An Integrated Dyspepsia Module for First Year Pharmacy Students; a Flexible and Generic Template for Integrating Science with Clinical and Professional Practice

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ABSTRACT

Objective. To design an integrated dyspepsia module for first year pharmacy undergraduates, which combines clinical and professional practice with fundamental sciences, in five different science subject areas, as a prototype for future disease- or system-based integrated modules.

Methods. The approaches used in designing this module are described with particular emphases on strategies adopted to integrate science and practice, and the new ways of working adopted by the design team. Students' views and experiences of the module, and its integration, were explored using questionnaires.

Results. A high proportion of students reported positive views and experiences of the module, the integration and its impact (as self-reported) on their learning and practice. The assessment of student performance indicated learning and attainment was at an appropriate level for a first year module. Both the student marks and research results indicate a positive student learning experience. The main activities undertaken whilst designing and developing the module, and the personnel involved are presented, and provide an indication of the staff time and resourcing required in developing this module.

Conclusions. The dyspepsia module provides a flexible and effective template for the integration of science and practice in theme-based modules, with students reporting positively about the integration, including their perception of its contribution to improving their learning and understanding. Our experience suggests that new more collaborative ways of working are required when designing integrated modules.

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INTRODUCTION

The integration of science with practice has always been an important component of the discipline of pharmacy, arising from the inherently multi- and inter-disciplinary nature of pharmacy. For example, The Galenic Pharmacy of 1893 describes pharmacy as "The art of applying the laws of Chemistry and Physics to the preparation of drugs in a form suitable for administration in medicine."[1] In recent years there has been increasing interest in the integration of science and practice within pharmacy curricula, as a means of supporting the development of pharmacy students' integrative and interdisciplinary skills, with many pharmacy regulatory bodies around the world now mandating effective integration within pharmacy degree programmes. In the UK, the most recent 2011 General Pharmaceutical Council (GPhC) standards for the initial education and training of pharmacists stipulate, for the first time, that an integrated experience of science and practice must be provided in the undergraduate Master of Pharmacy (MPharm) degree.[2] The Accreditation Council for Pharmacy Education (ACPE) in the United States, the Canadian Council for Accreditation of Pharmacy Programs and the Pharmaceutical Society of Ireland also require curricular integration in degrees that they accredit.[3-5]

In September 2012 the Nottingham School of Pharmacy launched a new MPharm degree programme, in which the integration of practice and science is embedded within the curriculum and the design of individual modules, from year 1 of the degree. One of the fundamental tenets of this new degree was to combine contemporary clinical training and skills, together with a rigorous and broad scientific education. The GPhC reinforces the requirement for scientific training, by stating (standard 10.4) that "To be safe and effective, the practice of pharmacy must be underpinned by relevant and up-to-date science. Sound science is the basis of effective pharmacy".[2] A similar requirement is mandated by the ACPE 2016 standards, where the provision of "rigorous instruction in all sciences that define the profession" is stipulated, and the foundational sciences, of appropriate breadth and depth are described as "central to a contemporary, high-quality pharmacy education."[3]

One key approach for delivering integration within the University of Nottingham course is through a series of 11 new Drug, Medicine and Patient (DMP) modules, each focusing on a disease state or physiological system, and in total representing two years of the four year programme. This paper describes the design of the first of the new integrated DMP modules, the approaches to integration

that have been developed, and the processes and ways of working that we adopted as a team in creating this module. The latter is included since our experiences suggest the need for different ways of working when creating integrated content of this type. The dyspepsia module was designed as both the first DMP module that our students would encounter, and also as a flexible template for use in the development of 10 future DMP modules. During the first year of delivery, research was carried out to explore the experiences of our students to the integrated module, and our findings are presented here.

The dyspepsia module provides an integrated description of the science and practice that underlies the treatment of dyspepsia, and as such contributes to GPhC standard 5, the requirement for an integrated experience of science and practice.[2] The dyspepsia module also incorporates the ACPE standard 1, and the Center for Advancement of Pharmacy Education (CAPE) educational outcome 1.1, which both stipulate the requirement for the learner to "develop, integrate, and apply knowledge from the foundational sciences to evaluate the scientific literature, explain drug action, solve therapeutic problems, and advance population health and patient-centered care".[3,6]

Integration within education has been described as the "intentional uniting or meshing of discrete elements or features" within the learning experience.[7] The Association of American Colleges and Universities defines it as "an understanding and a disposition that a student builds across the curriculum and co-curriculum, from making simple connections among ideas and experiences to synthesising and transferring learning to new, complex situations within and beyond the campus".[8] Integration in learning aims to develop an individual capable of connecting concepts to face new challenges and tackle future problems. It is not limited to the curriculum, but continues throughout one's personal and professional development as a member of an ever-changing society.[9]

