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The Interactive Construction of Learning Foci in Simulation-Based Learning Environments: A Case Study of an Anaesthesia Course

Hans Rystedt[♣]*, Oskar Lindwall**

* Department of Education, Göteborg University and Department of Nursing, Health and Culture, University of Trollhättan/Uddevalla, Sweden

** Department of Communication Studies, Linköping University, Sweden

ABSTRACT

The dynamic and interactive character of computer simulations is often thought to be advantageous in vocational education. In the present study, video-recorded data from a course in anaesthesia care are analysed in order to explore the conditions for students to understand and act in simulation-based case scenarios. The results show that the students orient themselves to the simulation in three different ways, thereby constituting three different learning foci. Sometimes, when students use resources from their education, the properties of pharmacological preparations are in focus. On other occasions routines at work organise their approach, whilst at other times, they focus on the specific characteristics of the simulation's user interface. In the discussion of the constitution of this hybrid activity, two aspects are presented as especially relevant: first, the students' previous experiences from their education and of nurses' work and, secondly, how the teacher guides the students' orientations toward different resources. Finally, we argue that the simulation could function as a unique learning environment since it provides opportunities for linking experiences from work with more theoretical forms of reasoning in distinctive ways.

Keywords: *interactive learning environments; simulations; collaborative learning; interaction analysis*

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1. Introduction

In common with other professional fields such as aviation, process industry, and ship piloting, computer simulations have been used extensively in anaesthesia to train staff for work in complex technological settings (Vince, 1995). In the present study, we analyse the interaction of nurse students and their teacher in a simulation-based learning environment. Our aim is to identify and explore the aspects of anaesthesia that students orient themselves towards during simulation activities, and to examine how these shared points of attention are created. The term *anaesthesia* refers to the absence of normal sensations, especially sensitivity to pain, which is induced by

[♣]Corresponding author: Hans Rystedt,
Department of Nursing, Health and Culture,
University of Trollhättan/Uddevalla,
Box: 1236, SE-462 28 Vänersborg, Sweden.
E-mail hans.rystedt@htu.se

specific medical preparations, anaesthetics, regularly in association with surgery (Anderson & Anderson, 1994). The work of nurse anaesthetists involves the responsibility for regulating the anaesthesia and for monitoring and maintaining the health-status of patients. A central task is to balance vital physiological functions. The need for proficient performance to sustain the safety and well-being of patients is thus extensive (Stoelting & Miller, 1994). In addition, medical innovations and new equipment are introduced continuously, which contributes to creating demands for more effective forms of education (Holtzmann et al., 1995).

It is often argued that simulations offer a potential that is distinct from other types of teaching media. One reason is that they provide the possibility for modelling complex and dynamic relations of real or hypothetical systems that students can act upon (Bennet, 1995; Towne, 1995). Considerable research has been carried out on the effects of using anaesthesia simulations and how such learning environments should be designed (Byrne & Greaves, 2000; Chopra et al., 1994; Gaba, 1991). Several findings have identified positive user attitudes to simulation and positive self-assessments of performance, and provide support for the claim that training in simulation environments could be beneficial (Holtzmann et al., 1995; Kurrek & Fish, 1996; O'Donell, Fletcher, Dixon, & Palmer, 1998; Riley, Wilks, & Freeman, 1997; Schwid, 2000). It has been hard, however, to demonstrate any significant impact on proficiency in work settings. The lack of such evidence has largely been blamed on methodological problems, mainly the difficulties in finding measures that capture improvements in real work performance (Fletcher, 1995; Holtzmann et al., 1995; Larbuisson, Pendeville, Nyssen, Janssens, & Mayné, 1999; Monti, Wren, Haas, & Lupien, 1998). The studies of simulations in anaesthesia, referred to above, have focused mainly on the potential of full-scale, high-fidelity simulations to improve learning. Research on aviation, however, indicates that screen-based, low-fidelity applications can be used for a more basic and penetrative elaboration of relevant conceptual frameworks (see Dennis & Harris, 1998). As has been shown by Schwid, Rooke, Michalowski, & Ross (2001), different simulation tools can also be used in anaesthesia for a variety of purposes and can be regarded as complementary to one another.

