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Conjecture mapping to support vocationally educated adult learners in open-ended tasks

Ruth Boelens [a], Bram De Wever [a], and Susan McKenney [b]

[a]Department of Educational Studies, Faculty of Psychology and Educational Sciences, Ghent University; [b]ELAN Department of Teacher Professional Development, Faculty of Behavioural, Management, and Social Sciences, University of Twente

ABSTRACT

Background: This case reports on a teacher education course that aimed to support adult learners with a vocational education background to accomplish open-ended tasks. Conjecture mapping was used to identify the most salient design features, and to test if, how, and why these course features supported learners.

Methods: Inspired by ethnographic approaches, sustained engagement and multiple data sources were used to explain the effects of the course design on participants' behavior and perceptions: student and teacher interviews, observations, and artifacts.

Findings: The results reveal that almost all of the proposed design features stimulated the participants toward the intended enactment processes, which in turn yielded the intended learning outcomes. For instance, worked examples (i.e., design feature) not only engendered the production of artifacts that meet high standards (i.e., enactment process) because they clarify the task requirements, but also fostered a safe structure (i.e., enactment process) by providing an overall picture of the task.

Contribution: The conjecture map resulting from this study provides a theoretical frame to describe, explain, and predict how specific course design features support vocationally educated adult learners (VEAL) in open-ended tasks, and assists those who aim to implement open-ended tasks in similar contexts.

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Introduction

Higher and adult education institutions are not only responsible for ensuring that students develop conceptual and procedural knowledge, but also

CONTACT Ruth Boelens ruthboelens@gmail.com Department of Educational Studies, Faculty of Psychology and Educational Sciences, Ghent University, H. Dunantlaan 2, B-9000 Ghent, Belgium.
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for developing lifelong learners who are able to respond to the changing needs of working life and empowered to engage in opportunities for continuing improvement (Damşa & Nerland, 2016; Hämäläinen et al., 2015). One of the most important skills these students need today is the ability to tackle open-ended tasks (Hämäläinen et al., 2015). Open-ended tasks consist of realistic and relevant problems (Van Merriënboer & Kirschner, 2013), divided in sub-skills or sub-tasks (De Croock et al., 2002), which learners need to solve by generating, critically examining, sharing, and using knowledge (Damşa & Nerland, 2016). The ultimate goal is that learners can coordinate and integrate these sub-skills to solve the realistic problem in a realistic context (De Croock et al., 2002).

When students carry out open-ended tasks, several diverse answers or solutions are possible (Hannafin & Hill, 2007). However, this does not mean that there are no predefined learning objectives or evaluation criteria possible. Teachers or educational designers can develop an assessment rubric with solutions that meet certain criteria, without prescribing *how* those criteria must be met. In addition, in open-ended tasks, both process and product outcomes are often interesting to assess. Therefore, assessing learners' performance on open-ended tasks is an intensive process. Questions regarding process outcomes are, for instance, do students make use of reliable resources or do students collaborate in a constructive way with each other. These competences are important as students will need these competences in their future work. Product outcomes measure how well the learners solved the authentic problem. Here, indicators of success are not only what learners know (e.g., summing up several signs of dyslexia), but also what they are able to do (e.g., recognizing signs of dyslexia in students) (De Croock et al., 2002).

Developing the ability to tackle open-ended tasks can be enabled by problem-centered instruction (e.g., Merrill, 2007), complex learning tasks (e.g., Van Merriënboer et al., 2002), inquiry-based learning tasks (e.g., Edelson et al., 1999; Hmelo-Silver et al., 2007), or resource-based learning tasks (e.g., Hannafin & Hill, 2007). All these approaches have several characteristics in common. First, they place high value on authentic, realistic, and relevant learning (Edelson et al., 1999; Hmelo-Silver et al., 2007; Merrill, 2007; Van Merriënboer & Kirschner, 2013). Second, students are prompted to take an active role in their own learning process, being tasked to critically examine sources, meaningfully use sources, develop data-supported explanations, and communicate their ideas, opinions, and knowledge (Hannafin & Hill, 2007; Hmelo-Silver et al., 2007). Third, the teacher fulfills the important role of facilitating and supporting the learning process (Merrill, 2007). And fourth, these approaches often encourage collaborative learning as a way to stimulate active knowledge construction processes (Hmelo-Silver et al., 2007; Könings et al., 2005).

While the abovementioned instructional approaches can support development of the ability to tackle open-ended tasks in general, they may work differently with specific groups of students. In particular, students lacking experience in carrying out open-ended tasks often find it too difficult to self-direct their learning without appropriate guidance and support (Van Merriënboer, 2013). One population of such students is that of adult learners with a background in vocational or technical secondary education, referred to here as vocationally educated adult learners (VEAL) (Hämäläinen et al., 2015). This is one group of adult learners, who enter adult education without previous (successful) experiences in higher education or who enter higher education based on credentials gained by means of work experience and without secondary education degree (Slowey, 2010). Adult learners have been expected, by the andragogical paradigm, to be self-directed or autonomous without the appropriate amount of guidance and support (Brookfield, 2018; Sandlin, 2005). However, critical adult education scholars have been arguing that while andragogy universalizes certain assumptions such as the autonomy and self-directedness of adult learners, this might not be representative for all groups of adult learners (Brookfield, 2018; Sandlin, 2005). For instance, VEAL are often accustomed to focusing mainly on the acquisition of practical skills. Typically, these students learn through hands-on experiences, demonstrations, and practice, and are less familiar with tackling open-ended tasks and problem-solving skills (Hämäläinen et al., 2015). In short, these VEAL are able to—and want to—take on self-direction. But, owing to limited experience with certain academic practices, they struggle to self-direct their learning without help when confronted with open-ended tasks. Previous research has shown that VEAL might encounter several obstacles in learning environments that include open-ended tasks. Regarding cognition, for example, teachers have indicated that VEAL often struggle to analyze task demands, identify core information, or structure and summarize information (Biemans et al., 2016; Boelens et al., 2018). Concerning behavior, it might be challenging for VEAL to devote sufficient time to perform the tasks (Boelens et al., 2018) or to manage effort to complete a task or course (Biemans et al., 2016). With regard to vocationally educated adult learners' motivation, research has found that they often have low self-efficacy beliefs (Dubeau et al., 2017), which can have negative effects on performing or completing (open-ended) tasks which they do not feel competent enough to perform.

To accommodate these cognitive, behavioral and affective struggles, a number of studies have argued that, especially for students unaccustomed to open-ended tasks, appropriate guidance and support is required (Brand-Gruwel et al., 2005; Damşa & Nerland, 2016; Van Merriënboer & Kirschner, 2013). For instance, research has found that students performed better and more efficiently when the open-ended task was split in a (limited) number

of phases (Nadolski et al., 2006). In addition, students receiving driving questions to carry out learning tasks also performed better, although not more efficiently (Nadolski et al., 2006). Another frequently mentioned supportive design feature is the use of worked examples (e.g., Van Gog et al., 2008), which seem to have efficiency benefits for students (McLaren et al., 2016).

Focus of the study

Prior research has thus revealed several course design features that can have an influence on outcomes. However, these design features are often studied in isolation from each other and the focus is mainly on whether a specific feature was effective to reach the outcomes. As such, it remains unclear how course design features function in concert with each other in a designed environment. Consequently, teachers are left with little guidance as to which features of learning designs should be prioritized when trying to find an appropriate balance between support and autonomy when designing open-ended tasks that address the needs of VEAL. The present study seeks to address this gap by identifying the salient features of a course design and the enactment processes they engender, making it possible for VEAL to reach the learning outcomes.

The current study was conducted in a course on psycho-pedagogical competence for VEAL enrolled in a teacher training program to become teachers in vocational secondary education. The main learning objectives of the course were that students will be able to recognize the most common learning and developmental disabilities, to state the consequences for pupils, and to develop classroom practices that address the needs of pupils with learning or developmental disabilities (further details are provided under Methods).

To achieve the study's aim, conjecture mapping was used as a tool to generate and test the theoretical basis of the course design, with the goal of affirming, rejecting, or refining initial hypotheses (McKenney & Reeves, 2019; Sandoval, 2014). A conjecture map reveals specific hypothesized relationships between design features, the processes they engender during enactment, and the resulting outcomes (Figure 1 presents an overview of the conjecture map elements used in this study). Design features (in this case, characteristics of the pre-service teacher course) can be described in terms of: (1) materials and resources (MR), which are the physical artifacts that are part of the intervention; (2) activity and task structures (AT), which describe the main events through which the intervention will be carried out; and (3) participation and practices (PP), including norms and expectations for how actors are to engage during those events (McKenney & Reeves, 2019; Sandoval, 2014). Design features are purposefully selected. Providing

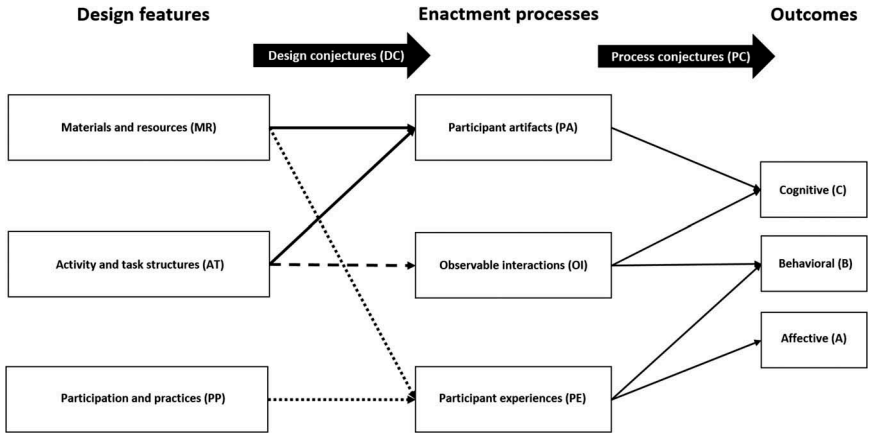

Figure 1. Schematic overview of this study's conjecture map (adapted from Sandoval (2014)).

