

Towards flexible delivery in engineering education: students' perception on block teaching delivery

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Abstract— The number of students entering higher education has been steadily increasing in the last decades globally. Such trend poses challenges to Higher Education Institutions to widen their offers and sustain participation in academia. Higher Education Institutions are therefore faced with the prospect of offering study programmes to a varied blend of learners from different social backgrounds, presenting specific needs and challenges. This trend is expected to become even more pronounced due to globalisation and technological improvements, thus enabling an unprecedented number of applicants to potentially enter higher education. It is therefore essential for Higher Education Institutions to create forms of flexible learning that can support students throughout their studies. This paper explores the idea of block teaching in the context of engineering education to enhance flexibility, inclusivity, and enjoyment of the engineering discipline. The authors devised a survey aimed at obtaining a deeper understanding of the suitability of block teaching as a valid tool to support learning and enable a flexible delivery mode. The students' response to the questionnaire demonstrated that block teaching brought advantages in all the three areas of investigation. The authors therefore propose that block teaching can represent a useful tool to ensure higher education programmes can be comfortably adapted to answer the needs of students from different backgrounds and social circumstances, avoiding the “Matthew Effect” to potentially favour only a part of perspective students.

Keywords— *Block teaching; flexible learning; engineering education, blended learning, inclusivity.*

I. INTRODUCTION

The number of students wishing to enter higher education has been steadily increasing worldwide. In a study conducted at RMIT University in Melbourne, the number of students in higher education was reported to have increased by 206% from 1970 to 2000; this number is expected to increase of a further 281% from 2000 to 2030, with an expected growth of 4.2% per year [1]. The article also suggests that online and blended learning will continue to be progressively utilised by universities as newer technologies are adopted to deliver study curricula; moreover, an increasingly culturally and ethnically diverse students' population will require the devising and adoption of specific measures in order to be fully supported.

In the United Kingdom, a research briefing submitted to the House of Commons Library in 2021 reported the total number of accepted university applicants through the Universities and Colleges Admissions Service (UCAS) to have increased by 5.4% in 2020 to a new record high. In the UK, home students with an accepted place increased by 2.9%; and a significant increase of accepted mature students was also recorded. The number of accepted applicants from overseas countries was also recorded to have increased by 16.9%.

These numbers reached their fourth consecutive record high in 2020 [2]. Moreover, according to the UK Department for Education, the number of students from a disadvantaged background entering Higher Education increased of 11% in 2020 compared to the previous year [3]. These trends highlight the compelling need for Higher Education Institutions to offer programmes of study that are flexible and diversified and can therefore address the needs of a highly varied blend of students from different backgrounds and social circumstances.

This paper reports a study conducted on students' perception of block teaching utilised to deliver a second-year undergraduate programme module with a cohort of 274 students (part of the BEng Aerospace, Automotive and Mechanical Engineering courses) in the 2020-21 academic session at the University of Hertfordshire. The subject of the module was Rigid Body Mechanics. The module was delivered online in the academic session 2020-21 as a result of the covid pandemic. The module team attempted to devise a delivery structure tailored to the needs of the module's blended student cohort, comprising of national and international students, as well as part-time and full-time students belonging to different age groups. A range of learning activities including asynchronous and synchronous classes, formative assessment, daily Question & Answer sessions, and independent study sessions were devised and offered to students, aiming at offering as flexible a learning experience as possible, and thus contributing to the need of building study curricula that are inclusive for an increasing number of students from different backgrounds and with different needs.

A questionnaire was presented to students at the end of the semester to enquire into students' perspective of this mode of delivery in the module's engineering subject study in three areas: academic performance and learning gains, time management, and satisfaction. The work was conducted under the University's Protocol for Reflective Practitioner Work by Academic Staff. All responses were anonymous, and student participation in the questionnaire was voluntary. The authors argue that block teaching represents a potentially valid tool to foster inclusivity by addressing the needs posed by an increasingly diverse student population entering higher education, whilst continuing to maintain higher academic standards by offering a solid preparation in their subject study.

II. BACKGROUND

The delivery of academic content in blocks and shorter timeframes was used in the past as in various Higher Education Institutions worldwide [4]. A number of American universities used intensive delivery methodologies in response to retention issues [5]. Initially, such an approach was treated with caution due to doubts as to whether it would enable

effective or sufficiently stimulating study programmes in comparison to traditional delivery formats [4]. Colorado College was among the higher education providers in the US to adopt intensive modes of delivery [6]. Similar methodologies became increasingly utilised by more US universities in the following decade [7].

