Got HOTS for students? Flipping Classrooms to Unlock Higher Order Thinking Skills

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Introduction

Higher order thinking skills (HOTS) extend beyond mere memorization and factual recall. They encompass creative thinking, critical analysis, and problem-solving. HOTS demand that students engage with information in more complex and meaningful ways, such as analyzing, synthesizing, and evaluating (Bloom & Krathwohl, 2020), or reflecting, theorizing, and hypothesizing (Young, 1997).

For education policymakers, instructors, and employers, HOTS serve as an overarching goal in teaching and education. Employers consistently prioritize HOTS highly when recruiting new talent (National Association of Colleges and Employers 2024), while policymakers seek to future-proof economies by emphasizing the importance of HOTS in a world characterized by an abundance of information (OECD, 2022).

Instructors play a pivotal role in fostering HOTS through teaching and learning activities (TLAs). These activities empower students not only to surpass basic thinking skills but also to independently form opinions, construct arguments, and challenge assumptions (Pluim et al., 2020). Arguably, in-class discussions not only embody democratic ideals by recognizing everyone's right to speak and obligation to listen (Brookfield & Preskill, 2012), they also align with scientific principles of reasoned deliberation and skepticism (Merton, 1973), actively engaging students in their own learning (Barkley et al., 2014).

However, despite the theoretical appeal of HOTS-focused teaching, practical implementation can be challenging. Classroom discussions, often dubbed the "dreaded part" of teaching (Frederick, 1981), require suitable framing, effective facilitation, and student

engagement. A recent meta-analysis indicated that while classroom discussions positively impact comprehension, critical thinking, and reasoning, achieving these benefits necessitates sustained deliberate effort from instructors (Murphy et al., 2009). Even dedicated and experienced instructors and course developers may find designing HOTS-focused activities daunting (Dallimore et al., 2004).

How, then, should instructors and university course designers engage students in HOTS? How can instructors accommodate the diversity of students' learning preferences and use students' diversity to construct learning situations conducive to HOTS? How can HOTS performed in social in-class sessions be assessed? In this article I explore a flipped classroom (FC) teaching format as a way to engage students in HOTS. FC is a pedagogical model that inverts the traditional learning environment by delivering instructional content outside of the classroom and moving the conventional homework into the classroom (Lage et al., 2000). In particular, I describe the development and implementation of a FC in a *Regulatory Science* course for 25 MSc students. On this basis, I discuss whether and how HOTS may be assessed as part of summative student performance assessment.

The article is organized in four sections. First, I describe the course setting that the FC was developed for. Secondly, I describe the rationale for implementing a FC and the components of the intervention. Third, I discuss the immediate outcomes of the intervention based on a survey of students' perceptions and satisfaction with the FC format. Fourth, I discuss the potential of assessing student performance in HOTS.

Setting: Introductory session of *Regulatory Science* for 25 MSc Pharmacy students

Engaging students in HOTS presents challenges when designing TLAs. This is due to the necessity for students to master lower-level skills and understand material that can be subjected to HOTS, such as in discussions or case studies (Bloom & Krathwohl, 2020). Additionally, the effectiveness of a TLA in achieving student learning goals is influenced by a range of different factors. These include the size and composition of

the student cohort, their motivation for the program or course session, their preparation strategies, and the assessment formats of the course.

This article revolves around engaging students in HOTS in a *Regulatory Science* course for MSc students in Pharmacy and Pharmaceutical Sciences. The course typically has around 25 students. After co-teaching the course several times, I've identified three main challenges with students' learning outcomes and engagement: 1) It is a 'dry' course which requires a fair amount of reading and studying administrative procedures and organizations, which differs from other, lab-based courses that students are more accustomed to; 2) the student assessment is continuous and based on participation and portfolio, with no final performative assessment; 3) the course material includes significant portions of law, public administration and political science - not habitual territory for students.