the theoretical basis for their selection, *design conjectures (DC)* articulate the processes that specific design features (should) engender. For example, "authentic tasks cause learner engagement because they are intrinsically motivating" conjectures that the design feature (authentic tasks) will yield a specific process during enactment (engagement) and offers motivation as an explanation. Enactment processes (i.e., called mediating processes by Sandoval (2014)) result from design features, and contribute to learning outcomes. They can be reified in three ways (Salomon, 1996; Sandoval, 2014): (1) participant artifacts (PA), such as the products that students generate from their activities; (2) observable interactions (OI), which are students' interactions that emerge from the design; and (3) participant experiences (PE), including how the learning environment is experienced by students. Typically, these processes are purposefully planned. Analogous to design conjectures, *process conjectures (PC)* (i.e., called theoretical conjectures by Sandoval (2014)[1]) articulate why the enactment processes (should) yield certain outcomes. For example, "learner engagement supports disciplinary understanding by keeping students on-task" conjectures that the enactment process (engagement) will yield a specific outcome (disciplinary understanding), and offers time-on-task as an explanation. Finally, the enactment processes mediate learning outcomes (Sandoval, 2014), which can be cognitive (C) (e.g., content-knowledge), behavioral (B) (e.g., persistence), or affective (A) (e.g., interest).

[1]McKenney and Reeves (2019) noted that Sandoval's term for the second set of conjectures, 'theoretical conjectures' can be misleading because it suggests that theory building only comes from one type of conjecture. We agree that investigation of design conjectures as well as process conjectures can yield theoretical insights.

Theoretical framework

The goal of the present study was to identify the salient features of a balanced course design that would yield the kinds of processes during enactment that are needed to benefit the learning outcomes of VEAL. We therefore take the desired enactment processes as starting points for building the conjecture map. For each enactment process, we describe what it is, why it is important for vocationally educated adult learners' learning outcomes (i.e., process conjecture), and how and why specific design features (materials/resources, activity/task structures, or participation/practices) could contribute to that enactment process (i.e., design conjectures). At the end of this section, a detailed representation of the relations between the course design features, the enactment processes, and the outcomes, is presented in the resulting conjecture map (Figure 2).

Enactment processes: Participant artifacts

Produce artifacts that meet high standards

The first enactment process is students' production of artifacts that meet high standards. The creation of an artifact entails, for example, that students have to gather and process information about a case study and produce a written report to show their performance. Creating artifacts affords opportunities to engage with the learning content and make sense of the instruction (Sandoval, 2014). Further, producing artifacts that meet

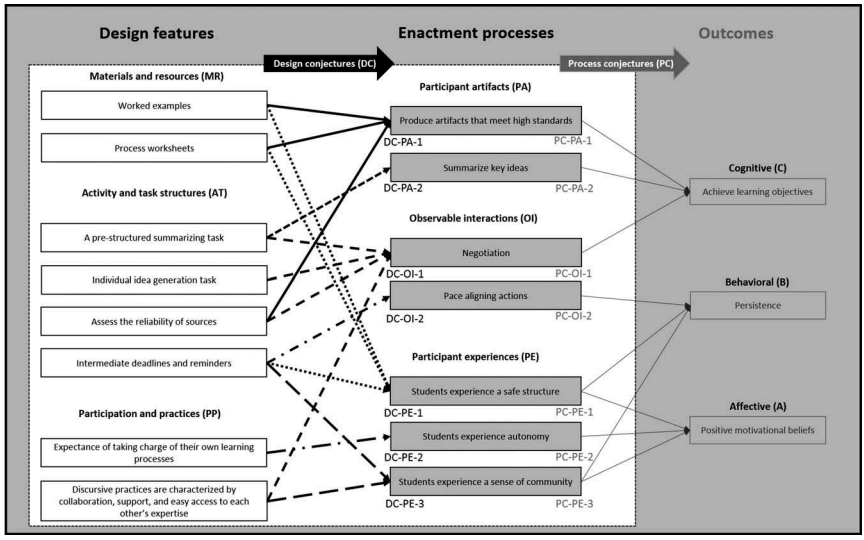

Figure 2. Design conjectures for supporting hands-on adult learners in open-ended tasks.

high standards requires students to master the subject matter (Pintrich, 2000). This enactment process thus stimulates cognitive processing and can help achieve the cognitive outcomes, namely reaching the learning objectives related to the course. In sum, the first process conjecture states (PC-PA-1): *if students produce artifacts that meet high standards, they will achieve the cognitive learning objectives*.

Creating artifacts that meet external expectations can be facilitated by three design features, namely: worked examples, process worksheets, and the explicit task of assessing the reliability of the sources used. *Worked examples*, which are specific demonstrations of the task students are required to do, provide students with acceptable solutions and useful solution steps (Van Merriënboer & Kirschner, 2013). This explicates the task demands and provides a valid standard against which students can compare their own work (Nicol & Macfarlane-Dick, 2006). As such, worked examples can lead to producing artifacts that meet high standards because they help students to become familiar with the task requirements and standards (Nicol & Macfarlane-Dick, 2006; Van Merriënboer & Kirschner, 2013). Providing *process worksheets* guide students through the different steps they need to take to perform the task (Nadolski et al., 2001), as it segments the open-ended task in problem-solving steps and accompanying guiding questions (Nadolski et al., 2006; Van Merriënboer & Kirschner, 2013). These questions can, for instance, guide students to select the most relevant information, or cluster the information in a specific way (Brand-Gruwel & Gerjets, 2008; Nadolski et al., 2006). Accordingly, process worksheets help ensure that students search for and present information in a structured way, which makes it more likely to meet the high standards. Finally, the explicit task of *assessing the reliability of sources* entails that students scan their information sources to decide whether the retrieved information is useful, relevant, and reliable (Brand-Gruwel et al., 2009). This is essential to gather and process correct knowledge, and thus to develop products that meet high standards. To sum up, the first design conjecture is (DC-PA-1): *the use of worked examples, process worksheets and the explicit task to assess the reliability of the sources will help students to produce artifacts that meet high standards*.

Summarize key ideas

The second enactment process related to participant artifacts is summarizing the key ideas. This includes, for example, that students reduce the learning material substantially by capturing the key information (King, 1992) in a summary of the case study on which they have worked. Actively retrieving and recalling information by means of creating an accurate summary might help students to reach the learning objectives. To be more specific, as long as the summary is accurate, this task supports

knowledge consolidation (i.e., strengthen students' knowledge and remember the content) (King, 1992; Roediger & Butler, 2011). Stimulating students to engage in this enactment process to process the learning material is especially important for VEAL, as both teachers in this context and previous research have indicated that these students often have not yet developed their own effective strategies for processing the content (Boelens et al., 2018; King, 1992). We therefore conjecture (PC-PA-2): *if students accurately summarize the key ideas of the topic, they will achieve the cognitive learning objectives*.

This enactment process can be elicited by a pre-structured summarizing task (e.g., students compile a leaflet for their fellow students) in which they are required to capture the core information about their case study. The pre-structured summarizing task helps students to summarize the key ideas because students have to actively run through and reconsider the content in order to extract, recapitulate, and present the main points (Weinstein et al., 2000). As such, the second design conjecture is (DC-PA-2): *a pre-structured summarizing task will help students to accurately summarize the key ideas*.

Enactment processes: Observable interactions

Negotiation

Negotiation during collaboration implies that all group members are engaged with the learning content by discussing about ideas, opinions, and (the meaning of) concepts to reach consensus and construct shared understanding (Dillenbourg, 2002). This enactment process emerges when group members not only share and compare their information and ideas, but also treat each other's opinions critically through explaining, arguing, or questioning one another (Gunawardena et al., 1997; Onrubia & Engel, 2012). Negotiation is important during collaboration to support the cognitive outcomes, namely achieving the learning objectives, as these processes of explaining, critiquing, or questioning lead to more advanced comprehension of the content or the co-construction of new knowledge (Barron, 2003; Dillenbourg, 2002). Previous research in vocational education settings has shown that this enactment process often does not occur spontaneously during collaboration (Hämäläinen & Oksanen, 2012). In addition, VEAL are often not familiar with collaborative (open-ended) tasks (Hämäläinen et al., 2015), and may thus need explicit guidance to develop effective ways to jointly build knowledge. The process conjecture states (PC-OI-1): *if students engage in negotiation during collaboration, they will achieve the cognitive learning objectives*.

