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The reflective diary as a method for the formative assessment of self-regulated learning

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Abstract. An increasingly desired outcome of engineering education is the ability to engage in self-regulated learning (SRL). One promising method for the formative assessment of SRL is the reflective diary. There is, however, a paucity of research on the use of reflective diaries in engineering education. To mitigate this gap, we report on a case study where reflective diaries were implemented in a master's course on tissue engineering. The objective of this paper is to explore the potential of reflective diaries for the formative assessment of three central aspects of SRL: conceptions of knowledge, conceptions of learning, and strategies for monitoring and regulating learning. Based on a theoretical thematic analysis of the diary entries, we show that reflective diaries can be used to assess these three aspects of SRL. We discuss ways of providing feedback to students, with a focus on dialogic feedback.

Keywords: self-regulated learning, formative assessment, reflective diaries, epistemological beliefs, dialogic feedback, theoretical thematic analysis

1. Introduction

An increasingly desired outcome of engineering education is the ability to engage in *self-regulated learning* (SRL), also referred to as *lifelong learning* (Ambrose et al., 2010). "Only lifelong learners will be able to keep up with the explosive growth of knowledge and skills in their career and to retool into a new career after their previous one runs its course" (Nilson, 2013). Self-regulated learners take control of their own learning, and are able to acquire and retrieve new knowledge and skills on their own (Butler & Winne, 1995). More specifically, SRL involves assessing the demands of a task, setting goals for learning, selecting suitable resources, selecting suitable methods for learning, and evaluating progress (Pintrich & Zusho, 2007). Student-centered teaching methods, such as problem-based learning and inquiry-based learning, can promote SRL by encouraging students to take responsibility for their own learning (Kuh, 2008). At the same time, students' engagement in SRL is strongly shaped by past learning experiences and influenced by *epistemological beliefs* and *conceptions of learning* (Muis, 2007). If students fail to see learning as an *active* process, where knowledge is constructed and co-constructed, they will not fully profit from student-centered teaching. It is therefore important to find out if students' epistemological beliefs and conceptions of learning hinder their engagement in SRL.

One method that could be used for the formative assessment of SRL is the *reflective diary* (Boekaerts, 1999). The purpose of *formative assessment* is to both *probe* and *promote* student learning, and formative assessment has been described as "assessment for self-regulated learning" (Clark, 2012). It has been argued that reflective diaries can probe and promote students' engagement in SRL (Tang, 2002). There is, however, a paucity of research on the use of reflective diaries in engineering education (Tanner, 2012). To mitigate this gap, we report on a case study where reflective diaries were implemented in a master's course on tissue engineering. The purpose of this paper is to explore the potential of reflective diaries for assessing or

probing three central aspects of SRL: *conceptions of knowledge*, *conceptions of learning*, and *strategies for monitoring and regulating learning*. Based on a *theoretical thematic analysis* (Braun & Clarke, 2006) of the diary entries, we present a selection of excerpts from the students' diaries to demonstrate that reflective diaries can be used to assess these three aspects of SRL. We also discuss different ways of providing feedback to students based on the diary entries, with a focus on *dialogic feedback* (Carless, Salter, Yang, & Lam, 2011). The work presented in this paper should be of interest and value to engineering educators wishing to help their students to become self-regulated learners.

2. Literature review

Our study is situated at the intersection of three areas: *self-regulated learning*, *formative assessment* and *reflective diaries* (see Figure 1). This section provides a more detailed account of how our research objectives developed from previous empirical and theoretical work in these three areas. Here, we also develop our *conceptual framework* (Leshem & Trafford, 2007), that is "the system of concepts, assumptions, expectations, beliefs and theories that supports and informs [our] research" (Maxwell, 2013).

