The Wicked Problem of Engaging Students in Their Studies

David Beaulieu and Julie Roberge

In December 2019, David Beaulieu, a teacher in Engineering Physics Technology, accompanied some students on an expedition to a glacier in Peru to use a classroom-designed weather station as part of a capstone project. The purpose of the expedition was to document the impacts of the melting of glaciers in order to mitigate its consequences. The expedition had unexpected impacts: as students became aware of their role in observing climate change, their teacher noticed they became highly motivated to examine the strengths and weaknesses of their measuring instrument and, as a result, became interested in further education. Whether teaching online or face-to-face, as teachers we are always looking for ways to spark motivation in our students. How do we get them to be motivated to pursue, commit to, and complete their studies? How do we find topics to captivate them? The topics addressed by so-called "wicked problems" and socially acute questions might be a way in.

In the winter of 2020, David set up another activity in an authentic situation to motivate his students: a technological innovation project to measure the distance between a car and a bicycle during an overtaking manoeuvre. In this way, the students could have observed that the knowledge acquired in their program could contribute to creating solutions to road safety issues. However, COVID-19 and the health measures imposed on the college system decided otherwise: the device intended to measure the distance between a car and a bicycle was transformed into a device intended to measure the distance between two people, in order to help the population maintain the required distance of two meters in public places.[1] Again, this experiment created unexpected impacts: participation in this project seemed to transform the students' sense of powerlessness created by the pandemic and distance learning into an ability to act. For some students, the motivation and engagement that seem to have followed would even confirm, according to the teacher, their vocational choice.

These two issues of melting glaciers and physical distancing between people are broadly aligned with climate change and the spread of the COVID-19 virus; they are, in principle, ill-defined and perhaps intractable societal problems for which students do not have answers. According to the literature, these issues or problems are likely to generate interest, motivation, and engagement in study because they are issues that students are concerned about and because they replicate a certain reality, even if not totally so. This is why it is so important to carry out these projects in authentic situations.

The authentic situation falls within the constructivist and socioconstructivist paradigms that place the student and social interactions at the center of learning. Measuring glacier melt by building a weather station and measuring the distance between individuals resemble the ill-defined problems that Engineering Physics Technology graduates will encounter in their professional lives. Thus, giving students a real task allows them to work in teams, and to apply the skills, knowledge and know-how developed in their program so that this learning is sustainable and,

[1] On this subject, see David Beaulieu's article "Former une relève en intelligence artificielle en contexte de pandémie : quand un projet d'innovation technologique génère l'innovation pédagogique" published in *Pédagogie collégiale* in the winter of 2021 (vol. 34, n° 2) or the text "Transfert de connaissances entre cégeps en Technologie du génie physique" published on Eductive.

eventually, transferable. The solution found, based on a synthesis of declarative, procedural and conditional knowledge, must be personal because there is no single expected answer: The authentic situation thus allows students to become truly competent because they mobilize a set of resources related to the cognitive, social and affective dimensions of learning (Duval & Pagé, 2012, p. 22). This meaningfulness of the task corresponds to the students' fields of interest and their concerns (Viau, 2000). In the case of the project to design a measuring instrument (the weather station or the distance between individuals), the authentic context is expressed, among other things, through interactions with the research team in designing the instrument, as well as extracurricular field trips to take measurements for functional testing throughout construction and in different contexts.

Motivation

According to Viau (2009, 2014), a motivated student must first perceive the **value and usefulness** of a learning activity in order to be willing to engage in it. This perception allows them to use learning strategies other than rote learning. Perceived **competence** also affects motivation: students who overestimate themselves will have difficulty dealing with failure, while those who underestimate themselves often give up before they have even honestly tried. From this perspective, a **sense of self-efficacy** refers to the ability a student believes they have—or do not have—to succeed at a given task in a given context (Bandura, 2003; Gaudreau, 2013). Perceived **controllability**, on the other hand, indicates that a link exists between the reasons for success or failure and the controllability a student has over their learning. The more responsible a student feels for engaging in a learning activity, the more they will want to engage in it. To be motivating, an activity must be diverse and integrated with other activities, be meaningful to the student, be challenging, be authentic, require cognitive engagement, empower the student by allowing them to make choices, allow the student to interact and collaborate with others, be interdisciplinary in nature, have clear instructions, and take place over a sufficient amount of time (Viau, 2014).