There has also been much research on the use of simulations in instruction on topics such as science and economics, frequently with a focus on the impact of various factors on learning outcomes. Some studies have focused on certain features of the simulations such as, for example, the level of fidelity (Alessi, 1988; Choi, 1997),

degree of complexity (Alessi & Alessi, 1994; Swaak, van Joolingen, & de Jong, 1998), and transparency of the model (Alessi, 2000; Quinn & Alessi, 1994). Other studies have focused on the impact on learning outcomes of certain strategies or individual attributes such as, for example, the significance of intelligence and metacognitive ability (Veenman & Elshout, 1995), strategies in hypothesis generation (de Jong & van Joolingen, 1998), and specific domain knowledge (Veenman, Elshout, & Hoeks, 1992). This research claims that the factors identified above – like certain learner characteristics or simulation features – are important by emphasising their general impact on students' learning outcomes.

In contrast to the research presented above, we are interested in conducting detailed analyses of students' and teachers' interactions in specific simulation-based learning environments. This type of analysis, we would argue, by providing guidance for the productive use of simulations, can offer valuable knowledge for both instruction and design. One way of highlighting the difference between the current study and those reported on above would be by making the distinction between a situative and a cognitive perspective. Greeno (1997) argues that the cognitive approach is concerned with factoring, the way in which discrete entities of external contexts are supposed to *influence* learning, whilst the situative approach takes social interaction in on-going activities per se as the unit of analysis. Our aim is to find interactional regularities (Jordan & Henderson, 1995) in the participants' accomplishment of the simulation assignment by focusing on their *orientations*. This means that the orientations of the participants are used to direct the researcher's attention, or, to use Goodwin's words (2000), "as a spotlight to show us just those features of context we have to come to terms with if we are to adequately describe the organisation of their action" (p. 1509).

By taking the participants' orientations as our point of departure our aim is to scrutinise those aspects of context made relevant by the students in their efforts to make sense of and act on the simulated scenarios. In the following analysis, these aspects are conceptualised as different forms of *semiotic resources* (Goodwin, 2000; Lave, 1988; Linell, 1998). A wide range of phenomena can function as resources for participants to go on with the tasks at hand. In our case, we are interested in exploring the ways in which students rely on their experiences from education and work as resources in their identification of simulation assignments as situations that they are familiar with. The concept of semiotic resources is used to analyse the ways in which elements of the participants' previous interactions in the on-going activity are employed in new acts of sense making. One example would be the ways in which

occurrences on the computer screen are defined as specific patient problems, and how these accounts can provide meaning and structure for the students' subsequent actions. We also use the concept of semiotic resources as a tool for scrutinising the significance of the simulation, i.e. the ways in which students pay attention to the symbolised monitors and interpret their readings (such as heart rate and blood pressure) as indications of typical health problems.

In our analysis of how semiotic resources are used to accomplish an assignment, we also consider how such resources are juxtaposed in different ways to establish and sustain a single focus of attention (Goffman, 1963). In our analyses that which the participants construe, collaboratively, as a focal event is treated as the content of the learning activity, or what we will call the *learning focus*. The constitution of a learning focus is thus seen as being intertwined with the participants' orientations and the resources they utilise to accomplish the simulation assignment. Actually, the former presupposes the latter and the relation can therefore be described as reflexive or mutually constitutive (cf. Goodwin & Duranti, 1992). Consequently, the object of learning, or learning focus, is not seen as something given in advance, but is analysed as a collective achievement.

2. Research questions

In the analysis, our aim is first, to provide a description of *what* students learn about anaesthesia by means of simulations, and, second, *how* specific learning foci are constituted by the participants' orientations to different arrays of semiotic resources. Such an analysis is in line with research traditions that focus on the ways in which participants, in interaction with one another and with the material aspects of the setting, are able to proceed with the activities in which they are engaged (Goodwin, 2000; Heath & Luff, 2000; Hutchins & Klausen, 1996). Much prior research on simulations (referred to above) has emphasised the effects of isolated factors on students' learning outcomes. In the present study, we will open up the practice of learning and reveal how, in simulation activities, participants construct interpretations and act in situ on a detailed level. This does not mean, though, that the students' activity is treated as a closed system without any connections to previous or future activities. In our study, both prospective and retrospective aspects of students' interaction will be highlighted and explicit connections will be made to students' experiences of their education as well as their future roles as nurse anaesthetists. The general aim of exploring what and how students learn in a simulation-based learning

environment can be divided into three more specific and interrelated research questions: (a) how can we understand the learning content of the simulation activity? (b) which resources can be seen as central in the constitution of this content? and, (c) how can the specific characteristics of the simulation-based learning environment contribute to learning for the professions?