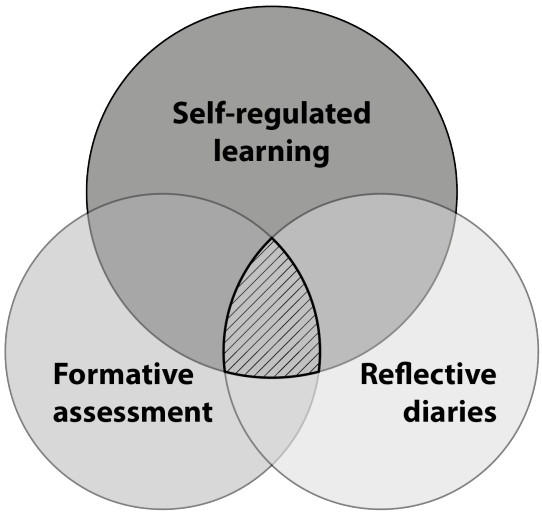

Figure 1. Overview of the conceptual framework for this study.

2.1 *Self-regulated learning*

Self-regulated learning (SRL) has become a central construct in higher education to capture the nature of effective academic learning (Butler & Winne, 1995). Simply put, SRL involves taking control of one's own learning by assessing the demands of a task, setting goals for learning, selecting suitable resources, selecting suitable learning methods, and evaluating progress (Pintrich & Zusho, 2007). This means that for students to become self-regulated learners, they need to develop suitable *cognitive, metacognitive, motivational* and *social* strategies that help them to actively construct goals, problem solutions, and meaning (English & Kitsantas, 2013; Fabriz, Ewijk, Poarch, & Büttner, 2014; Zimmerman, 2013). SRL can be described as a cyclic process comprising three phases: (1) *forethought*, where students analyze a task and

relate it to themselves; (2) *performance*, where students monitor and regulate their efforts while working on a task; and (3) *self-reflection*, where students evaluate the outcome of a task and the approaches that they used (Zimmerman, 2002).

While student-centered learning environments can promote SRL, it cannot be assumed that all students will automatically engage in SRL. Indeed, as pointed out by English and Kitsantas (2013): "For many students, [the SRL] role conflicts with deeply ingrained habits they have developed through more familiar classroom experiences, in which they have been passive recipients of knowledge". It is thus important to probe students' *epistemological beliefs* and *conceptions of learning* when helping them to become self-regulated learners.

Epistemological beliefs are the beliefs we hold about the nature of knowledge and how we can know things (Hofer, 2001). Developing students' ways of thinking about knowledge and knowing is an important objective of higher education, and instruction should focus on developing students' skills in processing, producing, and evaluating knowledge (Lahtinen & Pehkonen, 2012). Based on previous work by Perry (1968), Magolda (1992) proposed four *ways of knowing* to describe differences in epistemological beliefs from a developmental perspective – see Table 1 for a summary. Students do not necessarily enter higher education with a conceptualization of learning as "contextual knowing", and higher education should help them develop in this direction (King & Magolda, 1996).

Absolute Knowing	**Transitional Knowing**	**Independent Knowing**	**Contextual Knowing**
Knowledge is absolute and there is always an answer	Not all knowledge is absolute and certain	Most knowledge is uncertain and subjective	Knowledge is constructed within a context
Students focus on acquisition of knowledge	Students need to understand and start to be critical	Students think for themselves and create their own perspectives	Students construct and co-construct meaning
Teachers provide knowledge	Teachers facilitate understanding	Teachers promote independent thinking	Teachers support application of knowledge and the discussion of different perspectives

Table 1. Overview of the four 'ways of knowing' proposed by Magolda (1992).

Epistemological beliefs have a strong influence on all aspects of SRL. The way students think about knowledge and knowing will affect their approach to learning (Schoenfeld, 1985), problem solving (Schommer, 1990), and SRL in general (Muis, 2007). Hofer (2004) argued that there is a two way interaction between instruction and students' epistemological beliefs: instruction is interpreted through a filter of epistemological beliefs, and at the same time, instruction shapes those beliefs. Research suggests that certain epistemological beliefs are more common in some disciplines than in others (Paulsen & Wells, 1998). This means that the importance of SRL will be perceived differently in different disciplines. There are studies showing that students tend to hold more naïve epistemological beliefs in fields such as mathematics, science, and engineering. This could be seen as an attunement to the culture and teaching in these fields, with a strong emphasis on facts, principles, and procedures presented in a dualistic mode (Felder & Brent, 2004; Wankat, 2002).