Negotiation during collaboration can be facilitated by four supportive features, namely: a pre-structured summarizing task, an individual idea generation task, the explicit task of assessing the reliability of sources, and

discursive practices that are characterized by collaboration, support, and easy access to each other's expertise. The *pre-structured summarizing task* mentioned previously could also elicit negotiation if done collectively, as the group has to reconsider their previous work and decide together upon the most essential information to be enclosed in the overview. In addition, the *individual idea generation task* implies that, prior to working together as a group, students first have to explore and generate ideas individually (Onrubia & Engel, 2012). This can facilitate negotiation during collaboration because students will be inclined to share their individual ideas with one another, after which they need to reach consensus by comparing and contrasting ideas, expressing novel ideas, and discussing about the meaning of concepts. The explicit task to *assess the reliability of sources* requires students to scan each information source based on a predefined set of criteria. This activity can foster negotiation, as it provides students with a specific line of reasoning or argument when they are engaged in a discussion. For instance, when students encounter disagreements, they can identify and compare the reliability of the information sources to reach consensus based on sound arguments (Gunawardena et al., 1997). A last feature of the course design that aims to foster negotiation is *discursive practices characterized by collaboration, support and easy access to each other's expertise*. This design feature is important, as negotiation is only possible when students are willing to share their ideas and opinions with each other, and have a feeling of shared responsibility (Arvaja & Pöysä-Tarhonen, 2013). For example, a learning climate in which there is no threshold to approach fellow students or the teacher and in which it is allowed to make mistakes can foster negotiation. Altogether, the third design conjecture states (DC-OI-1): *a pre-structured summarizing task, an individual preparatory task, the explicit task to assess the reliability of the information sources, and a learning environment that is characterized by collaboration, support and easy access to each other's expertise will help students to engage in negotiation during collaboration.*

Pace aligning actions

Another salient enacting process related to observable interactions is that students align the pace of their progress with each other. For example, before starting the group work, it is important that students both generated individual ideas and finished their individual preparatory task. Aligning the pace of their progress is important to ensure that all students persist during the open-ended task. Student persistence involves students' attempts or resilience to continue to participate in a course or task, or to achieve a stated goal, despite the presence of possible obstacles (O'Neill & Thomson, 2013; Pintrich, 2004; Rovai, 2003). It is an important behavioral outcome, that is related to *doing* (Reeves, 2011), and students aligning the

pace of their progress support this outcome by diminishing possible obstacles such as lack of self-discipline, bad time planning or allocating insufficient time for performing the tasks (Pintrich, 2004; Rovai, 2003), and especially by helping them to sustain effort over time (O'Neill & Thomson, 2013). This enactment process is especially important for VEAL as research has indicated that these students might show unstructured learning behavior and often lack a sense of time, resulting in poor time planning skills and devoting insufficient time to the tasks (Biemans et al., 2016; Boelens et al., 2018). Applied to the current case, the process conjecture is (PC-OI-2): *if students engage to align pace with each other, they will persist throughout the course*.

This enactment process can be facilitated by dividing the open-ended task into subtasks with accompanying *intermediate deadlines and reminding* students of the upcoming deadlines and their learning progress. Reminders can be addressed to individual students, student groups, or the whole class. The provision of intermediate deadlines and reminders is important, as these might decrease students' concerns about the planning of the course and the allocation of sufficient study time for the subtasks (Karoğlu et al., 2014), and cause an increase in engagement and effort toward a goal throughout the course design (O'Neill & Thomson, 2013), both of which could contribute to students aligning the pace of their progress with one another. Consequently, the fourth design conjecture is (DC-OI-2): *intermediate deadlines and reminders will prompt students to align their pace with each other*.

Enactment processes: Participant experiences

Students experience a safe structure

The first enactment process related to participant experiences, is that students experience a safe structure in terms of: course and task details; sequencing and structuring of the (sub)tasks; and perceived workload and task difficulty (Nadolski et al., 2006). This holds for both behavioral and affective outcomes. First, regarding the behavioral outcomes, research has suggested that ensuring that all tasks, requirements, and procedures are clearly formulated and communicated fosters student persistence by avoiding frustrations about the consistency and the clarity of the course design (O'Neill & Thomson, 2013; Rovai, 2003). Second, experiencing a safe structure might also be associated with affective outcomes, namely motivation. Students' motivational beliefs about themselves in relation to the task (Pintrich, 2000) include (in this study): interest in or liking of the task, positive affective reactions to the self or the task, and self-efficacy judgments (O'Neill & Thomson, 2013; Pintrich, 2000, 2004; Ryan & Deci, 2000; Tsai et al., 2017). Motivational beliefs are

concerned with *valuing* (Reeves, 2011), as to be motivated is to be engaged to reach the goals of the course design (Ryan & Deci, 2000). Experiencing a safe structure can support students' self-efficacy judgments positively because they experience small pieces of success by seeing and completing the sub-goals (O'Neill & Thomson, 2013) what makes them feel more empowered to tackle challenging tasks. The experience of a safe structure is an important process for VEAL, as they often lack experience in open-ended tasks and might feel not competent enough to perform these tasks (Dubeau et al., 2017). In addition, research has shown that these students prefer learning in a structured environment, with a well-organized course structure and clear expectations (Jossberger et al., 2018; Smith, 2000). As such, the process conjecture is (PC-PE-1): *if students experience a safe structure, they will persist throughout the course and they will hold positive motivational beliefs*.

The experience of a safe structure can be facilitated by three design features, namely: worked examples, process worksheets, and the provision of intermediate deadlines and reminders. *Worked examples* ensure that the students experience a high level of support, since they can consult a complete elaboration of the open-ended task (Van Merriënboer & Kirschner, 2013). Studying a worked example ensures that students do not have to search for their own strategies or method to complete the open-ended task (Van Merriënboer, 2013). In addition, when students encounter difficulties during task performance, they can go back to the worked example to see how an expert approached a certain part. This can lead to perceptions of a safe task structure. *Process worksheets* ensure that the open-ended task is clearly structured and sufficiently detailed (Nadolski et al., 2006; Van Merriënboer & Kirschner, 2013). This fosters students' experience of a safe structure by dividing the task in subsequent steps and accompanying guiding questions, which direct students' attention to search for the most relevant information, to cluster this information according to the imposed structure, and to report the sources they consult. At last, *intermediate deadlines and reminders* emphasize the division of the open-ended task in subtasks. In particular, this design feature provides students with a timeline in which fixed deadlines are set, and frequently reminds students about upcoming deadlines and their learning progress. This influences students' perceptions of a safe structure by decreasing concerns about the course structure and avoiding that students are overwhelmed by the amount of work (Karoğlu et al., 2014). Accordingly, the fifth design conjecture states (DC-PE-1): *the use of worked examples, process worksheets, and the provision of intermediate deadlines and reminders will help students to experience a safe structure*.

Students experience autonomy

The second enactment process related to participant experiences, is the extent to which students experience autonomy while engaged in the course design. Experiencing autonomy refers to the psychological freedom that students feel and exert, to control and take responsibility for their own behavior and the learning activities they engage in (Deci & Ryan, 2000; Haerens et al., 2016). However, being mature and responsible adults does not necessarily imply that, in the role of learner, these adults should obtain full autonomy or control over their learning (e.g., by diagnosing their own learning needs, formulating learning objectives, identifying resources for learning, using appropriate learning strategies, and evaluating learning outcomes) (Chene, 1983), as autonomous *adults* are not always capable as autonomous *learners*. Therefore, in this study, student autonomy is conceptualized in two ways. First, when students engage in online activities, this offers them autonomy in terms of time and place, i.e. when and where to carry out the learning activities (Osguthorpe & Graham, 2003). Second, student autonomy can also be achieved by the pedagogical approach (Chene, 1983) in which students engage in open-ended tasks, i.e. where they take an active role in their learning process and mainly work independently or in small groups to acquire the required knowledge and skills to solve authentic problems (Damşa & Nerland, 2016; Hannafin & Hill, 2007; Hmelo-Silver et al., 2007). Experiencing autonomy is an important process that influences students' motivational beliefs such as positive affective reactions and interest in or liking the task because the feeling of autonomy responds to students' intrinsic motivation (Deci & Ryan, 2000; Ryan & Deci, 2000; Tsai et al., 2017). In the case of VEAL, research has indicated that although these students prefer a lot of structure and teacher control, they also want authentic learning tasks that challenge them (Jossberger et al., 2018). Accordingly, this process conjecture is (PC-PE -2): *if students experience autonomy when engaged in the open-ended task, they will hold positive motivational beliefs*.

In education, student autonomy can be fostered when students are expected to *take charge of their own learning process*. In this case, this design feature entailed both online learning activities, and the autonomy in the open-ended task. On the one hand, students have to take charge of their own learning by means of online learning activities, wherein students have control over when, what, where, and how long to engage in a learning activity (Barnard et al., 2009). On the other hand, in open-ended tasks, students are required to take an active role in the learning process by acquiring and processing new content on their own, and presenting their work to others (Drexler, 2010). This influences students' experience of autonomy by emphasizing their own responsibility to perform the tasks successfully. As such, the sixth design conjecture assumes (DC-PE-2):

students who are expected to take charge of their own learning process will experience autonomy.

Students experience a sense of community

The third enactment process related to participant experiences is students experiencing a sense of community. This process is characterized by group cohesion, which is a sense of shared identity or belonging to the class group (Garrison, 2007), open communication in a safe learning environment, and the development of personal relationships while acknowledging each other's individual personality (Garrison, 2007). This sense of community is characterized by both a supportive relationship among the instructor and the learners (O'Neill & Thomson, 2013; Prins et al., 2009), and respectful social contact and mutual support among learners (Prins et al., 2009). This enactment process is important with regard to the behavioral and affective outcomes. First, research has suggested that personal interaction among students and between students and the teacher, and the creation of a safe learning community can stimulate student persistence (Rovai, 2003). In particular, research has shown that students who believe that their instructor is concerned with them and their study progress, are more likely to persist (O'Neill & Thomson, 2013). A sense of community provides students who are unfamiliar with open-ended tasks with a more secure feeling (Ausburn, 2004) and can reduce certain obstacles or thoughts of dropout from the course (Pintrich, 2004). Next, Deci and Ryan (2000) have stated that feeling secure and connected to others in the classroom is important for students to be intrinsically motivated, what causes positive affective reactions to the self or the task. This is an important enactment process for VEAL as research in this context has found that vocational learners have a strong preference for learning in an environment with welcoming and supportive relationships between the students themselves, and the students and the teacher (Smith, 2000). The process conjecture is (PC-PE-3): *if students experience a sense of community, they will persist throughout the course and/or they will hold positive motivational beliefs*.