3. Background to the case and data analysis

In common with many other countries, becoming a nurse anaesthetist in Sweden requires a specialist post-qualification training. The case that we describe in this study is taken from a one-year, post-qualification program in critical, emergency or anaesthesia care. All of the students had worked as registered nurses, most commonly on wards in specialities such as medicine and surgery, although a number of them had also worked in intensive care units and emergency departments. Consequently, the students had both a theoretical background and work experience, factors that will be shown to be of great significance in the performance of the simulated anaesthesia. Their teacher was an experienced nurse anaesthetist, who had also worked as a tutor in anaesthesia courses for several years.

A central task in nurses' work during anaesthesia, and therefore a central element in their education, is the monitoring of the patient's health status. One way of monitoring is to observe medical-technical equipment that displays a number of physiological parameters such as blood pressure, heart rate, and oxygen saturation. Another way of monitoring health status is by examining the patient's body, for example by checking the colour of the patient's lips or the size of her pupils. These observations determine the ability to follow the depth of the narcosis and the physiological balance, as well as to detect indications of discomfort such as pain. Guided by these observations, the nurse's task consists mainly of administering various pharmacological preparations and intravenous fluids, regulating the anaesthetic gases and assisting the patient's breathing.

Monitoring the patient's health status was also the most prominent task in the desktop simulation the students used during their course and which provided them with the opportunity to train these skills in a safe environment. The simulation includes several case scenarios, based on models of the human physiology and which respond to any given set of interventions. The users interact with the model by, for instance, administering drugs, entering doses in dialog boxes and controlling the symbolised

medical-technical equipment on the screen with the mouse cursor (see Figure 1).

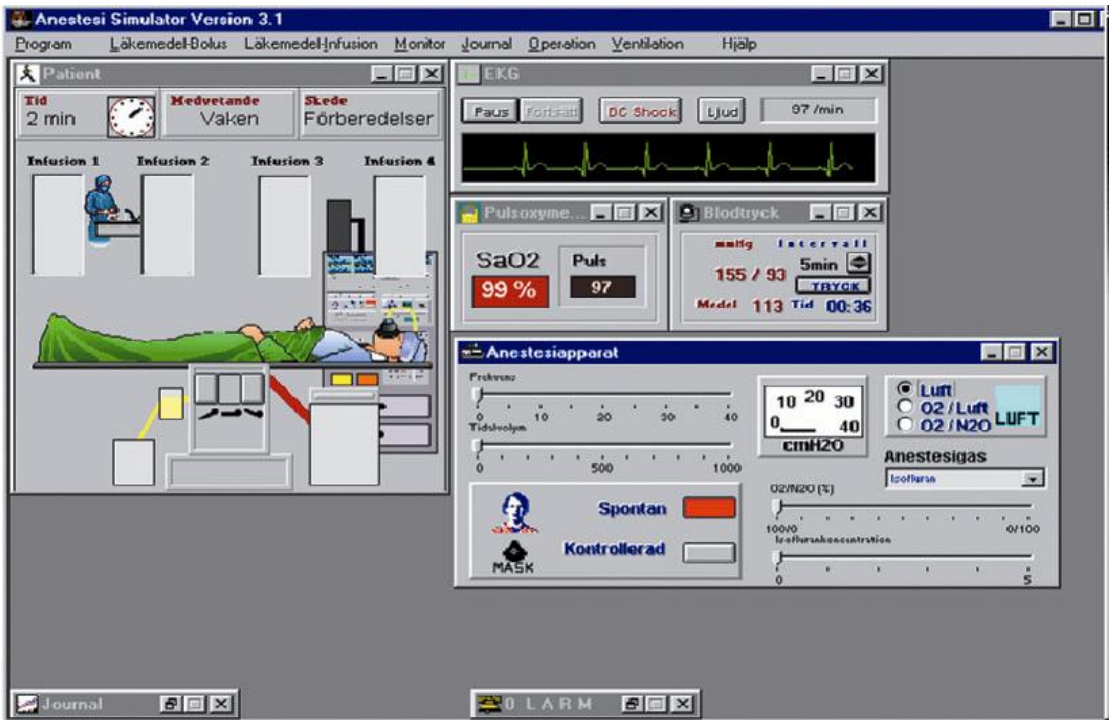

Fig. 1. Appearance of the screen from the start of the simulation with the exception of the anaesthesia machine down to the right, which is activated by an icon**.**