There is, however, little research on how to continuously assess students' epistemological beliefs and how to use this information to help students to develop more advanced epistemological beliefs in the context of a course. This is important to consider, as students' epistemological beliefs might prevent them from engaging in productive SRL. Formative assessment therefore plays an important role in helping students to become self-regulated learners.

2.2 *Formative assessment*

It is essential to distinguish between two different purposes of assessment. *Formative* assessment supports students during their learning by providing them with feedback on their performance, helping them to reach their full capacity (Yorke, 2003). Formative assessment is assessment *for* learning, in contrast to *summative* assessment, which is assessment *of* learning and focuses on outcomes (Clark, 2012). The purpose of formative assessment is therefore to help students to develop skills, knowledge, and beliefs that are central to the discipline (Clark, 2012). It is, however, important to acknowledge that students are different and will need different forms of help and scaffolding. This means that formative assessment is and should be subjective and individualized (Shepard, 2000) by allowing teachers to focus on the student's individual needs (Dopper & Sjoer, 2004). Frequent formative assessment provides information both to students and teachers about the learning process, and allows early intervention and informed scaffolding. Teachers can help students to learn from their mistakes through feedback (Higgins, Hartley, & Skelton, 2002). Feedback is at the core of formative assessment and provides students with a source of information which they can use to evaluate their progress and domain knowledge, goals, strategies and beliefs (Nicol & Macfarlane-Dick, 2006).

Feedback is considered to be "a crucial way to facilitate students' development as independent learners who are able to monitor, evaluate, and regulate their own learning" (Evans, 2013). However, the effectiveness of common feedback practices in higher education has been questioned (Bailey & Garner, 2010). While there has been a general shift towards *constructivist* teaching in higher education (Barr & Tagg, 1995), assessment and feedback practices still seem to be based on a *transmission* view of learning, i.e. feedback can be transmitted from the teacher to the student who will then automatically understand and act on it as intended (Nicol & Macfarlane-Dick, 2006; Shepard, 2000). There is strong evidence that feedback, which is only transmitted, often is of little use to the students as it is difficult to understand and act on. It is important that students are actively involved in the construction of meaning in order to fully profit from the feedback, for example through discussions (Higgins, Hartley, & Skelton, 2001; Laurillard, 2002). Feedback should be seen as a *dialogue* that empowers students to become self-regulated learners (Carless et al., 2011).

Bringing these aspects of formative assessment together, it is important to stress that formative assessment is not a tool or measurement instrument. It is a process and attitude to scaffold student learning and it is deeply embedded in effective teaching (Heritage, 2010). On this basis, Nicol and Macfarlane-Dick (2006) positioned formative assessment within SRL by developing a conceptual model that links feedback to the processes inherent in SRL. They argued that "in higher education, formative assessment and feedback should be used to empower students as self-regulated learners." However, the focus of previous work on the formative assessment of SRL has been on strategies for regulating learning, without much consideration of

how formative assessment could be used to probe and promote students' epistemological beliefs. In the next section, the reflective diary is proposed as a promising method for filling this gap.

2.3 *Reflective diaries*

Reflection and metacognition are core elements in SRL. Self-regulated learners reflect on their own learning, dissect their own thoughts, argue with themselves possible alternatives, and think about how their experiences will shape their future (Gall, Gall, Jacobsen, & Bullock, 1990). The metacognitive strategies that students need to develop for productive SRL help them to become aware of their own thinking and learning throughout all three phases of SRL (Flavell, 1979). There is mounting evidence that metacognition needs to be taught – it is not something that all students automatically engage in (Wedelin & Adawi, 2014). It has therefore been proposed that active learning methods in engineering education should encourage students to reflect not only on the content, but also on their own thinking and learning to develop metacognitive strategies (Vos & de Graaff, 2004). One active learning method to promote the development of metacognitive strategies is the *reflective diary,* also referred to as learning diaries, learning journals, or log books in the literature (Tanner, 2012). A good overview of practical approaches and factors to consider when implementing reflective diaries is provided by Moon (2003).