The idea of integration within learning is well established in higher education, with the focus more recently appearing to move towards educators designing and delivering integrated curricula, rather than students carrying out the integration entirely themselves.[10] Intentional integrated teaching strives to enhance students' capacities to connect concepts and to design assessment opportunities that test these capacities. The teaching should foster an intentional learning mind-set, whereby students find purpose to their learning, reflect on it and become self-aware of the integration taking place.[11]

An interesting opportunity afforded by integration may be in supporting the inter- or multi-disciplinary learning required in pharmacy, where the educational demands placed on pharmacy students (and pharmacists) are appreciable, as they are required to grasp and understand threshold concepts in a range of different discipline areas (e.g. chemistry, biology, clinical practice). Threshold concepts within disciplines illustrate "conceptual gateways" which, when crossed, lead to a transformed way of thinking that allows progression to a deeper level of understanding.[12] However threshold concepts may also become "troublesome" knowledge. For example, inert knowledge is "troublesome" as it remains unused by the learner due to a failure to relate it to real life; conceptually difficult knowledge becomes "troublesome" when it is complex, hard to grasp or seems illogical.[12-14] This would suggest that integrative approaches to learning may support pharmacy students in the challenges presented by the range of threshold concepts, from different disciplines, that they are required to master, by presenting clear links, context, sequence and logic in the subject material under study. Indeed it has been reported that when thresholds are crossed and understanding is reached, novel conceptual connections can be made, contributing to the process of integrative learning.[12]

The increased interest in integrated pharmacy curricula is demonstrated by the publication of two recent reviews in this area, together with two recent surveys exploring the extent of curricular integration in US pharmacy degrees.[10,15-17] It is clear that what constitutes curricular integration is interpreted in many different ways, and aims to deliver a variety of different teaching and learning outcomes. Harden suggests that there are varying degrees of integration, that lie on a continuum, from "isolation", where no linking of concepts is attempted, to "trans-disciplinary", where in a real-life practice situation students are able to integrate content themselves.[18] Pearson and Hubball in their recent review suggest a number of useful areas of inquiry in the evaluation of curricular integration, which include "how have instructors approached the task of implementing curricular integration?", and "what are the drivers, barriers, and pedagogical supports that affect curricular integration, from student and faculty perspectives?"[10] Our paper, together with providing a description of the new dyspepsia module, presents our experiences in the two areas of inquiry as suggested by Pearson and Hubball. Poirier et al suggest, from their recent survey of curricular integration in US pharmacy schools, that an area for future curriculum enhancement is the integration of a wider range of

disciplines, in addition to the commonly reported pharmacology, pathophysiology, medicinal chemistry and therapeutics.[17] The generic module template described here provides a potential means for addressing this, where the inclusion of diverse fundamental science, practice and clinical content is facilitated and supported. Within the dyspepsia module seven different subject areas are included.

The integration of science with clinical practice is a familiar approach, and aspiration, within medical education, with early pioneering work in this area including the McMaster approach in Canada and the Dundee curriculum in Scotland.[19,20] Similarly, dentistry degree programmes have also explored this approach, and rarer examples can be found of integration of science with practice in nursing and physiotherapy degree curricula.[21-25] There has been a steady expansion in the popularity and incidence of integrated curricula for medicine in recent years, and with this expansion has come the recognition, as with pharmacy education, that the term integration has been interpreted in many different ways, and what constitutes integration in different settings varies considerably.[26] Two recent reviews of the integrated curriculum in medicine have provided detailed commentary on this expansion, and the current state of play.[26,27] A number of key areas where future work and improvements would be of value have been identified, and include i) ensuring the collaborative design and synchronous delivery of integrated courses, by a multidisciplinary team consisting of scientists and clinicians; and ii) maintaining a strong fundamental science content, both in terms of the emphasis and depth of science coverage in integrated modules at all stages/levels of medical education, but also including an increasing number of science subject areas, as these become essential to understanding new areas of medicine.[26] The new dyspepsia module and our approaches to collaborative working as described in this paper, whilst designed with pharmacy in mind, may also provide interesting perspectives for colleagues in medical education, in relation to these two points.

The dyspepsia module has been designed as the first of a series of 11 integrated modules within the Nottingham pharmacy (MPharm) degree, and hence as a prototype module, to be easily customised to create other disease- and system-based courses or modules. As such the prototype described here would also be easily generalisable to other schools of pharmacy, and more widely in medical and healthcare higher education, where the integration of clinical and professional practice with robust and diverse fundamental science content, is a curricular requirement.

