

An Online Teaching Resource to Support UK Medical Student Education During the COVID-19 Pandemic: A Descriptive Account

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Abstract: This paper describes the development and use of the bespoke digital learning resource CAPSULE (Clinical and Professional Studies Unique Learning Environment) which was launched UK wide in May 2020 to facilitate the delivery of core learning content for UK medical students during the COVID-19 pandemic. CAPSULE is a digital learning resource comprising case-based scenarios and multiple-choice questions, encompassing all undergraduate medical specialities and supported by a pan-speciality editorial board. Following the COVID-19 pandemic lockdown and loss of face-to-face learning opportunities, CAPSULE was made available to all UK medical schools in May 2020. Following a global content review and edit and UK wide rollout, over 41,000 medical students and 3200 faculty registered as users. Approximately 1.5 million cases were completed in the first 12 months of use by up to 4500 distinct monthly users. Feedback from both students and faculty has been highly positive. CAPSULE continues to be used within UK medical schools and has allowed an entire cohort of medical students to access core curriculum content and progress their studies during the COVID-19 pandemic. Future directions may include further integration into UK medical school curricula, enhancement of platform functionality and potential expansion on an international scale.

Keywords: CAPSULE, COVID-19, digital learning platform, UK medical school

Introduction

The nature of undergraduate medical education has seen a shift in recent years as a result of the increased availability and accessibility of advanced digital computer technology.¹ Online learning is increasingly utilised to meet the educational requirements of medical students,² complementing more traditional methods of education. Available online learning resources include teaching videos, question banks, practical and examination skill guides,³ clinical guidelines and 3-dimensional anatomy.⁴ Whilst these applications were initially only suitable for computers or laptops, the development of mobile apps has allowed a transition into educational delivery independent of the location of the user. Medical students now use online learning and mobile apps to learn anatomy, physiology, pathology, disease investigation, diagnosis and management.² This transition from purely traditional face-to-face learning to the combination use of face-to-face learning with digital resources is referred to as blended learning.⁵

This paper is a descriptive account of the development of CAPSULE (Clinical and Professional Studies Unique Learning Environment), a bespoke digital learning resource and collaborative enterprise. The paper then reviews the subsequent

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United Kingdom (UK) wide launch of CAPSULE in May 2020 to support UK medical students in accessing their course learning requirements in response to the loss of face-to-face learning opportunities during the COVID-19 pandemic.

CAPSULE

Initial Development

CAPSULE is a clinical case-based learning resource first developed by Brighton and Sussex Medical School (BSMS) in the UK. Originally launched in 2007 using the local university learning management system quiz tool, it was designed to provide final-year medical students with equitable access to learning resources during regional clinical placements. It was initially comprised of over 250 clinical case-based scenarios with multiple choice (single/multiple answer) questions and a rich library of clinical images (radiological, electrocardiograms, drug charts and clinical photos) to support students in accessing knowledge of investigation, diagnosis, and management. The resource had a focus on formative assessment and strong emphasis on feedback for case answers.

All cases/questions were written by clinicians practising at senior trainee or consultant level, experienced in setting questions suitable for medical students in terms of level of difficulty and relevance to the course. Case writers were supported by a pan-speciality editorial board. The content and scope of the cases aligned with the General Medical Council (GMC) curriculum Outcomes for Graduates (formerly Tomorrow's Doctors)⁶ and the BSMS Year 5 curriculum, covering the breadth of all specialities within undergraduate medicine. A rolling process of case review, case editing and case additions was established, supported by regular editorial review of content to ensure it remained accurate and aligned to the teaching programme.

By 2016, the learning resource had expanded to approximately 600 cases, 3000 questions and 400 images, and the content was made available to BSMS medical students in Years 3, 4 and 5. Annual feedback from students consistently highlighted the perceived benefits of content written by faculty and provision via the medical school (as opposed to a commercial company). Feedback did also highlight the lack of mobile/tablet compatibility, which was of increasing importance to students. BSMS then invested in a new bespoke platform through collaboration with a local digital solutions company, Ocasta

Studios, to deliver a high-quality digital system optimised for mobile and tablet use. This new interface was successfully launched in 2017 to BSMS medical students and subsequent student feedback was extremely positive.