Fulwiler (1986) described the rationale for introducing reflective diaries, or journal writing, in higher education in the following way:

> In the academic world, where we teach students to gain most of their information from reading and listening, we spend too much time telling our students how to see or doing it for them. That's not how I would encourage critical, creative, or independent thinking. Our students have good eyes; let's give them new tools for seeing better: journal writing is, of course, one of those tools.

Reflective diaries are "containers" for writing that provide students with a framework to structure their thoughts and reflections. In writing a journal, "we take something from inside ourselves and we set it out: it is a means of discovering who we are, that we exist, that we change and grow" (Wolf, 1989). In this way, reflective diaries allow students to reflect on their beliefs, values, experiences, and assumptions that influence their learning, as well as their development and progress over time (Minott, 2008). Reflective diaries can focus on learning *content* or learning *behavior* (Fabriz et al., 2014), which can be translated into *activity* prompts and *self-monitoring* prompts (Davis, 2000). While activity prompts help students to improve their work, self-monitoring prompts help students to think about their learning approaches and processes, and thus make them visible (English & Kitsantas, 2013). The use of reflective diaries is well-aligned with the core ideas of formative assessment, and can help to unveil aspects of students' learning experiences that are invisible through other formative assessment methods (Ifenthaler, 2012; Tang, 2002).

McCrindle and Christensen (1995) have shown that students who are prompted to reflect regularly use more metacognitive and more sophisticated cognitive strategies in comparison to students who are not prompted. Asking students to explain their hypotheses, reasoning, and processes is an important part of helping them to make connections between learning activities, goals, and processes (Kolodner et al., 2009). One example from engineering education is the work by Babapour, Rahe, and Pedgley (2012) who used reflective diaries in a design course to help students to "(i) assess their activities and self-criticize the progress and content of their design

projects, (ii) better plan and organize their project activities, and (iii) better communicate with other stakeholders in the product development process, by providing an opportunity to articulate what they have done." Despite these examples and promises of reflective diaries, the implementation in higher education has been limited. Moreover, most examples come from nursing- and teacher education where students are learning during internships and placements (Jarvis, 2001). There is a clear lack of studies that explore the potential of reflective diaries for formative assessment in engineering education.

3. Study context and design

The context for this study is a master's level course (15 ECTS credits) on tissue engineering that runs over a five-month period at Chalmers University of Technology. The aim of the course is for students to: (1) gain an overview of the tissue engineering field; (2) understand the fundamental science and technology that form the building blocks of the field; and (3) develop research competencies relevant to the field and a research identity. The course consists of lectures, article review sessions and an authentic research project. The research project runs over the entire five-month period of the course and all projects are directly coupled to on-going research at the university. The aim of the project is not only to gain a deeper understanding of the outcome but also to experience research as it is conducted to gain an understanding of the scientific process. For a more detailed description of the teaching and learning activities in the course, see Wallin, Gold and Adawi (2013).

The dominant pedagogy in the tissue engineering course is *inquiry-based learning*, which belongs to the family of inductive teaching methods (Prince & Felder, 2006). To support students during the difficult and complex inquiry process, *expert guidance* is embedded in different ways, for example through lectures, modelling of skills, coaching during activities, and collaborative problem-solving (Laurillard, 2012). A strong focus is put on *formative* assessment to help the students to develop the necessary knowledge and skills during the course, *including the ability to engage in productive SRL*.

Reflective diaries were introduced as a formative assessment method for SRL in one of the project groups, consisting of four students (S1-S4), in 2014. The students differed in ethnicity and gender. All four students wrote weekly reflective diaries around a set of carefully designed prompts. These prompts were developed from and based on four categories of questions: (1) What has happened? (2) How did you approach the situation? (3) Why is it important? and (4) What did you learn from it? The prompts alternated between focusing on more general learning experiences in odd weeks and on the different phases of the project in even weeks (see Figure 2). The design of the prompts is described in more detail in Wallin, Adawi and Gold (2016), and a list of all prompts can be found in the Appendix.