METHODS

The dyspepsia module is the first of the DMP modules and runs over a dedicated four week block at the start of semester two of the first year. It comprises a wide range of different teaching activities, including patient narrative-based case studies, lectures, laboratory practicals, professional practice dispensing classes, and small group workshops, all of which have been designed to provide an integrated description of dyspepsia, where dyspepsia is used in its widest sense as an umbrella term to cover a range of diseases of the upper gastrointestinal tract. Seven subject areas are taught, also known as the vertical themes, of which two are practice related (Pharmacy and Clinical Practice; Professionalism and Leadership) and five scientific (Pharmacology and Therapeutics; Biology and Physiology; Pharmaceutics; Pharmaceutical Chemistry; ADME (Absorption, Distribution, Metabolism and Excretion)). The initial design and development of the module was carried out over a two year period. The module was delivered for the first time in the 2012/13 academic year.

The module design team consisted of five academic staff, each taking responsibility for one or two of the vertical subject themes (Table 1). In each case the vertical themes were the subject specialisms of the staff, who were all research active in these areas. One member of the team (CIDeM) was the lead for the module with overall responsibility for the design and delivery of the module. Two members of the team are GPhC registered pharmacists. As far as possible, one person was responsible for the delivery of each subject area, so that students would associate a given person with a given subject theme. As the first DMP module that students would encounter, clear signposting of the structure and content was felt to be important, hence having a specific "face" associated with each subject area was hoped to contribute to this labelling. This also allowed us to reduce the number of different staff teaching on the module, so creating a tighter knit, closer and more accessible community of teachers.

Despite all members of the design team being experienced teachers of pharmacy undergraduate courses, developing theme-based integrated content across seven subject areas was new to all of us. We had all used integrated approaches in past modules, but this generally involved integration across two or three subject areas. Our aspiration for the dyspepsia module (and the generalisable prototype that would ensue) was to develop wider and higher level integration, which, if one considers Harden's

integration ladder, could be interpreted as the module, or elements of it, being within the top third of the ladder.[18] To achieve this, design meetings, held monthly, were attended by all five members of the design team. On occasions, other staff were invited to join these meetings, when additional expertise and advice was required, or additional content and teaching activities were needed. The design process thus included regular round-the-table discussions and group-working between all the subject leads. This represented a new way of developing teaching content for all of us, reliant on significantly more sharing of ideas and discussion than in past teaching.

The following steps were adopted in the design of the module:

Module Narrative

To help decide when and how different content should be delivered, in which order, and at what level of difficulty and detail, a narrative for the module was defined (Figure 1). This allowed us to begin designing the horizontal integration in the module, of which the integration of science with practice, and practice with science, were key components.[7,15] The narrative allowed content to progress from simple to more challenging and provided the clinical perspective used when writing teaching material across all themes. It is worth stressing that the narrative was the starting point when writing all the teaching material, and as such was embedded within all the subject themes. The narrative was mapped onto our four week timetable, allowing us to define an order for delivery of content in each of the seven subject themes. Within each of the vertical subject themes the content was delivered in an order that ensured a coherent subject narrative (ie. effective vertical integration), together with close timings in the delivery of integrated content by different subject themes.[7,15] Our plan was that integrated content arising from a number of the different vertical themes should be experienced by our students in relatively close succession (ie. synchronously) within the four week block.

Case Studies

A series of patient narratives were created, to bring real-life patient experiences to pharmacy students, whilst also creating opportunities for students to develop their integrative learning, as they use their scientific knowledge and skills to understand clinical situations, and develop their clinical and professional practice. The aim was to simulate authentic clinical scenarios, in a variety of pharmacy

work spaces, which progressed over time, often in unexpected ways, to create immersive and integrative learning for our students. Clinical case study based teaching, incorporating the patient narratives, was developed as an integral part of the student learning experience within the module.[28] Centered on inquiry-based learning the case studies were designed to support student-centered learning, and to highlight the links between the seven themes and the relevance to practice.

Visually-rich, interactive case study material was created, which included tailor made videos, photographs, images, and interactive 3D molecular graphics, and was delivered via the open source web-based platform Xerte.[29] In a series of staff facilitated small group workshops (eg. three groups of five students each per workshop), students worked through questions and concepts associated with the case studies, using resources found on the internet. Feedback provided during these sessions, from peers and staff, developed students' abilities and skills in independent problem-based learning. The case study teaching (Xerte and internet browsing) was delivered using iPads in the timetabled workshops, with students expected to also review the on-line material outside of the workshops.

Laboratory Practicals

A series of new practicals were written, to develop students' experimental skills, ability to record and analyze data, and to integrate science and practice within the module. The four new practicals included manufacturing of medicines relevant to dyspepsia, exploration of the chemical properties of proprietary medicines and pharmaceutical chemistry analysis. In all cases these experiments and their results were integrated with practice. Students were able to manufacture their own specials medicines, ie. pharmaceutical compounding, in the form of an antacid suspension as described in the British Pharmacopoeia, and a bespoke antacid powder blend.[30] These were then analyzed for their acid neutralising capacity using British Pharmacopoeia methods, and their performance assessed in a variant of the Rossett-Rice test.[30-32] Students were also able to investigate how the chemical composition of proprietary alginate medicines affected their raft forming ability, and to observe how formulation and ingredients affected the anti-foaming ability of proprietary antiflatulent medicines.

