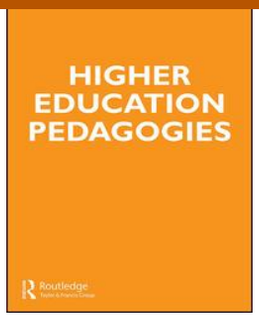

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The need for positive pedagogy in multi-disciplinary STEM courses in higher education: an opinion piece

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In the context of market demands and expectations from STEM graduates, we are moving from an era of specialisation to super-specialisation to multi-specialisation courses. In future, a significant proportion of the next generation of STEM graduates will come from multi-disciplinary courses. Courses such as Personalised or Stratified Medicine, Bioinformatics and Health Informatics, involving inter-disciplinary subjects like Medical Statistics, Genomics or Computational Chemistry and cross-disciplinary subjects such as Computer Programming, Statistics, Mathematics, to name a few examples, will increase. According to Irani (2018), this is increasingly the need across academia.

One issue is that multi-disciplinary courses are very challenging to learn because of their diverse nature, the aptitude required for learning and the number of subjects involved. The challenge is compounded by the expectation that students should learn not only all of the subjects with equal knowledge and skills but that they will also be able to integrate and apply them. Essentially, we want to create 'super-graduates' who know everything (as many STEM subjects as possible) and can do anything (e.g. conduct lab-based experimental work, write computer programs, perform data analysis, etc.).

Considering the newness of many of these multi-disciplinary courses, they may lack appropriately tailored teaching methods. This leads to a significant portion of the challenge of learning those diverse subjects being delegated directly to the students, causing huge stress and anxiety among them. The challenge may be even greater for postgraduate students whose courses last only one or two years compared to undergraduate students who have three or four years to assimilate and contextualise new learning. Therefore, there is an urgent need for research in the field of pedagogy for multi-disciplinary STEM courses in higher education.

As an example, in the context of the UK higher education system, the Higher Education Statistics Agency (HESA), which collects data about all aspects of the sector, unfortunately lacks data tracking of these new multi-disciplinary courses. One of the main reasons for this is that both the Joint Academic Coding System (JACS) and the newly developed Higher Education Classification of Subjects (HECoS), which will replace JACS in the future (HESA,

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2019), do not encode multi-disciplinary courses such as Personalised or Stratified Medicine. As these courses have not yet been classified by JACS or HECoS, this leads to a lack of granular data tracking by HESA. The consequence is a potential missed opportunity for the pedagogical research community to pay attention to the need for developing novel pedagogical approaches required for teaching and learning these difficult multi-disciplinary courses. For a problem to be researched, it first needs to be recognised within the field. Multi-disciplinary STEM courses should not be the 'poor relation' in STEM pedagogical research.

In Advance HE's STEM 2019 conference held at Birmingham, one of the conference propositions was that inter-disciplinary approaches to learning and teaching in STEM are necessary to develop the graduate attributes demanded by students, employers and society. A number of presentations at this conference showcased some excellent innovative and inter-disciplinary approaches to learning and teaching in STEM. However, few raised the issue of pedagogical challenges in multi-disciplinary STEM courses and the research required in this area. The lead author of this opinion piece presented findings from a pilot case study at this conference, highlighting the challenge of teaching Computer Programming to students from a Biology background (Shukla, 2019). This work has now been further developed with funding support from Advance HE through its Small Development Project grant (Shukla, McClean & Hidson, 2019). We have made an attempt to address the stress and anxiety in students caused by the challenges of studying a cross-disciplinary subject (in this case Computer Programming) in a multi-disciplinary course environment (in this case BSc Hons in Personalised/Stratified Medicine). We have used the term 'positive pedagogy' in this respect and argued that pedagogic approaches which facilitate positivity in the classroom (O'Brien & Blue, 2017) are needed to support students' wellbeing as much as their academic development.

The deliberate use of positive pedagogy approaches in this project has led to the reduction of stress and anxiety reported by students and an increase in their confidence (Shukla et al., 2019). We are committed to further work in this area to refine our positive pedagogic approaches in the context of other cross-disciplinary and inter-disciplinary subjects, and take it from university to school level. At this point in time, learning from the results of the current project, we recommend that for teaching cross-disciplinary STEM students, more active, student-centred, problem-based and hands-on learning approaches should be prioritised as compared to traditional lecture followed by practical approaches. These approaches help in decreasing the mental stress among students, foster a creative environment, encourage their independent thinking and teamwork, and overall provide an enhanced learning experience.

It is also important to recognise unique permutations and combinations of subjects in multi-disciplinary STEM courses. An appropriate classification of such courses by organisations such as JACS or HECoS will help in comparing multi-disciplinary courses across different institutions and also in understanding their student cohorts. This type of meta-data will encourage the pedagogical research community to undertake longitudinal studies to develop the field of positive pedagogy for STEM courses in higher education.

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