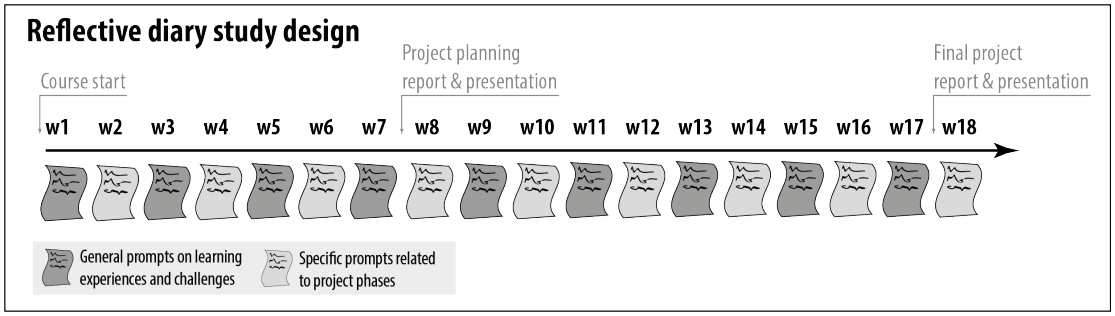

Figure 2. Overall design of the reflective diary study.

At the beginning of the course, the students were carefully introduced to the purpose of the reflective diaries and how this kind of reflective writing could help them to learn better and support them during their project work. The reflective diaries did not count towards final grades, and the person reading the reflective diaries was the project tutor, who was not involved in grading the students at the end of the course. All students gave their informed consent that their diary entries could be used for research.

As the purpose of this study is to explore the potential of reflective diaries for the formative assessment of SRL, a *qualitative case study* approach (Case & Light, 2011) was used. Case studies are characterized by a *bounded* system – such as an individual, a group, a course or a program – and "concentrate attention on the way particular groups of people confront specific problems, taking a holistic view of the situation" (Shaw, 1978). The system in a case study is often selected because it is "unique, experimental or highly successful" (Shaw, 1978).

The reflective diaries constituted the data for this study. We used three central aspects of SRL to guide the *theoretical thematic analysis* (Braun & Clarke, 2006) of the diary entries: conceptions of knowledge, conceptions of learning, and strategies for monitoring and regulating learning. This deductive analysis involved reading the diary entries several times to ensure that all aspects were noted, breaking up the data into segments, tagging each segment, and finally sorting the tags under the three themes or aspects of SRL.

We note that reflective diaries can be analyzed using different theoretical constructs or lenses to frame a study, and in previous work we used the diary entries to explore how the students experienced learning in a discovery-oriented environment (Wallin et al., 2017).

4. Using reflective diaries to assess three aspects of self-regulated learning

One of the main objectives of this paper is to explore the potential of reflective diaries for assessing or probing three central aspects of SRL: *conceptions of knowledge*, *conceptions of learning*, and *strategies for monitoring and regulating learning*. Below, we present and discuss a selection of excerpts from the students' diaries – organized around the three aspects of SRL – to demonstrate that it is possible to use reflective diaries to probe these three aspects of SRL.

4.1 *Conceptions of knowledge*

Through the reflective diaries we were able to gain valuable insight into the students' epistemological beliefs – that is, what knowledge is and how it is created. *Example 1* contains a detailed description of the *iterative* and messy nature of (experimental) research and knowledge formation:

> *I think our most important next step will be to get a deeper understanding of the capillary alginate gel, how it is prepared and how it can be modified to give the best mechanical and biological properties. I think it's important to get this part started as it is literally the base for the whole experiment. The risks with only doing it theoretically and not testing in the lab is that things very often don't turn out the way they are expected once in the lab. This is why it's important to come up with several back-up plans if the first one fails. (S3)*

In sharp contrast, *Example 2* contains a much more linear and non-reflective chain of reasoning in relation to learning or knowledge formation, where "a" leads to "b" from which "c" can be concluded:

> *This week I learned to make cell cultures. We also discussed about what are the most important parts in our project. We conclude that these are the scaffold, the cells and the bioreactor. (S2)*

In this way, the overall structure and details of the discourse can be used to probe the students' epistemological beliefs. A more complex chain of reasoning and reflective stance suggests a more mature view of how knowledge is created.