Monitors displayed on the computer screen show, among other things, blood pressure, heart rate, and oxygen saturation, which, taken together, could be regarded as representing the overall health status of the simulated patient. The task for the user of the simulation consists of keeping the indicated physiological parameters within appropriate limits. Several training sessions were arranged in which specific assignments were introduced by a teacher who also functioned as a supervisor during the sessions.

The data corpus of the study consists of interviews, questionnaires and 18 hours of videotaped material collected over a period of 12 months. The analysis presented below is of video data from the first term of the program. The remaining data provide a background for an assessment of the conditions that allow new insights from the simulation assignments to be gained. A video-camera, capturing both the occurrences on the screen as well as the participants' talk and pointing at the screen, was used to record the training session. The location of the camera made it possible to observe the participants' positions in front of the monitor and to get some indication of other activities such as, for instance, their use of literature and notes.

The videotapes were scrutinised several times to detect typical interactional patterns and to identify any evidence of the generality of such patterns (Jordan & Henderson, 1995). Initially, very preliminary hypothesis guided our search for regularities in the participants' interaction. After repeated viewings, however, some of the sessions seemed to include more interesting and comparable sections since they contained a variety of dissimilar interactional patterns. Sections that included significant shifts in the students' orientations were transcribed in order to allow for a detailed examination of how those different orientations were constituted.

4. Results

Three orientations to the simulation assignment were identified in which the participants formed three corresponding learning foci. By observing how the students orient to the assignment we can see the ways in which specific disciplines, work-based routines, and the user interface itself, are all constituted as learning foci. Further, we will provide detailed descriptions of how specific learning foci are built up by presenting a sequence from the interaction of two students dealing with a central task in anaesthesia, namely, how to awaken a patient from a narcosis. The problem that the students consider involves how to best complete the simulated anaesthesia whilst, simultaneously, avoiding indications of pain. The two students in the example had some years of nursing experience. Both of them, though, were novices in anaesthesia care, having had about a day of lectures in anaesthesia care prior to the training session. The teacher introduced the task by running one of the several case scenarios included in the simulation. At the end of the demonstration, the students were asked to run another case and the teacher announced to the students that she would be available for consultation while they carried out the task.

5. Educational orientation

In this section we will describe how the participants drew upon semiotic resources connected to experiences derived from their theoretical studies of anaesthesia care. The use of these resources implies a focus on theoretical aspects of anaesthesia, such as the properties of pharmaceutical preparations and physiological functioning. When about 10 minutes of the simulated surgery remain, the students begin to direct their attention to the consequences of decreasing the amount of anaesthetic gases given to the patient, a necessary procedure for waking the patient up from the narcosis. They notice that anaesthetic gases have the effect of reducing pain and

reinforcing the effects of analgesics. Furthermore, they conclude that when decreasing the amount of these gases, indications of pain may be induced.

Below, we can see that the students direct their attention to the possibilities of reducing pain by administering analgesics. They discuss two different analgesics, *Ketobemidone* and *Morphine*, and wonder how quickly each of these will take effect, how long their effects will last (their duration), and the best point in time to administer them. It is also noteworthy that they consult their course literature in order to arrive at a solution to the perceived problem:

Excerpt 1

81	Marie:	[we should have given him Ketobemidone
		[((turns to notes and books))
		we could give the Ketobemidone? the effects are quick anyway
82	Annika:	[Morphine has a long duration (4.0)
		[((turns to notes and books))
		inject a little morphine (8.0)(inaudible) but it goes quickly (.) it will start to take
		effect in a minute (.) and when there is one minute left (.) you can inject it

The students also consider the depressive effects of these drugs on respiration, which would suggest that they are concerned about these effects since patients are supposed to be able to breathe without support following the completion of the anaesthesia:

Excerpt 2

86	Annika:	Morphine also depresses breathing but…

The latter excerpt illustrates how they construe the problem in terms of a dilemma. On the one hand, they know that they have to wake the simulated patient without indications of pain, something that requires the administration of analgesics. On the other hand, though, these analgesics may depress the patient's respiratory functions.