By early 2020, CAPSULE had been adopted as a software subscription by four additional UK medical schools, on a not-for-profit basis, with proceeds from subscriptions being re-invested into platform maintenance and development. Participating schools varied in their use of CAPSULE according to their individual course structure, with some including early years medical students and others allowing access to senior clinical students only. The total number of student users in early 2020 was approximately 3500.

CAPSULE Functionality and Learning Design

CAPSULE employs key learning design features based on user feedback and educational expertise. Figures 1–5 provide selected screenshots of the current platform interface.

Specialty Approach

Students can work through cases within specialty, for example to support their learning during a particular clinical placement. Content is separated into 42 specialty sections under four main categories (medicine, surgery, other specialties, therapeutics; see Figures 1 and 2).

Quiz Approach

Students can assemble cases into a “Quiz” based on certain selection criteria: either a random selection generated by the system or by the student filtering by parameters including topic tags, previous performance, or previous attempts. Quizzes provide students with more targeted, personalised learning and can be saved to their mobile device for use offline, a key requirement for placement-based learning.

Question Format and Images

The majority of questions are multiple choice (single answer or multiple answer; Figure 3) and a small proportion of questions are ranking or matching style (Figure 4) to deliver a broader question style. Many questions are linked with an image (radiology, pathology, clinical drug chart, electrocardiogram or echocardiogram) to give students a better visualisation of disease and support diagnostic interpretation.