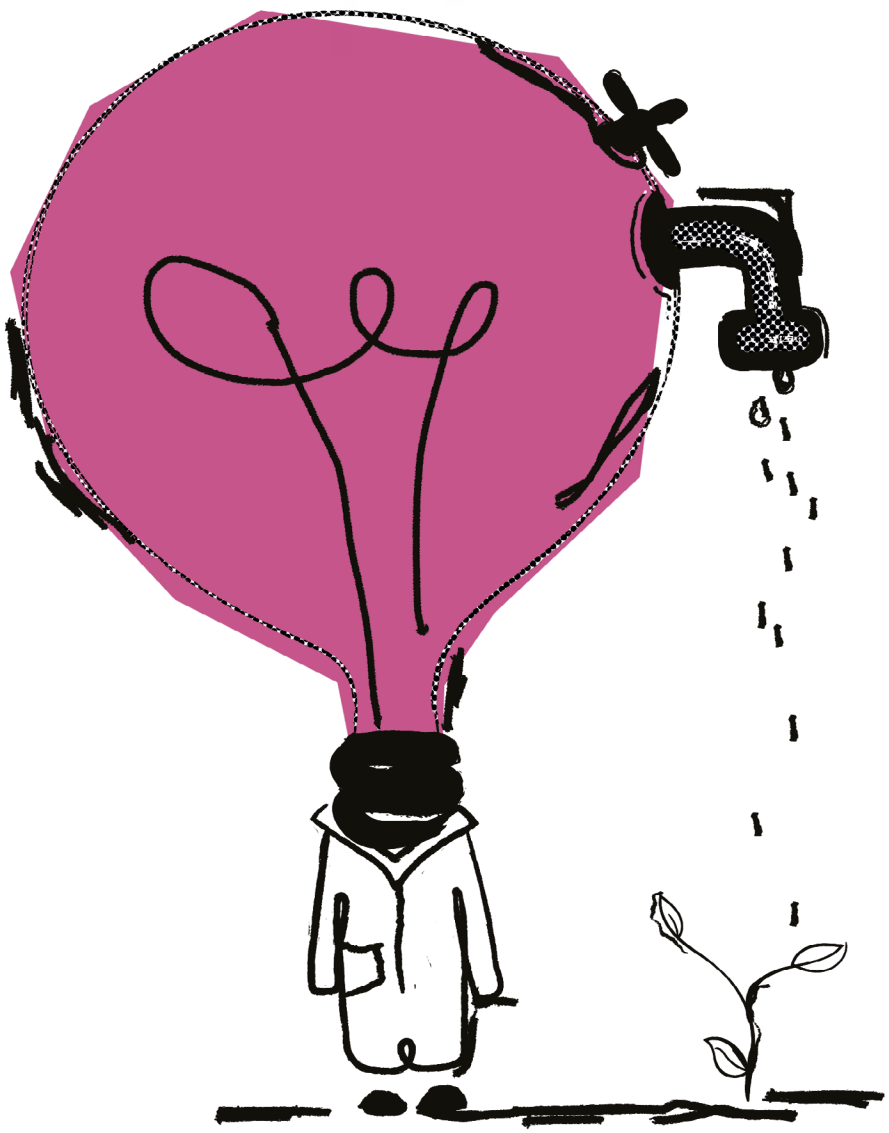
What are "wicked" problems?