Example 3 contains an explicit reflection on how knowledge is created:

> *A hypothesis can be made based on a literature review and discussing with you. But these will probably only be starting parameters that will have to be modified… accepting that these are things that cannot be planned ahead but will have to be investigated empirically. (S3)*

Again, the iterative and messy nature of knowledge formation comes to the fore. This excerpt also reflects a *contextual* way of knowing, where students construct and co-construct knowledge through inquiry and discussions. In contrast, *Example 4* seems to reflect a more *absolute* way of knowing, where an authority (the primary literature) provides knowledge and the students acquire it:

> *One of the biggest challenges when starting a new project is to classify the information, due to the large amount of information that exists on the internet… it is important to classify and select the one which is relevant to our project. (S2)*

Here, the iterative nature of knowledge formation seems to be neglected as well since what is "relevant information" can be decided at the start of the research project.

In *Example 5,* the value of failed experiments is emphasized:

> *I think it was also good to realize that 'bad' results aren't always bad…they are just results that can be used to make further decisions about a project and are equally important… I learned [from the literature] about important parameters that need to be considered for bioreactor design while reading and writing the report. (S3)*

Here, dichotomies like good and bad, right and wrong, are questioned. All results are seen as containing valuable information that can lead to new questions and new knowledge.

These examples show that reflective diaries can provide insight into students' epistemological beliefs. Through targeted feedback and questions teachers can then help students to conceptualize knowledge as something that is constructed and co-constructed within a given context. This is an important pre-condition for developing effective SRL strategies, as students are expected to explore an area rather than search for the "right" answer.

4.2 *Conceptions of learning*

Through the reflective diaries we were also able to gain insight into how the students conceptualize learning and their role in the learning process. In *Example 6*, learning is described as an *active* process:

> *I know very well that the course itself will not make my aims happen. I have to do my part in the project work and try to participate as actively as possible during the lectures. (S1)*

According to this way of conceptualizing learning, it is the students' responsibility to learn from the different teaching and learning activities that the course offers. This is a crucial pre-condition for productive SRL. In *Example 7* several learning strategies, aligned with the view that learning is an active process, are described:

> *I think it's important to start early to read the assigned literature and papers, so that I can discuss the topic with my peers and project group, and ask relevant questions to the lecturer. (S3)*

Asking questions and engaging in discussions are here highlighted as two of the most important strategies for effective learning. Moreover, challenges are seen as a natural and even important part of the learning process, as described in *Example 8*:

> *I think this approach is good … Although feeling totally lost in the beginning, one feels content after reading, getting into the problem and realizing afterwards that it is not as difficult as thought from the beginning. (S3)*

Here, challenges are not seen as something that should be avoided, since "being lost" is an important part of the learning process.

In contrast, consider *Example 9* with a strong focus on the first diary prompt (What has happened?), completely ignoring to address the other prompts:

> *In this week, I gained more detailed knowledge of our project, the structure and formation of muscles, clinical applications of tissue engineering for skeletal muscles. And also, I learned how to write a report…. (S4)*

In this example, there is a strong emphasis on *what* is learned without any reflection on *how* it is learned. This seems to reflect a more naïve view of learning, where doing a lot automatically leads to learning a lot, as indicated in *Example 10*:

> *I think everyone in our group is working hard and has read a lot of literatures related to the topic. However, a detailed word distribution would be needed so that we can work more efficiently. (S4)*

In *Examples* 6-8, there is a strong emphasis on the process of learning, where students' own ideas are challenged and refined. In *Examples* 9-10, on the other hand, there is a strong emphasis on the product of learning and learning seems to be conceptualized as an increase in knowledge. If students view learning as something that will happen to them or fail to understand what they need to do in order to learn, they will not be able to fully profit from courses using constructivist teaching methods (such as the tissue engineering course). Reflective diaries enable teachers to probe students' conceptions of learning and provide feedback that can help students to develop their view of learning.