Two design features that aim to foster the experience of a sense of community are: intermediate deadlines and reminders, and discursive practices that are characterized by collaboration, support, and easy access to each other's expertise. The provision of *intermediate deadlines and reminders* shows a high level of teacher commitment regarding the students. In particular, students may feel supported when the teacher reminds them of upcoming deadlines and students' learning progress but may also have the feeling that the teacher is available and accessible. In short, this can cause a sense of community by the commitment and the proximity of the teacher (Ausburn, 2004). The second design feature includes *environments characterized by collaboration, support, and easy access to each other's*

expertise. This design feature mentioned previously is also important to create a sense of belonging in a community, as this is only possible when both the teacher and the students show commitment toward each other (Tomlinson & Imbeau, 2013). Accordingly, the seventh design conjecture is (DC-PE-3): *the provision of intermediate deadlines and reminders, and an environment that is characterized by collaboration, support, and easy access to each other's expertise will prompt students to experience a sense of community*.

Summary

Based on the above outlined theoretical framework, seven design conjectures are articulated based on the association between the features of the course design and the enactment processes. In addition, also seven process conjectures are formulated based on the association between the enactment processes and the learning outcomes. The design and process conjectures for each enactment process are listed in Appendix 1.

A map showing how the course design features are related to the enactment processes and the learning outcomes is shown in Figure 2. The white zone represents the primary focus of this study. Regarding the enactment processes, we aim to be parsimonious and only connect the embodied design features with the most obvious enactment processes. Although these processes are discussed here in isolation from each other, we note that some of them may also influence each other reciprocally. However, such analyses extend beyond the scope of the present study.

The present study

The course design under investigation was the second design cycle of a research project that focuses on the design, implementation, and evaluation of design features that are particularly supportive to VEAL when tackling open-ended tasks in blended learning environments. In particular, based on a formal evaluation of the first design cycle (Boelens, 2018; Boelens & De Wever, 2017) and an informal evaluation of the course design that combined the perspectives of the students, the teacher, and the researcher (Könings et al., 2005), the teacher and the first author of this study (i.e., researcher) co-constructed and optimized the learning scenario. In this way, the course design under investigation was firmly informed by the teacher's expertise, international literature, and field testing (Könings et al., 2005; McKenney & Reeves, 2012). Situated against the background of our project, at this phase of development, the primary aim of the present study is to test the *design conjectures* of this course design. Secondarily, we examine the plausibility of the *process conjectures* to yield the intended

outcomes, in light of the design conjectures, and to determine if they require refinement. The research questions are:

- To what extent are the enactment processes achieved, and how do the features of the course design contribute to this?
- How do the enactment processes appear to contribute to the learning outcomes?

Method

Context

The present study is part of a research project on the design of blended learning environments for VEAL. This study is situated in a teacher training program, in which VEAL with prior craft knowledge (e.g., bakery, electricity, hairdressing) retrain to become teachers in vocational programs (see also Boelens et al. (2018)). These learners have participated in two of the four tracks of secondary education in [country]: vocational or technical (not general or artistic). The intervention under investigation took place in the course *psycho-pedagogical competence* throughout 16 weeks. This course is part of the second year of a 2,5-year teacher training program. The main course objectives were: students are able to recognize the most common learning and developmental disabilities (i.e., dyslexia, dyscalculia, non-verbal learning disability, attention deficit hyperactivity disorder, autism spectrum disorder), students are able to state the consequences for the learning behavior of pupils, and students are able to develop classroom practices that address the needs of pupils with learning or developmental disabilities based on these insights. Students had to tackle an open-ended task in which a case study of a student with a learning or developmental disability was given. We hypothesized that working on the case through the subsequent subtasks (e.g., how to define dyslexia, how is dyslexia diagnosed, what are the signs or symptoms, what are the consequences for pupils, how best to treat dyslexia on school- and classroom-level), would give students opportunities to gain insight into what they can do for pupils with a learning or developmental disability in their classroom. The teacher and the first author developed a rubric to assess students' process and product.

Research design

A case study approach was adopted to understand participants' behavior and perceptions regarding the blended course design in an authentic context (Yin, 2009). Given the goal of understanding the perceptions and

behaviors of those involved, the unit of analysis is the blended course, including its design and the teacher and students who participated in it. To obtain emic (participant) as well as etic (researcher) views, the design of the case study was inspired by ethnographic approaches (Hammersley & Atkinson, 2007). To get to know the context and the learners, the first author actively participated in the teacher training program, which enabled her to follow one cohort of VEAL during two consecutive academic years (2015–2016 and 2016–2017). Each year, the researcher conducted participant-observation throughout the duration of one course, and asked questions to students and teachers through formal and informal interviews. In addition, the same researcher worked together closely with the teacher in the present study through two cycles of course design, development, and evaluation and revision (Roschelle & Penuel, 2006), the second of which forms the context of this study. This afforded the researcher a detailed understanding of what happened precisely during this process, as well as the teacher's perspectives on it.

Participants

The participants were both the VEAL (n = 10) and the teacher who redesigned and implemented the blended course design. The average age of the students was 27 years (SD = 6.17, range = 21–39), and the female teacher was 43 years old. Participation was voluntary and both teacher and students gave their informed consent, having been made fully aware of the nature and purpose of the research. The response rate was 100%. Appendix 2 provides additional information about the VEAL who participated in this study (i.e., gender, age, diploma, the group in which they collaborated, and each one's pre-course perceptions about open-ended task) and the participating teacher.

Data collection

As is common in ethnographic studies, multiple data sources were used to explain the richness and complexity of the effects of the course design on participants' behavior and perceptions (Cohen et al., 2007; Hammersley & Atkinson, 2007). First, two student interviews and two teacher interviews were conducted to get a detailed understanding of individual experiences and interpretations that are of importance to the present study's research questions (Cohen et al., 2007). Additional information about the interview protocols is provided in Appendix 3.

Next to teacher and student interviews, all educational activities were observed as they unfolded (Brophy, 2006). In particular, all face-to-face meetings were observed and video-taped by the first author, while also the

Table 1. Data sources aimed to measure the enactment processes.

	Student interviews	Teacher interviews	Observations	Artifacts
Artifacts that meet high standards		X		X
Summarize key ideas		X		
Negotiation	X	X	X	
Pace aligning actions	X	X		X
Students experience a safe structure	X	X		
Students experience autonomy	X	X		
Students experience a sense of community	X		X	

online activities (e.g., e-mail conversations, forum posts) were observed and logged. During the observations, the researcher took notes to reduce the data (Brophy, 2006).

A last data source is the produced artifacts, including students' individual preparation, the group document, a leaflet of each group's topic, the lesson plan for their presentation, and student presentations. Additionally, the teacher's evaluation of the group document, based on the predefined rubric, was collected.

Table 1 presents an overview of each data source in relation to the enactment processes central to this study. In addition, the student and teacher interviews were used to test the design conjectures as well as the plausibility of the process conjectures.

Data analysis

In order to analyze students' and the teacher's perceptions, the interview transcripts were coded using NVivo 11. First, the first author read and reread the interview transcripts to become familiar with the rich information the data entailed and to ascertain if it would be sufficient to assess the course design. Second, a codebook was compiled based on the theoretical framework (which is based on the course design) and research questions. In this codebook, participants were listed in columns. The rows listed for each enactment process (1a) how the enactment process was achieved, and (1b) how the enactment process was related to the intended outcome(s) (i.e., process conjecture(s)), and (2) for each course design feature how this influenced the enactment process(es) (i.e., design conjecture(s)). As such, the patterns of response arising across the participants were put together in order to compare issues that each of them has raised (Cohen et al., 2007). Third, this codebook was used by the first author to analyze all transcripts. Each transcript was carefully read and reread to identify the relevant data. Appendix 4 provides (additional) samples of coded data.

Observations were used to provide insight in two enactment processes: negotiation and students experiencing a sense of community. First, direct

observations of students' interaction during collaboration were analyzed to investigate whether they went beyond sharing and comparing information and negotiated about their opinions and ideas to construct knowledge. The findings of this analysis are reported in a previous study (Boelens, 2018). Second, indications were searched in the field notes that the researcher took during the observations to explore whether students experienced a sense of community.

Artifacts were analyzed to investigate whether students produced artifacts that meet high standards, and whether students aligned their pace with each other. For the former, we analyzed the teacher's evaluation based on the predefined rubric to assess the group document. The rubric consisted of 17 criteria with 4 indicators for each criterion that described the specific expectations. For each criterion, a maximum of three points could be earned. For the latter, we analyzed whether each student met all intermediate deadlines. This was done by comparing the revision history of the documents, examining previous versions of evolving documents, and dates of saving during the course.