But why did the melting of glaciers and the distancing between individuals in times of pandemic create motivation and engagement among students? Probably because they are ill-defined problems of very large scale. This type of problem is called a wicked problem (Rittel & Webber, 1973). These are cases that are difficult to objectify, for cultural or social reasons, because knowledge on the subject is incomplete or contradictory, or because the number of people involved or the associated economic weight is too great (Fréchin, 2019). The concept of the wicked problem has emerged in the world of higher education relatively recently, although its teaching exists in Europe and English Canada. In the Quebec college system—though a higher education system—it is addressed only from a social point of view, using the term "question scientifique socialement vive" [the translation of "socially acute question," Ed.] (Bizier, 2020).

The wicked problem is a complex problem that has no obvious solution, cuts across disciplines, and can cause concern for individuals: climate change, pandemics, poverty, hunger in some countries, inequity in wealth, and world peace (Maxwell & Blanski, 2016). Given the seriousness of the problems, it is important that the approaches to wicked problems put forward solutions, so as to counteract the sense of helplessness that students might feel. Taking the time to teach about wicked problems can help students position themselves as global citizens (Bishop-Williams, 2020). All work around a wicked problem advocates active learning

that draws on application, analysis, and self-assessment activities that are rooted in real and meaningful contexts to engage students in finding solutions (MES, 2021, p. 56). The work must also be done in authentic contexts, especially since there is no single solution to a wicked problem: students must "create" answers according to the challenges of the world they face and the contemporary issues that are of interest to them. In order to avoid the problem to be addressed becoming a source of anxiety for students—one only has to think of the extent to which eco-anxiety manifests itself in young and old alike—it is important to address the wicked problem in an authentic situation, in action, in resolution mode. It is when students feel that their skills can be used to address even a small part of the wicked problem that the engagement to learning the necessary skills arises. The further these young people progress toward higher education, the more they expect their education to prepare them in meaningful ways to help address these grand challenges, especially in their future jobs (Cross & Congreve, 2021).

At the heart of wicked problem solving are teamwork, interdisciplinarity, trial and error in learning, reflection and discussion. Solving wicked problems also requires accepting different perspectives, using technical knowledge and skills, using imagination, developing problem-solving skills, and improving communicative skills (Termeer, Dewulf, & Briesboeck, 2019; Simm, Marvell, & Mellor, 2021). According to the latter, "the ability to deal with wicked problems will necessitate the development of new and innovative learning and teaching strategies" (Simm, Marvell, & Mellor, 2021, p. 483). The construction of the weather station and physical distancing instrument stretched the students' computer, physics, and electronics skills, while also leveraging their communicative skills essential for teamwork. As such, teachers have a responsibility to prepare students to deal with challenges. Despite this, little research exists on good practices for doing so, although it can be presumesd that transfer of scholarly knowledge into taught knowledge, active learning, and authentic situational learning may be avenues for doing so.[2]



[2] It is for these and other reasons that we have a real interest in doing research on the subject.

The ability to act as a lever of engagement

The theory seems to confirm the intuitive conclusions of David Beaulieu and his colleagues at Cégep André-Laurendeau who experimented with it: learning through a wicked problem, climate change and the pandemic, in an authentic situation (measuring the melting of a glacier in Peru and calculating physical distancing in the streets of Montreal), seems to demonstrate a greater engagement of the students in their studies. This suggests that motivation to learn the skills in the Engineering Physics Technology program would be greater because students used them in an authentic situation and applied to an issue of concern to them (climate change and physical distancing in times of pandemic).

In both projects, teachers believe that mobilizing interest in learning is essential to fostering motivation, engagement, and perseverance in students (Bradette & Cabot, 2020). Students' motivation could come from the actual situations they faced (perceived value and usefulness, motivating factors). Student engagement, in turn, could come from their motivation to see the impact they can make, however small, with regard to two wicked problems, two ill-defined problems in society. Situational interest, a factor related to motivation and engagement with positive emotions experienced, can subsequently give rise to individual interest: "a situation must first arouse and then maintain attention and positive emotions in the person for an individual interest to emerge, develop, and become an integral part of that person in order to trigger a well-developed individual interest" (Bradette & Cabot, 2022, p. 36). The interest that students show then shifts from situational interest to the consolidation of individual interest (Cabot, 2017). Wicked problems therefore contribute to giving meaning to learning, as they prepare students to meet the major challenges of our society.

