Vocations and Learning (2015) 8:75–93
DOI 10.1007/s12186-014-9124-x

ORIGINAL PAPER

Interactional Processes of Handling Errors in Vocational School: Students Attending to Changes in Vocational Practices

Charlotte Jonasson

Received: 27 March 2014 / Accepted: 15 October 2014 /
Published online: 23 October 2014

Abstract Making errors is an inevitable part of work and learning situations. Recent research has shown that errors can provide important learning opportunities, in particular in education or training, where there may be ample time and support to learn from them. Yet, more knowledge is needed of how learning from errors is developed through interactional processes in a particular context. Adding to prior research of learning from errors in education, the present study is conducted in a vocational school context, where there may be opportunities to learn from errors conducted as students gain new experiences with the complex work processes of a vocation. Thus, this study aims to provide novel insight into how students' learning from errors in school-based vocational training is developed. Findings from a 1-year field study of culinary vocational education show that teachers and students participate in learning activities of shared experience, improvisation, and reflecting on errors in ways, where the students learn to pay constant attention to the complex cooking procedures. The findings further demonstrate students' transformed participation in challenging and error-prone vocational assignments as a central part of their identification with the culinary vocation.

Keywords Learning from errors · Negative knowledge · Interactional processes · Skilled attention · School-based vocational training

Introduction

The phenomenon of errors has drawn much attention since they seem to be an inevitable, integral aspect of activity in multiple contexts, such as work, school, sports, and everyday life (Bauer and Harteis 2012; Harteis et al. 2012; Hetzner et al. 2012). In research exploring this theme, errors have been conceptualized as individual actions or decisions that lead to negative deviations from a desired outcome (Bauer et al. 2012).

C. Jonasson (✉)
Psychology and Behavioural Sciences, School of Business and Social Sciences, Aarhus University, Bartholins allé 9, Building 1340, 8000 Aarhus C, Denmark
e-mail: charlotte@psy.au.dk

Due to such negative impact on reaching anticipated goals, errors are most often unwanted (Harteis et al. 2012). However, at the same time, errors are worth paying attention to since opportunities for learning can arise from making errors (Bauer and Mulder 2007). In line with this argument, Bauer et al. (2012) define learning from errors in terms of particular learning activities through which persons' reflections on causes for and solutions to errors are negotiated.

Lately, it has been argued that more research is needed on how learning from errors is developed in education or training (see however Dalehefte et al. 2012; Keith 2012; Santagata 2005; Tulis 2013). In relation to this, it is maintained that students' errors can become learning resources if the school or training context allows for taking the time and effort to include this in the educational activities (Dalehefte et al. 2012).

A great share of studies in this field has focused on math and physics education (Dalehefte et al. 2012; Santagata 2005; Tulis 2013). However, little is known about learning from errors in school-based vocational training (see however Boldrini and Cattaneo 2013). This setting may be of particular interest since it, on the one hand, holds opportunities for the students to participate in complex methods and procedures resembling their future vocational work (Saint-Georges and Filliettaz 2008). On the other hand, in comparison with workplace training or apprenticeship, in a vocational school context, there may be ample time and instructional resources to support the students' learning from errors as part of their entering a novel vocational profession (Billett 2012; Heimbeck et al. 2003; Keith 2012).

Prior studies have shown that persons' development of various forms of negative knowledge of "what not to do" and "what one does not yet know" is an important outcome of learning from errors (Gartmeier et al. 2008; Gartmeier and Schüttelkopf 2012; Hetzner et al. 2012; Oser et al. 2012). However, several researchers argue that there is a need for additional research unveiling the processes through which students' learning from errors takes place in daily interactions (Bauer et al. 2012; Dalehefte et al. 2012; Gartmeier and Schüttelkopf 2012; Heimbeck et al. 2003; Seifried and Höpfer 2013). The article's aim is thus to investigate this in the context of school-based vocational training for culinary students.

Theoretically, while some prior studies have taken a cognitive perspective on learning from errors, it is suggested in this study that a sociocultural perspective on learning may also be relevant (cf. Bauer et al. 2012; Billett 2012). This will direct the focus of the study to contextually situated processes that could be central to this type of learning (Lave 2012; Saint-Georges and Filliettaz 2008). In regard to a methodological approach, Weinert et al. (1989) have argued that in addition to experiments, surveys, or interviews, more observational studies of instructional quality are needed. Therefore, an observation study is used to examine how learning from errors is being developed through social interactions in the context of school-based vocational training.

Background

Below, the research background for the current study will be outlined and related to particular sociocultural conceptualizations of learning. Three sections will be presented, dealing with 1) interactional processes related to experiencing errors, 2) shared reflections on errors, and 3) personal transformations of participation. The content of the

three themes will be summarized in a research question at the end of each section. The three themes comprise important steps in the students' learning from errors in school-based vocational training.

Interactional Processes Related to Experiencing Errors

A central question of interest is how processes of learning from errors are conditioned (Bauer et al. 2012). In particular, prior research has been concerned with how persons are given opportunities to participate in and experience the making of errors (Dalehefte et al. 2012; Gartmeier et al. 2008; Heimbeck et al. 2003; Keith 2012). For example, in a study of care nurses, it was found that their experienced knowledge about various workplace errors was important for their ability to actively avoid errors in their work (Gartmeier et al. 2011). This implies that the active experiencing of errors is important for persons' learning of how to improve their practices.

A number of studies (Dalehefte et al. 2012; Filliettaz et al. 2010; Harteis et al. 2008; Heimbeck et al. 2003; Keith and Frese 2008; Seifried and Höpfer 2013; Tulis 2013) have shown that it is important to encourage persons' experiences with errors rather than treat the making of errors with ridicule or intolerance. Other studies have emphasized teachers' roles in establishing instructional situations that allow for experiencing and exploring errors (Dalehefte et al. 2012; Santagata 2005; Tulis 2013). Such a positive error climate is also important in further work or training. Thus, a recent study by Baumgartner and Seifried (2014) conducted among apprentices in the hotel and restaurant industry shows that the perceived error climate, of e.g. trainers' explanations in error situations, predicts the ways in which apprentices approach errors.