In order to resolve the dilemma, the students draw upon different types of semiotic resources. First, they make frequent use of ordinary educational devices, such as their notes and course literature. In their efforts to select an appropriate analgesic (Excerpt 1), they turn to *written material* that they brought into the seminar room, and make comments on the effects of morphine (Turn 82). The use of the texts exemplifies how concrete aspects of the educational setting became prominent parts in constituting the specific focus. Secondly, the students utilised their *prior experiences* as a resource. Their use of the written material presupposes that they are reasonably conversant with the topics in question. A prerequisite for considering the preparations mentioned above

is an ability to identify occasions when to use them and to access information about them. Furthermore, the sequence presented demonstrates how the students are able, independently, to focus on several relevant problems, such as, for instance, the assumed need for the administration of analgesics (Excerpt 1), and the impact of the different proposed interventions on respiratory parameters (Excerpt 2). The links between the activity taking place and the students' educational practice can thus be seen as remarkably strong.

The activity described above shows how the effects of drugs used in anaesthesia formed the learning focus. Up to this point, the students' discussion is characterised by an awareness of the effects of different analgesics and their side effects. Moreover, they pay attention to the interactions between the different types of drugs being administered, considering, for example, whether they inhibit or increase each other's effects, and how they should be used in the different phases of anaesthesia.

5.1 Work orientation

Below we examine the ways in which the students orient towards nurses' work. This shift happens when the teacher intervenes in the students' discussion and refers to workplace procedures and routines for managing the problems that they are experiencing. It is apparent that their reliance on these procedures and routines introduces semiotic resources that constitute a different focus. By guiding the students' orientation away from the effects and side effects of medical preparations and towards the performance of specific nursing tasks, the teacher has initiated a focal shift.

As we have described, the students did not come up with a satisfactory solution for the completion of the simulated anaesthesia. On Marie's initiative, they ask the teacher for help. When the teacher intervenes, the students stop searching in their literature and, instead, direct their attention to her. In Excerpt 3 below, the teacher responds to the students' question about the correct analgesic to choose by referring to the routines in the intensive care unit, ICU.

Excerpt 3

116	Teacher:	in that case it is Ketobemidone that is appropriate and that's what you have in the ICU

What we can see here is a shift from a learning focus centred on the pharmacological properties of analgesics towards one that concentrates on workplace guidelines. Thus, the participants disregard some of the semiotic resources they had used previously and, instead, draw on a new set of resources, *institutional routines,* to

carry out the assignment. The shift in focus implies a transition from the sphere of texts and teaching media to numerous demands inherent in the institutional order of the clinic, in this case local regulations governing the appropriateness of different preparations. Obviously, the premises for how to perceive and act in relation to the current task are altered, as is the actual constitution of the learning object.

The shift in focus becomes even more apparent when the simulation produces problems that require prompt interventions, as for example in the period immediately before the simulated surgery is due to be completed. A moment before the episode recounted below (Excerpt 4), the students had decreased the delivery of gases in order to awaken the simulated patient. The discussion between the students is suddenly interrupted by Marie, who notices a remarkably rapid heart rate (Turn 194 below). An increase in heart rate during anaesthesia and surgery is an undesirable condition that could have many causes. In this case the students interpret it as an indication of pain (Turn 200).

Excerpt 4

194	Marie:	[look here now [((points at the displayed heart rate))
195	Teacher:	whoops
196	Marie:	mmm
197	Teacher:	(inaudible) one hundred and sixty-five (.) it shouldn't look like that
198	Marie:	no
199	Teacher:	no
200	Marie:	then it's pain (.) or? (.) what do we do now?
201	Teacher:	yeah (.) [yeah (.) fortunately the operation is over [((a window *operation over* is displayed))
202	Marie:	yeah
203	Teacher:	how lucky you are (.) so ((Marie clicks on the OK button in the window showing *operation over*))
204	Marie:	what should we do?
205	Teacher:	now we can give a little pain relief
206	Annika:	click on preparations ((Marie clicks on *medical preparations* in the menu))
207	Teacher:	so (.) so you could administer
208	Annika:	[analgesics [((Marie clicks on *analgesics* on the menu))
209	Teacher:	yes
210	Marie:	[Fentanyl again? [((Marie points at another analgesic preparation on the menu, Fentanyl))
211	Teacher:	you could do that (.) but its very rare that we would do that outside (in practice) (.) [but we'll do