Intensive modes of delivery were also adopted in Australia to offer flexible study programmes aiming at including part-time, mature or postgraduate learners. The authors of these studies sustain that such delivery modes allowed students to adequately embrace their academic courses whilst attending to work and family life [8], [9]. The interest in immersive scheduling continued to grow in Australia following initial promising results [10].

In the United Kingdom “block teaching” has been implemented in a variety of ways following the approach of American universities earlier on; a common definition applicable to them all is a delivery mode in which “an equal number of class hours is delivered in more concentrated bursts”, rather than a few hours weekly over an entire semester or an entire academic session [8]. These authors also concluded that in order to inform contemporary policy making in Higher Education Institutions, more insight is needed into the impact of the adoption of block teaching on the delivery of higher education study programmes.

Previous studies have shown that block teaching improved the level of students’ attainment and long-term knowledge retention [4], [8], [11]. The authors showed that block teaching proved to be effective in improving students’ performance and satisfaction in Tourism Management study programmes. Harwood [12] showed that block teaching was effectively utilised to improve students’ performance as well as satisfaction in Health Professions education programmes.

Research conducted in the evaluation of the pedagogical implications of adopting block teaching in Science and Engineering study programmes remains under-represented in the literature, compared to other subject areas. There is a need to ascertain and evaluate the potential benefits of block teaching to create engineering programmes that are flexible, enjoyable, and contribute to students’ long-term knowledge retention. Previous studies showed block teaching to be both a methodology that increased students’ performance and satisfaction, and one to make university study programmes more inclusive for an ever-diverse student audience [13].

The importance of inclusive pedagogy has been highlighted in several studies [14], [15], [16]. In the article [17], the authors propose that pedagogy is the most strategic place to begin providing more access to education to disadvantaged groups of students, because of its location as a central message system in education. In this paper, the authors propose that block teaching could be utilised as a means to not only devise study programmes that are engaging, enjoyable and rewarding, but to also ensure that these same programmes are accessible to an increasingly diverse student population. The rationale of the study presented in this paper is to shed light on the perception of block teaching as an effective and flexible method of delivery in engineering programmes aimed at a diverse student cohort. The need of such research is particularly required in the engineering sector of higher education [9], [18].

III. METHODOLOGY

The authors of this paper investigated students’ perception of their academic performance and learning gains, time management, and satisfaction in the context of block teaching. To achieve this, a survey consisting of closed response items was devised. A 5-point Likert Scale ranging from 'strongly disagree' (=1) to 'strongly agree' (=5) is used to score each item. The questionnaire was distributed among all the second-year students who attended an online module focusing on Rigid Body Mechanics delivered adopting a block teaching approach as part of their engineering degree. Participants were purposely selected to assess whether implementing a block teaching delivery in an engineering context could positively contribute to students’ performance.

To gauge students’ perspective three sets of questions were asked as shown in the table below:

TABLE I. STUDENTS’ SURVEY ON BLOCK TEACHING

Dimension	Question
Perceived academic performance and learning gains	Q1. My learning is more effective in a block teaching module.
	Q2. A block teaching delivery mode improves my academic performance.
Time management	Q3. Time management is improved in a module taught in a block teaching mode.
	Q4. Attending a module delivered in a block teaching mode enables better focus on my studies.
Satisfaction	Q5. I have enjoyed the module.
	Q6. The range of learning activities and study material provided allowed me to personalize my learning experience according to my needs.
	Q7. The delivery structure of a block teaching module enhances my engagement with the module.
	Q8. It is easy for me to prepare for the assessment(s) in a block teaching mode.

IV. DELIVERY STRATEGY

The module considered in this study has the largest Level 5 cohort of students among all engineering undergraduate programmes offered at the University of Hertfordshire in the academic session 2020-21 and was delivered online in intensive delivery format. The authors of this paper sustain that block teaching represents a mode of delivery that could address different needs of very large cohorts of students whilst maintaining high academic standards, particularly if the module is delivered remotely.

