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The Struggle to Understand: Exploring medical students' experiences of learning and understanding during a basic science course

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Abstract

The aim was to explore students' 'journey' towards conceptual understanding during an undergraduate course. The task that medical students face - to learn a substantial quantity of detailed knowledge and integrate into a coherent whole in a limited time frame - is demanding. Seven students were interviewed in a group, and seventeen students gave their reflections in writing. Data was gathered from both groups on five separate occasions. Our findings suggest that students seek different kinds of understandings as they get to grips with their studies. The forms of understanding were: understanding as 'knowing the language', 'knowing the map', 'knowing the catalogue' and as 'experiencing an integrated whole'. Students first appeared to focus on the first two forms, and later in the course, as they learned more, they focused on the 'catalogue' or the 'integrated whole'. Our findings point to potential pathways students might take towards gaining deeper understanding.

Keywords: deep learning, course experience, forms of understanding, approach to learning, medical education

Introduction

Learning is a complex and multifaceted phenomenon that has intrigued both researchers and educators for a long time. Since the 1970s, researchers have explored learning from the learner's perspective, which has revealed new insights into students' learning. Marton and colleagues found two main approaches that students adopted: the surface and the deep approaches to learning (Marton and Säljö 1976a, 1976b, 1997). The intention students have with their studies seems to have a major influence on their learning (Entwistle and Peterson 2004; Entwistle 2009). A surface approach has been associated with an intention to memorize and reproduce learning material in order to meet the assessment requirements. In contrast, students who approached their learning with an intention to understand, wanted to learn for their own sake, looked for the underlying meaning in the task or text, related new information with prior knowledge, and were also more likely to reach a deep understanding. However, the relationship between memorizing and understanding has been shown to be more complex, and students aiming for a deep understanding have also been found to use memorization as a learning strategy (Kember 1996; Entwistle and Entwistle 2003; Marton, Wen, and Wong 2005). Other researchers described student learning patterns more broadly, including aspects such as study strategies, conceptions and regulation of learning (Vermunt 2005, Vermunt and Vermetten 2004; Lonka and Lindblom-Ylänne 1996). These studies show four different learning patterns that students adopt in relation to specific learning environments: meaning-directed, reproduction-directed, application-directed and undirected learning patterns. A meaning-directed learning pattern is associated with a deep approach to learning, self-regulation and a conception of learning as "construction of knowledge". A reproduction-directed learning pattern is related to a surface approach to learning, external regulation and a notion of learning as "intake of knowledge". The third pattern was application-directed learning where the use of knowledge and concrete processing was important, together with a vocational learning orientation. The fourth pattern is associated with a lack of regulation and an ambivalent learning orientation. Together these studies have contributed significantly to our understanding of student learning, but there are still considerable gaps in our knowledge of how students' understanding develops in a course at the university level. Thus, we followed students' 'journey' during a nine-week university course in the second year of a medical undergraduate program in order to explore how students' experience learning.

Students' Experiences of Understanding

Although there is a substantial body of knowledge about student learning in higher education, students' experiences of understanding have only recently been explored by educational researchers. In a series of interview studies, students' experiences of understanding when preparing for examinations were investigated (Entwistle and Entwistle 1992; Entwistle and Entwistle 1991). Students mentioned that understanding was perceived as a sense of coherence and wholeness. Students' experiences differed regarding the breadth and depth of understanding, and regarding the structure they used to make sense of the material. Some students used structures from lectures or books, while others worked out their own structure, which could be experienced as an integrated whole that could be visualized and manipulated flexibly, like a mental 'knowledge object' (Entwistle and Marton 1994; Entwistle and Entwistle 2003).

Researchers have become increasingly interested in learning and development of understanding in different disciplines, acknowledging the contextual aspects of learning (McCune and Hounsell 2005; Anderson and Hounsell 2007; Newton, Newton, and Oberski 1998). In medical education however, researchers have mainly focused on the development of expertise and how the organization of medical knowledge differs between novices and experts (Schmidt and Rikers 2007). Research findings suggest that a deep, integrated understanding of the basic sciences, for example anatomy, cell biology, physiology, pathology, is important for solving clinically relevant tasks (Ahopelto et al. 2011; Woods et al. 2005, 2007). However, there are few studies on students' experiences of understanding in the medical context. A study by Fyrenius and colleagues (2007a) found similar patterns as Entwistle's study in how medical students achieved understanding in physiology. Students in Fyrenius' study also had different conceptions of how details related to the understanding of wholes. Some students thought the relation was unproblematic and linear; when you learn more details you understand more. Other students focused either on details or on wholes when they studied, as they felt these were competing aspects, and some students believed details and wholes evolved together and worked together to improve understanding. In anatomy, which is the study of the structure of the human body, students are faced with the task of learning a vast amount of details. In a study on medical students' understanding of anatomy it was found that students needed to relate the anatomical details to either the three-dimensional structure of the body, or to other subjects in order to achieve understanding (Wilhelmsson et al. 2011). Students seem to have the idea that anatomical knowledge is about details and not understanding, and the relevance of anatomy in medicine often become clear to students first after clinical experience (Bergman et al. 2013). Physiology, on the other hand, is perceived to be about complex interrelated mechanisms and students reach qualitatively different understandings of the underlying principles of physiological phenomena (Fyrenius et al 2007b). Scheja and Bonnevier (2010) found that medical students experienced understanding as developing gradually, and that they missed having a sense of the 'big picture' in the early years of their education. However, the students also seemed to be comfortable with the apparently slow development of understanding, and as topics reappeared in different courses the understanding developed as things fell into place. A significant transformation of the students understanding seemed to occur as they entered the clinical phase of their education, when knowledge from the different pre-clinical courses became integrated into a larger whole (*ibid* p.253).