4.3 *Strategies for monitoring and regulating learning*

Finally, through the reflective diaries we were able to gain insight into the strategies that the students use for monitoring and regulating their learning, in particular during the forethought and self-reflection phases of SRL. In *Example 11*, one of the students

identifies a need to improve her/his writing and to learn how to write a professional report:

> *I also have to learn and practice how to write a report better – the sentence and paragraph organization, word selection, etc. And it is not so easy for me to write a "professional" report, I will spend more time on this, to learn how to compose and edit. (S4)*

Similarly, in *Example 12*, another student identifies a lack of previous experience and knowledge in a certain area:

> *I lack practical experience of treating biological samples…I will need to practice and gain proficiency. I realized once again that I really like the subject…Personally I am sometimes a bit inhibited when it comes to the scaffolding and a more chemical expertise. (S1)*

These two excerpts exemplify how reflective diaries can provide insight into students' goal setting during the forethought phase of SLR. While students might be able to identify their own weaknesses and areas of improvement, they do not necessarily know what to do to improve in these areas. Teachers can use the information from the diaries to help students to achieve (or reconsider) their goals.

Turning to the self-reflection phase of SRL, reflective diaries can provide insight into students' preferred approaches to learning. In *Example 13*, a student describes his/her preference for practical and self-governed work in the laboratory:

> *I really enjoyed working in the lab so far, the self-governed work feels very rewarding. (S1)*

Here, self-directed learning is linked to positive emotions. Similarly, in *Example 14*, a student reflects on learning preferences and motivational strategies by comparing the tissue engineering course with another course:

> *The difference between the value for me in what I am learning in this class compared to the mandatory Advances Analytical Chemistry is enormous, and what I can conclude from that is that the subject of this class is what I probably should be working with because it makes me engaged, and that to get through the mandatory classes I just have to focus on the good parts. (S3)*

Reflective diaries can thus provide insight into the students' preferred cognitive and metacognitive strategies, how previous learning experiences have shaped students' strategies, what is needed to change their strategies, and what motivational aspects help them to move forward. In addition, it is possible to gain a better understanding of what type of learning environments students have experienced and prefer.

Finally, in *Example 15*, one of the students goes beyond describing what works for him/her to reflect on group work:

> *I also learned that I sometimes need to ignore my perfectionism and accept that even if it isn't done in the way and according to the standard I am used to, it can be good anyway. That's the benefit of working in groups one has to evaluate oneself. (S3)*

In this way, reflective diaries can help teachers to understand central aspects of group dynamics and learning in groups. This information can help teachers to discover potential problems in a group early on and intervene, as well as to provide individual support to students by helping them to overcome challenges within the group.

These examples show that reflective diaries can provide insight into students' cognitive, metacognitive, social, and motivational strategies for SRL. We note that these strategies are not easily observed in the classroom. Reflective diaries enable teachers to provide feedback on strategies that students use to monitor and regulate their learning, based on the students' own reflections around them, which situates the feedback directly in the students' experience.

5. Discussion

In this case study, we have explored the potential of reflective diaries for assessing or probing three central aspects of SRL: conceptions of knowledge, conceptions of learning, and strategies for monitoring and regulating learning. By presenting and discussing a selection of excerpts from the students' diaries, organized under the three aspects of SRL, we have demonstrated that it is possible to use reflective diaries to probe these three aspects of SRL. A summary of our results is provided in Table 2.