In regard to school-based vocational training, the teachers' establishment of instructional situations that allow for exploring errors has been related to an overall aim of preparing students for apprenticeship (Berner 2010; Jonasson 2013). Here, the students gain experiences with various materials, methods, and understandings of procedures and timing (Lindberg 2003). As shown by Saint-Georges and Filliettaz (2008), these micro vocational learning activities are highly contextualized. Nielsen (2007) further argues that errors in, e.g., handling particular ingredients or carrying out particular work methods cannot be isolated from the contextual conditions. An example of the relation between micro vocational learning activities and the work context is how culinary students must learn how to handle what are considered rather "delicate" and fragile ingredients, which need to be timely coordinated into the preparing of a full menu for a particular group of customers. The culinary vocation thus provides interesting examples of learning from errors related to complex cooking procedures.

Theoretically, in this study, it is argued that in regard to studying the contextual conditions for learning from errors, a sociocultural approach to learning is suitable (Bauer et al. 2012; Bauer and Mulder 2007; Billett 2012; Lave 1990). In correspondence with such a theoretical framework, learning involves persons' changed participation in changing practices (Lave 2011; Lave and Wenger 1991). In terms of learning as changed participation, Ingold's (2001) concept of "an education of attention" presumes that novices' learning is not about acquiring knowledge but rather a matter of persons' skilled formation within an environment. Ingold (1993, 2001) emphasizes

the skilled practitioner as continuously responsive to the perceived environment through movements of attention:

> The expert . . . is attuned to "picking up" critical features of the environment that the novice simply fails to notice. The accomplished woodsman . . . looks around him for guidance on where and how to cut . . . (Ingold 2001: 149)

Skills are thus built from interacting with the environment while considering prior experiences and unfamiliar paths of knowledge. For the novice, development of this skilled attention to the work practices involves two interrelated aspects, namely: imitation and improvisation. Imitation is not a mere copying of others' doings but a matter of following other persons' skilled attention to ongoing tasks and exercises, depending upon the particularities of environmental experiences (Ingold 2001). Such opportunities of imitation may be provided by the students' social interactions in a particular environment, where there is room for what, in Heidegger's terms, can be called "circumspectum" (Heidegger 1988; Nielsen 2007). This is a particular way of orientation in the context, where students are enabled to look around at others' closely related activities and come to understand how a particular object relates to other objects and doings. Attention to the tasks in a particular environment also involves improvisation as a sort of guided rediscovery, where novices are encouraged to find other ways of approaching the assignment (Ingold 2001). Such improvisation may be particularly likely in situations where experiences of errors are used to generate a new solution to a new problem (cf. Keith 2012). The proposed sociocultural theoretical framework is thus supporting an analysis of the students' and teachers' situated and changing attentions to errors as part of school-based vocational training. Based on the above, the first research question guiding this study is: *How are vocational students' experiences with and attention to errors developed as part of everyday interactional processes and learning activities in school-based vocational training?*

Shared Reflections on Errors

A number of authors argue that a vital condition for learning from errors is that persons are given ample opportunities to not only experience and improvise on various errors but to take time to reflect on them (Dalehefte et al. 2012; Heimbeck et al. 2003; Hetzner et al. 2012; Keith 2012). In this line of research, errors are individual actions or decisions that lead to negative deviations from a desired outcome and, moreover, learning from these errors involves persons' reflections on related causes and solutions (Bauer et al. 2012; Bauer and Harteis 2012). Reflections on errors may therefore lead to enhanced knowledge of why such errors occur and what specifically characterizes the actions or decisions as deviations.

From a cognitive perspective, it has been argued that reflections on errors may lead to the development of negative knowledge (Gartmeier et al. 2008, 2010, 2011; Hetzner et al. 2012). Negative knowledge can be specified in terms of, for example, negative procedural knowledge of "what not to do" and, as such, it constitutes persons' active ability to avoid errors. In regard to situations in which a student's work practices do not lead to the desired goals, this person develops knowledge of what to do and negative knowledge of what not to do. Another form of negative knowledge has been defined as

declarative knowledge of "what or how something is not" (Gartmeier et al. 2008, 2011; Minsky 1994; Oser et al. 2012). In addition to the mentioned two dimensions of negative knowledge, recent studies have added another aspect termed "self-reflective negative knowledge" (Hetzner et al. 2012). This refers to students' considerations of their own limitations or deficiencies in knowledge and skills. The learning from errors outcome may therefore include a strengthening of persons' self-reflective knowledge and the development of certainty in their work methods (Gartmeier et al. 2008; Hetzner et al. 2012). Related to this, Gartmeier and associates (2012) propose that such negative knowledge needs to be based on a person's own experiences with particular errors in a particular context.

While errors have been defined as persons' actions deviating from the norms, it may also be argued that an error only becomes an error when somebody declares it to be so. Although this judgment is often done by an expert or teacher in relation to the novice or student, even experts' error judgments may be ambiguous and can vary in relation to the context (c.f. Billett 2012; Harteis et al. 2012; Lave and Wenger 1991). This relative perspective on errors has been referred to as a social negotiation perspective on error judgments (Bauer et al. 2012). Such a perspective corresponds well with a sociocultural theoretical approach to learning, by which it may be explored how the teachers' and students' context-specific experiences with and negotiated reflections on errors may influence their development of certainty in work methods (Bauer et al. 2012; Billett 2012; Lave 2012). Ingold (2001) emphasizes the difficulties and potential problems with reaching certainty in students' work methods, thereby questioning the impact of negative knowledge for developing skilled work practices. He argues that when the novice makes errors, the cause may be that the novice fails to notice critical features of the environment and thus attune to the world. Here, a central dilemma is that gaining abilities to carry out what are considered proper, normative work procedures does not ensure error-free tasks. This is due to the fact that work procedures are subject to ongoing changes in the environmental conditions, thus changing the norms and the limitations of one's abilities (Billett 2012; Saint-Georges and Filliettaz 2008). Based on such a theoretical framework, it will be investigated how the students are supported in their gaining of negative knowledge. This knowledge, however, may not always be sufficient for handling changes in the vocational environment. Hence, the second research question can be formulated: *What characterizes the processes of shared reflections on errors, and how are these related to outcomes of negative knowledge and attention to the vocational environment?*

Personal Transformations of Participation

In regard to outcomes of learning from errors, Keith (2012) proposes that in addition to outcomes of negative knowledge, persons may, through relevant training, become better prepared to cope with changes. This coping with changes is related to the *emotional* components of learning from errors, where it is suggested that a person's anger and frustration in relation to errors is reduced (Keith 2012). Moreover, research has shown positive outcomes of *cognitive* components of learning from errors, where persons are encouraged to further explore and try to find their own novel solutions to erroneous tasks (Heimbeck et al. 2003; Keith 2012). Keith and Frese (2008) further emphasizes that enhancing such emotional and cognitive components benefits performance

in the long run, in particular, in relation to adaptation to tasks that require a wide range of skills that may not be similar to the training situation. As a result of such openness to changes, persons may develop a more productive attitude toward errors as a learning resource and engage in the ongoing development of improved work practices (Bauer et al. 2012; Bauer and Mulder 2007; Heimbeck et al. 2003; Keith 2012). Persons' ability to handle changing environments has thereby been emphasized as an important potential outcome of learning from errors (Heimbeck et al. 2003: 357).