Further Signposting of the Horizontal Integration

Lectures and small group problem-solving workshops were used to deliver a sizeable proportion of this module, in addition to the case study teaching and practicals. To help students' understanding of the horizontal integration between the lectures from different subject specialists, extensive use was made of both visual and verbal cues to highlight connections and links, together with joint presentation of lectures. For example, the integration of content was highlighted to students by showing relevant slides from different subject specialists' lectures within one's own lectures. Joint lectures allowed a common topic to be delivered by two different subject specialists, providing an alternative approach to labelling integration. And on one occasion three lectures on omeprazole, from three different subject perspectives, were delivered in succession, again highlighting connections.

Since this was the first of the DMP modules that our year 1 students had come across, the decision was made to clearly signpost and label lectures as being associated with one of the seven vertical themes. This was felt to be important so that students could understand, at this early stage, the name and content of these subject areas, which has considerable importance in understanding the nature of academic disciplines and how academic content is organised and labelled, including the likely location of textbooks in libraries.[33] The reduction or removal of this level of signposting as students progress through the DMP modules is likely to be desirable, to allow students to further develop their own integrative learning. [9,10,15]

Assessment

The syllabus and learning outcomes for this module and the level at which they would be taught and assessed were defined as part of the early stages of the overall new MPharm course design process at the University of Nottingham. All 11 prospective DMP modules, together with the modules that were to precede and follow, defined a skeleton content for their modules, where the main overarching principles to be included were outlined, together with the GPhC learning outcomes to be assessed and at which level of Miller's triangle[2,,34] The pyramid (or triangular) structure created by Miller provides a framework for the assessment of "clinical skills/competence/performance" in medicine, and has been adopted in a variety of healthcare education settings. This allowed the vertical integration between modules to be explored, and concepts of spiral learning to be developed at an early stage of

the course design.[35] The GPhC mandates the use of Miller's triangle to assess competencies, together with a spiral curriculum approach, whereby concepts and knowledge are revisited and reinforced throughout the curriculum, but at increasingly complex levels as the course progresses.[2]

The dyspepsia module was assessed by both coursework and summative examinations, the latter divided between a short mid-module assessment, from which immediate feedback on performance was provided to candidates, and an end-of-semester assessment. The assessments were designed to assess all the GPhC learning outcomes associated with the module, with questions drawn from any part of the module curriculum. The coursework consisted of laboratory reports describing the four experimental practicals, and also requiring students to answer key questions that explored knowledge and understanding, together with ability to integrate science with practice.

Evaluation

Two approaches to evaluating the first year of implementation of the dyspepsia module were a research study of students' views and experiences of the new module and analysis of the students' performance in the module. University of Nottingham ethics approval and School of Pharmacy permission was obtained prior to the start of the research study, and head of school permission was provided for the analysis of module performance.

A questionnaire was used to capture the views of first year pharmacy students, which was distributed in the timetabled dyspepsia module review lecture on the penultimate day of the module, with dedicated time being provided for their completion. Students were emailed 24 hours prior to the session, to inform them of the questionnaire distribution. The resulting quantitative data was analyzed using SPSS 22.0; frequency counts with percentages were calculated.[36] Data presented in 5-point scales (eg. strongly agree, agree, neutral, disagree and strongly disagree) were collapsed to 3-point scales (agree, neutral, disagree) for analysis. The questionnaire also contained a 5-point "symbol-based" scale incorporating smiley face type emojis, and this was re-categorised to a 5-point scale reflecting degree of happiness/unhappiness (ie. very happy, happy, neutral, unhappy, very unhappy).

In order to determine student performance during the first year of delivery, whilst no direct comparisons were possible, we compared the new module with a previous module which contained

some of the same science, namely the former first year pharmaceutical chemistry module. In the previous MPharm course, the clinical and professional aspects of the dyspepsia module were delivered at various stages of the programme, and predominantly in years 3 and 4, and many aspects of the science were also delivered in later years, for example the physical pharmacy of enteric coatings. This meant that no meaningful comparisons could be made of student learning in the new dyspepsia module and of comparable material in the old programme. The new dyspepsia module contains a significant pharmaceutical chemistry content, and hence the first year module in pharmaceutical chemistry from the previous programme was considered the most useful comparator available. Student module marks on the dyspepsia module (1 year available) were compared to marks on the first year pharmaceutical chemistry module (3 years available). In broad terms we wanted to ascertain whether students were able to demonstrate their learning in an assessment, or assessments, to the expected standard for a first year module, factoring-in the prior qualifications and grades that our students arrive onto the programme with. The above comparison we believe achieves this.

