Deception in the Pursuit of Knowledge: Unpacking the Illusion of Engineering Education

Dr. Astrid Jensen, Dr. Kasper Rasmussen

Dr. Astrid Jensen, Department of Mathematics, Faculty of Science, Aarhus University, Aarhus, Denmark;

ABSTRACT

Following principles derived from self-regulated learning and self-determination theory, good feedback practice should provide feedback on the subject and learning practice. However, large groups and lack of time prevents the teacher from providing individual written feedback. In a qualification course in mathematics, we have implemented an assessment practice with immediate feedback that aims to create a dialogue between the lecturer and the students. The feedback is combined with selfevaluation. We also ask the students to reflect on the learning process. Common challenges appearing in the written reflections are then addressed in a subsequent intervention.

Today, learners have access to online video lectures that can support learning or in some cases replace lectures. In these online videos, they can watch experts explain a subject and perform calculations with ease. However, watching these instructions or lectures alone might create the illusion of having acquired the skills without having spent the effort.

What we see from the students' self-evaluations and reflections is that they often fail to recognize the difference between understanding a subject and being able to apply the knowledge. Through these assessments, students experience the difference between doing calculations with a textbook or a guide available compared to working on their own. Using what the students write after such assessments are used to introduce what interventions are needed. “I don't know what happened today, because I know this!” represents an experience that was used to initiate a discussion with the students on the concept *illusion of learning*.

INTRODUCTION

This comment appeared as a part of a student's written reflection after a formative assessment in mathematics. Clearly, the student was surprised by the actual performance compared to the efficacy beliefs held by the student. The experience expressed through this statement is not unique. However, the question is: How can we understand this and similar experiences? Of course, there could be numerous reasons for this experience – some of which are outside the student's control. He or she could have been surprised by an unusually difficult set of mathematics problems. It could be that the student had a bad day or problems concentrating. However, there is a self-reflecting message here. The student seems to judge the problems to be within what he or she expected to master, but there appears to be a mismatch between

© 2024 Computer Engineering. All Rights Reserved.

the perceived knowledge and the actual ability to solve the problems. What are the possible reasons that might cause this experience? Can we as teachers learn something from trying to interpret these short reflections?

The experience given in the comment above can also shed light on similar experiences. For example, students participating in regular lectures make comments like, "it is so easy when you do it!" This illusion of knowing the material after having seen others solve and explain problems may falsely give the students the impression that they have acquired the transferred knowledge. Some students even believe in the idea of an ideal student, for whom it should be enough to just show up for lectures, to achieve the necessary skills.

Adding to this, a part of the modern way of studying is to use online videos of skilled professionals solving problems and explaining. Students find video lectures online, some closely related to the curriculum in the Norwegian language, like "campus increment" and "matematikk.net". In addition, international pages like Kahn Academy and YouTube provides a lot of excellent presentations where professionals explain and show how a student can understand and solve problems. Merely watching others may create the illusion of having acquired the skill [1]. The students have limited knowledge about learning as active construction of knowledge and skills, and the amount of work needed to learn mathematics.

In this paper, we describe how the initial comment appeared in the context of a dialogic feedback process related to formative assessments. Finally, we will offer a theoretical interpretation of the initial citation which may be useful when addressing this and similar student experiences.

THEORETICAL BACKGROUND

It is a known problem that students have varying degrees of knowledge about how they learn. When we ask first-year engineering students at NTNU "*Would you say that you study the way you do because a teacher (or teachers) taught you to study that way?*" between 80-85% answer "no". Similar results are reported by Hartwig and Dunlosky [2] and Kornell and Bjork [3], where 64% and 80% of the students (respectively) report that they have not been explicitly taught how to study. As stated by Bjork et al. [3], "*people often have a faulty mental model of how they learn and remember*" (p. 417). How to study and manage the learning process is probably the most important knowledge structure that we co-construct in a lifelong learner's mind.

Koriat and Bjork [4] define the illusion of competence as the "overestimation of one's future memory performance"(p.187). Koriat and Bjork point at the fundamental difference in conditions between learning and testing situations as a cause for the overestimation. Formation of a belief about future performance is made in a learning context, with social support from peer students and a teacher, textbooks, and the answer readily available. In contrast, in an exam (i.e. test) context, support and resources are strictly limited.

Carpenter, Wilford, Kornell, & Mullaney [5] has shown that fluent and well-prepared lectures give the students an illusion of having learned more than from an unprepared and disorganized version of the same lecture. However, the actual student

© 2024 Computer Engineering. All Rights Reserved.

performance as a result of participating in these lectures was shown to be equal in these two cases. The way a student makes a judgment of his or her learning is based on a system that might give rise to such illusions.

Koriat and Bjork [4] do not include the emotions involved in the learning context. Learning, attention, memory and decision making, in general, are influenced by emotions [6]. Recent theory links emotion as a cue for learning, and so people may be misled by recent emotional states to infer that they have learned more than they have [7].

