

Student Experience of Flexible Engineering Education: A Case Study at Two Foreign Universities in the Far East

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Abstract—This paper presents a flexible online learning approach for engineering education. The approach was developed during the pandemic in 2020, and it was extended when the education disruption happened. To determine the efficacy of this online approach in British education in the far east, a case study was conducted on engineering students at the University of Nottingham Ningbo China, and the University of Glasgow, Singapore. The primary research question is how students perceive the effectiveness of online learning tools in enhancing their synchronous learning during a sudden transition from physical to online classes. Using Microsoft and Google forms, survey results were collected from junior and senior engineering students enrolled in different programs of study at the two universities. The response rate is approximately 70%. The survey revealed that students utilized technology effectively and quickly adapted to online learning. During their online learning journey for British engineering education, students found using the most up-to-date online teaching tools to be very comfortable. The findings of this study could inform future pedagogical practices for educational disruption.

Keywords— flexibility in learning, engineering education, online learning

I. INTRODUCTION

Widespread use of an e-learning approach was made to combat educational disruption amid the pandemic [1]. Due to travel restrictions, many international faculty and students were stranded abroad, posing an added challenge for international universities in China. A series of outbreaks in China prevented students from returning to campus on occasion for nearly three years [2]. At the same time, the second phase of this pandemic was declared in Singapore around September 2021 and lasted approximately six months longer [3]. During this period, the government of Singapore implemented stringent measures. Initially, due to the sudden increase in cases, higher education instruction shifted immediately to home-based learning. As of September 2021, e-learning has become a requirement for higher education institutions. Some universities were in a position to respond immediately to the pandemic with their proposed e-learning strategies [4-5]. Numerous universities have adopted "the best that we can do" as their initial online instruction strategy [6]. Various universities employed a diverse range of online learning strategies [7]. This disparity was a result of multiple factors, including the accessibility of platforms and advances in digital learning technology. Teaching professors had to

spend extra time getting ready for online teaching, including filming, editing, streaming, recording, and uploading material. Another important aspect was the students' end of the internet facility [8], especially when the students' geographical dispersion was considered. Alternatively, student engagement was another primary concern [9].

This paper uses a flexible online learning approach at two British universities in the far east. The used approach focused on student engagement and interaction as an essential requirement of engineering education. The approach maintained effective learning to enhance engineering students' experience of blended learning during ongoing educational disruption. Final year students from electrical and electronic engineering studying at the University of Nottingham Ningbo China (UNNC), and year two students from mechanical engineering at the University of Glasgow, Singapore (UGS) were involved in this study. The study investigates the similarities between Asian engineering students' experience of online learning who study at foreign universities in the far east. The study is motivated by the need to find pedagogical practices of flexible learning for future engineering education. The remainder of the paper is organized as follows after this introduction: a brief literature analysis on blended and online learning during educational disruption in various nations is presented in section II. The instructional delivery of the few engineering modules used in this study is described in section III, along with how it was modified in the course of the epidemic. The methodology to carry on this study is presented in section IV, while the findings are presented and discussed in section V. Section VI gives recommendations to policymakers in higher education, and the paper concludes in section VII.

II. LITERATURE REVIEW

The education sector is one of the main sectors that was massively impacted during the covid situation. Due to the sudden rise in cases, many universities decided to shut down or conduct all calls online remotely to help out students to meet government restrictions. On the other side, the university has to deliver the study program without affecting students' morale and maintain a high standard of achieving learning outcomes through proper student learning and assessment. Nearly every area of college life, including admissions and enrollment and intercollegiate athletics, could be drastically altered by the pandemic [10]. The challenges

were different for different disciplines. In [11] in-depth review of the history of different instruction approaches like online teaching, hybrid teaching, and blended mode of teaching before Covid has been discussed. Mohammad in [12] mentions challenges faced during e-learning and also eLearning advantages and disadvantages. Despite adopting the latest video conferencing tools, reading students' facial expressions and body language is complex, significantly affecting effective teaching [13]. Because of mentioned reasons, it is crucial to know students' perceptions of the adopted methodology at the university level during the covid pandemic. These efforts of changing education delivery varied throughout the world according to the requirement of students, culture, geometry background, resources available, and many more to add to this list which is briefly described by Amar Kumar et. al. in [14], and some glimpse of their study is mentioned below.