212	Annika:	[Morphine (.) a five milligram dose?
213	Marie:	should we do that? (.) you decide

When the students are considering the appropriateness of different analgesics, it is notable that they no longer discuss the pharmacodynamic properties of these in terms of effects and side effects. Instead, they defer to the teacher and her references to work routines. When the unacceptable heart rate calls for prompt decisions the teacher's support is amplified: "shall we do that? you decide" (Excerpt 4, Turn 213). We can see how closely the students' conduct is linked to the simulation in the way that the occurrences unfolding in real time encourage them to respond immediately, without taking time for deliberations or for reference to their written material. Their approach is thus more in line with the supervision of students in clinical settings where both timely and appropriate decisions are of vital importance (Rystedt & Lindström, 2001).

The involvement of the teacher in the students' performance of the task indicates that a shift in the organisation of the *participation framework* (Duranti, 1997; Goffman, 1981) has taken place. When the teacher arrived, the students discontinued their exploration of possible alternatives. Instead, they turned to the teacher for support, who, in turn, gave them instructions. One might say that the students and the teacher mutually defined the teacher as being more knowledgeable, and as someone whose suggestions could be relied on.

Another way in which we can see the change in the participants' stances to the task and to one another, is the specific use of the terms *you* and *we*. The teacher's use of the generic *you* when she says "in that case it is Ketobemidone that is appropriate and that's what *you* have in the ICU" (Excerpt 3, Turn 116) indicates that she is speaking on behalf of generalised ICU practice. The specific framing is further underlined by her use of *we* when she says "it is very rare that *we* would do that outside (in practice)" (Excerpt 4, Turn 211). The teacher's position in the interaction can be described as that of enacting the role of an expert, not only talking on behalf of herself, but also on behalf of the collective expertise of practitioners.

These different forms of role-taking accord well with the distinctions noticed by Goffman (1974), namely, between the speaker as the author and principal. Taking the role of the author means accepting personal responsibility for what is expressed, whilst the role of principal involves taking the part of the person or institution whose positions or beliefs are being presented. As Duranti (1997) suggests, the speaker's use of the term *we*, creates, in different ways, identification with the speaker. In the current case,

it can be seen as the articulation of the views, needs and goals of the students' future professional community.

5.2 Simulation orientation

The students' educational and work orientations are, from time to time, disrupted and, instead, the management of the simulation itself stands out as the object of learning. Temporary breakdowns can, for instance, result from the fact that some workplace tasks are not included in the simulation, or that the students do not know how to carry out the necessary interventions in the simulation environment. In the following excerpt, the students respond to the teacher's directives to remove a tube from the patient's trachea (*extubate*), which is regularly used during narcosis. They are also supposed to carry out ventilation manually using a mask. When the teacher says that the patient's breathing could be assisted manually, both of the students seem to be confused because a corresponding intervention is not represented in the interface. The teacher then explains how to find the function for tube-removal by telling the students that they can find it in the 'ventilation' menu:

Excerpt 5

229	Teacher:	now the operation is over (.) so you can switch to ventilation (.) extubate him
230	Marie	and then by hand?
231	Teacher:	yes (.) you ventilate by hand
232	Annika:	spontaneously?
233	Marie:	how do we [then
234	Teacher:	[go up to the ventilation

We can observe that in this sequence the simulation temporarily returns to the forefront (Turns 233-234), as the participants try to locate the function for carrying out the requested interventions in the simulation environment. Similar disruptions, when the focus was on the management of the user interface, were fairly common during the simulation sessions. However, what is notable is that a work orientation is also prominent when the students interpret and decide how to act in relation to the events unfolding on the screen. This orientation is illustrated below when one of the students asks for further clarification of what ventilating manually means and in what circumstances this type of intervention is required:

Excerpt 6

279	Marie:	in reality, it's like [this (.) if it goes down to five
		[((points on the displayed breathing frequency))
		[so I could have done it with the mask
		[((makes some pumping movements with her hand in front of the screen))
		and assisted the breathing