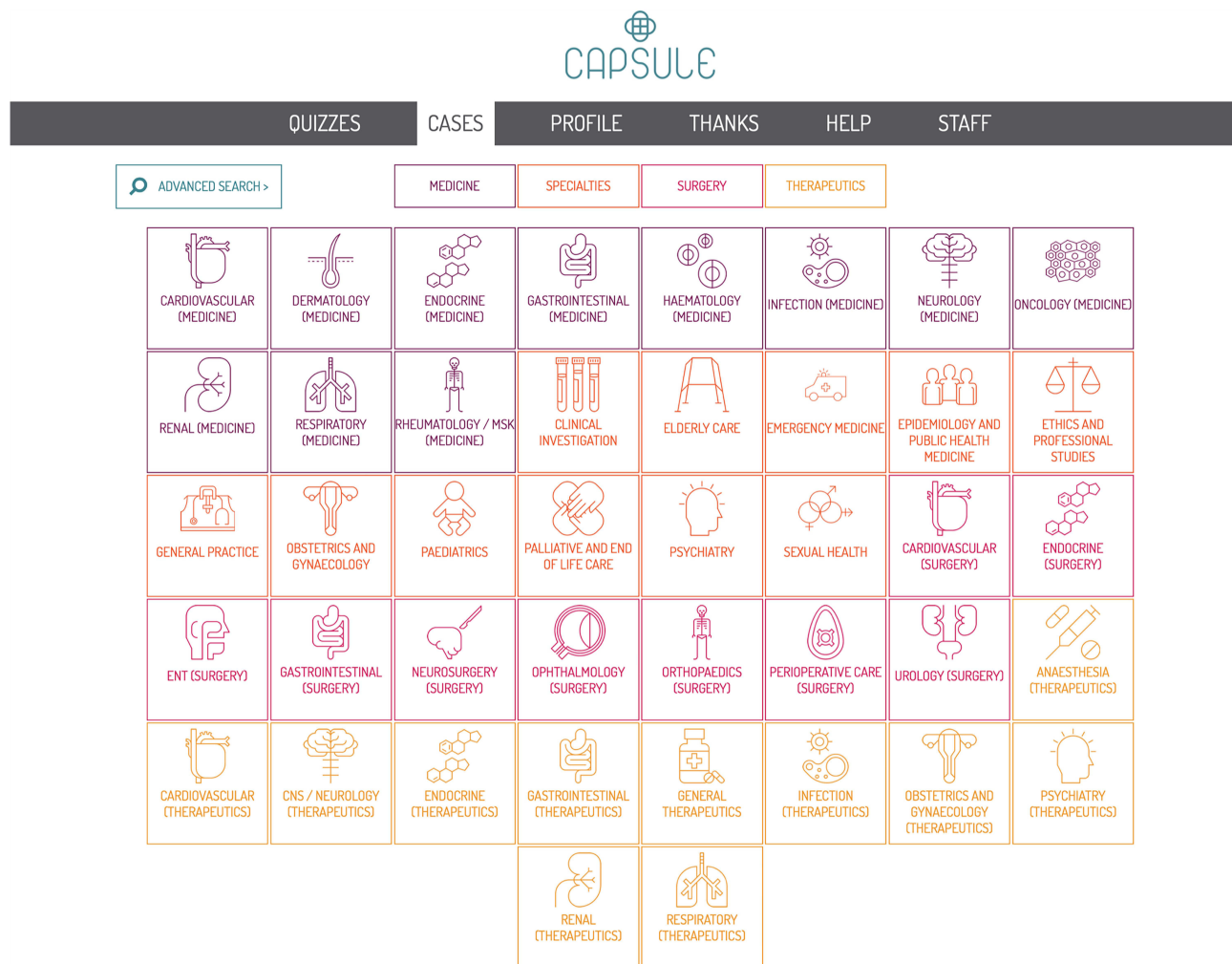


Figure 1 The initial user interface detailing the range of specialities available to choose.

Feedback on Performance

Paramount to the learning efficacy is the feedback on each question with detailed answers and feedback regarding disease diagnosis, investigation, and management, linked to current guidelines where relevant (Figures 3 and 4). If they wish, students are also provided with breakdown of their average performance across the four main categories and with comparison against their year cohort average score (Figure 5).

Feedback on the System

The system includes opportunity for students to flag any case for investigation by the editorial team (technical or content). This triggers investigation and response from the faculty, engages the students in quality control, and helps maintain content accuracy.

Mitigating the Impact of the COVID-19 Pandemic

The COVID-19 pandemic had serious consequences for the delivery of undergraduate medical education in the UK (and worldwide). In March 2020, hospitals temporarily suspended medical attachments for clinical medical students⁷ and universities suspended all face-to-face teaching, including that for medical students.⁸ There was concern amongst UK medical schools and the Medical Schools Council (MSC) that this reduction in formal teaching, clinical exposure and patient contact would negatively impact the acquisition of knowledge and clinical competencies for medical students and also reduce student to doctor transition at a critical time where more doctors were needed.⁷ To minimise this disruption, UK medical schools had to adapt quickly with recognition



MEDICINE - ENDOCRINE 15		>
A 78-year-old woman presents to the medical assessment unit with a 2-week history of abdominal pain,...		
MEDICINE - ENDOCRINE 159	22%	>
A 42-year-old woman with a history of poorly controlled hypertension, palpitations and headaches has...		
MEDICINE - ENDOCRINE 160		>
A 52-year-old man is panhypopituitary following surgery and radiotherapy for a non-functioning pitui...		
MEDICINE - ENDOCRINE 195	19%	>
A 65-year-old female patient has been referred to you by her GP on the surgical assessment unit with...		
MEDICINE - ENDOCRINE 218		>
A 45-year-old man presents to the ophthalmology clinic complaining of problems with his vision. He r...		
MEDICINE - ENDOCRINE 22		>
A 35-year-old teacher has lost 1 stone in weight over 2 months without really trying. Her husband ha...		
MEDICINE - ENDOCRINE 226		>
A 17-year-old boy presents to the ED with a recent history of shortness of breath, tiredness, weight...		
MEDICINE - ENDOCRINE 257		>
A 55-year-old female has been referred to gastroenterology outpatients with a 6-month history of int...		
MEDICINE - ENDOCRINE 293		>
A 25-year-old male presents to the ED feeling generally unwell, having returned from a two-week holi...		
MEDICINE - ENDOCRINE 294		>
A 17-year-old female, is brought into the ED by ambulance. She had been found at home by her mother ...		
MEDICINE - ENDOCRINE 401		>

Figure 2 Case content by speciality.

Clinical Investigation 492

CASE STUDY QUESTIONS

QUESTION 4 of 10

The gastroenterologist identified two lesions: a cancer in the in the sigmoid colon (image below) and a large polyp in the rectum. Biopsy confirmed sigmoid colon cancer. The polyp was reported as a tubulovillous adenoma. At this stage, you must be seriously considering a genetic cause of this cancer, which one?