All UK universities had to follow the protocol of Universities UK [15] during the pandemic. All labs for national interest were kept open for the maximum benefit of students who can, by chance, travel. Oxford university decided to provide accommodation to students who could not return to their hometown or local accommodation [16]. The University of Cambridge canceled examinations [17]. The initial response at Bristol involved incidents requiring a thorough cleaning of residence halls/facilities [18]. Almost all staff not directly contributing to the teaching process were eventually instructed to work remotely. In addition, Barradale university [19] indicated that students would not be penalized in terms of grades, but they must pass the module. The University of Durham has offered "online-only" degrees [20]. At a few universities, students who could not take school tests were evaluated using alternative criteria. For the new academic year [21], they modified the duration of online examinations and established a flexible admissions method. All United States universities had to follow the protocol the Centre for Disease Prevention and Control set up. The first university in the US to announce the cancellation of in-person classes was the University of Washington [22]. Within a few weeks, almost 1100 HEIs shifted to e-learning [23]. The University of California eased admission requirements to cope with the Covid situation [24]. For conventional degree programs in this region, certain colleges utilized distance-learning platforms. For 2021–2022, only a few institutions utilized in-person education, while the majority opted for restricted reopening and mixed learning [25]. In Brazil, many universities encouraged digital inclusion programs. Also distributed internet kits to the needy [26]. Numerous HEIs in Brazil [27] have provided masks, laser thermometers, thorough signage, and occupancy limitations.

In Indonesia, the Director General of Vocational Education established a policy mandating that learning for vocational education is conducted at home or by continuing to observe health protocols [28]. The efficiency of executing such learning during the pandemic is the subject of one of the studies. In both theoretical and practical sessions, they discussed three areas of the primary focus: learning methodologies, platforms, and instructional media used throughout the pandemic. They offered a summary and suggestions for vocational high school [29]. In Pakistan, "social distancing" studies in classrooms and labs got

impacted. In this type of society, the lack of internet connection throughout the country and the lack of resources available to the large population to earn and learn during epidemics posed the most significant challenge. One study offers several regulatory requirements for the online delivery of engineering courses and assessment methods, as observed in Pakistan during the global pandemic. These standards will serve as a road map for online engineering courses' quality instruction and assessment [30]. The engagement of students during a pandemic is a key obstacle in India. The key objective was to ensure that their academic interest is maintained, that their performance does not drop, and that they have timely access to enough resources during the covid epidemic. The pedagogical framework for advanced learners is established through targeted interventions such as exposure to industry-oriented challenges, worldwide virtual events, online courses and software, career counseling by industry leaders, and preparation for higher education. Adopting mixed learning is becoming a boon for students by utilizing online resources effectively [31].

In China, all educational activities were postponed in late January 2020. In higher education institutes, the Chinese Ministry of Education (MoE) announced the use of online delivery as an alternative to face-to-face instruction. This is the first time in China that online delivery of formal education has been approved on a substantial scale. In response, the majority of provinces, municipalities, and autonomous regions in mainland China pushed back the beginning of the spring semester and shifted to online instruction. On 4 February 2020, the Ministry of Education (MoE) published [32] "Guidance on the structure and management of online teaching and learning in normal higher education institutions" in an effort to facilitate the transition of educational institutions to online learning. The Ministry of Education offered ongoing directions and instruction, including implementing online learning. It devised strategies to implement online courses and developed evaluation procedures to check the quality of online course offerings, classroom examination discipline, and more.

III. TEACHING DELIVERY

A. Standard Module Delivery

This research was conducted using two elective final-year electrical and electronic engineering modules and one required product design module. Integrated Circuits and Systems is worth twenty credits at UNNC, while Embedded Computing is worth ten credits. In their final year of study, students are required to complete 120 credits overall. In the program for electrical and electronic engineering, both modules are included. As level-3 optional modules, they were made available to students in two separate programs, BEng in Electrical and Electronic Engineering and BEng in Mechatronic Engineering. These modules were taught over the course of two consecutive semesters, eleven weeks of instruction, one week of review, and three weeks of final exams. Each module is conducted with a two-hour lecture once per week. One module has a one-hour seminar each week, while the other module's seminar begins during teaching week five and lasts one hour.

