Student motivation and disciplinary expertise in Challenge-Based Learning

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ABSTRACT

Challenge-based learning (CBL) seeks to help students acquire skills necessary for collaborative real-world problem solving. It generally favours self-learning, in which students should seek out their own role in a problem-solving environment and choose their own set of skills to develop which are relevant to the challenge. However students from traditional degree programmes may enter with an expectation that their disciplinary expertise will count and be valued in the context of a project, but face a situation that the problem chosen by a group or the dynamics of a group render their expertise less relevant. In survey-based studies of two CBL modules, we explore the relationship between the roles students play and their levels of motivation. We find no evidence that the lack of a disciplinary role strongly affects student motivation. Rather the data suggests that if a CBL environment is properly framed around self-development and multiple potential learning goals students can relax any commitments or expectations related to their expertise, and take on different roles. This is good news for the CBL aims and goals. That said students do have a tendency to revert to disciplinary roles over the course of projects and are against their disciplinary roles being excluded when they are clearly relevant. Instructors can potentially avoid problems by having students evaluate their role choices against desired project outcomes.

1 INTRODUCTION

Challenge-based learning (CBL) is increasingly advocated as an important option for scientific and engineering curricula, as a means of preparing engineers and other scientific groups for solving real-world problems and engaging better with societal interests and values [1,2]. CBL aims to train interdisciplinary skills, important for real-world problem solving [2,3]. CBL is often (although not exclusively) offered as part of disciplinary programmes [3]. Such courses operate across university programmes and draw students from different disciplinary backgrounds. As such students bring their own expertise and potentially their own expectations regarding the roles they should play in a project team. For example a psychology student may enter a technological design-based challenge with a view that he or she will have a role evaluating how users might engage with a technology, only to find out that the most pressing issues are technical and there is little time or place to consider the psychological dimensions. This might be manifest in the way the challenge is constructed or the decisions groups reach about how best to complete the task. As a result though it is plausible to hypothesize that such events affect negatively student motivation. While the effectiveness of self-learning has been studied [4] the interdisciplinary aspects of CBL have lacked attention [5]. In this paper we pursue the research question: is the motivation of students from bachelor programmes entering CBL courses affected by their ability to apply their disciplinary expertise?

2 METHODOLOGY

2.1 Study design

To explore whether disciplinary roles (and resulting expectations) might affect student motivation we performed surveys of students in two CBL courses. Students were surveyed once in the first two weeks, and again in the last two weeks. Intrinsic motivation was measured with the nine-item version of the intrinsic motivation inventory in both surveys to detect variations [6]. Both surveys also included a variety of statements related to their more explicit motivations, expectations, based on their roles, and responses to behavior of fellow group members (1 to 5 Likert scale; strongly disagree = 1, disagree, neither, agree, strongly agree = 5). See Table 1 below for examples.

2.2. Included Cases

The first course titled “Course 1”, is taught in the third year of bachelor students and is open to students from across a Dutch technical university for one quartile (10 weeks; 15 ECTS). Students collaborate in interdisciplinary groups on a real-world product design problem provided by a “challenge-provider”; either a government agency, foundation or corporation. Challenge-providers provide a problem description and relevant group skills, and provide help on request from students. Learning goals for the module concentrate on developing collaborative and communication skills, integrating stakeholders into a solution and sound design-based decision-making. Students may be from technological or social science backgrounds.

The second course “Course 2” is run for European consortium of universties (5 ECTS; two semesters). Students collaborate on real-world tasks constructed by challenge-providers. Students may come from any background. For learning goals students should develop skills in analyzing complex societal problems and working in teams. But they are also given a choice regarding others; such as whether to work on presentation or leadership skill, design skills, or stakeholder involvement. Project outcomes are not graded. Students are asked to provide reflections on their personal targets, and personal and team development

3 RESULTS

3.1 Figures

Table 1: Sample of questions from the first survey round. Results are Likert averages.