To support an investigation of changes in attitudes toward errors as part of a changing vocational environment, again, a sociocultural perspective on the personal implications of learning from errors is suggested. Following such a perspective, learning from errors may not only involve the development of negative knowledge. Rather, learning may also be defined as students' ongoing adjustment of methods or practices in response to handling errors as part of a complex and rather unpredictable vocational context (Chan 2013; Dreier 1999; Filliettaz et al. 2010; Lave 2011, 2012).

The potential findings of learning outcomes in terms of transformed participation may also respond to what earlier research has labeled a central dilemma of transfer of what is learned from errors (Gartmeier and Schüttelkopf 2012; Keith 2012). This dilemma concerns problems related to transferring situation-specific learning from errors into more long-term, durable, and general knowledge. In response to this dilemma, it can be argued that the students' personal transformations of ongoing adjustment of their methods and handling of errors may be considered important general learning features. Hence, based on the outlined research, the third and final research question guiding this study is: *How can learning from errors, in terms of students' transformed participation in the vocational practices, be developed, and what characterizes such transformed participation?*

Research Design

Setting: A Danish Vocational School

The fieldwork was conducted at a Danish vocational school over a period of 1 year. Altogether more than 120 days were spent at the school or on school excursions. The vocational school in which the research was carried out was located in a medium-sized Danish provincial town. The Danish Vocational Education and Training (VET) system is an upper secondary educational system consisting of alternating programs in which students shift between periods of apprenticeship at a company and periods of attending a vocational school (Juul and Jørgensen 2011). Much attention is therefore directed toward connecting school and workplace learning. Before entering the main course, where apprenticeship is initiated, the students must complete a basic course at a vocational school, where more academic classes are combined with school-based vocational training taking place in, e.g., the school kitchens or auto workshops. Prior research has shown that although such school-based vocational training takes place in a school context, the students and teachers share an engagement in developing vocational experiences and knowledge, which prepare them for apprenticeship or job positions within the specific vocation (Berner 2010; Jonasson 2013).

Unit of Analysis and Sample

The unit of analysis in this article pertains to the school-based vocational training taking place in the school kitchens of one particular class. The class consisted of 20 students between 17 and 52 years of age. Only two of the students entered directly from lower secondary school, whereas most of the students had prior experiences with other upper secondary educations or prior or current experiences with both skilled and unskilled labor—some even with the culinary profession. The students' level of engagement in completing their education reflected the generally held problems in the Danish VET system, with low percentages of educational completion (estimated 52 % in 2012). However, the problems with lack of student engagement were primarily present in the more academic classes and to a lesser extent the school-based vocational training in the kitchens (Jonasson 2012).

Data Collection

An ethnographic field study approach was chosen because it is especially suited to studying persons' situated participation and interaction processes in complex, everyday practices, which was the aim of this study (cf. Hammersley and Atkinson 1997; Lave 2011; Walford 2009). The main data sources applied here were participant observation and semi-structured interviews. Inspired by Spradley (1980), an observation guide was developed, pertaining primarily to participant observations of error-prone assignments, prioritized over more routine-based activities. Moreover, the observation criteria were closely connected with the overall aim of studying the interactional processes of learning from errors in school-based vocational training. This included observations of the instructional conditions for students gaining experiences with various errors as part of their handling of rather fragile ingredients by use of various preparation methods. Also included were observations of the students' shared attention to rather complex cooking procedures. Also, based on a sociocultural theoretical framework, the participant observation criteria were related to the students' interactions with each other and negotiations with the teachers in regard to feedback on their assignments and the errors made. These observation criteria were outlined in the focused observations of: 1) location, 2) learning activities, 3) instructional demonstrations and feedback, 4) materials and tool use, and 5) students' social interactions within and between groups. In addition to observations of the students' and teachers' cooking practices, the informal conversations in the kitchen concerning socially negotiated reflections on the cooking procedures were given primary attention. The direct quotes were subjected to immediate "jotting" (Sanjek 1990) and immediately after classes were transformed into more structured written transcripts as part of the extensive field notes generated throughout the fieldwork.

In addition, semi-structured interviews were also conducted (cf. Bernard 1995). Altogether, semi-structured interviews with students (59), teachers (19), and school managers (5) were conducted throughout the fieldwork. Informal conversations and interviews were held in Danish and later translated into English by the support of native-speaking proofreading. For the present unit of analysis, the interview data mainly informed the data selection in terms of the teachers' instructional intentions and experiences with learning from error situations. Based on triangulations of

observations and interview data (cf. Hammersley and Atkinson 1997), it was found that the teachers' self-reported accounts of their professional aims validated the findings from the observations of the teachers' arrangements of learning activities providing opportunities to experience and improve erroneous practices.