At UGS, student experience of flexible engineering education has been examined through a second-year Mechanical engineering module in design specialization,

entitled MEC 2131 'Design and Manufacture 1'. This module includes lectures, case studies, laboratory, projects, and CAD modeling/visualization. The module was taught over thirteen weeks of instruction, which included one week of mid-term break. It had a one-hour lecture and two-hour lab sessions per week. This module focuses on the industrial design process, which includes defining customer requirements, concept ideation and selection, material selection, cost analysis, embodiment design, and detailed design, among others. Students learn to effectively communicate design concepts and solutions through freehand sketching. Later, students make concept selections and proceed with 3D CAD development of the product. Students are required to work in a team for the given project. Students are assessed based on their team dynamics, the engineering design process, report writing, oral presentation, and project management during project work. There is no exam and a 100% continuous assessment module.

B. Online Teaching Adjustment During the Ongoing Educational Disruption

Due to the fact that most of the UNNC students are from China, they return to campus as usual in late spring 2020. Accordingly, face-to-face instruction was scheduled to be provided for all modules during the fall semester of 2020. However, due to travel restrictions, stranded international staff and students could not return to China. Domestic students in China have also experienced periodic outbreaks in various cities and provinces, preventing them from entering campus. To accommodate remote students and faculty, teaching and learning authorities at UNNC have determined that a hybrid learning model must be implemented. It was agreed that all modules must meet a minimum level of engagement with the official virtual learning environment (Moodle), that pre-recorded lectures should be uploaded prior to the teaching session, and those teaching sessions are streamed to students attending from a remote learning environment whenever possible.

At UGS, in Singapore, the second phase of this pandemic was declared around September 2021 and lasted for around six months as a heightened alert [33]. Strict measures were implemented in all sectors. The higher education institution decided to run the show in a blended mode where more than 50 students were not allowed in the room, and the group size was limited to 5 students. As a result, students had online lectures (due to the limitation of 50 students in a room, where in this module total of students was 65) and lab sessions conducted on campus with less than 50 students in a room. This arrangement lasted for the first two weeks out of 13 weeks. In the later part, due to more seriousness of Covid, everything converted into online mode. Subsequently, traditionally known as the e-learning mode long back, it has become [13,34] mandatory for higher education in Singapore.

C. Flexible Module Delivery under Educational Disruption

In addition to the two universities' general instructions mentioned above, this study utilized a flexible approach for synchronous online learning to deliver the three engineering modules. Multiple teaching tools were utilized to make this approach as interactive as possible. MS Teams were added to UNNC's Moodle to facilitate instantaneous student-teacher communication and office hours. This provided further guidance and sufficient pastoral care. Zoom was used as a platform to host live classrooms. A tablet equipped with digital ink facilitated material annotation and an electronic

whiteboard. PowerPoint was found to be a simple but efficient tool for pre-recorded videos of the lecture material for its adequate resolution and manageable video file size. Whenever necessary, pre-recorded lectures were edited using video editing software. Homework assignments based on programming and computer simulation were moved online. A specialized video platform (Panopto) was used together with Moodle to facilitate the video teaching material. All students enrolled in the modules had access to online teaching delivery, no matter the reason for being in a remote environment. That was either because they were still stranded off-campus or could not attend one or more face-to-face learning activities for other reasons, allowing them to participate from anywhere.

At UGS, with synchronous lectures and lab sessions, a fully flexible online approach was implemented within the Design and Manufacture 1 module. The zoom platform was used to deliver lectures and lab sessions. Live online classes, live online lab sessions using breakout rooms per group, recording live lectures, and uploading them on LMS. Using the whiteboard, chat, polls, quizzes, raising hands, and annotating teaching material helped to achieve better student engagement during this disruption. In comparison, taking place online rather than in a real classroom, Zoom lectures and lab sessions aided in maintaining the original timetable's contact hours for teaching and studio sessions. Students had further chances to clear their module-related concerns during office hours via text messaging or brief audio/video sessions. The MS-Teams platform was utilized to offer pastoral care for conversation between tutors and students over minor issues. Students were required to submit an interim report, an interim presentation, a logbook, a final report, and a final presentation as part of the evaluation in the designated folders on the university's learning management system, called xSiTe. At the halfway point of the trimester, an online test was also given as part of the evaluation.