Engagement

While motivation plays a role in engagement and perseverance, it is also a type of outcome. Engagement is, in a sense, the missing link between motivation and success. Motivation is the force that drives the learner to take the first step toward action, while engagement is the force that propels the learner, leading them to take the second and subsequent steps (Parent, 2014, p. 14). Engagement is seen in the student's sense of belonging to the course, program, or institution; this engagement increases their perseverance, sense of self-efficacy, and confidence, then develops their learning maturity (Roberge, 2021). Engagement is a multidimensional construct that can be broken down into three types: first, **affective engagement** is seen, among other things, through the pleasure of performing a task. **Behavioural engagement** is manifested through participation in class and interaction with peers and teachers. As for **cognitive engagement**, it is revealed in the mobilization of knowledge, skills and abilities to show that someone is able to solve problems creatively and rely on reasoning (Kozanitis, Leduc & Lepage, 2018).

Wicked problems, like socially acute questions, can be addressed in any course, from any perspective! Discussing climate change is possible: think of the drying up of certain rivers in geography, the lives of climate refugees in sociology, or the resurgence of certain diseases that were thought to have been forgotten in nursing. Let's also think of research on vaccines in biology, the calculation of statistics on people suffering from COVID or the study of the novels *The Plague* (Camus) or *Station Eleven* (St. John Mandel) to talk about the effects of a pandemic. Here, discussion is at the heart of the learning process, based on the behaviour of the characters in fictional situations, but which may resemble reality. Not necessarily all projects related to a wicked problem need to be dealt with in a concrete way, in collaboration with other disciplines; they can and must raise questions, positions and reflections that can eventually be transposed to the field.

Teaching wicked problems, in an authentic context, constitutes what Lavoie (2021) calls a high impact practice in higher education, which must meet four criteria: the teacher-student relationship, the pedagogical method, the assessment of learning, and the structuring of teaching. The second criterion, the pedagogical method, must present active and collaborative learning to generate in-depth and contextualized learning, diversified and adapted to the curriculum. It is under these conditions that the teaching of wicked problems allows students to use, compare and improve their knowledge and skills.

Harnessing teachers' creativity to captivate students and to make them enjoy what they are working on (Cabot, 2017; Bélec, 2018) may enable these learners to engage in their studies. The interest generated by projects pertaining to wicked problems could lead to their engagement in both the projects and their studies, because the students would feel that they have a lever that will have a real impact on the wicked problem they have been presented with.

Given the seriousness of the problems, it is important that the approaches to wicked problems put forward solutions, so as to counteract the sense of helplessness that students might feel.