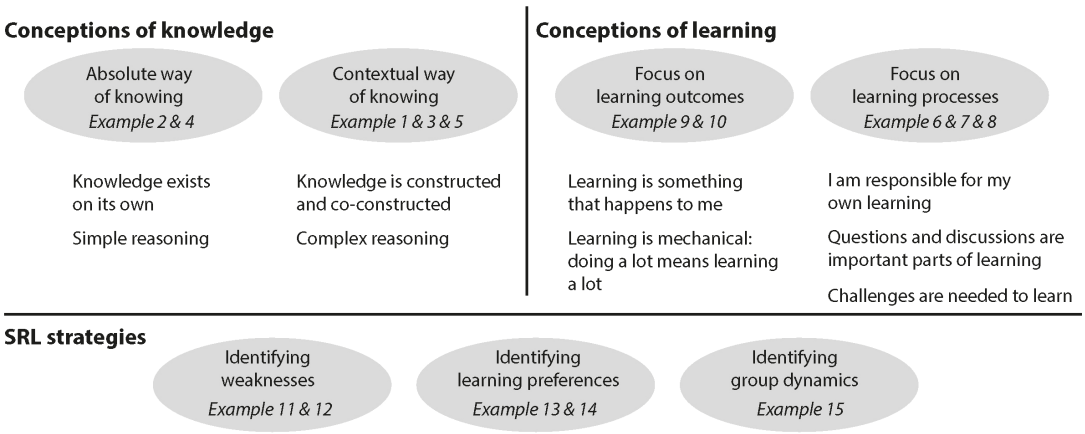

Table 2. Overview of the results with the examples (diary excerpts) organised under the three aspects of self-regulated learning.

The diary excerpts that formed the empirical data for our study showed that the students differed in their epistemological beliefs and conceptions of learning. As illustrated in Table 2, some students seem to have an absolute way of knowing and focus on learning outcomes, whereas other students seem to have a more contextual way of knowing and focus on the learning process. It is therefore important that teachers find out if the students' epistemological beliefs and conceptions of learning are hindering their development towards SRL (Bråten & Strømsø, 2005; Muis, 2007). Reflective diaries can be used to track students' epistemological beliefs and conceptions of learning over time and, through suitable feedback, help students to develop more constructive epistemological beliefs and conceptions of learning.

Furthermore, we found that the students focused on different aspects in the forethought phase and self-reflection phase of the SRL cycle. Using reflective diaries to learn more about students' self-perceived weaknesses, motivations, and self-evaluations can help teachers to design more effective scaffolding and feedback.

We note that reflective diaries allow teachers to assess and provide feedback on aspects that are normally invisible to them (Jarvis, 2001). A common problem in relation to inductive teaching methods (Prince & Felder, 2006), such as project-based learning, is that students mainly work independently and with little intervention from the teacher, limiting the possibility for formative assessment and scaffolding (Clark, 2012). The feedback students receive often focuses on a product (e.g. a report or a

design object) in final or draft form (Yorke, 2003), whereas reflective diaries allow teachers to provide feedback on the processes students engage in.

Based on the information that teachers can get from the reflective diaries, as exemplified in the previous section and summarized in Table 2, there are several possibilities for providing feedback to students. Teachers can provide feedback by: (1) replying or talking to the individual students directly, (2) providing more general and collective feedback, or (3) using the information to modify course content and approaches to instruction (Jarvis, 2001; Moon, 2003). It is important to conceptualize feedback more broadly than replying to students in direct connection to the diaries. By integrating the feedback into (other) course activities, teachers are able to help students in many implicit and explicit ways to become self-regulated learners and develop more contextual ways of knowing.

The effectiveness of traditional feedback practices has been questioned (Bailey & Garner, 2010). To unlock the full potential of formative assessment, it is important to conceptualize feedback as constructed in a *dialogue* between students and teachers, instead of seeing it as something that can be transmitted from teachers to students (Nicol & Macfarlane-Dick, 2006; Shepard, 2000). Reflective diaries offer an alternative way to initiate feedback, where the diary prompts themselves are already part of the feedback or scaffolding as they set the frame and help students to focus on specific topics. The prompts encourage students to think and reflect on certain aspects of their learning experiences. The emphasis on feedback as a dialogue is further strengthened by the fact that each student can decide what to share or not in the reflective diaries.

6. Conclusions

Self-regulated learning (SRL) has emerged as a central construct in higher education to capture the nature of effective academic learning. While student-centered teaching methods aim to promote engagement in SRL, students' epistemological beliefs and conceptions of learning influence their engagement in SRL. It is therefore important to find ways to assess students' epistemological beliefs and conceptions of learning. We have demonstrated that the reflective diary can provide valuable insight into conceptions of knowledge, conceptions of learning, and strategies for monitoring and regulating learning. The reflective diary therefore constitutes a promising method for helping students to become self-regulated learners.

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