The intervention was designed for the first session of the course, a 4-hour session. The first hour introduces the course plan, the instructors, and the students to each other. The remaining three hours introduce the legal and political framework for medicines regulation in the EU. My specific part of the course requires students to study and discuss normative questions. These are questions that, by definition, do not have finite answers and instead rely on judgment according to values, principles, and norms.

Intervention: Flipped classroom

I organized the three-hour course session using a FC approach. This involved providing students with three concise video lectures and accompanying quizzes as preparatory material. During our 3-hour face-to-face session I gave a 25-minute recap of the videos and facilitated discussions and case-work activities. This constitutes a fairly typical design of FC material and activities (Shi et al., 2020).

An FC approach to teaching sets different requirements from both students and instructors. For students, FCs puts a premium on active participation and necessitate coming to class prepared, having already reviewed the lecture material and gained a basic understanding of the concepts covered. For instructors, FCs requires an interest in creating or

curating instructional material, such as video lectures, podcasts, or quizzes. This process can be more time-consuming than preparing traditional lectures, especially initially. Instructors also need to focus on specific concepts that suggest direct application. The in-class time is dedicated to active learning activities like discussions, problem-solving, or group projects. Managing these activities and ensuring student engagement can require different skills compared to delivering a traditional lecture. Lastly, FCs require instructors to modify assessment strategies.

The first course session was organized as a FC for several reasons. The intended learning objective of session was for students to understand the political and legal framework of medicines regulation in the EU. A key point in this regard is to understand that norms and values underpin the regulatory system; it is political and reflects the diverse political communities of the EU and its member states. An FC approach allowed more in-class time to discuss these normative aspects and reach understanding of the multiple values and interest that shape this political field. Moreover, creating the preparatory material myself allowed me to develop the video lectures with the discussions and case-studies in mind at the level of complexity that I expect from students. Given that regulatory science is an interdisciplinary field of study, there is no suitable reading material that I know of which gives students with a science background an introduction to the political and legal framework.

Preparing to deliver a lecture in a video format forced me to focus specifically on the concepts that students needed to master in order to reach the intended learning outcomes. For this introductory session the existing lecturing material I 'inherited' covered a wide range of content on regulatory institutions and procedures and legal and political governance - more than students could realistically absorb and construct knowledge with. So, rather than focusing on the '*what*' of medicines regulation, I focused on '*why'* the regulatory system in designed this way. My purpose was to get students to understand underlying mechanisms of the legal and political framework, because they should be able to apply them as analytical concepts later on in the course.

Outcomes: student reactions, work-load reflections and course material design

Students were overall positive about the FC video material and quizzes, but they indicated room for improvement of the connection of video material and in-class TLAs. Those are the conclusions of an anonymous, five-questions survey I distributed to the students a week after the FC intervention. More specifically, the students found the videos informative, and half of them found them very informative. The students also found that the quizzes designed for each video helpful for retaining the information: 55% found that they helped very much and 40% somewhat helpful. The students found that teaching activities helped understanding the material in the videos, but the answers were more mixed than questions 1 and 2: 40% found teaching activities very helpful; 30% somewhat helpful; and 30% neither.

While the survey responses demonstrate overall satisfaction, my pedagogical supervisors' and my own observations about student participation in the in-class discussion were less positive. The participation was characterized by few active participants, short replies and students distracted by other activities on their devices. I have observed the same in previously renditions of this course. In the subsequent discussion with my pedagogical supervisors, we discussed various factors in this disengagement: The course session introduced new format and new types of questions which may cause some students to hold back with participation and observe instead. Also, the student group was culturally diverse, and some may not have experience with plenary discussions.

Another important outcome FC intervention revolved around its sustainability as a teaching format, namely that designing and implementing FC required few additional resources. Initially, my main reservation with the FC teaching format was that it would require a lot of resources to develop lectures, videos and quizzes from scratch. While I spent significant time developing lectures because the material was new to me, recording videos and making quizzes did not require significant extra work. All videos were scripted word-for-word and subsequently recorded in one take. In the future, the scripts will allow me to update and

re-record videos every time I need them. The quizzes were developed by uploading the video scripts to AI chatbots with a prompt to develop a quiz, which I then screened for quality and accuracy and selected the quiz items that were suitable, revised them or added my own.