In the excerpt above, the students focus is on the ways corresponding tasks are carried out in the workplace. A work orientation emerges anew when Marie tries to manage the task by using her hand to mime manual ventilation. She apparently draws upon experiences of well-known situations that serve as semiotic resources for understanding what to do next. These resources are combined with a concrete object in the setting, i.e. the computer screen. Gestures are used in sense-making, not only to accompany verbal utterances, but also for the elaboration of ideas by referring to both objects on the screen and movements commonly performed in the workplace. Neither talk, gestures, on-screen images nor the experiences of tasks at work are dealt with as isolated phenomena, but are juxtaposed to create an understanding as to what *ventilating by hand* means and when it is needed (Goodwin, 2000; Goodwin & Goodwin, 1996).

6. Discussion

The results show how the learning content of the simulation assignment is constituted from the students' prior experiences. In the following discussion we will expand on this idea as well as focusing on how educators and designers, assuming that they are aware of the kind of resources students need to make sense of the simulated scenarios, can guide students' orientations to different resources. Finally, we will consider how a new learning arena can be created in which experiences from work practice can be linked with theoretical forms of reasoning.

6.1 The importance of previous experience

A central issue in research on simulations is the impact of students' prior knowledge on their learning outcomes (e.g., Veenman et al., 1992). In our analysis, however, the question posed has been formulated differently, which results in a different kind of answer. Our questions concern how the participants – when working with the task – make use of prior experiences from education and work. As we have demonstrated,

certain semiotic resources are used to construct specific learning foci, which are closely connected to the disciplines of pharmacology and physiology that are covered on the course. Prior knowledge of anaesthesia and pharmacological preparations can be seen as a prerequisite for students to be able to formulate the problem in the way that they did. As we were able to observe, the problem that arose during the simulation also functioned as a dilemma, forcing the students to continue to look for a solution. The actions taken by the students to reach this solution implied an orientation to several readings and indications of relevance to anaesthesia practice, where their prior familiarity with the disciplines functioned as an important resource for making sense of the events.

The frequent connections made to work highlight the fact that learning in a simulation environment involves more than just the comprehension of theoretical relations and having a grasp of the underlying model (cf. de Jong & van Joolingen, 1998). Larger social networks also provide meaning and significance. The students' approach to the indications of pain, for instance, can be seen as an enactment of the responsibilities of practicing nurses and a recognition that pain is regarded as an undesirable condition within the discipline of anaesthesia. Simulation activities, thus, do not only concern learning about the execution of discrete tasks. They also involve a change in the nurse's identity as part of the process of becoming a specialist with a range of professional duties and obligations (Beach, 1999; Lave & Wenger, 1991). The students' prior experiences also stand out as a prerequisite that enables them to perceive the simulated scenarios as representing typical problems in anaesthesia, i.e. to see the cases as a simulation of something specific (Rystedt & Lindström, 2003). It follows that the learning focus in a simulation activity is closely related to the specific content of the educational arrangements, such as the topics covered in previous courses and experiences from clinical settings.

6.2 The importance of guidance

In the previous section, we argued that if students had not had experience of either the educational setting or of nursing practice, then the semiotic resources drawn upon, and thus also the learning foci, would have been different. Having a background in anaesthesia is not the only aspect of central importance in the formation of this particular activity; supervision is also a crucial element in constituting the content in the simulation task. The teacher's interventions, for instance, were decisive when it came to shifting the focus from pharmacologic properties to routines at work. Furthermore,

when their own ability to contribute to an appropriate solution to the problems proved to be limited, the students became largely dependent on the teacher's advice and guidance. .

These results point to three important implications for instruction. First, in order to utilize and elaborate upon students' theoretical understandings and prior work experience, the guidance of simulation assignments must be sensitive to interactional dynamics. The differences in the participants' reasoning, when for example choosing analgesics, might normally be overlooked in everyday educational practice. It is apparent, however, that the change from an educational to a work orientation did not imply any improvement in the students' understanding of the properties of specific analgesics. Instead, the activity involved a focus on the types of analgesics that are regularly used and the question of when to use them. Both of these foci may be legitimate targets of training in anaesthesia, but one problem is that the latter orientation did not immediately link to any available resources that the students could have used for further developing their understanding.