Since the collection of the research data and hence the evaluation occurred at the end of the module, we tried to obtain informal feedback from students during the earlier parts of the module, so that any immediate issues, if they were to arise, could be addressed. Students were encouraged to let us know at any point during the module, how they were getting on and what was working well and/or less well.

RESULTS

The design and development of the dyspepsia module took place over a two year period and involved monthly meetings with all five members of the module design team. Initially meetings were half-day, then two-hour, and near to the launch of the module were one-hour long. Between meetings, design team members worked creatively on key aspects of the new approach, and these would then be shared, discussed and further developed at subsequent meetings. Monthly meetings were also held during the first year, and then as required, with members of the University of Nottingham Learning Technology Team, the module convenor, and other members of the design team as required, to discuss and take forward the development of the case studies and the module virtual learning environment (VLE). The new teaching and learning material and activities were written by all

members of the design team, in discussion with fellow design team members. In the case of the laboratory practicals, workshops and professional practice dispensing classes, other members of academic and technical staff also provided considerable input. It is difficult to accurately estimate the cost of creating the dyspepsia module, but the above give some indication of the main activities and personnel involved. It is worth noting that the investment made in terms of staff time, IT infrastructure, and other resources has allowed the successful development and delivery of not only the new dyspepsia module, but also the template which has served as the foundation for the development of 10 further integrated DMP modules.

The questionnaire response rate was 83% (*n*=124) of the total cohort of students. Male respondents accounted for 31% of the total number of participants (*n*=38), and respondents between the ages of 18 and 20 years constituted 92% of the total number of participants (*n*=114).

General views of the module; overall students reported positive perceptions of the module, with 87% agreeing (*n*=108) that they had enjoyed the module, and 90% agreeing (*n*=112) that the module content links together effectively to provide an integrated description of dyspepsia and its treatment.

Methods of integration; students were asked their views of the different approaches to integration in the module (Tables 2 and 3), and in all cases were overwhelmingly positive. The case study workshops, responding to symptoms workshop and practicals were most highly rated, with 87%, 79% and 68% respectively being happy or very happy with these activities, 91% of students agreed that case studies effectively integrated all aspects of this module and 89% agreed that the practicals had helped their understanding of the mode of action of drugs and medicines used to treat dyspepsia.

Impact of integration on learning; a high proportion of students reported positive perceptions of the effect the integration had had on their learning and practice (Table 4), with the majority agreeing that the integrated approach had enhanced their understanding of the role of the pharmacist (81%), had enhanced their clinical decision-making (78%) and had aided their learning (89%).

Students' performance in the module was very pleasing, as reflected in all three components of assessment, and indicated that the module learning outcomes were successfully met. Marks in the UK are reported as percentages, where 40% is a pass and 70% a first class piece of work. The average

overall mark for this module was numerically comparable, if slightly higher (67.3% (SD=11.6)) than for the pharmaceutical chemistry first year module previously run at Nottingham (64.5% (SD=16.9)), with a similar spread of marks (from the perspective of our examination review processes), indicating that student attainment was typical of a first year cohort of pharmacy students at the University of Nottingham, with the assessment able to discriminate between different levels of student performance (Table 5). This is suggestive of a successful learning experience for our students, with opportunities available to demonstrate their learning, skills and abilities, to the expected standards, in the module assessment. However, given the radically different nature of the content, learning outcomes and assessment/examinations in the new module, and also in the new programme as a whole, as compared with previous years, it is difficult to draw further conclusions about changes to student knowledge, skills and performance arising from the new module, or between these two cohorts.

DISCUSSION

The recent enhanced requirement for integration of science and practice in pharmacy curricula places significant demands on academics to create new approaches to teaching and learning, and to better understand the pharmacy students' experience of integrative learning. In this paper we describe the development of a new integrated first year module on dyspepsia, which is also designed to serve as a template for future integrated theme-based modules. We also present the results from our research exploring students' experiences of the new module and we describe in broad terms the performance of students in the module assessment. From this it is clear that the module has worked well, receiving positive feedback from the vast majority of students and showing good levels of student attainment. We report details of the mode of collaboration we adopted in producing the new module, since we believe this is a fundamental component of the design process, one we consider well worth sharing.