Baumeister, Alquist, and Vohs [7] have investigated how emotions shape the way we make judgments of our knowledge. Their participants "*rated that they learned more after an emotion had been induced than in emotionally neutral control conditions*" (p.149). Baumeister et al. observe that the illusion of learning is caused by emotions in general.

THEORETICAL BACKGROUND FOR ASSESSMENT

To facilitate a formative assessment, we have to create conditions where we generate feedback on performance in a way that improves the learning process [8]. It is a goal to develop the students' ability to self-regulate their learning. The term self-regulated learning refers to the degree to which students can regulate their thinking, motivation, and behavior during learning [9].

Literature on self-regulated learning has long been concerned with higher-order information processing and metacognition, and only recently have emotions been included as a factor [10]. In this context, we claim that a metacognitive perspective of the emotions observed is one of the important skills that should be included in formative assessments. However, finding the form, the language and conditions to discuss emotions in a mathematics class, is a challenge. Providing feedback in an interactive dialog with the students might be one solution.

Nicol and Macfarlane-Dick [11] suggested seven principles for feedback practice that we have used as the main guide to developing the situations where we provide feedback. Good feedback practice:

1. helps clarify what good performance is (goals, criteria, expected standards);
2. facilitates the development of self-assessment (reflection) in learning;
3. delivers high-quality information to students about their learning;
4. encourages teacher and peer dialogue around learning;
5. encourages positive motivational beliefs and self-esteem;
6. provides opportunities to close the gap between current and desired performance;
7. provides information to teachers that can be used to help shape teaching.

In the next section, we will describe the didactical procedure that was used during formative assessment sessions in mathematics. We will also specifically describe how we addressed the 7th principle from Nicol and Macfarlane-Dick [11] using the students' written reflections as a source for subsequent interventions.

© 2024 Computer Engineering. All Rights Reserved.

METHODS

We are developing ways of providing feedback, where the students' learning processes are explored and challenged in a qualification mathematics course. The mathematics covered is typically precalculus with an introduction to calculus. The "class" consist of approximately 60 students, where most students are from 19 to 25 years old. Most of the students have a vocational background and participate in the qualification course to start an engineering education. Previous knowledge in mathematics within the group is varied. The described feedback practice has been implemented in a qualification course in mathematics for the last five years. There are five parallel classes. However, written reflections focusing on self-regulated learning, which in turn informs subsequent interventions have been carried out in only one parallel for the last two years.

We introduced formative tests where the students are given problems similar to the level they will encounter at the final exam. Each student must participate in 10 of 14 assessments to be allowed access to the final exam. The assessments are not graded except for two larger ones that last for 5 hours. Assessments are given one week after the material has been taught. Each test lasts for two hours. In the first hour, the students must solve 4-6 problems with the same aids that are allowed at the final exam. The tasks are handed out on paper and students work with the problems on paper as they would on an exam. In the second hour, after a short break, the problems are reviewed. This provides the students with immediate dialogical feedback. As part of the review, students are asked to judge and reflect on their performance.

Information from students is gathered in two ways: written reflections related to the assessment conditions, and feedback in subsequent interventions where students respond using a text-based response system. In the final part of each assessment, students are asked to judge and reflect on their work. To guide the students, they are encouraged to answer questions about the experience, reasons for the experience, and the learning process in general. The question "What is the biggest challenge in learning this subject for you right now?" generated a lot of information about what students face or experience when learning the subject. Selected responses to this question are used to initiate interventions to create a dialog around learning.

The interventions aim to create an understanding for and at the same time challenge the learning strategies that the students use. Based on the reflections, an intervention consists of a session lasting approximately 20 minutes, taken from the regular lecture time. The text-based student response system iLike [12] is used to interact with the group. Students respond to questions, either multiple choice or open-text-questions and students respond using their mobile phone or PC. Text-responses provided by the students are used immediately and in subsequent interventions and such address principle 7 from Nicol and Macfarlane-Dick [11].

When students answer open text questions, anonymity makes it possible to discuss questions that student often perceives as private. Text responses often contain much information and can give insight into the variability in the student's perceptions, which sometimes is difficult to comprehend when the subject is discussed in class. The perceived degree of trust in the room is essential to get this process

© 2024 Computer Engineering. All Rights Reserved.

going. The information given by the students is an essential part of the 7th principle of Nicol and Macfarlane-Dick [11] "good feedback practice provides information to teachers that can be used to help shape teaching".

DISCUSSION

The statement "*I don't know what happened today because I know this!*" can be interpreted as a problem associated with the illusion of knowledge. A citation like this, taken from a student, provides an opportunity to start discussing the phenomena. A part of this way of working is that it is the students' initiative, reflection or comment that trigger the intervention. The intention is that the intervention can provide a deeper understanding of how learning works, in a context where the students experience a need for such information.

Two possible reasons might cause the illusion of knowledge; the difference in context during learning and assessment, and how emotions may be misinterpreted when we learn.