Results

For each of the seven enactment processes, we present three classifications to help answer the research questions, together with the data which yielded the classifications. First, a classification is given for the *enactment process* in relation to intentions (i.e. achieved, not achieved, or sometimes achieved), justified by description of what it looked like. Next, the related *process conjecture is* classified (plausible, not plausible, plausible but limited data, or insufficient data to comment on plausibility), in light of results concerning the outcomes. Third, the *design conjectures* are classified (supported, not supported, and supported but with limited data), explained by findings about if and how specific features of the course design influenced the enactment process.

Enactment processes: Participant artifacts

Produce artifacts that meet high standards

Producing artifacts that meet high standards was a successfully enacted process. The students first performed an individual task in which they searched for information and generated their own ideas to gather knowledge about the topic. Later on, students collaborated in small groups to create a group document in which they brought together and negotiated about their retrieved information, ideas, and opinions to acquire and process knowledge about their topic. Finally, the groups presented their work to each other. The teacher indicated during the interview that, due to

the individual preparation, all students were well prepared for the group work. In addition, she stated that the group documents differed from each other, but all met the (minimum required) standards. The teacher's evaluation based on the rubric showed that students' mean score was 7.4 (out of 10) (*SD* = 1.12), with a minimum score of 5.74 and a maximum score of 8.19. The differences in quality were, according to the teacher, attributable to the individual responsibility of the groups, as they decided for themselves how deep to process the information in the open-ended task and how much time they spent on the open-ended task. The teacher was also satisfied with students' presentations: "I was very proud during the presentations (…) They did their best to elicit learning effects in their fellow students".

The results suggest that PC-PA-1 is plausible: *Produced artifacts that meet high standards can lead to cognitive outcomes, because students process and master the content*. The majority of the students (n = 6) indicated that by means of actively processing the content, they already mastered the content and remembered it better, as opposed to when the teacher tells everything in class. In addition, three students commented that they valued the fact that all students could learn from each other through the presentations, and Esra argued that she memorizes things better when presented by her fellow students. The teacher also reasoned during the interview that students remember the content better in this way than when an expert tells about the learning and developmental disabilities. However, she also acknowledged that not all content was 100% correct or well nuanced, which may have been less the case if an expert came to speak.

Three features of the course design were intended to support students in producing artifacts that meet high standards: worked examples, process worksheets, and the explicit task of assessing the reliability of the sources. During the student interviews, all students perceived the *worked examples* as helpful for their learning, because these helped them to familiarize themselves with the external expectations related to the open-ended task. Students consulted the worked examples mainly when they felt the need for more clarification. For instance, Olivia reported: "when we were unsure about something while performing the task, we consulted the worked example." These external expectations concerned both content-related expectations, for instance, Eva said: "two questions in the process worksheet were very similar to each other, and by analyzing the worked example, I could know what was actually intended", and editorial requirements, such as lay-out, length and formulation of the responses. However, Lucas was the only student who was less enthusiastic about the worked examples. On the one hand, he did not recognize the added value of some of the worked examples, because the examples "covered a different topic", while on the other hand, he indicated to have trouble to retrieve documents on the learning platform, and, in this case, he was not inclined to seek and open

the worked examples. In line with what the majority of the students reported, the teacher stated during the interview that the worked examples clarified the external expectations and requirements. Finally, also the classroom observations during the group work showed that students consulted, or the teacher redirected students toward, the worked example when they disagreed with each other or were in doubt about what was exactly expected from them. As such, worked examples support the production of artifacts that meet high standards because students are aware of the task requirements.

Regarding the *process worksheets*, the student interviews revealed that all students preferred this structure above a less structured task. In particular, students stated that the process worksheet contributed to their learning, as the different steps with sub-questions helped them to select main ideas and cluster the information. Charlotte putted it as follows: "About some questions in the task I would not have written anything without the process worksheet. In my opinion, it was good that the process worksheets were there, otherwise the task might be less complete than the teacher would expect." This view was echoed by Lucas who indicated that the process worksheet prevented the copying and pasting text from an existing source into the task, since the information needed to be carefully selected and clustered. From the interview with the teacher no information related to this part of the design conjecture was obtained. Observations revealed that students strictly followed the sequence of the process worksheet. This helped them to get grip on the (sometimes) large amount of information. Nonetheless, process worksheets support the production of artifacts that meet high standards because students select and cluster main ideas in a structured way.

Turning now to the explicit task of *assessing the reliability of the sources*, the majority of the students (n = 7) reported during the interviews that they took into account the proposed criteria to scan their sources. For instance, both Olivia and Emma said that this helped them to get a better view on the reliability of the source when the retrieved information seemed not very plausible, which helped them to direct their attention to objective or reliable information. However, Mia indicated that she did not pay attention to this. The teacher mentioned during the interview that the students generally used reliable sources to build their knowledge. Observations during the group work showed that while some groups paid a lot of attention to the reliability of the sources, other groups had to be reminded by the teacher to assess the reliability of sources. In sum, the task of assessing the reliability of sources supports the production of artifacts that meet high standards because students gather and process reliable information. These results support DC-PA-1 with confidence: *The use of worked examples, and/or*

process worksheets, and/or the explicit task to assess the reliability of the sources can help students to produce artifacts that meet high standards.

Summarize key ideas

The enactment process aimed to accurately summarize the key ideas was not achieved. The groups compiled a leaflet based on their group document with the intention to reconsider and recapitulate the content once again. Although the teacher emphasized the added value of the summarization of key ideas during the interview, she was not completely satisfied with its elaboration: "I should have safeguarded the quality of the content of the leaflet better. For instance, sometimes supportive measures (to cope with a learning or developmental disability in a classroom) were given that had little to do with the students' field."

Since this process was not enacted as was intended, we have insufficient data to comment on the plausibility of PC-PA-2: *Summarizing key ideas can lead to cognitive outcomes, because students consolidate their knowledge*. During the interviews, students particularly indicated that the leaflet will assist them to study for the exam, but they did not state that the creation of the leaflet helped them to, for instance, remember the content better. During the teacher interview, the teacher did not elaborate on the outcome of summarizing key ideas, as she was not satisfied with the enactment of this process.

A *pre-structured summarizing task* was intended to support students to accurately summarize the key information. Eight students indicated that they perceived this task as an essential element that supported their learning, because this helped them to produce a clear overview of their own topic. Sophie indicated: "When you are tackling an open-ended task for such a long time, you sometimes lose the overview. And now (by means of the summarizing task) you have an overall picture of the topic." By way of contrast, two students indicated that the summarizing task did not contribute to their learning. For instance, Mia said: "this was redundant, because the same information of the task came back in the leaflet." Moreover, the student interviews revealed information about how the groups approached the creation of the leaflet. On the one hand, Esra reported that they did not spend a lot of time and effort to compile the leaflet but copied and pasted the earlier retrieved information. On the other hand, Olivia argued: "while we summarized the retrieved information, we reconsidered whether everything was well formulated, or whether we should do something different." During the teacher interview, the teacher concluded that the summarizing task itself does not guarantee the enactment of accurately summarizing key information. The observation data revealed that the groups did not spend a lot of time on the summarizing task during the face-to-face meeting or that they appointed one group

member with this task. These findings provide no support for DC-PA-2: *the pre-structured summarizing task did not contribute to summarizing key ideas because it did not stimulate students to reconsider the content to extract and recapitulate the main points*.

Enactment processes: Observable interactions

Negotiation

The process of negotiation during collaboration was sometimes achieved. The small groups first interacted with each other through an online forum, and later during a face-to-face meeting. Nine students indicated during the interviews that they jointly discussed about the information to compile the final group document. Only Eva indicated that she did most of the work alone because Charlotte was busy doing other things during the face-to-face moment. In addition, Emma noted that she and Sophie often had similar opinions and therefore little negotiation. The teacher provided a similar picture during the interview. She noted that Eva and Charlotte quickly passed the task without negotiation, Sophie and Emma exchanged a lot but negotiated less, while the other two groups seemed to negotiate more about their opinions and ideas. Furthermore, the direct observation of students' interaction during collaboration has illustrated that these two latter groups jointly constructed knowledge in a few occasions, while the interaction in all groups generally was limited to sharing and comparing information and ideas without treating each other's opinion critically (Boelens, 2018).

The results suggest that PC-OI-1 is plausible: *Negotiation during collaboration can lead to cognitive outcomes, because students have a more advanced comprehension of the content*. Six students indicated during the interviews that actively processing the content in small groups helped them to master the content better. In addition, the teacher commented during the interview that students processed the content more in depth because they did not share out different parts of the task and worked apart from each other, but were mutually engaged in task solutions.

Four features of the course design were intended to foster negotiation: the pre-structured summarizing task, the individual idea generation task, the explicit task to assess the reliability of sources, and discursive practices that are characterized by collaboration, support, and easy access to each other's expertise. Regarding the *pre-structured summarizing* task, it became clear during the student interviews that three groups jointly composed the leaflet, while in group 3 Eva composed the leaflet on her own. From the groups who jointly composed the leaflet, group 1 commented that it was simply copy-pasting the information, while group 4 stated that this was a last check to jointly discuss about the content of the group task. Thus, the

groups approached the summarizing task in a different way, which not always resulted in the process of negotiation. From the teacher interview no information related to this part of the design conjecture was obtained. Observation data confirmed the variety in approaches: the copy-pasting of information, appointing the task to one group member or using the summarizing task as a last check. In sum, the pre-structured summarizing task did not contribute to negotiation because it did not stimulate students to collectively reconsider their work and decide upon the most essential information.

