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How To Think About Fluids In and Out of Classrooms: Developing Interactive Strategies for Learning Fluid Mechanics in a Hybrid Setting

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1. Introduction

In this extended abstract we report on the strategies used in an introductory fluid mechanics course that transitioned from a fully in-person mode of delivery in Fall 2019 to a hybrid mode in Fall 2020. The course was delivered in a fully in-person mode in 2019, consisting of two weekly lectures and a recitation session by the main instructor of the course. In 2020 on the other hand all lecture sessions were held online and weekly recitation sessions were offered both in person and online. We leveraged Matlab live scripts in the homework assignments to integrate the mathematical and graphical representations of the fluid mechanics problems in Fall 2020, which as shown in recent studies can decrease the cognitive load for students during their work with abstract mathematical concepts [1]. Furthermore, to address the challenges that students face in terms of motivation and engagement in an online mode of delivery we developed team-based “scavenger hunt” missions around everyday fluid mechanical concepts and systems that students typically encounter all around them. This decision is based on research that shows motivation is driven by the fundamental needs of students for autonomy and relatedness of the learning experiences to everyday life [2]. In this extended abstract we report on the development of these activities and include a brief set of preliminary results.

2. Design of Activities: Transitioning to the Online Setting

The in-person fluid mechanics course that was offered in the Fall 2019 was based on the textbook written by the instructor of the course himself and the lecture sessions followed a *case study* format which help concretize the subject matter and make it relatable for engineering students beyond an exercise in abstract thinking [3]. For example, to teach the concepts and principles of hydrostatics, several lectures were devoted to water towers, aqueducts and canal locks. Through the examination of engineering systems and their functionalities we can help students develop a sense of how ideas and theoretical concepts tie to practical problems and specific challenges that engineers need to deal with in practice.

2.1. Matlab Live Scripts:

In Fall 2020 we added a new component to the weekly homework assignments. To support students' development of a visual as well as mathematical intuitions in topics such as vector fields, surface integrals, and streamlines, the instructor developed Matlab live scripts to accompany a number of the weekly homeworks. In the literature, live scripts have been used in various ways to support student learning and to promote computational thinking in engineering courses [1,4]. Our typical live scripts include a set of codes that produce a dynamically adjustable figure. In some cases as shown in Figure 1 students can symbolically define functions, for instance corresponding to the components of a velocity field or the volumetric pressure function. With that we direct students to go beyond mathematical derivations, and to interpret how changes in the behavior of a system (of equations) is explainable.

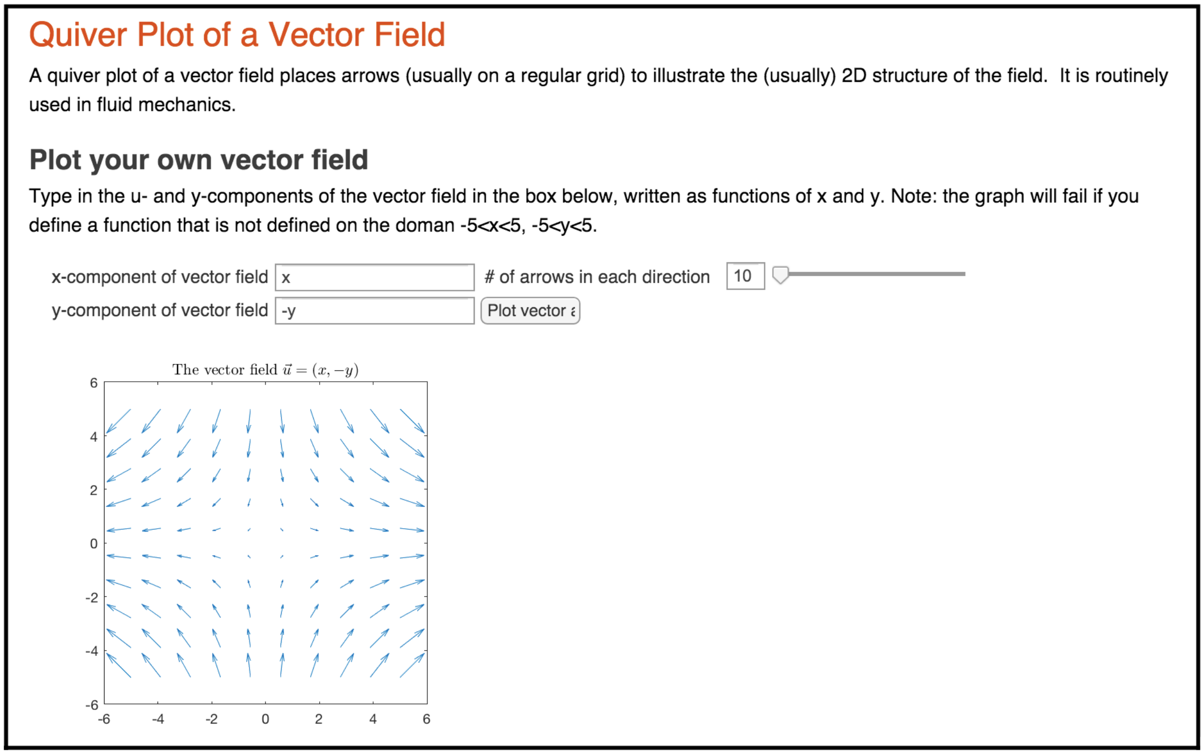

Figure 1. A snapshot of the live script developed to accompany a homework problem on velocity field.

2.2. Scavenger hunts:

The next new component of the course in the Fall 2020 was a set of weekly team-based scavenger hunt missions that we implemented by a mobile application called goosechase [5]. In the application we described and progressively released a set of weekly missions that allow student teams to gain reward points based on completion of each mission. Student teams are allowed to submit a photo or a video evidence in addition to a brief caption. Our goal in using this platform was manifold. It served as a means to more closely engage students with the course material outside the classroom since we ask them, among other things, to look at the everyday objects and processes around them through a fluid mechanics lens. This activity also served as a way to foster a sense of community since students shared their creative and at times artistically expressive solutions with each other. Overall we received 1072 submissions from 25 teams, one of which was formed by the members of the instructional team, with an average number of approximately 42 submissions per team.

3. Discussion and Conclusions

We measure students' motivation and attitudes towards learning by adopting portions of the Motivated Strategies for Learning Questionnaire (MSLQ) that was administered towards the end of each semester [6]. The survey included multiple items related to intrinsic and extrinsic motivation, self-efficacy, task value, and peer learning and the only statistically significant change (t-test, $p \ll 0.01$) that we observe in the survey results is students' attitude towards lectures. In 2020 students regard the lectures as more beneficial towards their learning compared to 2019. Further analysis of this data and the comparison of course grades across two offerings will be the next step of this research to get a better sense of students' learning.

Going forward we are interested in expanding both of the strategies used in the Fall 2021. Matlab live scripts can be leveraged as classroom activities in Zoom breakout sessions or otherwise in more homeworks assignments. Scavenger hunts can be further used to sensitize the students on the wealth of fluid mechanical phenomena all around them and their ability to understand and articulate them from an engineering point of view. It can also help us create and sustain a culture of collegiality and positive competition in the future offerings of this course.

References

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