The dyspepsia module is the first experience of an integrative approach to learning that our year 1 pharmacy students have encountered, and on the basis of their feedback and their performance, this transition appears to have worked well. This suggests that our approach of maintaining the visibility of subject areas, whilst attempting to integrate them horizontally, has been successful. Spelt et al suggest that knowledge of disciplines remains imperative in integrated curricula, where this "appears

to be required for enabling students to step beyond the disciplinary theories and methods in order to make connections between disciplines."[33]

Of note from the student responses are the high levels of popularity and positive perceptions of the module and the integration. Whilst this in isolation does not necessarily correlate with pedagogic merit and value, it is clear that the students have positively engaged with this module. This is particularly reassuring considering that approximately 40% of the total content within this module (considering both contact-time and summative assessment activities) was pharmaceutical chemistry and pharmaceutics, with principles of acid-base chemistry, ionisation, solubility and partitioning being covered at length. There was no indication that the students experienced any significant difficulty in engaging with this physical science content.

A 2004 study reported on UK undergraduate pharmacy students' attitudes to the science and practice content, and to their balance, within MPharm programmes. This study indicated that students felt too much emphasis was placed on fundamental science in the early years of their degrees. They expressed the view that more practice experience from the start of their course would make the content more interesting and help to contextualise the science.[37] Despite the challenging physical and biological sciences within this module, we have no suggestion of any similar tension for our students, rather our students report overwhelmingly on their enjoyment and appreciation of the module. Kullgren et al reported similarly positive views from doctor of pharmacy (PharmD) students with respect to the basic science content in their integrated course in pain management and palliative care.[38]

Students reported overwhelmingly the perception that the integration in the module had enhanced their learning, together with improving their clinical skills and understanding of their professional role. The different approaches to integration in the module were all positively received, with the integration within the case studies and practicals proving popular. Pearson and Hubball comment on the likely individual nature of integrative learning, varying "between students and contexts", and likely to be different from that perceived or intended by "curriculum planners and instructors".[10] More detailed discussions with pharmacy students about how they experience integrative learning, would be of considerable value, as we continue to design and develop new integrated teaching and learning.

Our experiences in designing and delivering the dyspepsia module, including the results from the student evaluation of the first year of delivery, were shared with colleagues in the school, to support the development of future integrated DMP modules and as part of our quality assurance procedures. This process of sharing began one year before the launch of the new programme, and continued during and after the new DMP modules were rolled-out. The results from our research were also used to evaluate our first year of delivery, and to consider changes to the module that might be needed for the second year. Given the success of the first year of implementation, only relatively minor alterations were considered necessary, which included some improvements to the experimental practicals and to the explanations provided to students about the integration. The latter arose from informal conversations with students where it became apparent that some clarifications were needed.

Pearson and Hubball describe a number of potential barriers to the implementation of integration in pharmacy curricular reform, including the "effort in planning and implementation" and "the nature of academic disciplines".[10] Similar commentary has been published in relation to curricular integration in medicine.[27] The demands of an integrated programme include communication between subject specialists within one or more modules, agreement on the time given to each discipline, more complicated scheduling of teaching activities. These aspects add to the workload in designing and delivering the programme.[10,39,40] Kullgren et al describe how through "effective planning and communication" academic colleagues were able to "overcome [the] challenges" to create a new integrated module on pain and palliative care for doctor of pharmacy students.[38] In addition, differences in the culture of academic disciplines, in part expressed by their differing threshold concepts, but also their specific traditions, practices and identity, present significant challenges to effective curricular integration for both academic staff and students.[10,12,33,40] We have reported here details of how we collaborated as a multidisciplinary team to create this new module: significant time, increased levels of communication and sharing, together with staff commitment, were all required in creating the integrated narrative and organisation within the module. Despite these challenges, this has been a rewarding and stimulating process, which has resulted in a close-knit and integrated team. The team consisted of both practicing GPhC registered pharmacists and non-pharmacy trained pharmaceutical scientists (ie. applied and foundational scientists, respectively, to use the preferred

terminology of Bauer and Ferguson), and were also involved in the "synchronous" delivery of the new integrated course. As such our approach is in keeping with the recommendations by Brauer and Ferguson for best practice (and suggested areas for improvement) in integrated medical curricula.[26]

A number of potential limitations to the data and report are worthy of note. We describe here the design and implementation of a single new module, at a single institution, within the UK, where the pharmacy training involves a master's level undergraduate programme of study. As such, this may affect the generalisability of the approach and of our research findings, to different institutions, countries and programmes of study. For example in the US the training of pharmacists is via the professional PharmD degree, in Australia and New Zealand the bachelors of pharmacy undergraduate degree is the most common route, whilst in the UK students study an MPharm undergraduate degree. We recognise that customisation of the dyspepsia module and its approach will be needed to accommodate varying curricular requirements in different institutions and countries, and a number of suggestions of how this could be achieved are provided below. In addition, the reliance in this study on students' perceptions of the new module is a further potential limitation. Whilst our results show overwhelmingly positive student perception of the new module, together with areas where students self-report educational value, our study did not directly assess how the new module and its integration affected students' learning and educational outcomes. Such insights would clearly be very valuable. Furthermore, our use of smiley face type emojis in a "symbol-based" response scale, and the re-categorisation of this scale to reflect degree of happiness or unhappiness is an additional limitation, since it introduces a further level of interpretation or subjectivity to the analysis.