The second benefit of the flipped classroom approach was that I not only gained time in face-to-face sessions with students to do in-class activities because they had already seen the lecture; I also gained significant mental resources to focus on in-class activities in preparing for the session. Where I would normally focus too much on lecturing material (particularly for new lecturing content), in the flipped classroom the lecturing was already completed, and I had more time and energy to think more creatively and dynamically about what in-class activities would support the material best and move students towards ILOs.

Facilitating and assessing classroom discussions

The FC was beneficial to students in realizing intended learning objective of understanding the political and legal frameworks. But it seemingly did not have a significant positive effect on the students' engagement in HOTS, at least based on the character and degree of student participation in the plenary activities. While this may be immediately disappointing, it raises relevant questions about whether student participation is a useful indicator of engagement, particularly of engagement in HOTS. Shi and Tan (2020) argue that the prevailing notion that vocal students are engaged in learning and silent students are disengaged is too simple and potentially problematic. It overlooks that silent students may be equally or more emotionally and cognitively engaged in learning than vocal students, and the implication may be that instructors focus disproportionately on vocal students over silent students who may, in turn, become less engaged over time.

In the case of the FC intervention, this point is important because it brings nuance to the observation that most students were disengaged in the plenary activities. Again, this was the first course session, the subject matter and the teaching format was new, and the epistemic perspective (i.e. normative aspects) was different. On the one hand, this degree of novelty may have caused students who would otherwise have participated

vocally to be silent. But on the other hand, following Shi and Tan (2020), the important question is whether the plenary discussion was the right activity to engage students in HOTS given the novelty of the session. Plenary discussions will typically prioritize students who are vocal. But there are other ways of engaging students in HOTS that may have worked in combination with the FC. For example, Aflalo (2021) suggests generating questions as a way to contribute to a discussion may be an important component of engaging students in HOTS. While HOTS like constructing arguments, critiquing assumptions, and engaging in debate may not be conducive to some students' learning preferences, activities that promote reflection and questioning about the course may be better suited to some students' styles of cognitive and emotional engagement.

Nonetheless, teaching situations where students feel more at home in the material and where the social dynamics of the student group are more established, plenary discussion may be a very valuable format to engage students in HOTS. While classroom discussions are typically a means to an end, namely to discuss to learn, we may equally perceive discussions as an end in itself, namely to learn to discuss as a way engaging socially with the knowledge. Kristine Bruss (Bruss, 2009) has composed a set of guidelines to assess the quality of students' participation in in-class discussions about an assigned text. The guidelines differentiate contributors in terms of mastery of material, quality of ideas, effectiveness of argumentation, and general impression. For example, the contributions of a student who the highest assessment ("A") are characterized by

1) reflect[ing] exceptional preparation as evidenced by frequent authoritative and/or creative use of textual/material evidence.
2) Ideas offered are always substantive (i.e., unusually perceptive, original, and/or synthetic) and provide one or more major insights as well as direction for the class.
3) Agreements and/or disagreements are well substantiated and persuasively presented.

[In conclusion] *If this person were not a member of the class, the quality of discussion would be diminished markedly*." (Bruss, 2009)

While the applicability of Bruss' framework for assessment is limited to classroom discussions where students discuss an assigned text in a seminar-style format where instructors can observe the discussion of all participants, the application of HOTS concepts in an assessment framework may provide basis for further development.

Conclusion

This article reports on the implementation of a flipped classroom teaching format to engage students in higher order thinking skills. While students found the flipped classroom format valuable and the video lectures and quizzes helpful in learning, the connection to in-class activities required further consideration. In particular, the observed low student engagement in plenary discussions raised questions about how to determine suitable activities to engage HOTS and how assess them. Further consideration of how different types of student engagement may linked to different kinds of activities (Shi & Tan, 2020) should be considered, and the assessment of students' HOTS should be performed on the basis of a framework that directly applies concepts from HOTS theory (Bruss, 2009).

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