With respect to the *individual idea generation task*, eight of the students indicated that this was a good starting point to compare and discuss about each other's work. Olivia stated: "by means of the individual preparation, each student possessed the basic information before we started with the collaborative task". Moreover, Victor reported that "we had to underpin our answers in the individual preparation, and we automatically did this too during the group work." In sum, student interviews revealed that this individual idea generation task helped them to share and compare their work, and served as a starting point for negotiation and jointly constructing knowledge. According to the teacher, this approach ensured that every student felt individual responsible for the group work and was prepared for the discussion, which led to a thoughtful discussion. In addition, she stated that the fact that there was a difference in nuance and new thinking exercises in the group task, ensured that it was not just copy-pasting information, and students were inclined to negotiate with each other. Observations confirmed these findings: students brought their preparations to the class, compared their contributions with each other, and negotiated to a greater or lesser extent about what to include in their final work. Therefore, the individual idea generation task caused negotiation because students discussed their individual ideas to reach consensus.

Turning to the explicit task to *assess the reliability of the sources*, whereas the majority of the students (n = 7) indicated that they scanned their sources on reliability, none of the students stated that they used this as an argument in their discussion during the collaboration. In contrast, the teacher stated in the interview that she noted during the face-to-face conversations that students were very conscious of the reliability of their sources. This was also revealed in the observations by the researcher. In addition, when students were stuck in the discussion, the teacher stimulated them to assess the reliability of the sources by asking "which source is the most reliable you think?". In short, the task to assess the reliability of sources appeared to cause negotiation by providing an objective argument during collaboration.

The last feature of the course design intended to foster negotiation was the emergence of *discursive practices* that are characterized by collaboration,

support, and easy access to each other's expertise. During the interviews with the students, both Victor and Esra argued that because they had a good relationship with the other group members, everyone shared his or her ideas and "you can more easily tell your opinion (Victor)". Moreover, for Lucas it was important to feel that he could rely on the support and expertise of the other group members, what enabled him to discuss and negotiate during collaboration. The interview with the teacher revealed that, in her opinion, the students were willing to invest time in the group work, resulting in qualitative dialogs during collaboration. During the observations, it became clear that there was a good atmosphere in the class group, respect for each other's background and mutual trust. Only in the group of Eva and Charlotte there were struggles because Charlotte was reluctant to cooperate. Thus, discursive practices characterized by collaboration, support, and easy access to each other's expertise did support negotiation because students were willing to share and probe ideas.

To summarize, these findings only partly support DC-OI-1: *an individual idea generation task, and/or a learning environment characterized by collaboration, support and easy access to each other's expertise, can help students to engage in negotiation during collaboration*. In addition, the results appear to support the conjecture that *the explicit task to assess the reliability of the sources can help students to engage in negotiation*, but data are limited. Finally, one part of the conjecture, *a pre-structured summarizing task can help students to engage in negotiation*, was not supported by the results.

Pace aligning actions

Students enacted successfully pace aligning actions during the open-ended task that was divided in eight parts with intermediate deadlines. The student interviews, teacher interview, and direct observations revealed that all students met the deadlines for the individual task, except Charlotte missed the first deadline to accomplish the first two steps of the individual task. Consequently, her group could not proceed with the group work. However, she had quickly caught up with her backlog so that the group did not run into problems to align their actions and meet the predetermined deadlines. Afterward, all students and groups met all deadlines and everyone stayed in pace with each other.

The results show that PC-OI-2 is plausible: *Pace aligning actions can result in student persistence, by reducing possible obstacles (e.g., bad time planning)*. During the student interviews, Esra said that "the guidance in the time has ensured that she successfully completed the open-ended task". Moreover, Charlotte indicated that she often postpones doing schoolwork, so "it was actually good that we had to submit a part of the project every week or every two weeks, and not all at once." In addition, the teacher

stated during the interview that if it would be difficult for the students to stay in pace with each other and meet the deadlines, then there would be a lot of resistance against the open-ended task or students would dropout from the program.

This enactment process was fostered by setting *intermediate deadlines and frequently reminding students* to upcoming deadlines and their learning progress. The student interviews revealed that all students were positive about the planning with intermediate deadlines. Moreover, seven students indicated that this was one of the success factors of the course design. The intermediate deadlines and reminders helped students to feel less insecure about the course planning (n = 6) and empowered them to stay engaged during task execution (n = 3). For instance, Lucas said: "This was fantastic, you know for sure that you are on track and you did not forget to post anything, it provides a secure feeling." Regarding the reminders sent by the teacher, the majority of the students (n = 7) agreed that this was useful to know that a deadline is approaching or where they are situated in the learning process. However, three students (Emma, Sophie, Mia) did not feel the need for additional supervision provided by the teacher. Emma said: "on the one hand, I felt that this was redundant, however, on the other hand, it can be useful to receive a reminder when you still need to submit a task". The teacher indicated during the interview that having intermediate deadlines was good for the students to spread the work at a maximum because this ensured that it was feasible for them to stay in pace. These results provide support for DC-OI-2: *Intermediate deadlines and reminders prompt students to align their pace with each other because it avoids procrastination and decreases concerns about the planning*.

Enactment processes: Participant experiences

Students experience a safe structure

This enactment process was achieved. All students indicated during the interviews that the open-ended task was very clear, had a good and detailed structure, and was well supervised by the teacher. For instance, students stated that the open-ended task was clearly formulated (Emma, Eva) and expectations were clear (Mia). In the teacher's opinion, students received sufficient supervision and the students experienced the clear structure underlying the open-ended task.

The results indicate that PC-PE-1 is plausible, but with limited data: *If students experience a safe structure this can result in student persistence by reducing insecurity and frustrations, and in positive motivational beliefs by feeling more empowered to tackle challenging tasks*. Concerning the behavioral outcome, the student interviews revealed that the clear structure

helped them to gain confidence in how to approach the task, to be sure they did not forget something, and to ensure that they did not start too late with the execution of the tasks (Lucas and Sophie). Victor argued that the clear structure helps to prevent himself from panicking, procrastinating, and dropping out. The teacher said during the interview that she felt that the students really needed that structure to keep up and feel confident.

With regard to the motivational outcomes, all students indicated during the interviews that they had no trouble motivating themselves for the open-ended task. Four students (Esra, Olivia, Sophie, Eva) explicitly indicated that the clear structure entailed a motivating element. For instance, Olivia stated that it helped her to keep track of her own progress: "The division in the separate steps gave a good feeling. Then you know, after this, we already completed step one and two. You see the result immediately." As such, the clear structure ensures that students feel empowered to tackle the open-ended task, by ensuring that students are not overwhelmed and stay motivated. No information about this process conjecture was obtained from the teacher interview.

Three features of the course design were intended to ensure that students experienced a safe structure: worked examples, process worksheets, and intermediate deadlines and reminders. Four students reported during the interviews that the *worked examples* were useful to get an overall picture of what you have to do (Sophie, Anna, Eva, Charlotte), and to estimate the workload or how much time the task will cost (Sophie). According to the teacher, worked examples were really useful, because students can look at them whenever they want to get a global view of the open-ended task. The observations during the face-to-face groupwork showed that students consulted the worked examples when they were in doubt about what was exactly expected from them and how the product outcome should look like. Briefly, worked examples enhance students' experience of a safe structure by providing an overall picture of the task.

Turning to the *process worksheets*, all students were satisfied about the structure this brought. Emma indicated that the clear guiding questions ensured that they sufficiently elaborated on the information and reported their sources. Next to this, Esra said: "It was good to see, for instance, that we are already at step three, or we have to take two more steps and then we are done." Emma also indicated that the structure helped her to organize and plan her learning: "For those pieces that I had to make at home, I could easily divide the work, or say that I'm going to stop (after a certain step), and then I can easily start working on it (the next step) next time." From the teacher interview no information about this part of the design conjecture was obtained. Observations also revealed that students did not deviate from the proposed structure and thus strictly followed the sequence and structure of the process worksheets. In sum, process worksheets

enhance students' experience of a safe structure because they scaffold the search and learning process.

Nine of the ten students explicitly argued during the interviews that *the intermediate deadlines and especially the reminders* felt good to know whether they are processing well, or they still have to do a lot of work. Victor said: "in this way, you are sure that you have not lost sight of certain tasks." During the interview, the teacher indicated that she had the impression that by regularly reminding the students (face-to-face and online) of upcoming deadlines and their learning progress, students had a clear structure to fall back on. Observations showed that although the deadlines were articulated at the beginning of the semester and posted on the learning platform, students still wanted reminders. For instance, they often asked the teacher to present an overview of the deadlines and where they were situated at that particular moment. To summarize, intermediate deadlines and reminders enhance students' experience of a safe structure by providing feasible steps to tackle open-ended tasks. These findings provide support for DC-PE-1: *the use of worked examples, and/or process worksheets, and/or the provision of intermediate deadlines and reminders help students to experience a safe structure.*

Students experience autonomy

The enactment process of students experiencing autonomy was achieved. The students had to perform specific learning activities in the online environment and had an active role in acquiring and processing knowledge individually and in group. In eight of the interviews with students, it became clear that they experienced autonomy. They talked about the independence they perceived (Eva, Olivia), the opportunity to choose when to engage in the learning activities (Anna) and to work at your own pace (Sophie), the chance to showcase your own ideas and to present your work to each other (Victor, Emma, Lucas, Eva, Esra), and the opportunity to discuss in group about the content (Victor, Emma). Also, the teacher indicated during the interview that students experienced autonomy in a positive way.

The findings indicate that PC-PE-2 is plausible: *If students experience autonomy this can result in positive motivational beliefs, because student choice fosters intrinsic motivation*. During the student interviews, seven students emphasized that this autonomy was satisfying and contributed to their motivation. In particular, students used the following concepts: fun, motivating, interesting, and pleasant. Also, the teacher indicated during the interview that, in her opinion, students experienced the autonomy positively, and find the open-ended task more pleasant and motivating than receiving all information during a lesson from the teacher.

