much load as possible (Fig. 5). Students are using Mola models [6]. They are given a limited amount of elements, but have no design restrictions. Such assignment fosters creativity and engineering thinking. It allows students trying and changing designs several times, discussing strategies and making design decisions – placement walls, columns and bracing placements. Finally, all structures are loaded and filmed to collapse under critical loads. Structure that withstands highest load wins the competition. This particular method is well suited for smaller academic groups (6-25 students)

and can take up an entire lecture (1-2 hours).



Figure 4: Active learning lecture from the course “Steel structures I”: student made structures (left) and a “Championship board” (courtesy lecturer G. Sandovič)

4.2 Learning from environment

While game based and model building lectures are fun, civil engineering education is always full of real life examples. It is very important for students to learn from environment and social contexts. First, the big events – study field trips guided by lecturers and industry professionals. These trips has many social benefits for students, but in terms of academic performance, there are two important aspects to cite the [7]: first, changing the physical location of education fosters the learning process and therefore learning objectives can be achieved faster; and second, encountering real world problems and interacting with professionals motivate students in learning relevant subjects. VILNIUS TECH FCE organizes trips regularly (Fig. 6).



Figure 4: Fieldtrips with students: commercial building, inside a bridge, foundation installation site

Field trips are difficult to organise on a frequent basis, so learning from the environment needs to be regularly incorporated into the study process. Author’s share just one approach that had success and was well received by students. This method is called “Mini project: structures around us”. The principle is simple: students would upload pictures of structures they have personally taken (not from the internet!) on a study platform (e.g. Moodle or similar) (Fig. 7).

In the beginning of every lecture, one student would present the structure from his picture. Then lecturer would guide a brief discussion about structural aspects of it (the emphasis might change depending on the course). This method fosters observation skills, critical thinking and allow students to talk and discuss – encourages active participation and engagement. This method can be easily adopted to any size audience and time frame.



Figure 7: Pictures taken by students: roof structure of a shopping centre, railway transmission lines and a watchtower, cable connection detail, steel bridge underside

4.3 Project based learning

If we try to combine group work, field trips, hands-on experiments and active learning we end up in project based learning or problem based learning (PBL) approach. These are demanding methods for lecturers, but it can produce excellent results. Both methods are increasingly used in FCE. It requires (and encourages) great student engagement, fosters student oriented learning and highlights individual talents. An application of PBL in structural dynamics course is described in [8]. A variation of this PBL involves experiments with real structures, numerical analysis and making a quantitative and qualitative report (Fig. 8). A recent reflection of a student summarises good outcomes: *“I would like to thank you for giving us an opportunity to learn effective and productive dynamics and stability of buildings. It was the best learning experience of my studies”*.

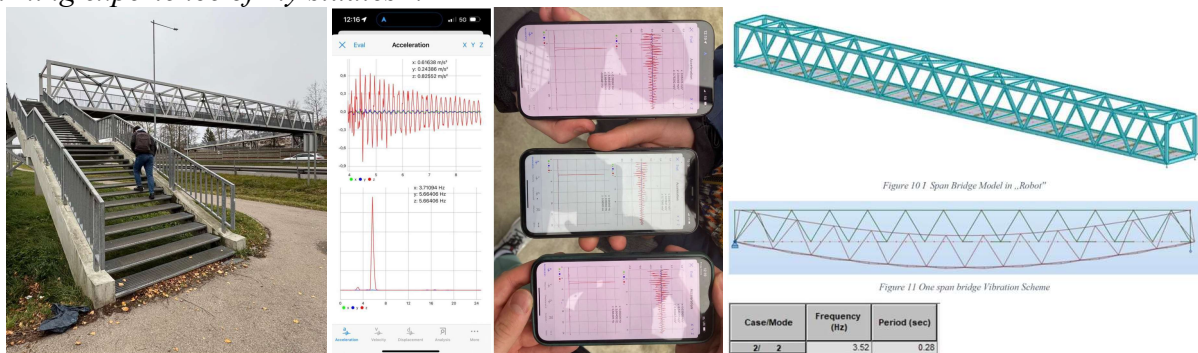


Figure 8: Structural dynamics study project. Bridge under investigation (left), mobile app acceleration testing (middle), numerical model for experiment verification (right)

12 DISCUSSION

- Improving student engagement in studies requires a holistic approach. There are multiple reasons why some students in civil engineering lack motivation and have low academic performance. Some of these reasons can be mitigated with administrative tools – making study environment as inviting as possible, controlling lecture

- attendance, ensuring individual psychological support or finding sponsors for scholarships. All these show overall positive effects, yet it is not all easy to measure.
- However, the major responsibility for study quality lies on the shoulders of the lecturers. Investing in pedagogical competencies is essential. As science production is much easier to measure, teaching competences frequently remains unrecognized. VILNIUS TECH ASC works specifically on improving these competences and recognizing those lecturers who achieve excellence. The qualitative measure – student feedback – shows great results. Even if it does not directly raise student grades, improved engagement should produce good outcome in the longer run. Finally higher student satisfaction with studies should gradually improve public perception of civil engineering and promote it among young people.

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