The dyspepsia module was created as a prototype and flexible template, which has now been successfully customised and used in ten further integrated DMP modules within the Nottingham MPharm degree. Given the generic nature of the template, this could easily be customised to create other theme-based integrated modules, either within pharmacy education or more widely within other health-care professions. Features of the template and approach that could easily be customised to different institutional, programme or degree subject requirements include the duration and timetabling of the module, the range and type of teaching and learning activities included, the approaches to integration used, and the subject disciplines to be included and integrated within the module. For

example, at Nottingham students are enrolled on, and experience one integrated module at a time, for a dedicated four week block in the case of the dyspepsia module. This could easily be modified so that the module might run over a longer period of time, in parallel with the delivery of other modules. At Nottingham we incorporated seven vertical subject themes within the template, but the number and choice of subjects could easily be modified to reflect different profession-based, institutional or academic priorities and preferences. As such the template would prove useful in supporting the pharmacy curriculum enhancements suggested by Poirier et al, where the integration of a wider range of disciplines is recommended, together with the issue identified by Bauer and Ferguson, where an increased emphasis on foundational sciences is suggested as a necessary improvement in integrated medical curricula.[17,26] Based on the spiral curriculum approach, the template is easily customisable, to create individual, or series of vertically integrated, disease- or system-based modules, where the inclusion of robust and diverse fundamental science content is facilitated, supported and ensured.[35]

CONCLUSIONS

We describe the design and implementation of a new integrated module on dyspepsia, which combines clinical and pharmacy practice with strong fundamental physical and biological sciences. The approach we describe is flexible and is intended for use in other disease-based or systems-based integrated modules. In particular, the approach provides a simple structure for assisting and ensuring the integration of clinical and professional practice with rigorous multidisciplinary science. Feedback from the first cohort of pharmacy students enrolled on this module is extremely positive with students articulating appreciation of the integration of science and practice. Student attainment also suggests a successful student experience. Despite the evident challenges for academic staff in creating effective integrated teaching and learning, it is our view that the rewards far exceed the costs and for this reason we describe in some detail our collaborative approaches to achieving this module.

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Table 1. The Seven Subject Areas that are Integrated in the Dyspepsia DMP Module, Together with Example Concepts Covered in Each Area.

Pharmacology and Therapeutics	Biology and Physiology	Pharmaceutics	Chemistry	Absorption, Distribution, Metabolism and Excretion	Clinical and Pharmacy Practice	Professionalism and Leadership
Diseases and Symptoms Causes of 'chest pain' The process of peptic ulceration Drug (especially NSAID[a])-induced ulceration Anaemias and full blood counts Gastro-oesophageal reflux disease	Anatomy and Function of the Human Body Structure and function of the stomach and GI[b] tract Physiology/biology of parietal cells Digestion Epithelial membrane /epithelial cells Autonomic nervous system	Physical and Chemical Properties Relevant to Formulation Solubility and solutions Suspensions pH and its impact on solubility, partition and buffering The Henderson-Hasselbalch equation (link to chemistry)	Mechanism of Drug Action Antacids Raft-forming agents Antiflatulents PPIs[c] Fundamental Concepts Further molecular structure, functional groups, nomenclature, stereochemistry	Absorption Local and systemic effects of drugs (eg antacids vs PPIs[c]) Acid/base effects, buffers, ionisation, pH partition, diffusion partition theory, lipid permeability, drug solubility and salts	Responding to symptoms of dyspepsia Differential diagnosis Health promotion advice with dyspepsia. Role of diet and lifestyle in causing/aggravating /alleviating symptoms OTC[d] product selection	Personal Development and Professionalism Communication skills Reinforcement of calculations Reinforcement of CPD[e] opportunities Start of reflective portfolio (and link to placements)

[a] Non-steroidal anti-inflammatory drug
[b] Gastrointestinal
[c] Proton pump inhibitors
[d] Over-the-counter
[e] Continuing professional development

Table 2. Students' Feelings Towards Different Teaching Methods Used in the Module

	n	Percentage of Students		
		Happy	Neutral	Unhappy
Lectures	122	65	29	6
Case study workshops	124	87	12	1
Laboratory practicals	122	68	23	9
Dispensing class[a]	60	63	28	8
Chemistry workshop	122	65	25	10
Responding to symptoms workshop	122	79	19	2

[a] Half the year group had their dispensing class after the questionnaire distribution