When we make judgments about the world around us, we tend to do this from a momentary active state or the emotions as an important source of information [13]. However, we see that in a learning context, this might lead to false judgments of own learning. Learning how to use these emotions from the learning context, which rarely are explicitly noticed or reflected upon, and to develop a sound metacognitive perspective of the learning situation is important.

Developing students' metacognitive skills in interpreting and acting upon emotions is important. According to the theory of constructed emotions [14], emotions are seen as learned idiosyncratic interpretations that the brain has constructed. This means that it is impossible, even in principle, for a teacher to provide concise, constructive feedback to the individual student. Hence, we can argue that students need to, and in fact, can learn to recognize and interpret the small signals gained from the experience of insight. The students should, however, recognize that this is only a step towards gaining knowledge and not be misled by the emotion.

CONCLUDING THOUGHTS

Working actively with dialog-based feedback where the current level of performance is assessed, should be combined with ways to challenge the students' learning strategies [15].

The main challenge is time, and the feeling of psychological safety in the room in such a way that students dare enter the subject of reflecting on their own learning experience. We recognize that response technology where students can respond to questions anonymously is an essential element in creating the dialog.

Having the metacognitive skills to reinterpret experiences with learning as a step towards gaining knowledge, and not as a signal of having achieved knowledge is important. More importantly, when these emotional signals appear while learning from an online video, these emotional impressions might be uncorrected since there are no one around to adjust or correct the reactions. If these learning conditions are left untested, this might lead to false judgments of own learning. However, finding

© 2024 Computer Engineering. All Rights Reserved.

occasions and the language to discuss emotions in a mathematics class is challenging.

In a search for ways to expose the students to experiences and later focus on how to challenge the students' individual experiences, this way of working is interesting. So far, the exam results compared to parallel mathematics courses, suggest that this way of working towards the students seems promising, but it is too early to state any conclusion.

REFERENCES

[1] Kardas, M. and E. O'Brien (2018), Easier seen than done: Merely watching others perform can foster an illusion of skill acquisition. Psychological science. Vol.

[2] Hartwig, M.K. and J. Dunlosky (2012), Study strategies of college students: Are self-testing and scheduling related to achievement? Psychonomic Bulletin & Review. Vol. 19(1): pp. 126-134.

[3] Bjork, R.A., J. Dunlosky, and N. Kornell (2013), Self-regulated learning: Beliefs, techniques, and illusions. Annual review of psychology. Vol. 64: pp. 417-444.

[4] Koriat, A. and R.A. Bjork (2005), Illusions of competence in monitoring one's knowledge during study. Journal of Experimental Psychology: Learning, Memory, and Cognition. Vol. 31(2): pp. 187.

[5] Carpenter, S.K., et al. (2013), Appearances can be deceiving: instructor fluency increases perceptions of learning without increasing actual learning. Psychonomic bulletin & review. Vol. 20(6): pp. 1350-1356.

[6] Immordino-Yang, M.H. and A. Damasio (2007), We feel, therefore we learn: The relevance of affective and social neuroscience to education. Mind, brain, and education. Vol. 1(1): pp. 3-10.

[7] Baumeister, R.F., J.L. Alquist, and K.D. Vohs (2015), Illusions of learning: Irrelevant emotions inflate judgments of learning. Journal of Behavioral Decision Making. Vol. 28(2): pp. 149-158.

[8] Sadler, D.R. (1998), Formative Assessment: revisiting the territory. Assessment in Education: Principles, Policy & Practice. Vol. 5(1): pp. 77-84.

[9] Zimmerman, B.J., et al. (2003), Self-regulated learning. Psyccritiques. Vol. 48(1): pp. 16-18.

[10] Op't Eynde, P., E. De Corte, and L. Verschaffel (2007), Students' emotions: A key component of self-regulated learning?, in Emotion in education. Elsevier. pp. 185-204.

© 2024 Computer Engineering. All Rights Reserved.

[11] Nicol, D.J. and D. Macfarlane-Dick (2006), Formative assessment and selfregulated learning: A model and seven principles of good feedback practice. Studies in higher education. Vol. 31(2): pp. 199-218.

[12] Talmo, T., T.M. Thorseth, and R. Støckert. iLike “Byod” in Language Learning. in Conference proceedings. ICT for language learning. 2013. libreriauniversitaria. it Edizioni.

[13] Schwarz, N. and G.L. Clore (1983), Mood, misattribution, and judgments of well-being: informative and directive functions of affective states. Journal of personality and social psychology. Vol. 45(3): pp. 513.

[14] Barrett, L.F. (2017), The theory of constructed emotion: an active inference account of interoception and categorization. Social cognitive and affective neuroscience. Vol. 12(1): pp. 1-23.

[15] Hattie, J. and H. Timperley (2007), The power of feedback. Review of educational research. Vol. 77(1): pp. 81-112.

© 2024 Computer Engineering. All Rights Reserved.