The structure of each teaching week of the module aimed at ensuring that the intensive pace of delivery would not preclude an enjoyable students’ experience. In order to achieve this purpose, the diversity of the student cohort was taken in consideration, thus attempting to create a balance among a blend of teaching activities that were logically sequenced. Each pre-recorded lecture was supported by a Question & Answer (Q&A) session in order to offer students the possibility of addressing doubts, promote discussion and offer opportunities for expanding on the subject. Tutorials followed the lecture and were delivered live in order to attempt at ensuring students could relate theoretical knowledge from lectures to practical examples. The gap between theory and practice is one of the major challenges of any intensive delivery mode [18]. A recorded version of each tutorial was made available to all students, thus ensuring that

those who were not able to attend the live sessions would not be disadvantaged. Additionally, recordings were useful for revision purposes. Each week period of independent study time was assigned to the students' timetable in order to create some buffer within the intensive delivery. Half a day was assigned to formative assessments in order to create opportunities to apply theoretical knowledge to real-world examples, as well as helping students prepare for the summative assessment at the end of two-weeks teaching block. General feedback to the formative assessment was offered during a subsequent Q&A session.

Lectures were pre-recorded and assigned to a 2-hour slot in students' personal timetable; the module team attempted at preserving the ordinary timetable structure that was used to deliver classes face-to-face, whilst at the same time allowing some degree of flexibility to students who were not able to listen to the recording at the assigned time. The objective of tutorial sessions was to foster dialogue between students and the module team as well as promote the interaction among students.

The last session of the day was a Q&A session, in which students could request clarifications on pre-recorded lectures, and tutorial sessions; Q&A sessions were also offered to ensure as much contact time between the students and the module team, and among students themselves. This type of sessions was thought to be particularly pivotal to ensure block

teaching delivery would not overwhelm students, as well as fostering a sense of community among the cohort.

One day of each of the four-block teaching weeks was dedicated to formative assessments based on the subject taught until that time, followed by a feedback session. Opportunities for self-assessment were offered as a means to encourage students to critically reflect on their work as well as to monitor and assess their own performance.

V. RESULTS

The results obtained from the students' survey are shown in Fig. 1(a)-(d) and 2(e)-(h), using pie charts. Results confirmed that students have a positive attitude towards this mode of delivery, as already reported by [19]. For the first question, shown in Fig. 1(a), about 79% of students – 55% of which in strong agreement – agreed that block teaching is an effective mode of delivery and effectively supports students learning. About 15% of students found block teaching to be as effective as more traditional approaches. For the second question, results are displayed in Fig. 1(b). Similarly, the majority of students perceived that block delivery has positively contributed to their academic performance. The combination of various learning activities in the module, and the daily interaction with the module team stimulated and nurtured students' interest in the subject study. Responses reported in Fig. 1(c) and (d) suggest that the approach is perceived to improve consistently learners' ability to plan and