IV. METHODOLOGY

This study seeks to determine how Asian students enrolled in distinct programs at two British universities in the far east perceive various online learning tools intended to facilitate their adaptation to the abrupt change in their learning environment caused by the education disruption. Students in their final year of the Electrical and Electronic Engineering department at UNNC, and in their second year of the Mechanical Engineering department at UGS were asked to complete a questionnaire for this study. The research was first approved by the faculty of science and engineering's research ethics committee. After the academic year, the questionnaire was distributed to students at the two universities. MS Forms and Google Forms were used to collect student survey responses. All enrolled students were invited to participate in the survey via MS Teams and xSiTe, with a few reminders from student representatives. Students enrolled in two optional electrical engineering modules over two consecutive semesters and students enrolled in a required engineering design module over one semester received the survey. A total of 109 students were invited to participate in a quantitative survey to provide feedback on their learning quality. The survey also investigates the effectiveness of online delivery using a flexible learning approach. Roughly, 70% of respondents participated in the survey.

V. RESULTS AND DISCUSSION

The investigators were interested in determining the intervention's efficacy during such an intervention. In order to

accomplish this, students were asked if the live streaming of the teaching sessions facilitated their effective learning and if the technology was simple to use. The perceptions of learners regarding the two questions are depicted in Fig. 1 and Fig. 2 on a scale from one to ten (where ten is for strongly agree and one is for strongly disagree) using an Excel clustered data chart.

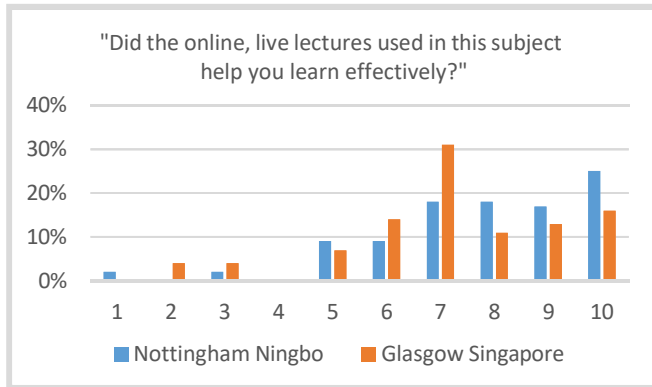


Fig. 1. Students' response to the success of online lectures.

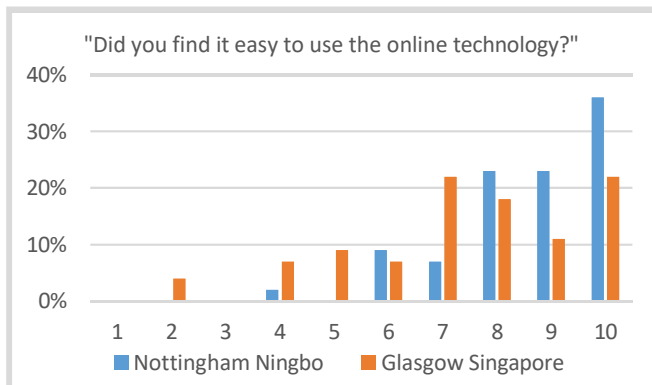


Fig. 2. Students' response to the success of the technology.

From Fig. 1, it turns out that 87% of UNNC students rated six or higher. The percentage of UGS students was almost the same at 85%. 60% of UNNC students rated eight or higher, compared to 40% of UGS students. As for the technology ease of use, 98% of UNNC students and 80% of UGS students rated six and above, with 82% of UNNC students rated eight or above compared to 51% from UGS. Based on student responses, it is evident that students have no trouble using various technologies in online learning and that they enjoy the interactive learning they receive. In their comments, students from both universities noted that the delivery of these modules was superior to other remote learning modules they attended. According to them, the employed method emphasized communication and group brainstorming more than technical knowledge, unlike other modules. Students laud the educators' efforts to instruct them online. These findings indicate that one of the factors driving student engagement in online course delivery will be live online lectures. This is consistent with previous research, which shows that when students realize their teachers care about their education, their engagement increases [35].

Moreover, there were distinct associations between motivating teaching practices and student engagement [36]. The students found the real-time live lectures motivating.