Questions Round 1	**Course 1**	**Course 2**
	n=17 (/40)	n=17 (/31)
I selected the programme to work… on a real world challenge	4.2	4.5
…apply my disciplinary expertise to a real world problem	3.5	3.9
…apply non-disciplinary skills	3.5	4.1
… on new skills	4.3	4.3
I chose my challenge..…as societally relevant	4	4.5
…as relevant to my disciplinary skills	3.2	3.5
…as relevant to professional skills	3.2	3.5
.. to develop new skills	4.2	4.2

Table 2: Sample of questions from the second survey round. Results are Likert averages. Some questions, marked ‘X’, were only developed after surveys of “Course 1” students.

Questions Round 2	**Course 1**	**Course 2**
	n=7 (/40)	n=12 (/31)
Most of my challenge contribution has come from…my discipline	X	3.2
… professional skills	X	3.8
….new knowledge and skills	X	3.5
My contributions fit the kind of role I expected to play	X	4.0
The challenge did not offer all members the same chance to use their expertise.	2.9	2.3
We would have a more optimal solution if I had used my disc. expertise more.	3.3	2.7

3.2 Discussion

In neither course was there evidence that a failure to contribute disciplinary expertise played a substantial role in student motivation. This holds despite many students having a non-disciplinary role geared towards the use of professional skills or development of new academic skills (roughly half of Autumn Challenge students).

Overall student intrinsic motivation increased for each programme rather than fell, likely as a response to students becoming more familiar with their challenges, their roles and their group members.

In terms of the explicit motivations guiding their choice of these CBL programmes or their challenges students put more weight on developing new scientific/engineering skills outside their area of expertise or working on a societal problem over use/development of disciplinary skills or professional skills (see Table 1 below; first question round). As both courses explicitly allow students to consider and take different roles beyond their background expertise, not being able to use one's expertise is likely not considered an issue. The vast majority of students in the Autumn Challenge felt they performed a role in line with their expectations going into the programme. Students from neither programme felt that they were excluded from playing a disciplinary role if they wanted to. Fellow group members were generally open to including any approach. Further students did not feel it necessary to have a disciplinary role if this was not relevant to an optimal or indeed just a good enough outcome. This is good news for CBL which stresses flexible and personal outcomes.

However there are a few notes of caution before drawing the conclusion that students will always be happy to look passed disciplinary roles and be flexible. In the first place many students (around 25%) do still express a primary preference for having a disciplinary role, and for a fraction of students, being excluded, particularly those from the social sciences, is demotivating. Secondly in Course 2 projects were not formally assessed or graded, relaxing incentives for producing an optimal result. A majority of students in both groups did not feel that taking a disciplinary role would have improved the overall project outcome. However most students still felt that they would not be happy if their disciplinary expertise was excluded when it would produce a more innovative outcome. Most students agreed that if their discipline was equally important to a problem solution it should have an equal role. Further while students generally think that their group members respect their disciplinary expertise, and to a lesser extent are willing to learn from it there is a measurable change in how students perceive the willingness of their teammates to work outside their disciplines over the course of a programme. For the statement "*My fellow group members are willing to experiment with methods and ideas outside their background disciplines.*", which was asked both rounds average agreement dropped 25% in both groups. This suggests that students do revert somewhat to disciplinary approaches or familiar skills, even if initial attitudes are towards acquiring new skills, possibly because it takes time to recognize a disciplinary role or because it turns out easier.

Students were free to choose these programmes. Both were offered additional to their normal disciplinary education, rather than part of it. Applying CBL as say part of normal disciplinary education, in which projects are graded, thus might face motivational issues related to disciplinary roles on the basis of these student preferences. However with the right expectations, self-selection of students and opportunities for transversal skill development, educators should avoid potential motivational problems. Regardless there are different possible responses educators can take to manage such problems were they to arise. Students might be given an innovation management strategy (such as knowledge cross-fertilization or Scrum) which help students plan upfront their roles, and systematically integrate their expertise [7]. Students can be otherwise guided to explicitly consider their desired project aspirations when making role decisions; e.g. “Is my role choice likely to generate the most optimal or practical outcome? Do I want that?”. Further it can be useful for groups to consider the potential contributions of all disciplines before settling on an approach.

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