Analysis

An ethnographic approach to analysis of the data involved an iterative process, in which potential openness in theories and ideas is used to inform data, and data are used to develop ideas and theoretical concepts (Hammersley and Atkinson 1997). Thus, prior studies and perceptions of learning from errors informed the selection and analysis of three intrinsic, and thus outstanding, thematic case narratives on the interactional processes of learning from errors (cf. Braun and Clarke 2006). The selection and analysis of the thematic case narratives were guided by an aim to identify situations or events that concerned the outlined research questions and in particular the students and teachers' experiences with constructive handling of errors. The selected examples of interactional processes of such situations of handling errors were part of more holistic and procedural learning activities being developed throughout the vocational basic course. Yet, during the process of analysis a selection based on dialectics of identifying and investigating outstanding or puzzling examples of handling errors and of exploring patterns or relations between these examples was conducted (c.f. Miles and Huberman 1994). In particular, three thematic case narratives, each responding to the respective research questions, were identified concerning 1) how students' experiences with making and finding solutions to errors are developed through particular shared attention to learning activities in the kitchen, 2) how students and teachers' shared reflections on errors as deviating from the norms are related to outcomes of negative knowledge, and 3) the learning from errors potentials of students' transformed participations in improving vocational practices. Through the thematic analysis and writing of the cases, novel conceptual understandings were developed through dialectics of sociocultural theoretical deduction and analytical induction of attention to data that did not fit prior notions and understandings of learning from errors—a way of learning from deviances (cf. Vaughan 2004: 320). This analytical process developed into the presented narratives of how learning from errors is developed through particular learning activities in the school kitchens.

Findings

Below, the findings of the three thematic case narratives are presented. The findings described in the three sections each respond to one of the three research questions by identifying and contextualizing central aspects of students and teachers' constructive handling of errors. The presented findings overall respond collectively to the research questions by providing insight into the interactional processes through which errors are handled in ways that lead to the development of students' learning as transformed participation in the changing vocational practices. Theoretical implications are outlined at the end of each of the three sections and further elaborated on in the discussion.

Interactional Processes of Erroneous Imitation and Improvisation

Occasionally, the teachers explained how the day's lessons were considered particularly difficult. For one such lesson in the kitchen, the teacher introduced the fileting of and three different ways of preparing flounder. The teacher brought in a whole box of flounders and asked the students to gather around the demonstration table. He thereafter explicated the purpose of the lesson as learning how to prepare delicate dishes containing fish. The students were told to work in groups of 2–3 persons and that they could prepare the fish as they preferred, choosing between frying, steaming, and poaching, with garnish of their own choice. In addition, the dish was to be presented according to the timetable given on the blackboard. The teacher briefly introduced the preparation methods of fish, emphasizing the identification of a fish well done, where the fish had turned milky white instead of transparent in look but was still firm enough to not shred into pieces. The teacher then proceeded with the demonstration of how to skin and filet a fish. It was done rather quickly and resulted in four filets.

The teacher called up one of the students to give one of the fish a try. The entire class, including the student himself, began laughing when the fish slipped out of his hands. The student exclaimed: *"It's really difficult to get a grip—it looked so easy when you just pulled the skin off."* The teacher said:

> I know, and you just have to keep on trying. I tell you, I have spent much time helping my friend, who sells fish, to be able to do this, and it took me some time before I was even allowed near a fish by my old chef.

The teacher showed the student how it was important to have dry fingers and a dried-off fish to get a good grip on the skin. The student was allowed to try again, and this time he managed to get a grip and peel off the skin. Yet, the fileting afterwards resulted in a tiny filet, where much meat was left on the bones. The teacher corrected the student's angling of the knife and showed how he used his fingers to feel where to put the knife as close as possible to the bones. This time, the student presented a much bigger filet with only a little meat left on the bones, to the open applause of the class.

The students then proceeded in groups of two to three persons with their own share of fish. In the group with the student who was part of the demonstrations, the other two group members encouraged this student to skin their fish since obviously he had some experience. However, this was noticed by the teacher, who said, *"Come on, give it a go. You don't get anything out of not trying."* In another group, one of the students started with fileting the backside instead of first skinning the upper side as the teacher had done. Thus, when she then had to skin the fish, she had trouble holding the now somewhat thin and wobbly fish, and they ended up having to cut off the skin with a knife, leaving quite a lot of meat on the skin. They then observed how their neighboring group approached their fish, and the student having fileted the backside first said: *"Oops, I missed out on skinning the fish before fileting it."* The students thus improved on their assignment by being able to look around and pay attention to other students' practices.

A group of students decided to poach their fish. The students had, in previous lessons, also been told about the principles of poaching, steaming, and frying, which added to the teacher's initial instructions of how a well-prepared fish should look.

However, the group let the fish boil in the bullion while they were busy preparing some garnish and thus cooked the filet into little pieces. This was noticed by the teacher, who asked what the conditions were for poaching. None of the students answered, and the teacher said:

> Once you have added the fish, you cannot let it boil. It's a "soft cooking method". You have already been told this in previous lessons. But then toss this away and try again with your remaining fish. It's just onto it again.

The making of errors based on forgetting knowledge attracted the teacher's attention, which gave them an opportunity to recount the proper method to apply on their second try. The second time, the students carefully made sure that the water did not boil. Yet, when they tried to place the fish on the plate, it broke into several pieces, and the students were frustrated that it had still been overcooked. Another group of students passed by to observe their second try before attending to their own poaching, and one of the observing students suggested that they remove the pot entirely from the stove while the fish was still clear and thus not ready. They could then immediately take out the fish when it seemed to have just changed from clear to milky white. The students followed this advice on their third try and apparently succeeded in arranging on their plate a whole, milky-white, poached fish.

In response to the first research question concerning the students' experiences with and attendance to errors, the examples underline several points. First, in regard to the context of the learning activities, it could be noticed that the students' making of errors were not ridiculed, but the students and teachers shared a humoristic approach to their erroneous actions (cf. Santagata 2005; Tulis 2013). Second, in regard to prior studies' emphasis on the teacher's role, the examples show that the students were strongly encouraged by their teacher to experience a wide range of errors related to their participation in the cooking assignments (cf. Dalehefte et al. 2012). The examples indicate that the teacher meant for the assignment to be particularly challenging. The students had to both imitate the teacher's difficult techniques of handling delicate ingredients and pay attention to the exact timing of troublesome cooking methods. Errors were caused by the students' difficulties with paying skilled attention to such complex work procedures (cf. Ingold 2001). Third, in regard to the development of students' learning from errors, it could be registered that the students' social interactions and orientation toward the various activities in the kitchen supported their discovery and exploration of their own and other students' errors (cf. Nielsen 2007). The students' interactions were therefore central to the development of negative procedural knowledge of deviant actions (cf. Gartmeier et al. 2008). The students' orientation in the kitchen also encouraged socially negotiated efforts of finding solutions to improve erroneous challenging tasks (cf. Heimbeck et al. 2003; Ingold 2006; Keith 2012; Nielsen 2007).