This is a possible area for future research into the motivation of students enrolled in e-learning. This is demonstrated by the responses in Fig. 3, which reflect the students' view of synchronous learning. It turns out from their responses that while some students can proceed with their online learning with pre-recorded lectures, the majority agreed that they prefer synchronous teaching for engineering modules.

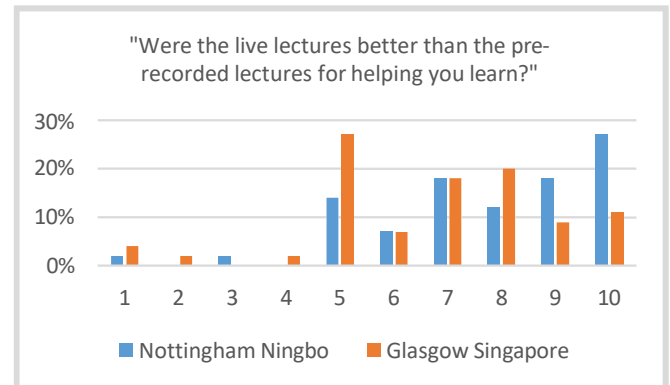


Fig. 3. Students' view of synchronous learning.

It was also intriguing to investigate student perceptions of the employed technology in order for future teaching and learning authorities to know which resources are most effective for adapting to unanticipated circumstances or which resources to invest in for future engineering education. At this point, students were asked whether the whiteboard and annotations were advantageous and whether live lectures were superior to recorded ones. Figs. 4 and 5 depict the outcomes. Teacher annotations were the most beneficial learning intervention, according to the data. After attending live lectures, students' motivation and engagement improved. 86% of UNNC students and 78% of UGS students agreed that teacher annotations on lecture materials enhance their learning. This is a high percentage considering the various engineering subjects taught and the year of the study utilized in this case study. The results indicate that online engineering education could be improved by online discussion between the lecturer and students and by emphasizing their learning with annotations, which would aid students in remembering the scenario used during the teaching session. These results demonstrate the need for digital ink to be an essential component of online engineering education toolkits. According to Fig. 5, 86% of UNNC students and 67% of UGS students concur that the electronic whiteboard has enhanced their learning. The results are consistent with another study that demonstrates the advantages of exchanging engineering learning materials between students and their lecturer, as most engineering students today use digital ink as their primary learning tool for annotation, drawing, and note-taking [37].

Students were asked to compare their experiences with distractions in online and in-person classes and if they were willing to continue attending online courses. As evidenced by their responses in Figs. 6 and 7, students were content with substituting in-person lectures with online lectures, despite divergent opinions on the matter of distraction. The percentage of the students from UNNC (59%) was very close to that of UGS (61%), that students agreed they felt distracted more quickly during their online learning, rating the statement six or above. In comparison, 32% of UNNC students and 27% of UGS students rated eight or above. The results are

commensurate with previous research demonstrating that students prefer to attend in the classroom even though online learning is offered as an alternative [38].

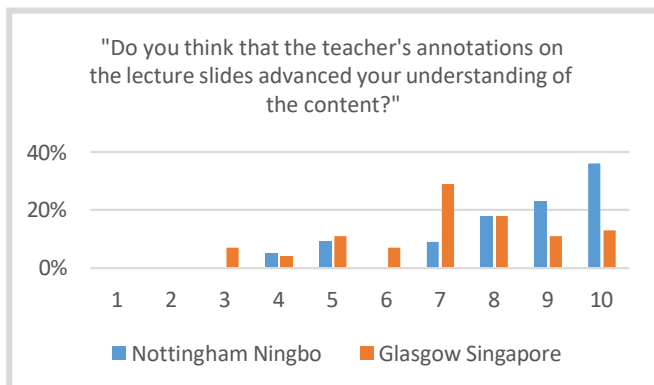


Fig. 4. Students' view of slide annotation.

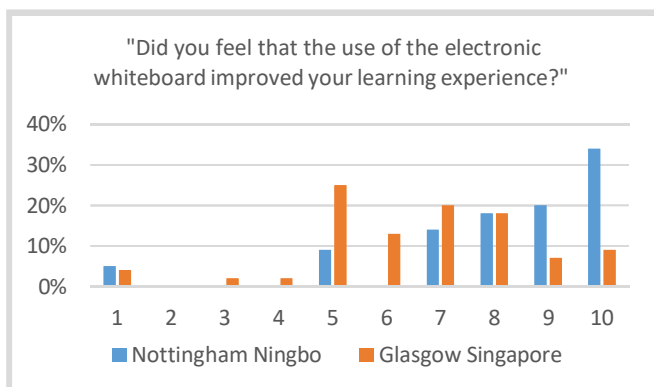


Fig. 5. Students' view of the electronic whiteboard.