Table 3. Students' Views on Case Study Workshops, Laboratory Practicals and Chemistry Workshops

	n	Percentage of Students		
		Agree	**Neutral**	**Disagree**
The case study workshops linked together all the aspects of this module to provide an integrated description of dyspepsia and its treatment	124	91	7	2
In laboratory practicals, seeing the medicines in action helped me understand the mode of action of drugs and medicines used to treat dyspepsia	122	89	7	4
The practicals have enhanced my understanding of the clinical effectiveness of some of the drugs and medicines used to treat dyspepsia	122	87	9	4
I found the chemistry workshop a useful tool to consolidate my knowledge from the lectures	122	74	15	11

Table 4. Students' Opinions on how Integration Impacts Their Learning

	n	Percentage of Students		
		Agree	**Neutral**	**Disagree**
The focus in this module on the 'Drug, Medicine and Patient' has facilitated my learning	123	89	9	2
The science I have learned in the module will inform my clinical decision making in the future	124	78	18	4
The integration of the science and practice teaching has helped my understanding of my future role as a pharmacist	124	82	15	3

Table 5. Comparison of Student Marks for the Integrated Dyspepsia Module and Superseded First Year Pharmaceutical Chemistry Module

	Integrated Dyspepsia Module	**Pharmaceutical Chemistry Module**
	Percentage of Students[a]	**Percentage of Students[b]**
Less than 40% (fail)	2.0	6.3
40-49%	4.0	14.4
50-59%	16.7	17.2
60-69%	31.3	18.7
70% and above (first class)	46.0	43.4

[a] marks from single cohort of students (n=150), 2012-13
[b] marks from three cohorts of students pooled (n=536), 2009-10, 2010-11, 2011-12

Figure

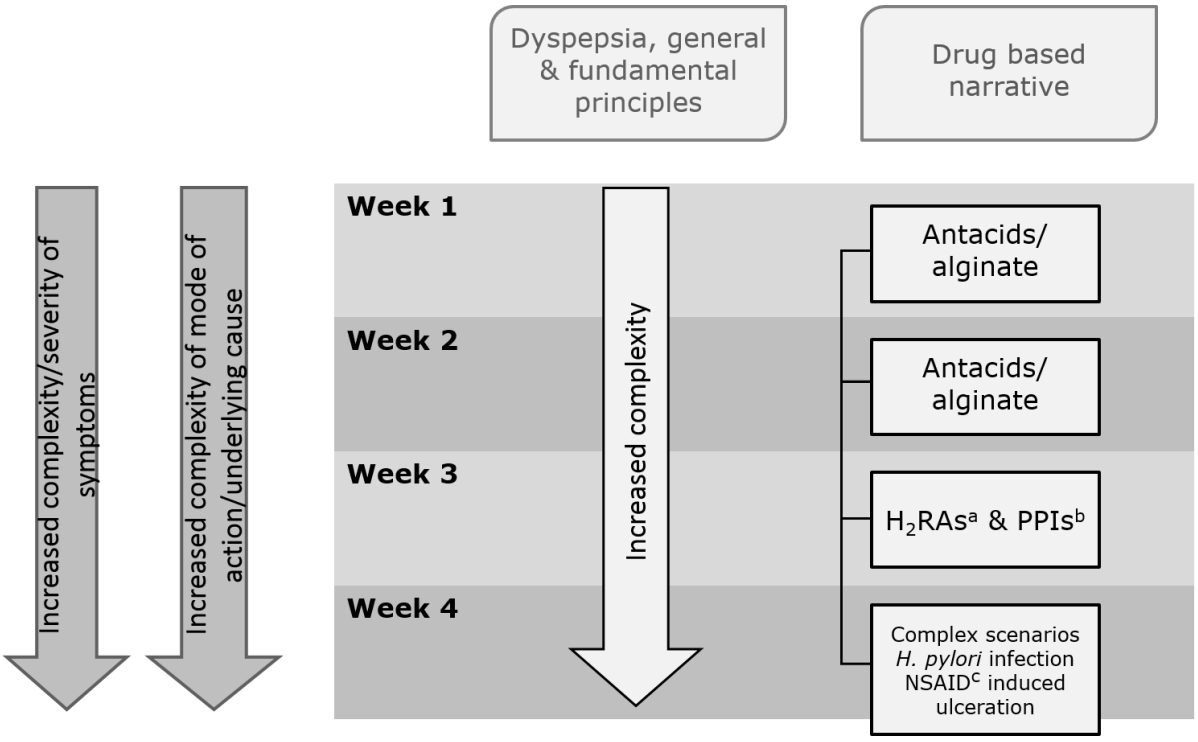

Figure 1. Narrative structure for the dyspepsia module, mapped onto the 4-week timetable.
[a] Histamine H_2-receptor antagonists, [b] Proton pump inhibitors, [c] Non-steroidal anti-inflammatory drug