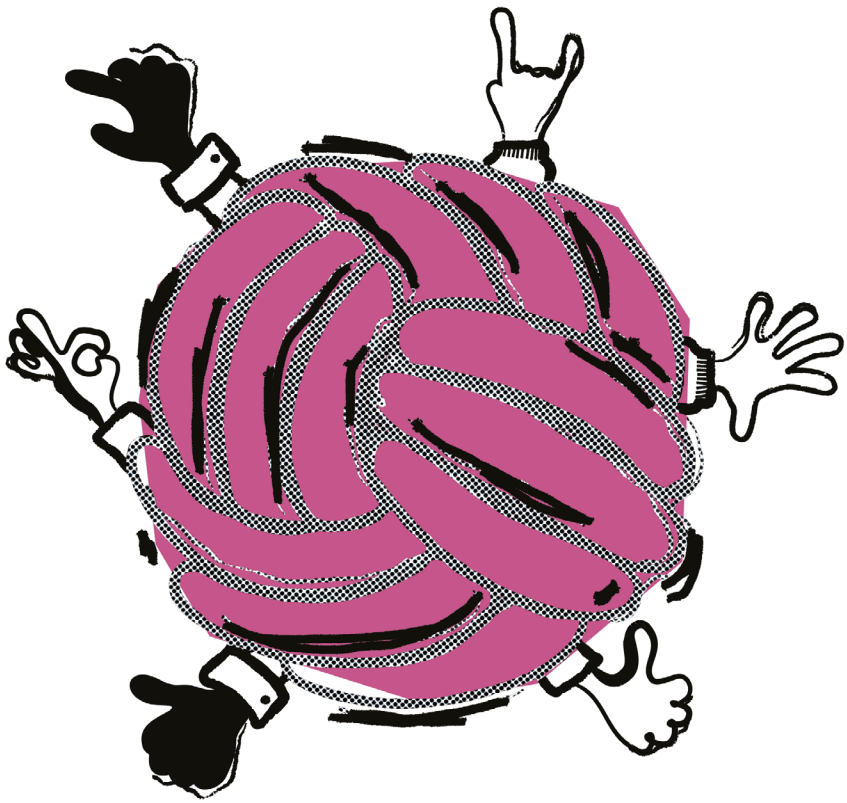
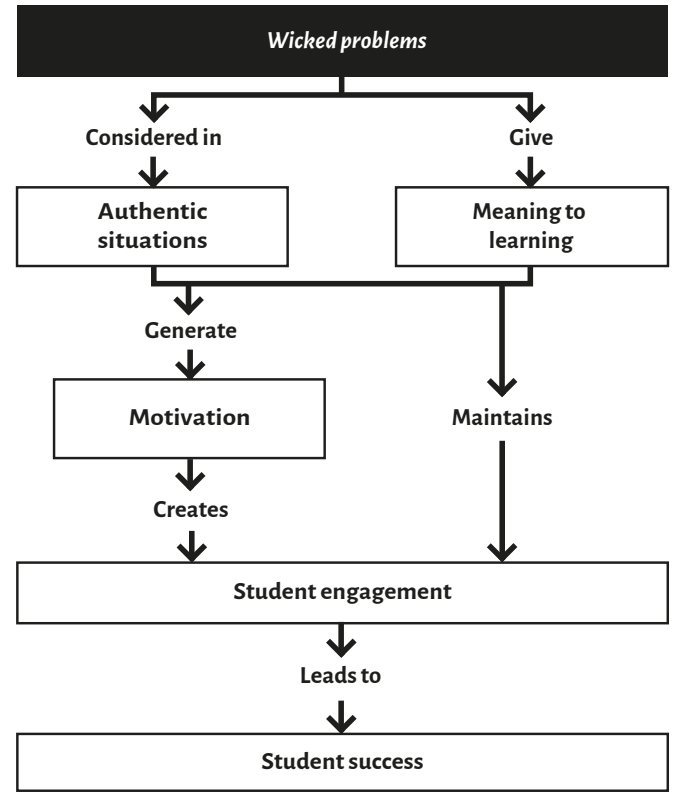


Figure 1

From Wicked Problems to Academic Success



Finally, as shown in **Figure 1**, we believe that wicked problems, because they are experienced in an authentic situation, generate motivation in students who see the opportunity to work on an issue that interests them. Participating in solving a wicked problem would therefore give meaning to the students' learning since they see the result, whether it is the construction of a weather station or an instrument for measuring physical distancing in the case of Engineering Physics Technology students. What is important is that the students' engagement is more present, guided by the meaning they ascribe to their learning and the motivation that comes from it. We believe that it is under these conditions that educational success will be achieved.