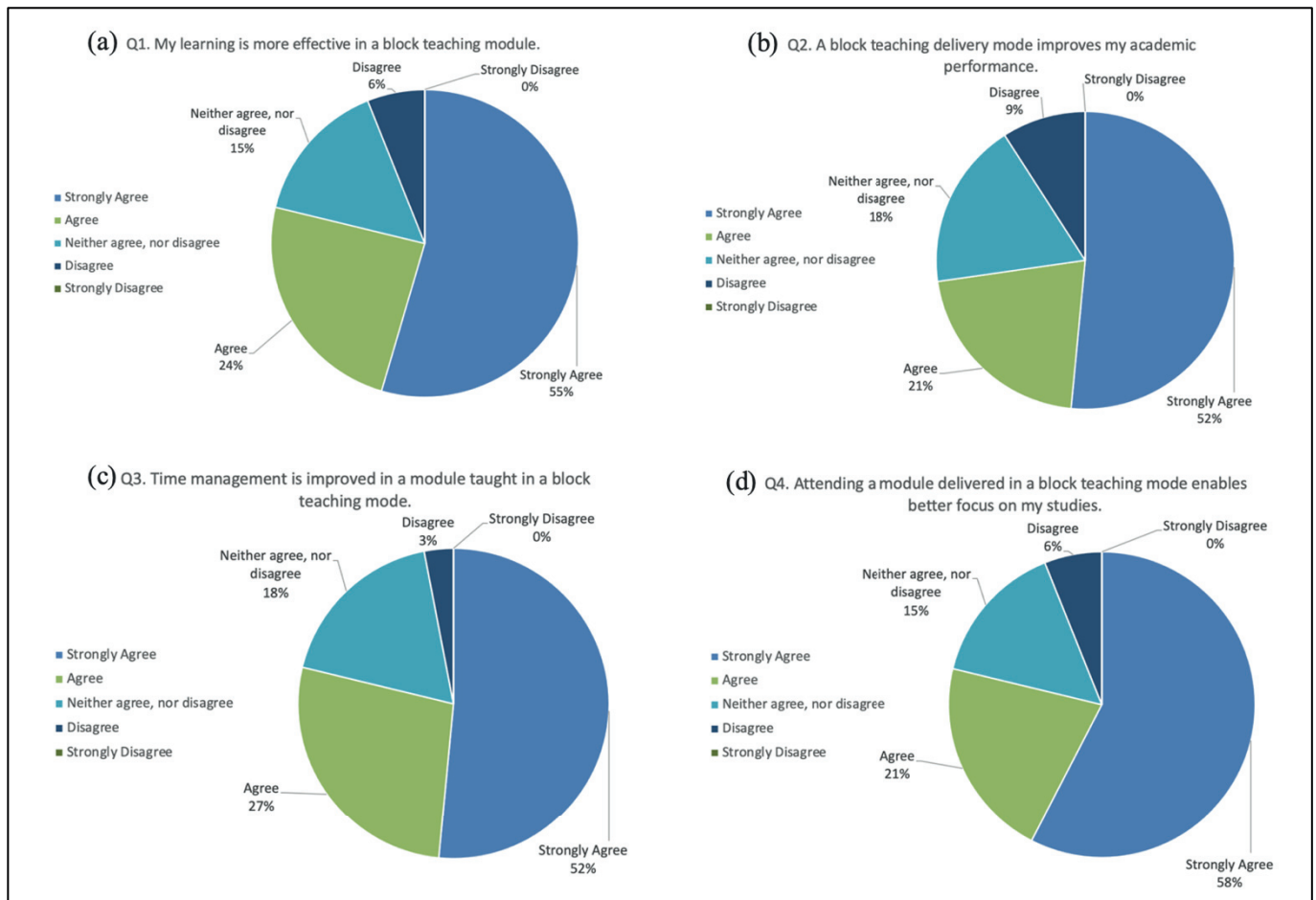


Fig. 1. Responses in percentage, based on the following questions from Table I. (a) Q1. My learning is more effective in a block teaching module. (b) Q2. A block teaching delivery mode improves my academic performance. (c) Q3. Time management is improved in a module taught in a block teaching mode. (d) Q4. Attending a module delivered in a block teaching mode enables better focus on my studies.