Secondly, the results underline how the use of simulations has to be properly integrated into educational programs and curriculum design if students are indeed to learn what is in fact intended in any particular simulation training. The readings and icons on the user interface provide somewhat sparse information about a hypothesised health status, something referred to in authentic anaesthesia as an under-representation of problems (e.g., Jacobsen et al., 2001). In the simulation environment, this may pose an even greater difficulty, since many of the indications afforded in authentic anaesthesia, such as observable bodily responses, are not represented. For students to understand the simulated scenarios and to be able to act on these, we think that there is both a need to introduce relevant conceptual frameworks into instruction and to form explicit connections with procedures in the anaesthetist nurse's work.

Thirdly, we claim that it is important to carefully consider the goals of any training. From the sequence presented here we can discern three potential goals. The first can be described as the attempt to arrive at a better understanding of conceptual relations, i.e. learning about the complex interplay between medical preparations and physiological parameters. Another possible goal is to learn when and how to carry out certain procedures in relation to typical courses of events in anaesthesia practice. Finally, the results point to yet another goal, that of creating a learning environment

that affords opportunities for students to make important connections between theory and practice. It is to this final goal that we turn in our concluding discussion below.

6.3 The simulation-based learning environment as a new arena for learning

A common reason for using simulations for educational purposes is the potential for interacting with dynamic scenarios (Bennet, 1995). As suggested by Brooks, Robinson and Lewis (2001) the benefits of this characteristic are often taken for granted although at the same time as it is not clearly demonstrated how it improves learning. In contrast, our analysis shows concretely how the dynamics of the simulation become an inseparable part of the participants' interactions. There is continuous new information, which the students respond to in the light of prior occurrences and actions, as well as the dynamics of the underlying model. These dynamics, however, can contribute to different orientations, depending on the resources that are available and how the scenario is interpreted. The educational orientation was dependent on an awareness of the evolving character of events. The students correctly anticipated that they would probably confront problems later on, which led them to orient themselves towards their course literature and notes, i.e. the resources available to them at that time. Another example is how the sudden rapid increase in heart rate (Excerpt 4) caused the students to respond in certain ways and not in others. Since the events unfolded in real time, the participants were required to react immediately, leaving no time for checking in their literature. Most importantly, the students were compelled to consider *when* to give analgesics, *when* to decrease the delivery of anaesthetic gases, *when* to extubate and *when* to ventilate manually, etc. Furthermore, they related these interventions not only to a sequential order corresponding to different phases of anaesthesia practice, but also to specific patterns of signs and occurrences. The increased heart rate, for instance, was immediately interpreted as pain, which was probably related to the fact that they had decreased the amount of anaesthetics before the surgery had been completed. The unfolding course of events obviously encouraged the students to address many questions relevant to anaesthesia practice that, in addition, could also be dealt with in theoretical terms. Their discussion of the pharmacological effects of analgesics was, for example, related to a number of different factors including the time remaining time for the operation, the need to reduce the administration of anaesthetics and concerns for the simulated patient's ability to breathe effectively after the period of anaesthesia.

By orienting to the task in a variety of interchangeable ways, the students utilised resources from different activities, creating what we could call a *hybrid activity*. The simulation activity can thus be seen as entailing multiple connections to both education and work. The question of how the simulations can contribute to improved work performance can thus be examined from a different perspective. Instead, unlike much research on simulations in anaesthesia training (e.g., Chopra et al., 1994) that considers the extent to which students display a more skilled performance in work settings as a result of training, the present analysis focuses on the conditions necessary for creating a simulation environment that can function as an arena for learning about relevant problems. Our study has revealed, for example, how students when dealing with central tasks in anaesthesia, such how to awaken patients from narcosis, can negotiate meanings and co-ordinate adequate and timely interventions. As Engeström (1999, p. 257) puts it, the creation of such an arena can be described as "opening up possibilities of creating entirely new patterns of activity." The focus is thus placed on how separate, historically constituted practices can be interlinked in new forms of learning activities (Kirshner & Whitson, 1997; Lemke, 1997). In our study, these connections are illustrated in the way that various aspects of professionals' tasks are explored and elaborated in the simulation environment and which, in addition, also allow participants to address the theoretical content of their studies.

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