Conclusion

Teachers of all disciplines try to propose activities that motivate students and thus engage them in their studies; this was the case for the two projects proposed to the Engineering Physics Technology students by their teacher, David Beaulieu: the weather station to observe the melting of a glacier in Peru and the instrument measuring distancing between two individuals, as part of the health measures put in place because of COVID. We believe that proposing wicked problems (or socially acute questions) to students will make them think about their contribution to society, and the importance of their studies in order to achieve this. We believe that wicked problems, large-scale ill-defined problems, can lead teachers and students to think collectively to find solutions, regardless of the course or the angle chosen to address them. ▬

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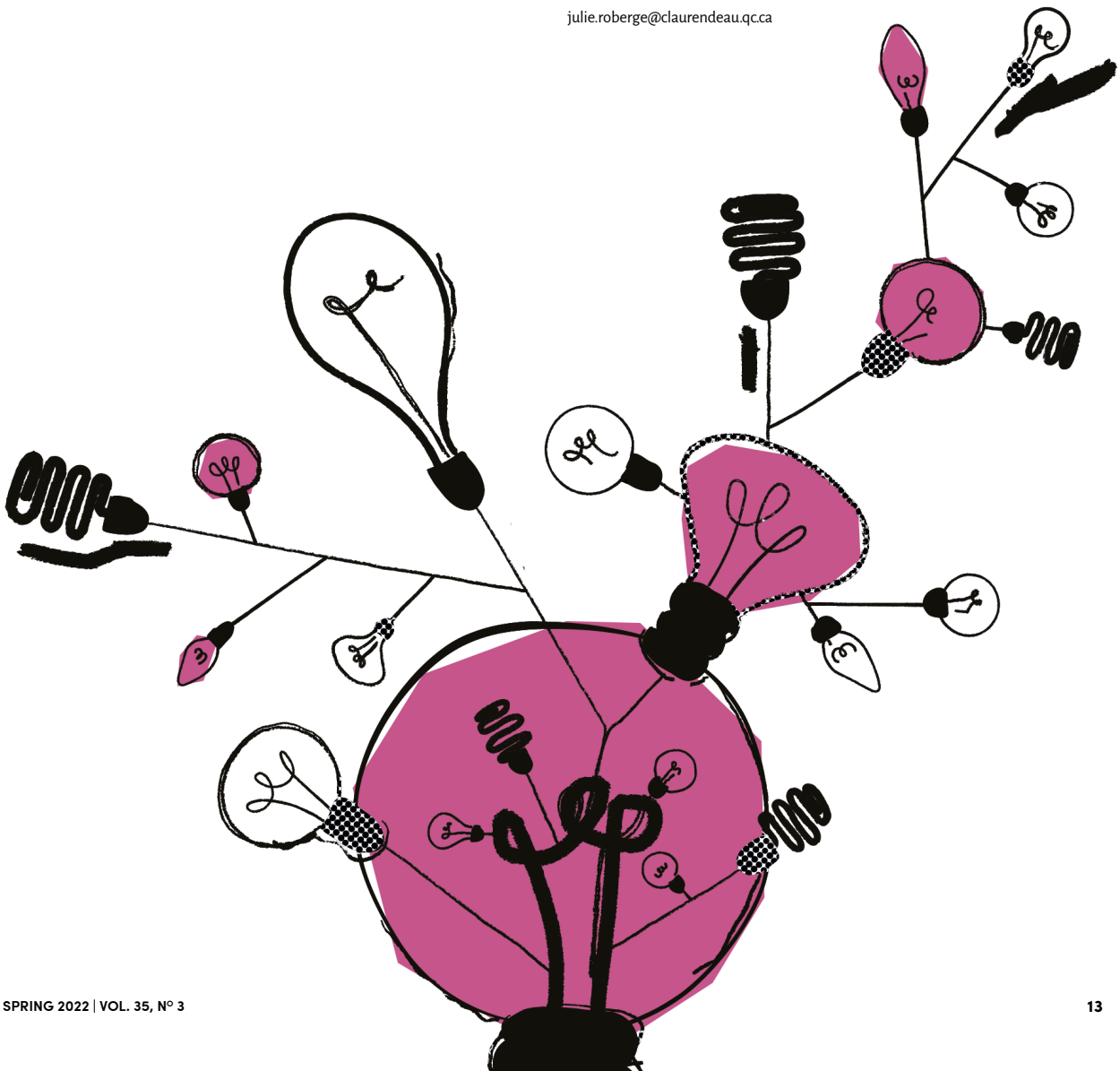

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