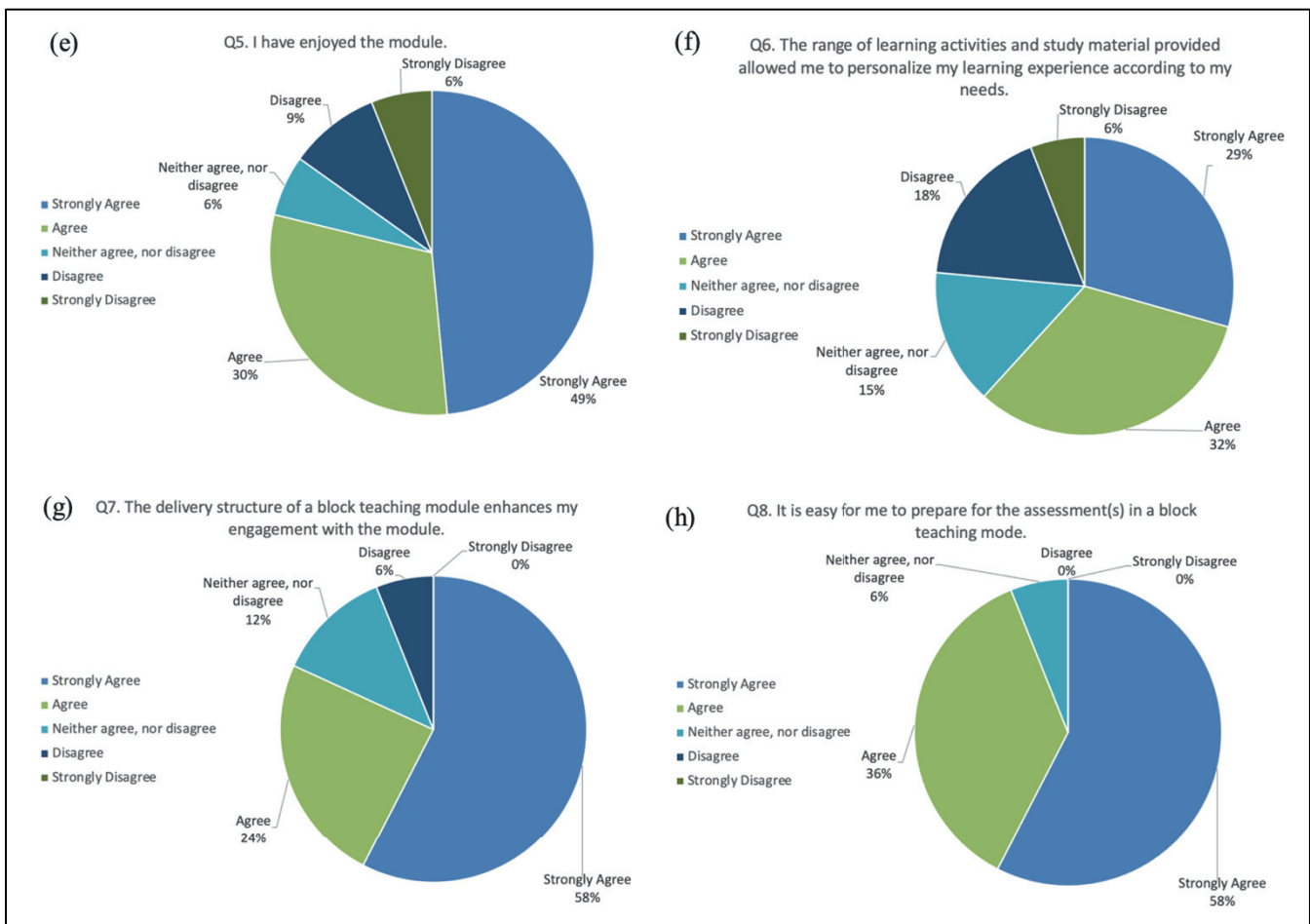


Fig. 2. Responses in percentage, based on the following questions from Table I. (e) Q5. I have enjoyed the module. (f) Q6. The range of learning activities and study material provided allowed me to personalize my learning experience according to my needs. (g) Q7. The delivery structure of a block teaching module enhances my engagement with the module. (h) Q8. It is easy for me to prepare for the assessment(s) in a block teaching mode.

manage their own time, confirming the research of [20]. In fact, about 79% of the population felt their time management improved. This finding is further reinforced by the data showing that nearly 60% of the students strongly agreed that this delivery mode helped them to better focus on their studies. The response to question Q3 and Q4 supports students' response in question Q1 and Q2; the authors confirm the analysis of [18], reporting that the intensive nature of block teaching enhances students' focus on the subject study. Very few students were found to be in disagreement. In reference [9] and [19] argued that any intensive delivery mode, such as block teaching, could potentially hinder students' learning if not carefully planned. As discussed by [8], a similar approach requires extensive planning and preparation prior to the commencement of the academic session. More specifically, the time constraints, the limited availability of resources, the workload, and the students-staff ratio need to be considered in the planning to prevent side-effects that could hamper deep learning.

Responses to question Q5 are depicted in Fig. 2(e). Results showed that 49% and 30%, respectively, of the learners strongly agreed or agreed that they enjoyed the block teaching delivery format. Nevertheless, 15% of students disagreed with this statement whilst 12% of students neither agreed or disagreed. In Fig. 2(f), the responses to question Q7 were collected: nearly 82% of the respondents reported that the delivery structure of a block teaching module is functional to

promote their engagement with the subject study. In reference, [18], it is reported that intensive delivery modes are beneficial to promote engagement and interaction. In Fig. 2(g), students were asked to evaluate the perceived ease in preparing for the assessments. Above 90% of students responded that block teaching delivery made it easier to prepare for the assessment. It is to be noted that no student was in disagreement. Furthermore, students were asked to share their perceptions regarding their satisfaction with the time available to complete the assessments. Results in Fig. 2(h) show that 58% and 36% of students declared that it was easy to prepare for assessment. In turn, only 6% of the population thought that this delivery mode does not facilitate the preparation.

VI. DISCUSSION

The results obtained align with the previous studies available in the literature [8], [9], [20], [22].

The authors feels that the positive response to all questions is a proof that the delivery in block teaching mode of this module captured the various needs and requirements of the diverse students' cohort, and that the learning activities and structure of the module promoted flexibility, which positively contributed to students' engagement and, consequently, performance. Evidence from the literature [22] suggests there is a positive correlation between engagement with the module and performance in the context of block teaching. Therefore, by increasing the variety of content offered as well as learning

opportunities as part of the module design process, instructors will be able to address different learning needs. Furthermore, the variety of teaching material and activities included in the delivery will allow students to customise their learning and embrace a flexible learning approach. The authors argue that the structure of the module, taught as block teaching, needs to consider and be tailored to the students' cohort type. In the case study presented in this paper, the cohort was very large and included 274 second-year engineering students. Teaching activities and the timetable were therefore structured to capture such diversity and to promote inclusivity among the students' cohort; the response of the students confirm this analysis.