Based on such findings, it is proposed that a sociocultural perspective is relevant for investigating how students' experiences with and growing attention to errors are developed. It must be noted that the students' experiences with various errors were developed through learning activities that encouraged the students to make errors. In regard to the students' attention to improve their erroneous practices, this was

supported by opportunities of being part of a social environment, where novel improvisations could be exchanged with fellow students.

Shared Reflections on Adjustment to Changing Work Procedures

The final part of the lesson on fish was the presentation of the students' fish courses, where the teacher assessed the students' dishes of food. During one of the other groups' presentation, the group expressed doubt about the teacher's judgment of their potatoes being undercooked:

[The teacher cut the biggest of the four potatoes, making the effort evident by saying]:

Teacher: This is not done.

Student: It isn't?

Teacher: Well, did you remember to check it before serving it?

Student: Yes, we did.

Teacher: Then go on, taste it yourself.

[The students tasted and said nothing but nodded a bit].

Teacher: Perhaps the potatoes were not the same size and therefore are not done at the same time. That is why it is also a good idea to peel-shape the potatoes, not only that it looks good.

The teacher thus acknowledged that some of the errors that he pointed out could be doubted and thus made the students taste it themselves. Some of the other students came by to closely follow the teacher's feedback on their fellow students' presented food. Upon hearing the teacher's advice about the undercooked potatoes, one of the attending students returned to his group and made sure that they checked up on the potatoes that were large to see whether they were actually done. When presenting their plate, their potatoes passed the teacher's cutting test. At later classes, the students could also be seen taking care to check if uneven-sized potatoes or pieces of meat were all well done, not trusting that they would necessarily be done at the same time.

With regard to the previously mentioned group having improvised on their poaching method, this group also presented their dish, upon which the teacher began by tearing the fish into pieces, saying:

Teacher: See, this is very well poached, nothing like the first time you tried.

Student: Yeah, but we actually found out by the second fish that it had still gotten too much, even though I swear the water did not boil. So we

actually on this one took the pot off the water before it was completely done.

Teacher: That will work since the water was warm enough to still let the fish be done. However, this may not be that easily done if you, for instance, in a restaurant, have several fish to poach; then the water will cool down too much. But by then, you will also have gotten the knack of keeping the fish simmering just long enough. And you have obviously understood how important it is to keep an eye on it and check up on when exactly it is done, when I look at the firmness and the color.

The teacher hereby opened up for shared reflections on the students' process and improvisation toward serving a well-cooked fish. The study shows that the students had experienced troubles even when carrying out their assignment according to the proper method of poaching and thus had resorted to what seemed to be successful improvising. Yet, as argued by the teacher, their improvisation would meet challenges when being applied in larger scale cooking. The teacher further emphasized that the students' gaining experience of a repertoire of "proper" cooking methods and related often-made errors, as a way of actively trying to avoid potential future errors, was not sufficient in their becoming skilled.

In regard to the second research question concerning the processes of shared reflections on errors, the outlined examples imply two central findings. First, the examples of shared reflections show that the students and teachers negotiated and exchanged views on how the presented meals deviated from desired outcomes (cf. Bauer et al. 2012; Billett 2012; Heimbeck et al. 2003; Hetzner et al. 2012; Lave 2012). Moreover, the participation of other students in the shared reflections gave them opportunities to imitate and learn from others' errors and thus add to their own experienced repertoire of various errors. Second, in regard to prior studies of self-reflective negative knowledge (Gartmeier et al. 2008; Hetzner et al. 2012), the study shows that the students learned how their use of particular methods introduced in previous instructions was important for correcting errors. Yet, the teacher also stated that such application of prior knowledge could far from ensure that errors would be avoided in the future. Rather, the examples suggest that the students learned to continuously adjust their practices in correspondence with the unstable, dissimilar ingredients as part of complex cooking procedures (cf. Ingold 2001).

In relation to the outcomes of students and teachers' negotiated reflections on errors, it is therefore proposed that these reflections did not result in the development of certainty in the students' work methods. Instead, the students learned how the boundaries of certain, normative ways of timing and carrying out cooking methods are in no way fixed and stable.

Students' Transformed Participation in Improving Vocational Practices

The teachers' accounts of their teaching experiences and goals seemed to validate the findings of how it could be observed that the students gradually learned to handle the

constant challenges of encountering errors as part of the cooking procedure. When interviewing the teacher some days after the aforementioned fish lesson, he said:

> I'm glad you were with us in that lesson with the fish the other day. You see, I really think this is one of the ways of becoming vocationally prepared and gaining a basic repertoire. We have a lot of students who start with thinking they are world champions, but then, after an hour in the kitchen, they are not world champions anymore, but then it is also our responsibility to give them some challenges. It is about trying not to ridicule them in front of others but also making them understand, "Well, this was something I did not know," then you try; if they get angry, which also happens, and where they say "Why the hell can't I do this right, and you are also giving me something which is much too difficult," and then I have a talk with them about how this is about their gaining the right attitude of also thinking inwards and allowing that you make errors, and that it is just a very important part of this.

According to the teacher, a central part of becoming vocationally prepared was to rehearse basic methods and handling of ingredients. The students did not always find the obvious rehearsal lessons interesting and complained when having to attend yet another lesson of preparing fish a couple of weeks later. Yet, the students had to learn that their rehearsal efforts were important to apply to more challenging tasks, where they had to embrace the making of errors.

Over time, the students did not so easily give in when encountering difficult tasks, where errors were prone to be made. It seemed that the students potentially, through the continuous attention-demanding lessons, developed a great understanding for and skilled handling of situations that demanded their full attention, in particular, refusing to give up on the tasks even though they appeared difficult and involved making errors. One such example was toward the end of the basic course, where the students were presented with the overall task of presenting a full cake buffet. They had free rein to choose different cake recipes, and no prior instructions or recipes were given by the teacher, as was common for many of the kitchen lessons during this time period. Three students chose to make profiteroles with cream, while two other students chose to decorate their sponge cake with handmade chocolate decorations. Both of these groups, having chosen unknown recipes and methods, made several errors along the way.