Figure 1

Feedback

HNPCC syndrome due to abnormality of DNA repair genes is associated with familial non-polyposis cancer. Although this patient has one polyp this is insufficient to be termed polyposis. FAP manifests as numerous polyps, which carpet the large bowel mucosa and would have manifested at an earlier age. PJS present with other manifestations.

Figure 3 A single best answer question, with feedback.

Puetz Jegher's syndrome (PJS)

Familial adenomatous polyposis (FAP)

Hereditary non-polyposis colon carcinoma syndrome (HNPCC)

BRCA 1 mutations

p53 abnormality

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that the medical curriculum would need to be delivered remotely and online.⁹ During this period of change and uncertainty, CAPSULE was identified by the MSC as a digital learning resource that could potentially support UK clinical medical student education.

Following discussions with senior faculty at BSMS, Imperial College London (a partner CAPSULE user since 2018) and Ocasta (the technological partner), the MSC provided core-funding to cover the technological costs of a UK-wide expansion of CAPSULE to all UK medical schools as an additional learning support. Volunteer medical school clinical editors from across the UK worked with the CAPSULE (Q/A) team at BSMS to accomplish a full quality assurance review of case content. Ocasta Studios developed the technical capability to support large-scale

expansion, supported in part by a successful bid for a UK government emergency COVID-19 related grant. In addition to this, cases were “tagged” with keywords from a taxonomy comprised of the presentations of illness and conditions listed in the GMC’s Medical Licencing Assessment MLA Content Map.¹⁰ This ensured that the content was aligned to the national examination due to replace UK final year medical school exams (and the Professional and Linguistic Assessments Board test for international medical graduates) in academic year 2024/2025. Further cases were added to meet content gaps, to bring the total number to 700 cases, 3700 questions, and 500 images. CAPSULE was made freely available to all UK medical schools on the 1st of May 2020, with free access to continue until September 2021.

Surgery - Cardiovascular 443

CASE STUDY QUESTIONS

QUESTION 2 of 8

On examination he is fully alert but in obvious discomfort, tachycardic and hypotensive. On examining his abdomen, you find an 8cm expansile mass in his epigastrium. This confirms your suspicions of a ruptured AAA. List in order your immediate management steps:

Feedback

It is very important to follow the principles of ABC. We know he has a patent airway so after giving oxygen we rapidly move on to C (circulation). Again, it is important to place large diameter lines so that fluid can be administered as quickly as needed. In these cases aim to keep the systolic blood pressure at about 100 mmHg. Remember that a central line is long so actually has high resistance and is NOT for resuscitation. The only person who can save this patient is a vascular surgeon so they should be involved early. A urinary catheter is connected to a urometer to accurately measure urine output which reflects renal perfusion and, therefore, cardiac output.

- Give 1L normal saline at a rate sufficient to keep his systolic blood pressure at around 100mmhg ☰
- Administer oxygen and site two large-bore intravenous cannulae into large veins ☰
- Insert a urinary catheter ☰
- Inform the vascular surgeon ☰
- Take blood for FBC, U&Es, clotting and a cross-match for 6 units ☰

Correct Order

- Administer oxygen and site two large-bore intravenous cannulae into large veins ☰
- Take blood for FBC, U&Es, clotting and a cross-match for 6 units ☰
- Give 1L normal saline at a rate sufficient to keep his systolic blood pressure at around 100mmhg ☰
- Inform the vascular surgeon ☰
- Insert a urinary catheter ☰

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Figure 4 Ranking style question, with feedback.

UK-Wide Usage of CAPSULE and Feedback

Following the UK Wide launch on the 1st of May 2020, all 33 UK medical schools registered with CAPSULE, comprising a total of 41,404 medical students and 3187 faculty. The number of monthly cases completed and the number of monthly users of CAPSULE showed a substantial increase between May 2020 and June 2020. During the first 12 months of use, approximately 1.5 million cases were completed in total. By September 2020, students largely returned to clinical placements, yet the number of users of CAPSULE showed an increase, demonstrating its integration into student learning patterns. At the current time, the number of cases

being completed monthly are approximately 140,000 and current numbers of distinct monthly users are approximately 4500. These usage patterns are illustrated in Figures 6 and 7.

Feedback from UK students and faculty using CAPSULE has been highly positive, with selected, anonymised student comments presented below in Table 1.