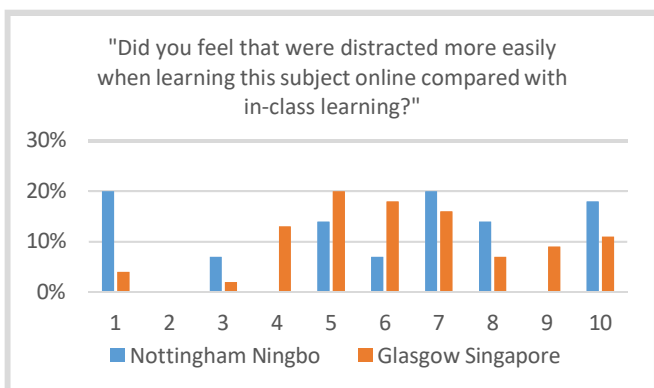


Fig. 6. Students' distraction during an online class.

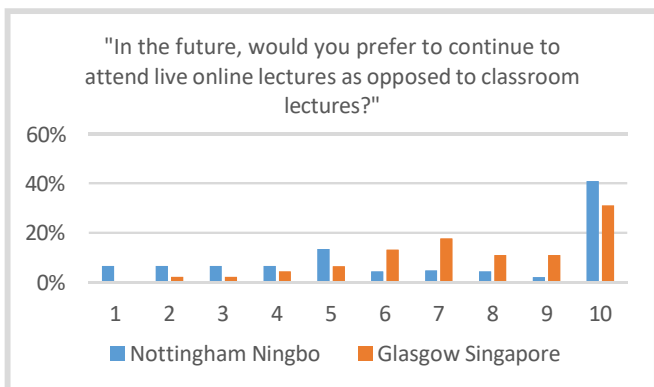


Fig. 7. Students' willingness to shift to online learning.

VI. RECOMMENDATIONS

In general, engineering students have no difficulty integrating technology into their education and are eager to experiment with new technologies and quickly adapt to digital transformation. Therefore, institutions should implement modern digital learning technologies whenever possible. However, it is recommended that digital transformation pedagogies be accorded the same level of importance and that they form the basis of future learning policies. Face-to-face or online, students applaud the efforts of educators to instruct them.

When students perceive their teachers are invested in their education, they will be more motivated to learn. As there are distinct associations between motivating teaching practices and student engagement, it is advised that teaching and learning authorities in higher education place a greater emphasis than ever before on the development of lecturers. Therefore, digital learning technologies should not become the objective but continue to serve as a tool to ensure that the fundamentals of teaching and student learning are not neglected.

Effective online engineering education can be enhanced by online discussion between the lecturer and students and by emphasizing their learning with annotations, which would aid students in remembering the scenario used during the teaching session and reduce distractions when learning online. Students and instructors need to exchange teaching materials in engineering. Since the majority of engineering students use digital ink as their primary learning tool for annotation, drawing, and note-taking, digital ink must be an integral part of online engineering education toolkits to aid the exchanged material.

VII. CONCLUSION

This study examined how engineering students learn when using an effective and flexible teaching approach. The study involved students enrolled in two distinct engineering programs at two British universities in China and Singapore. Students participated in a survey at the end of the semester to determine the effectiveness of the flexible learning methodology. Despite the diversity of students who participated in this study in terms of program and year of study, the results indicate that the responses of southeast Asian students are similar. Students had no difficulty utilizing various technologies for online learning and enjoyed the interactive learning environment. They valued the method that emphasized communication and group brainstorming more than technical knowledge. These findings suggest that live online lectures will be one of the factors influencing engineering student engagement in online course delivery. The students found that teacher annotations on lecture materials during online teaching delivery improved their learning and emphasized the subject, as it helps to record their memories of teaching sessions. Despite the availability of online learning, engineering students typically prefer to attend classes in person.

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