The group making profiteroles was encountering difficulties with making the dough. In their first try, the students made the error of not stirring immediately when applying the flour to the water and butter, leaving great lumps of flour in the dough. The teacher advised them to pay careful attention to the immediate stirring. The second time, the students did stir but were left with a runny dough, where the flour and butter did not seem to bind properly. In their third try, the students decided to exchange the whisk for a wooden spoon, having been told by their teacher that they had to beat the flour, butter, and water together. This time, the students succeeded and were able to make small profiteroles ready for the oven. Yet, in the meantime, they also had to prepare a crème filling of combined crème patissière and whipped cream, which also had to be remade because they added too much cornstarch to the crème patissière—something the students did on their own initiative. When later tasting one of the filled profiteroles, one of their fellow students, who was allowed a bite, commented that the crème was

still rather thick, which caused the students to remake their crème once more, this time adding more lightly whipped cream before finally serving it as part of the cake buffet. The three students tasted the profiteroles, and one of them said: *"Well, next time I guess they should be baked a bit longer."*

Meanwhile, another group of students had prepared their sponge cake and were experimenting with the chocolate decorations. First, they had to pay attention to the melting of the chocolate, which they unfortunately overheated, leaving the chocolate lumpy and smelling slightly burned. This was corrected by their teacher, who said that they had to melt the chocolate very slowly and make sure they gained the right temperature of 30–32° and no more. The students therefore used a thermometer to check when they had reached the right temperature. Thereafter, they proceeded to make a paper cone for applying the chocolate to the paper-printed chocolate designs. After several attempts, the two students began considering whether they had cut the hole in the paper cone too thick to be able to follow the more detailed designs that they found were most appealing. The students therefore started again, cutting a smaller hole in their cone, yet this made the decorations very fragile, and most of them broke when trying to apply them on the cake. Thus, the students produced many failed and broken chocolate decorations and had to heat yet another portion of chocolate, but they kept working until they finally had enough chocolate patterns to decorate their cake.

In regard to the third research question concerning learning from errors as students' transformed participation in the vocational activities, the examples have shown that the students pursued opportunities to encounter difficult and potentially erroneous cooking procedures and methods. The study thereby demonstrates that a central learning from errors outcome is the students' transformed participation in terms of self-initiated, continuous improvement of erroneous cooking procedures (cf. Dreier 1999; Lave 2011). In particular, the teachers' arrangements of the learning activities seemed to become transformed from a basic repertoire of cooking procedures into new opportunities for the students to choose unfamiliar and more challenging baking repertoires (see also Jonasson 2013; Saint-Georges and Filliettaz 2008). The transformed learning activities demanded of the students that they themselves set their level of error-prone conduct of challenging methods and paid attention to make improvements that they found fit.

As part of this transformed participation, the students seemed to have learned to attend to the ongoing making of errors in ways that required them to rehearse challenging methods and continue their socially negotiated improvisations - not striving for perfection but for ongoing improvement. Most importantly, the students' learning from errors involved their gradual identifying with the culinary vocation (cf. Jonasson 2012; Lave and Wenger 1991; Lindberg 2003). The students' identification with the vocation was defined in terms of their determination to not give up, even on repetitious efforts to correct numerous errors. In regard to prior studies' emphasis on emotional components of error learning, it could be observed that the students responded to their errors with patience rather than frustration (cf. Keith 2012). Based on these findings, it is proposed that the students' transformed participation was developed through gradually more challenging learning activities. The students' transformed participation was characterized by their engagement in the ongoing improvement of erroneous practices as an integrated part of becoming culinary skilled.

Discussion

By observing situations in culinary education in school-based vocational training, this study has responded to calls for more research on how learning from errors is developed through interaction in the educational context (Bauer et al. 2012; Dalehefte et al. 2012; Gartmeier and Schüttelkopf 2012). The findings show that interactional processes of negotiated experiences with and reflections on errors are central parts of this type of learning (Bauer et al. 2012; Billett 2012; Lave 2012). Results of the study also suggest that such interactional processes are closely connected to learning activities, through which the students learned the importance of paying constant and adjusted attention to their handling of delicate ingredients as part of complex cooking procedures.

For the theoretical foundation, a sociocultural perspective was chosen (cf. Ingold 2001; Lave and Wenger 1991; Saint-Georges and Filliettaz 2008). This perspective was useful in terms of understanding interactional processes and teachers' arrangements of learning activities that supported students' skilled attention to the environment (cf. Ingold 2001). By using this approach, it became apparent that teachers' support of such development of skilled attention involved arrangements of learning activities that gave the students ample room for making and discovering errors as part of imitating challenging work methods. A novel finding in regard to prior studies of error climate (Baumgartner and Seifried 2014; Dalehefte et al. 2012; Filliettaz et al. 2010; Harteis et al. 2008; Heimbeck et al. 2003; Keith and Frese 2008; Seifried and Höpfer 2013; Tulis 2013) may be that the students' learning was developed in a learning arrangement, where a humoristic approach to the making of errors was shared by the teachers and students. In future studies, it may be important to further investigate how such humorous aspects, rather than e.g. bad mood and negative emotions, may affect persons' learning from errors.

Furthermore, it could be noted that room for circumspectum, or guided orientation of other students' practices, was important for creating shared and negotiated improvisatory improvements on erroneous practices (cf. Ingold 2006; Nielsen 2007). Thereby, the students had ample time and opportunities to experience a wide range of errors and improvements based on such errors. Moreover, through negotiated improvements, the students developed what prior research has called negative procedural knowledge of actions to be avoided and a self-reflective notion of negative knowledge of their own and other students' limited cooking methods (cf. Gartmeier et al. 2008, 2010; Oser et al. 2012). Thus, the socially negotiated handling of errors was central for the students' gaining an experienced understanding of the complexity of the vocational profession.

In accordance with prior studies (cf. Heimbeck et al. 2003; Hetzner et al. 2012; Keith 2012; Keith and Frese 2008), feedback and shared reflections were central for the students' learning from errors. The teachers arranged negotiated reflections on past knowledge of methods to improve presently made errors. Through the negotiated reflections on errors, the students not only gained negative knowledge but also learned to pay attention to timing and changes in vocational work practices. Finally, a sociocultural perspective on learning was relevant for investigating the students' transformed participation in the changing vocational work practices. Through the arrangements of gradually more challenging assignments, the students' participation was transformed in terms of their engaged efforts to constantly improve their erroneous actions.