Discussion and Conclusions Changes to Medical Education

As a result of the COVID-19 pandemic, online learning within the entire educational sector has become a key component in teaching and learning. A survey of UK medical schools demonstrated this increased reliance on

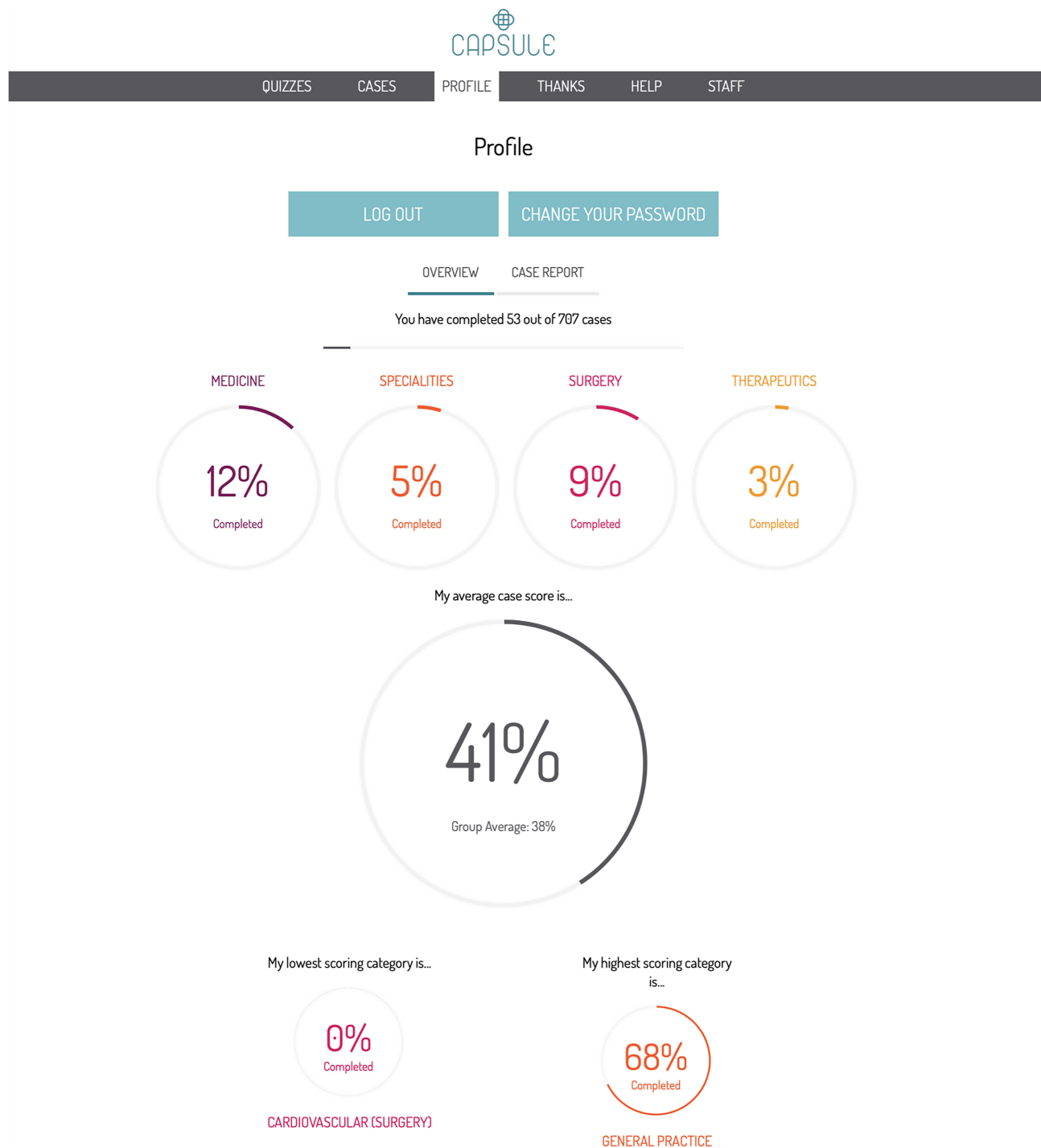


Figure 5 Comparison of personal scores against group scores and breakdown of high and low scoring specialities.