As the students' population increases, so will the number of students from different social backgrounds [1]. Those students whose background favour their access to higher education may therefore have a distinctive advantage compared to an increasing counterpart. The authors of this paper therefore sustain that if higher education does not adequately offer as flexible and inclusive modes of delivery as possible in engineering higher education, the Matthew Effect, closely related to the concept of preferential attachment in network science [21], may therefore inadvertently shape negatively the future of higher education, potentially reducing innovation among nations [1]. The students' response gathered by the authors show that block teaching could represent a valid mode of delivery to embrace increasing diversity among engineering students and promote flexibility in this sector of higher education.

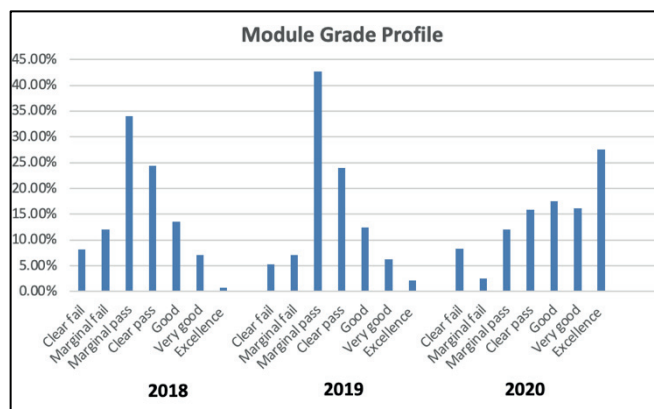


Fig. 3. Module Grade Profile distribution from 2018 to 2020.

Fig. 3 highlights the distribution of students' grades from 2018 to 2020. From the graph, it could be noted that when block teaching was introduced for the first time in 2020, the Module Grade Profile (MGP) was subject to a major change, whereas in 2018 and 2019 the majority of the students was awarded a marginal pass. In 2020, with the introduction of block teaching, the number of students awarded good, very good, and excellent grades increased, resulting in a higher number of students achieving an overall higher average grade in their second year of study as a result of the introduction of block teaching. This delivery mode seems to have created new opportunities for learners and a flexible environment enabling students to customise and tailor their learning experience according to their needs. A set of learning activities, teaching materials, and resources is made available through the online student platform. Therefore, students are offered the option to identify and select activities, which enable them to acquire knowledge, investigate the subject matter, as well as develop

relevant skills and attributes. The authors also believe this approach to be particularly suitable to promote an inclusive and student-centred learning environment.

TABLE II. HISTORICAL STUDENTS' PERFORMANCE ON THE MODULE

Year	Performance Indicators			Block Teaching
	Average Grade	Failure Rate	#Students	
2020	++	--	274	YES
2019	+	-	297	NO
2018	+	+	229	NO

Legenda: '++' means above the threshold and in line with the desired value, '+' means above the threshold, '≅' means in line with the threshold, '-' means below the threshold, '--' means below the threshold and in line with the desired value.

Table II shows the historical students' performance on the module from 2018 to 2020. Prior to the adoption of a block teaching approach, the Module Average Grade (MAG) was satisfactory and above the threshold. However, with the introduction of block teaching this figure has increased of about 41%. Similarly, significant improvements were noted in the failure rates. The failure rate dropped of about 47% from 2018 to 2020. This confirms the findings from the literature [6] that a similar delivery strategy does not compromise students' performance. Evidence suggests that an intensive delivery format does not disadvantage, and it is well-received by learners.

VII. CONCLUSIONS

This paper reports a study conducted on a block teaching module, part of aerospace, automotive and mechanical engineering programmes offered at the University of Hertfordshire. A questionnaire on students' perception of block teaching in the areas of perceived academic performance and learning gains, time management, and satisfaction posed to students show that the vast majority of the cohort felt that block teaching favourably brought advantages in all the three areas of investigation. The authors therefore sustain that block teaching, suitably tailored to target cohorts of students, may play a key role in ensuring that engineering higher education remains flexible and receptive to the needs of an increasing diverse students' audience, avoiding the Matthew Effect [21] to potentially favour only a part of perspective students [1].

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