The fact that students were expected to take charge of their own learning processes was aimed to ensure that students experienced autonomy. The interviews with the students showed that the autonomy students experienced was mainly due to the fact that they had both the individual and the group responsibility to gather and process information, and to present their work to each other (Victor, Emma, Eva, Esra, Sophie, Lucas, Olivia). In addition, two students (Anna, Sophie) explicitly referred to the increased responsibility to take charge of their own learning process during the online part of the open-ended task. During the teacher interview, the teacher also stated that students took charge of their own learning processes by having an active role in processing the content and presenting their own work to their peers, and by having the responsibility (in the online part) to decide when, where, and how long to engage in the learning activities. The observations revealed that almost all students felt responsible for the open-ended task, as they stimulated each other to work efficiently or reminded each other to complete the task(s) for which he/she was responsible. Only Charlotte did not seem to feel responsible and depended a lot on Eva to complete the open-ended task. These results provide support for DC-PE-2: *students who are expected to take charge of their own learning will experience autonomy by taking responsibility and an active role in the process.*

Students experience a sense of community

This enactment process was achieved, namely: students experienced a sense of community. The students were expected to work together in small groups, to present their work to each other, and to support each other during the presentations, while the teacher created a safe and supportive learning climate. During the majority of the student interviews (n = 9), it became clear that students experienced a sense of community. For instance, students said that they perceived the collaboration as successful because all group members showed commitment and dedication (n = 4), open communication was possible (n = 3), everyone said honestly what they thought (Anna), and Esra emphasized that all group members had a close relationship with each other. In addition, Charlotte stated that everyone was very open to each other during the presentations. Regarding the role of the teacher, Charlotte and Eva indicated that the teacher showed her commitment to bring the open-ended task to a good end. During the observations, indications were found that students were experiencing a sense of a community. For instance, students asked each other for advice and shared experiences (e.g., how did you tackle this?) before, during and after the face-to-face meetings, they communicated immediately when there were ambiguities regarding the course, and also for general issues regarding the teacher training program they consulted (the advice of) the teacher. Moreover, they also met each other in their free time, for example, they

often went to lunch together before the start of a face-to-face lesson or carpooled to the school.

The results indicated that PC-PE-3 is plausible, but with limited data: *If students experience a sense of community, this can lead to student persistence because it reduces obstacles and insecurities, and increases positive motivational beliefs because students want to contribute to the group*. With respect to student persistence, Sophie said that she would not be sure if she would be up for completing the open-ended task when she would have to do it by herself, as it is a lot of work. In addition, Lucas reported that this process gave him a more secure feeling by sharing each other's ideas about how the task should be tackled. From the interview with the teacher no information related to this part of the process conjecture could be obtained. Regarding motivational outcomes, students argued that both the supportive relationship with the teacher (Eva and Charlotte), and the feeling of belonging and open communication in a small group (Sophie, Mia, Lucas) had a positive effect on their motivation. The teacher also stated that she felt that immediate positive feedback and quickly responding to students' questions motivates the students.

Two features of the course design were intended to establish a sense of community: intermediate deadlines and reminders, and discursive practices characterized by collaboration, support, and easy access to each other's expertise. First, two students explicitly indicated that because the teacher provided *intermediate deadlines and sent frequent reminders* and offered them help, this gave them the feeling that the teacher was committed and willing to help when they experienced problems. Charlotte putted it as follows: "in this way the teacher showed that she wants to stimulate and support us [to bring the open-ended task to a good end]." From the interview with the teacher no information related to this part of the design conjecture was obtained. Observations revealed that the teacher sent personalized reminders. For instance: 'congratulations Emma, you already completed this part' or 'good luck to Charlotte and Lucas who are almost there'. Still, intermediate deadlines/reminders prompt the experience of a sense of community because of the commitment and the proximity of the teacher.

Second, regarding the *discursive practices* that are characterized by collaboration, support, and easy access to each other's expertise, all students indicated that the teacher was easily accessible, both online and face-to-face, and quickly replied on their questions, concerns and frustrations. Five students explicitly stated that the teacher was one of the success factors of the course design, as she provided them with a lot of support and motivation (Anna, Sophie, Olivia, Eva, Charlotte). Next to this, students also supported each other during the project. For instance, all students experienced the collaboration as very positively. They reported that there was open communication, everyone showed commitment, they complemented

each other and learned a lot from each other. The teacher also argued during the interview that when students encounter difficulties, she tries to respond to that. In this way, she shows that she wants to help them and pays attention to their problems, which is important to create a sense of community and belonging. The observation data showed that the teacher indeed supported students and showed her commitment. For instance, when she noticed that students were restless or stressed at the beginning of a lesson, she listened to them, and although their aspirations were sometimes related to another class, she gave them advice and supported their feelings. Moreover, this also applied to the students themselves: when the researcher met them for example, during lunch for an individual interview, students were also often helping and advising each other. In short, discursive practices characterized by collaboration, support, and easy access to each other's expertise support the experience of a sense of community because the students and teacher showed commitment toward each other. These results support DC-PE-3: *the provision of intermediate deadlines and reminders and/or an environment that is characterized by collaboration, support, and easy access to each other's expertise will prompt students to experience a sense of community.*

Discussion

Reflections on the findings

This study focused on salient design features of a teacher education course that aimed to foster VEAL' learning in an open-ended task. Conjecture mapping was used to explore if, how, and why the course design supported learners. While we also examined the influence of the enactment processes on the learning outcomes (i.e., process conjectures), the primary aim of the present study was to investigate the influence of course design features on specific enactment processes (i.e., design conjectures). Findings revealed that almost all of the proposed design features stimulated the VEAL toward the intended enactment processes, which in turn yielded the intended outcomes. However, the results show that there is still room for improvement with regard to two of the seven enactment processes, namely: summarizing key ideas and negotiating. Therefore, Figure 3 shows the retrospective conjecture map, which underpinned this course and could be used as a basis for shaping other courses aiming to support VEAL in open-ended tasks. Thereafter, we discuss possible explanations for the findings related to summarizing key ideas and negotiating, and propose alternative design features, accordingly.

Regarding the first enactment process, *summarizing key ideas*, the results show that the pre-structured summarizing task, in its current form, did not

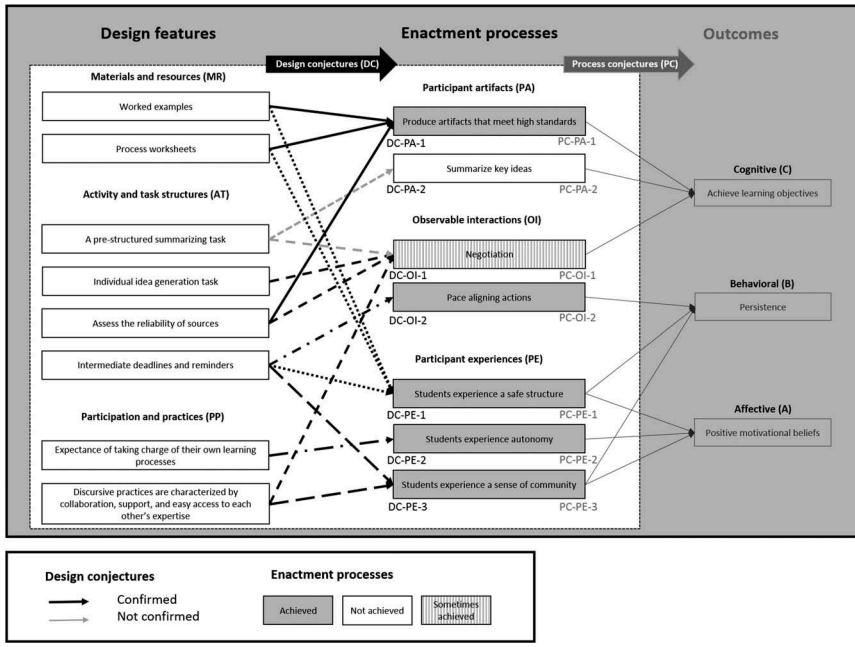

Figure 3. Revised conjecture map for supporting hands-on adult learners in open-ended tasks.

help students to accurately summarize key ideas. In particular, the findings suggest that in some cases, this task leads to copying and pasting information instead of actively processing the content to extract the main points. A possible explanation for this might be that students do not possess effective summarizing strategies. As such, students might benefit from deliberate practice exercises in which they, for instance, learn to use their own words to summarize the material (King, 1992), which might empower them to more accurately summarize key ideas. Another explanation could be that the summarizing task was too structured and did not provoke active processing of the content. In future attempts to improve the design, the summarizing task could be adapted, for instance, by prompting students to focus more on keywords to ensure that students actively reconsider and process the content (De Bruin et al., 2011).