online learning, showing that prior to the COVID-19 pandemic, medical students would on average spend 4 to 6 hours weekly engaging in online learning, whilst during the pandemic, this increased to 7 to 10 hours weekly.¹¹ Prior to the pandemic, 7.35% of students would regularly spend >15 hours a week doing online learning and during the pandemic, this increased to 19.7%.¹¹

There are reported benefits to online learning, including greater time flexibility, comfort, reduced travelling, reduced anxiety and ability to study the course from another country should travelling restrictions exist.¹¹ However, there are also reported disadvantages, with students citing undermotivation, internet connectivity problems and lack of practical application as particular

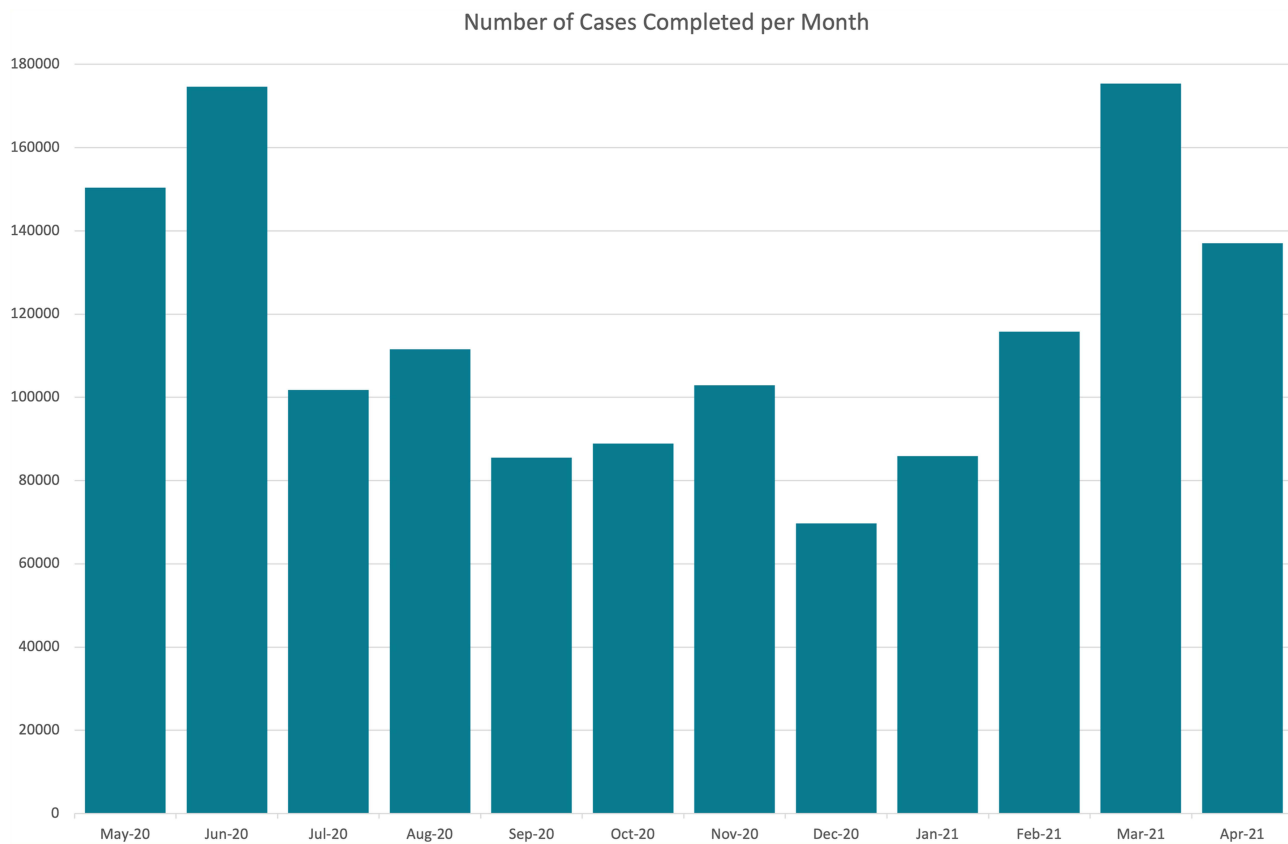


Figure 6 Total number of cases being completed per month, across the UK.