In terms of theoretical contribution, this study provides new knowledge on two important aspects of learning from errors. First, the findings suggest that through thorough considerations, students gained an understanding of why proper procedures or methods were not always sufficient to avoid future errors in complex environments. Rather, the students learned the importance of careful, skilled attention to the tasks in order to continuously adjust their actions to the ongoing uncertainties of the cooking procedures (c.f. Heimbeck et al. 2003; Ingold 2001; Keith 2012). This adds to prior studies (Gartmeier et al. 2008, 2011; Hetzner et al. 2012; Oser et al. 2012) having emphasized how learning from errors results in the development of negative knowledge and certainty in persons' work methods and procedures. Instead, the current study suggests that students and teachers share reflections of how what are judged to be proper procedures are negotiable and changeable in relation to the task context, rather than being fixed and stable. The students thereby become conscious about the fact that reaching full certainty of one's own work methods may not be possible in complex, changing learning environments. Certainty as a concept related to negative knowledge and learning from errors should therefore be approached with care since knowing that and how some methods or procedures do *not* work does *not* mean that one has reached certainty in how something does come to work and how to solve the related problems. There may still be numerous, and perhaps yet to be discovered, ways in which to reach one's goal, thus, making certainty in work methods difficult to reach.

Secondly, the findings show that interactional processes of learning from errors resulted in subjective transformations of the students' engaged participation in ongoing improvements of challenging activities. In relation to prior cognitive perspectives on negative knowledge, this study thereby offers a sociocultural understanding of learning as students' transformed participation in improving actions and procedures marked by errors (cf. Billett 2012; Dreier 1999; Lave 1990; Saint-Georges and Filliettaz 2008). The findings thereby contribute with responses to what prior research has called a dilemma of transferring context-specific learning from errors into more general and durable long-term learning outcomes (Gartmeier and Schüttelkopf 2012; Keith 2012). The study suggests that students' transformed participation in ongoing improvements of challenging assignments may be considered as more durable learning outcomes, having positive impact on students' vocational performances in and across various contexts, such as that of the school and future apprenticeship. This, however, needs to be further investigated.

The findings also have practical value, providing insight into how teachers support learning from errors. Based on the findings, it is suggested that the experiencing of errors become an integrated part of the students and teachers' vocational activities. Moreover, the teachers should arrange vocational learning activities, through which the students are given ample time to negotiate and to try for themselves novel adjustments of methods and procedures. While it may lead to even more errors, this is important for the students in order to become acquainted with a particular vocational context. In future workplaces, the time for shared reflections and for students' ongoing rehearsals of failed tryouts may be restricted by resources and demands of a quick and efficient work process resulting in a flawless outcome to be presented to the customers (cf. Billett 2012; Filliettaz et al. 2010; Jonasson 2013). Yet, this may be the exact reason why it is vital to emphasize such interactional processes of learning from errors as an important part of school-based vocational training before entering apprenticeship – or

as an ongoing part of workplace-training, which may over the long run result in higher quality service to the customers.

Suggestions for worthwhile further research may also be a result of this study. It seems that an important task for future research is to investigate whether or not the students' transformed engagement in improving erroneous procedures is sustained through error-learning processes at the workplace or in apprenticeship. Future studies may also investigate how the learning outcomes of transformed participation can be supported in educational contexts other than vocational school.

Acknowledgments I sincerely thank the anonymous reviewers, whose comments and suggestions have helped improve and clarify the manuscript.

References

Bauer, J., & Harteis, C. (2012). The ambiguity of errors for work and learning: Introduction to the volume. In J. Bauer & C. Harteis (Eds.), *Human fallibility: The ambiguity of errors for work and learning* (pp. 1–14). Dordrecht: Springer Science and Business Media.

Bauer, J., & Mulder, R. H. (2007). Modelling learning from errors in daily work. *Learning in Health and Social Care, 6*(3), 121–133.

Bauer, J., Gartmeier, M., & Harteis, C. (2012). Human fallibility and learning from errors at work. In J. Bauer & C. Harteis (Eds.), *Human fallibility: The ambiguity of errors for work and learning* (pp. 155–169). Dordrecht: Springer Science and Business Media.

Baumgartner, A., & Seifried, J. (2014). Error climate and how individuals deal with errors in the workplace. In C. Harteis, A. Rausch, & J. Seifried (Eds.), *Discourses on professional learning: On the boundary between learning and working*. Dordrecht: Springer Sciences and Business Media.

Bernard, R. H. (1995). *Research methods in anthropology: Qualitative and quantitative approaches*. Thousand Oaks: Sage.

Berner, B. (2010). Crossing boundaries and maintaining differences between school and industry: forms of boundary-work in Swedish vocational education. *Journal of Education and Work, 23*(1), 27–42.

Billett, S. (2012). Errors and learning from errors at work. In J. Bauer & C. Harteis (Eds.), *Human fallibility: The ambiguity of errors for work and learning* (pp. 17–32). Dordrecht: Springer Science and Business Media.

Boldrini, E., & Cattaneo, A. (2013). Written identification of errors to learn professional procedures in VET. *Journal of Vocational Education and Training, 65*(4), 525–542.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77–101.

Chan, S. (2013). Learning through apprenticeship: belonging to a workplace, becoming, and being. *Vocations and Learning, 6*(3), 367–383.

Dalehefte, I. M., Seidel, T., & Prenzel, M. (2012). Reflecting on learning from errors in school instruction: Findings and suggestions form a Swiss-German video study. In J. Bauer & C. Harteis (Eds.), *Human fallibility: The ambiguity of errors for work and learning*. Dordrecht: Springer Science and Business Media.

Dreier, O. (1999). Læring som ændring af personlig deltagelse i sociale kontekster. In K. Nielsen & S. Kvale (Eds.), *Mesterlære - Læring som social praksis*. København: Hans Reitzels Forlag.

Filliettaz, L., de Saint-Georges, I., & Duc, B. (2010). Skiing, chese fondue and Swiss watshes: analogical discourse in vocational training interactions. *Vocations and Learning, 3*(2), 117–140.

Gartmeier, M., & Schüttelkopf, E. M. (2012). Tracing outcomes of learning from errors on the level of knowledge. In J. Bauer & C. Harteis (Eds.), *Human fallibility: The ambiguity of errors for work and learning* (pp. 33–51). Dordrecht: Springer Sciences and Business Media.