Concerning the second enactment process, *negotiation during collaboration*, the results show that this process was partly achieved, meaning that student interaction was mainly restricted to sharing and comparing information, and only two groups sometimes jointly negotiated about the content or co-constructed knowledge. Findings related to the pre-structured summarizing task indicate that students did not always perform this task collectively, nor did the task encourage students to discuss the relevance of

the information. While the other three design features (i.e., individual idea generation task, the explicit task to assess the reliability of sources, and a learning environment characterized by collaboration, support, and easy access to each other's expertise) seemed to prompt interaction, they were insufficient to obtain the intended process of negotiation. This result is likely related to the fact that most of the students were unfamiliar with collaborative learning in an open-ended task. Consequently, more practice moments may be needed to familiarize them with how they can effectively negotiate with each other to construct knowledge. Another possible explanation might be that students are not naturally inclined to construct new knowledge through negotiation, as shown by previous research in vocational education settings (Hämäläinen & Oksanen, 2012). Further work should be undertaken to support the likely tradeoff decision concerning additional practice moments (if they are sufficient to elicit more negotiation), versus adding a different design feature (which might entail the risk of over-scripting collaborative learning; see Dillenbourg, 2002).

Reflections on the methods and suggestions for further research

A first consideration of the methods used concerns the fact that, although the whole class group participated in the study, the sample size was rather small. However, the aim of this study was in the first place to gather in-depth information about how the design worked in this type of context, and small-scale case studies are certainly appealing to achieve this aim (Boddy, 2016). Further, the triangulation of data sources made it possible to substantiate the results by examining the conjectures from different angles. In most of the cases, the data sources strengthened each other's findings, while in some cases this unraveled (small) variations between students. We acknowledge the possibility of our own biases and potential blindness to negative evidence. Nevertheless, we did explicitly scrutinize the data and report negative evidence related to the design and process conjectures. Now that this study has provided detailed explanations for why the design features contributed to the enactment processes and the learning outcomes, future research should explore their adaptation tolerance by studying variation in results with different manifestations of these features.

In line with this, the second consideration is that the course design articulated in this study was enacted in only one context: a teacher training program for adult learners who are transitioning from vocational and technical careers to secondary level teachers in their field. Although a single case can be highly instructive (Boddy, 2016), this also places limitations on the generalizability of the designed solution. However, the generalizability should not be restricted to only this particular context. On the contrary, we believe that these insights are valuable for teachers,

educational designers and researchers working in similar contexts where adult education programs involve students with prior craft knowledge or students without previous experience in higher education, for example, in workplace learning, second chance education or other graduate studies (O'Neill & Thomson, 2013; Slowey, 2010).

Third, by presenting a case of conjecture mapping, we were able to articulate a theoretically-grounded course design and to empirically test the design conjectures. In this way, this study addressed the current need for educational design research to more clearly articulate its core (pedagogical) building blocks (Graham et al., 2014). Both the design conjectures and the process conjectures constitute predictive arguments underpinning the course design. While the research design does seek explanations for consequences, it does not allow causality to be (dis)proven. Although our findings provide support for the design and process conjectures, our data do not rule out alternative explanations. Consequently, further research is needed to ascertain if the enactment processes and outcomes were indeed caused by the proposed mechanisms, or if other mechanisms better explain them. Furthermore, by linking more than one design feature to one enactment process (e.g., worked examples, process worksheets and intermediate deadlines/reminders contribute to students experiencing a safe structure), we cannot make individual or competing hypotheses to determine which design feature has more or less influence on the desired enactment process. In view of disentangling which ingredients are contributing to which outcomes, quasi-experimental research can be set up with the purpose of investigating which design feature has more or less influence on an enactment process.

A fourth consideration is that this study did not focus on transfer of the skills to solve open-ended tasks in realistic settings. Students practiced with case studies to develop and show their competences, but this investigation was situated in their coursework, which does not offer students opportunities to show or practice their competences in their classrooms. The transfer to external contexts (i.e., an authentic classroom situation) was done during the next semester, when students had an internship in which they could apply their competences. However, this was beyond the scope of our study. Future research should dive deeper into the outcome variables and include transfer as an outcome variable.

Fifth, in the present study, we illustrate some key design features that structure students' learning and help them to complete the open-ended task. However, as there was no follow-up study to see whether they have been able to structure similar open-ended tasks for themselves, we cannot make any predictions about which design features can be diminished or left out in a next phase because students have mastered the self-directed skills to tackle an open-ended task. Future research, for instance, a follow-up

study with the same group of students, could leave out some design features (e.g., individual idea generation task) or diminish the amount of support (e.g., less intermediate deadlines) to investigate whether students mastered the skills to plan and organize their individual/group work in advance, and to prevent themselves for procrastination.

Implications

The results of the current study hold several important implications. The primary contribution of this study is the theoretical understanding concerning *why* specific design features yield certain enactment processes (refined design conjectures) and outcomes (refined process conjectures). This kind of theoretical understanding is both descriptive and explanatory. At the same time, this understanding has helped us refine hypotheses regarding how to support VEAL in open-ended tasks. As such, the theoretical understanding is additionally used for prescriptive purposes. This kind of work has been undertaken by many champions in our field. For example, Maria Montessori theorized that "children should learn through exploration in an environment that is socially engineered by the teacher, based on pupil learning needs during their sensitive periods, and prescribed methods for doing so (McKenney & Reeves, 2019, p. 38)". Across this study, we used existing theory to describe, explain, and predict relationships (e.g., worked examples support the production of artifacts that meet high standards), and tested if and why these relationships occurred (e.g., because students are aware of the task requirements). As such, investigation of both the design and the process conjectures has yielded theoretical insights.

To a great extent, the findings in this study confirm the existing theories described in relation to the individual design and process conjectures (e.g., worked examples support the production of artifacts that meet high standards) and provide insight into why these design and process conjectures work or not. Moreover, this study adds to these previous insights by bringing these ideas together in a carefully aligned set of design and process conjectures. In this way, not only a design framework, but also as a theoretical framework is created, as a holistic set of design and process conjectures for this group of learners has not previously been articulated. For instance, what stands out in our results is that all learning outcomes were achieved by a combination of multiple enactment processes. This also implies that most of the design features indirectly lead to more than one learning outcome. For instance, while in the literature worked examples and process worksheets mainly stem from a cognitivist perspective and benefits are described in terms of performance and efficiency (see e.g., Nadolski et al., 2006), these design features also seem to contribute to behavioral and affective outcomes through the process *students experience*

a safe structure. This finding highlights the added value of looking at an educational intervention from a holistic perspective, and acknowledging the most important components (i.e., design features, enactment processes) to see how they function and interact with each other to achieve the learning outcomes (Sandoval, 2014). Given that the intended outcomes were obtained in this study, it seems warranted to recommend for further elaboration and critique of this framework (e.g., by others).

A direct implication is that this work can assist those who aim to implement open-ended tasks in similar contexts. The framework could be used as a whole, but also provides multiple entry points and thus flexibility of use. For instance, course developers may choose to design open-ended tasks that include the specific supportive features that are shown here to be important for students' learning processes and outcomes. Alternatively, developers may consider the specific enactment processes they aim to engender and implement the corresponding design features. Additionally, developers focusing on student outcomes, could direct their attention toward specific enactment processes related to that outcome and the associated design features. As such, the design solution proposed in this study provides guidelines, though no certainties, to develop open-ended tasks aiming to achieve cognitive, behavioral, and affective outcomes in an educational context with VEAL (Edelson, 2006).

This study has shown that these adult learners crave support and structure in some areas (e.g., deadlines and approach to the project), but really appreciate and embrace choice and open-endedness in other areas (e.g., content and direction of the project). This more subtle understanding of this group of learners offers better guidance and insight to both practitioners and researchers: the task is neither complete support nor complete autonomy, but a careful mix of both and this course design seems to offer, on the whole, an effective mix of those elements. Moreover, next to this direct implication for course design, this study also shows that universal assumptions about learners, such as the assumption that adult learners are self-directed or autonomous, can block access to learning for learners who do not meet that 'norm' (Brookfield, 2018; Sandlin, 2005). As such, this kind of instructional design has also an emancipatory potential.

The secondary contribution of this study is that it embodies a worked example of how conjecture mapping can be used in an ecological setting. Moreover, this has provided us with new insights concerning the affordances and limits of the conjecture mapping approach for research and practice. First, the fine-grained approach used in this study connects two levels of research that are often separated: (meso-level) course design and (micro-level) instructional design. As such, conjecture mapping is a way to bridge the gap between these two levels of design work that can be difficult to align. Second, while it was very useful and informative to use the conjecture mapping

approach in such a fine-grained way, this also proved to be a very difficult and time-consuming process. We experienced value in this approach with regard to both the process of articulating the conjectures and the process of investigating them. As such, we see potential for this basic process to support practitioner thinking as well as the development of theoretical understanding. However, the form that we used does not seem feasible for practitioners. Future research is needed to develop and test alternative modes of conjecture mapping that make this approach a more accessible reflection tool for practitioners (e.g., by using a rougher grain size).

Closing remarks

This study was undertaken to better understand how to support lifelong learners as they respond to the changing needs of their working lives. Specifically, a course was designed for professionals transitioning from vocational careers into the role of teaching at vocational education institutions. For this kind of VEAL, the study showed for instance, that worked examples not only engender the production of artifacts that meet high standards because they clarify the task requirements, but also foster a safe structure by providing an overall picture of the task. In addition, deadlines and reminders support pace aligning actions by taking away concerns about the planning, as well as stimulate a sense of community because of the commitment and proximity of the teacher. Finally, discursive practices characterized by collaboration, support, and easy access to each other's expertise foster negotiation by feeling a shared responsibility to share ideas. These individual findings, as well as the revised conjecture map as a whole, constitute modest yet important steps toward understanding how to support VEAL to accomplish open-ended tasks.

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ORCID

Ruth Boelens http://orcid.org/0000-0001-8290-0026
Bram De Wever http://orcid.org/0000-0003-4352-4915
Susan McKenney http://orcid.org/0000-0002-6028-4098

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