drawbacks.¹¹ The lack of alignment of generic question banks and online learning resources to specific medical school curricula is also a significant disadvantage.¹²

With the emergence of new coronavirus variants and the possibility of further outbreak and lockdown possible in the UK and across the world, it is likely that online learning will continue to significantly support medical education for the foreseeable future. Even beyond the COVID-19 era, the advantages of online learning may make it likely that blended learning remains the norm for higher education, including medical education.¹¹

The Impact of CAPSULE as a Learning Resource

A recent study, undertaken prior to COVID-19 pandemic, demonstrated the impact of CAPSULE in helping medical students improve their knowledge and translate this to better summative examination scores.¹³ This cross-

sectional study reviewed the performance of the 2019 graduating cohort of 70 medical students at BSMS, who had had access to CAPSULE during their fourth and fifth years of study. Following their final examinations, the students' CAPSULE meta-data and decile rankings were obtained and compared. This was compared against the students' decile at the beginning of their third year of study, prior to access to CAPSULE.

This study demonstrated that students who completed more cases on CAPSULE scored significantly higher marks overall in their exams ($p < 0.0037$) and that students with a better score on CAPSULE were part of a stronger decile within their cohort ($p < 0.019$).¹³ This study provided evidence that digital learning with CAPSULE may be associated with better exam performance.¹³

A further benefit of CAPSULE, for UK medical students and international graduates looking to come to the UK, is its alignment with the MLA. This can ensure that those preparing for the examination achieve breadth and