Gartmeier, M., Bauer, J., Gruber, H., & Heid, H. (2008). Negative knowledge: understanding professional learning and expertise. *Vocations and Learning, 1*, 87–103.

Gartmeier, M., Gruber, H., & Heid, H. (2010). Tracing error-related knowledge in interview data: negative knowledge in elder care nursing. *Educational Gerontology, 36*(9), 733–752.

Gartmeier, M., Lehtinen, E., Gruber, H., & Heid, H. (2011). Negative expertise: comparing differently tenured elder care nurses' negative knowledge. *European Journal of Psychology of Education, 26*(2), 273–300.
Hammersley, M., & Atkinson, P. (1997). *Ethnography: Principles in practice*. London: Routledge.
Harteis, C., Bauer, J., & Gruber, H. (2008). The culture of learning from mistakes: how employees handle mistakes in everyday work. *International Journal of Educational Research, 47*, 223–231.
Harteis, C., Bauer, J., & Heid, H. (2012). Research on human fallibility and learning from errors at work. Challenges for theory, research and practiced. In J. Bauer & C. Harteis (Eds.), *Human fallibility: The ambiguity of errors for work and learning* (pp. 255–265). Dordrecth: Springer Science and Business Media.
Heidegger, M. (1988). *Being and time*. Oxford: Basil Blackwell.
Heimbeck, D., Frese, M., & Sonnentag, S. (2003). Integrating errors into the training process: the function of error management instructions and the role of goal orientation. *Personnel Psychology, 56*, 333–361.
Hetzner, S., Gartmeier, M., Heid, H., & Gruber, H. (2012). Error orientation and reflection at work. *Vocations and Learning, 4*, 25–39.
Ingold, T. (1993). Technology, language, intelligence: A reconsideration of basic concepts. In T. R. Gibson & T. Ingold (Eds.), *Tools, language and cognition in human evolution*. Cambridge: Cambridge University Press.
Ingold, T. (2001). From the transmission of representations to the education of attention. In H. Whitehouse (Ed.), *The debated mind: Evolutionary psychology versus ethnography*. Oxford: Berg.
Ingold, T. (2006). Walking the plank: Meditations on a process of skill. In J. R. Dakers (Ed.), *Defining technological literacy: Towards an epistemological framework* (pp. 65–80). New York: Palgrave Macmillan.
Jonasson, C. (2012). Teachers and students' divergent perceptions of student engagement: recognition of school or workplace goals. *British Journal of Sociology of Education, 33*(5), 723–741.
Jonasson, C. (2013). Defining boundaries between school and work: teachers and students' attribution of quality to school-based vocational training. *Journal of Education and Work, 27*(5), 1–21.
Juul, I., & Jørgensen, C. H. (2011). Challenges for the dual system and occupational self-governance in Denmark. *Journal of Vocational Education and Training, 63*(3), 289–303.
Keith, N. (2012). Managing errors during training. In J. Bauer & C. Harteis (Eds.), *Human fallibility: The ambiguity of errors for work and learning* (pp. 173–195). Dordrecht: Springer Sciencese and Business Media.
Keith, N., & Frese, M. (2008). Effectiveness of error management training: a meta-analysis. *Journal of Applied Psychology, 90*(4), 677–691.
Lave, J. (1990). The culture of acquisition and the practice of understanding. In J. W. Stigler, R. A. Shweder, & G. Herdt (Eds.), *Cultural psychology* (pp. 259–286). Cambridge: Cambridge University Press.
Lave, J. (2011). *Apprenticeship in critical ethnographic practice*. Chicago: Chicago University Press.
Lave, J. (2012). Changing practice. *Mind, Culture, and Activity, 16*, 156–171.
Lave, J., & Wenger, E. (1991). *Situated learning. Legitimate peripheral participation*. Cambridge: Cambridge University Press.
Lindberg, V. (2003). Vocational knowing and the content in vocational education. *International Journal of Training Research, 1*(2), 40–61.
Miles, M., & Huberman, M. A. (1994). *Qualitative data analysis*. London: Sage.
Minsky, M. (1994). Negative expertise. *International Journal of Expert Systems, 71*(1), 13–19.
Nielsen, K. (2007). Aspects of a practical understanding: Heidegger at the workplace. *Scandinavian Journal of Educational Research, 51*(5), 455–470.
Oser, F. K., Näpflin, C., Hofer, C., & Aerni, P. (2012). Towards a theory of negative knowledge (NK). Almost-mistakes as dirvers of episodic memory amplification. In J. Bauer & C. Harteis (Eds.), *Human fallibility: The ambiguity of errors for work and learning*. Dordrecht: Springer Science and Business Media.
Saint-Georges, I. D., & Filliettaz, L. (2008). Situated trajectories of learning in vocational training interactions. *European Journal of Psychology of Education, 23*(2), 213–233.
Sanjek, R. (1990). *Fieldnotes: The makings of anthropology*. Uthaca: Cornell University Press.
Santagata, R. (2005). Practices and beliefs in mistake-handling activities: a video study of Italian and US mathematics lessons. *Teaching and Teacher Education, 21*, 491–508.
Seifried, J., & Höpfer, E. (2013). The perception of error in production plants of a chemical organisation. *Vocations and Learning, 6*(2), 159–185.
Spradley, J. P. (1980). *Participant observation*. New York: Holt Rinehart and Winston.
Tulis, M. (2013). Error management behavior in classrooms: teachers' responses to student mistakes. *Teaching and Teacher Education, 33*, 56–68.

Vaughan, D. (2004). Theorizing disaster, analogy, historical ethnograpy, and the *Challenger* accident. *Ethnography, 5*(3), 315–347.
Walford, G. (2009). For ethnography. *Ethnography and Education, 4*(3), 271–282.
Weinert, F. E., Schrader, F.-W., & Helmke, A. (1989). Quality of instruction and achievement outcomes. *International Journal of Educational Research, 13*(8), 895–914.

Charlotte Jonasson, Ph.D. is Assistant Professor at Department of Psychology and Behavioural Sciences, Aarhus University, Denmark. Her research interests are retention and drop out in vocational education and training, student engagement, and learning from errors in school-based vocational training. She has published articles in British Journal of Sociology of Education and Journal of Education and Work.