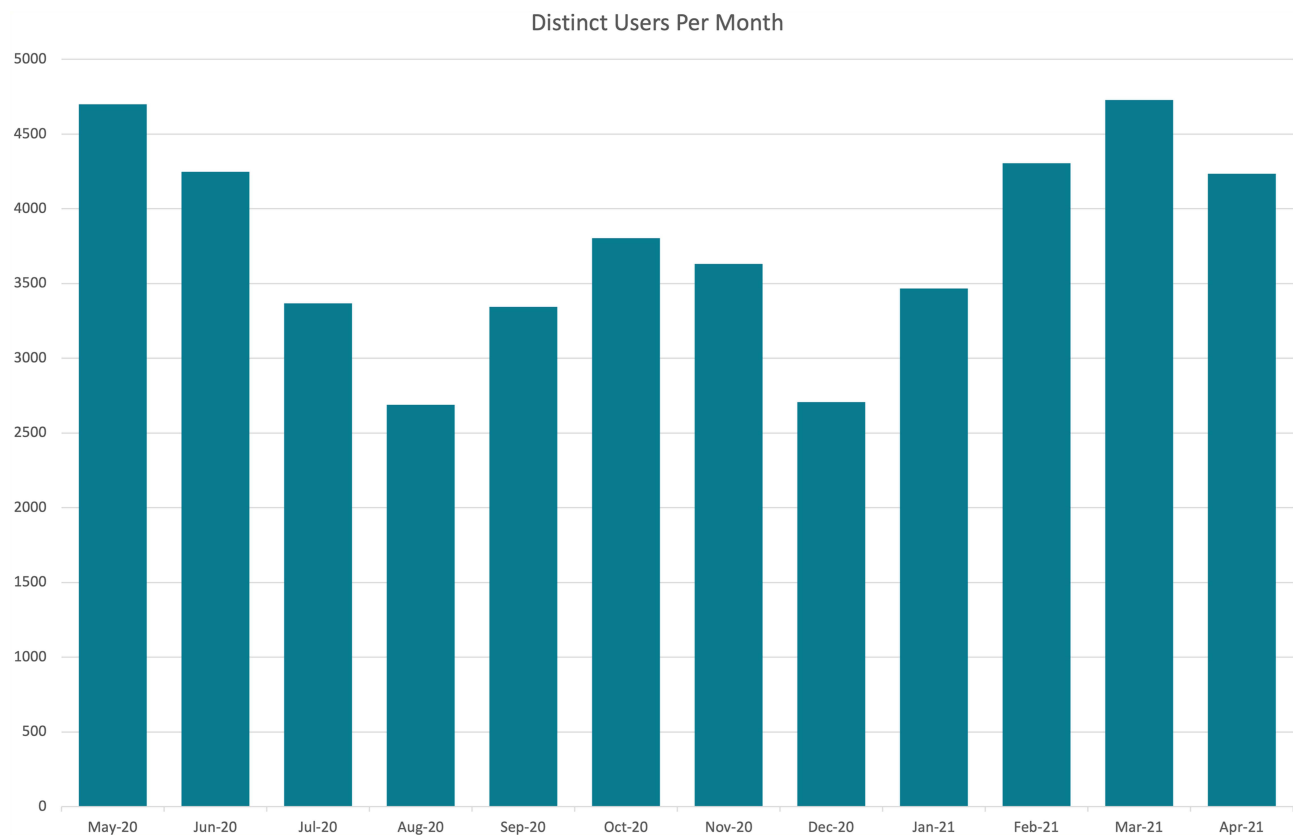


Figure 7 Distinct registered UK student users per month.

depth in areas where direct experience may be limited in order to ensure that all areas of the assessment map are sampled with formative questions. This makes CAPSULE a sustainable and up to date learning resource with in-built longevity.

Possible Future Directions of CAPSULE

Discussions are ongoing as to how CAPSULE provision to UK medical schools continues beyond September 2021. A key component to success at medical school level is the effective engagement of school faculty, who in turn will promote interest and usage by their students. A key element to faculty engagement is to encourage faculty members to review and add speciality cases to the platform, which can be targeted towards their interests and individual medical school curricula. These cases can then be formally embedded within teaching.

There is also potential for faculty to identify underperforming students and to offer them additional targeted educational support or to identify particular questions or subject areas in which students are underperforming and consider focused teaching interventions. Extra functionalities and bespoke content may also be added to the platform, as suggested by partner schools.

CAPSULE is an excellent example of how a digital learning resource can be used successfully to complement existing teaching modalities and help students improve their knowledge and required competencies. CAPSULE has already demonstrated its efficacy as a teaching resource and its scalability by early 2020, with COVID-19 providing the stimulus to facilitate UK-wide expansion and delivery of educational content in support of a UK-wide cohort of medical students. In the future, there is the potential for CAPSULE to expand further, to other healthcare-related disciplines and internationally, to benefit medical students on a wider scale.

Table 1 Selected Feedback from User Survey from Students Across the UK, to the Question, “What Do You Value Most About CAPSULE?” Consent for Publication Gained

Student 1	Very relevant to undergraduate learning outcomes. Clearly explained answers and cases. Bolsters understanding of conditions as a whole.
Student 2	Use it mainly for revision as the format of questions is similar style to my exam and the feedback given is extremely helpful. Easy format to understand and I enjoy having it as an app as well as on my laptop.
Student 3	Really good cases with thoughtful questions and excellent feedback/explanation on answers.
Student 4	The fact that we get to study with cases and follow through from diagnosis to treatment. It helps me consider aspects of management I would not have previously. The questions are at an appropriate level.
Student 5	The application of knowledge to work through a case is realistic to questions doctors ask on placement. I use it after I have made revision notes to check my understanding and apply knowledge to cases/ exam questions.
Student 6	I like the case-based questioning - and how the story unfolds within the case. The feedback is also really valuable.
Student 7	I enjoy the range of questions and the depth of the questions. Good for revising what you do and do not know about conditions. I like how can choose specialties.
Student 8	I love that the cases and questions are written in the same structure as I would have it in an exam. The rationales given for the answers are very helpful as they further help me build my knowledge. This has been a wonderful study resource for me.
Student 9	I use it to make notes and learn. It is great because it is an interactive way of learning. I love the range of subjects it covers and the detailed feedback.
Student 10	I used it heavily in preparation for my year 3 exams using the questions in surgery, medicine, elderly medicine and psychiatry. I really appreciate how the questions match the learning outcomes for each module as it is a great way to consolidate my knowledge. I also found it really helpful that it was a case study-based approach with aspects of the history, examination, investigations and results for interpretation.
Student 11	You are great! Please keep up the good work. I genuinely impressed a consultant on the wards when I spotted a (real!) patient with potential hypothyroidism thanks to a capsule case I had recently done.

Ethical Approval

Ethical approval was not required for this paper as it is purely a descriptive piece.

Consent

Informed consent was gained from the students to participate in feedback and have their anonymised feedback responses published.

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Disclosure

The authors report no conflicts of interest in this work.

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