Developing understanding is more than a cognitive process; it also involves emotional, visual, tactile and social aspects. The sudden 'aha' moment when things fall into place, or being able to follow a lecture, gave students a feeling of satisfaction (Entwistle and Entwistle 1991; Entwistle and Entwistle 1992). In addition, the sense of coherence and connectedness made students feel confident about explaining to themselves or to others what they had understood. A form of perceptual understanding was found when medical students learned anatomy, suggesting that visualization of the human body was important for their learning (Wilhelmsson et al. 2011). Furthermore, tactile experiences seem to be important for learning in medicine. Students seem to learn more when participating in anatomical dissections or using physical anatomical models rather than virtual models (Preece et al. 2013, Saltarelli et al. 2014). The importance of seeing and touching real organs when learning pathology has also been reported by Weurlander and colleagues (2009). These findings suggest that understanding the complexity of the human body in three dimensions is facilitated by visual

and tactile experiences (Granger 2004). Social aspects, when students work together, solving problems or tasks that require elaboration and explanation, the discussion might also help them develop understanding (Weurlander et al. 2009; Weurlander et al. 2012b).

The purpose of the present study was to get a more nuanced picture of how students approach their learning during a university course. Specifically we wanted to investigate if, and how, students' experiences of learning and understanding changed during a university course; we wanted to follow their 'journey' towards understanding.

The Nature of Understanding

High quality learning is associated with an intention to understand. In order to understand, the learner has to make connections and relate new information to prior knowledge in a meaningful way (Ausubel, Novak, and Hanesian 1968). Thus, understanding involves building a coherent whole, integrating the many pieces of new and "old" information (Burns, Clift, and Duncan 1991). The process of integrating new knowledge into richer and increasingly complex mental structures has been found to occur in phases, when for instance medical students learn more and more about diseases and their symptoms (Schmidt and Rikers 2007). The knowledge becomes 'encapsulated', meaning that concepts and understandings of detailed mechanisms and their inter-relations are structured into high-level, more abstract concepts that can be used to explain the same phenomenon.

Understanding can be achieved to different degrees, or levels, ranging from a low degree with a limited understanding, to a high degree with a deep understanding. Students with a limited understanding are able to mention and describe topics briefly, whereas students with a deeper understanding can, for instance, explain the same topic and relate to similar topics (Newton 2000; Perkins 1998). Students' understanding is personal, dependent on the richness of the knowledge they have regarding a certain phenomenon (Nickerson 1985; Burns, Clift, and Duncan 1991), and influenced by their interpretation of the task and the context (Entwistle and Smith 2002; Halldén, Scheja, and Haglund 2008).

Understanding has both a process and a product dimension (Nickerson 1985). It involves an active exploration of connections between pieces of information, and interpretation of concepts and processes (the process). The result of this process is coherent wholes that are more or less rich in interconnections (the product). Understanding can grow gradually, when more knowledge is learned and more connections between pieces of knowledge are made, in an additive, bottom-up process (Vosniadou, Vamvakoussi, and Skopeliti 2008). However, understanding sometimes seems to appear suddenly, like an 'aha' experience or insight (Auble, Franks, and Soraci 1979; Wills et al. 2006).

Context of the Study

The context of the present study was an undergraduate medical curriculum at a Swedish medical university. The curriculum had a traditional design with two years of basic sciences (e.g. cell biology, anatomy, physiology) followed by clinical courses (e.g. surgery, medicine) for three and a half years. We studied the pathology course taught at the end of the second year. The students were at this point familiar with university studies. Pathology, the study of diseases, is a core subject of medicine, and links basic and clinical sciences (du Boulay 1997,

Kumar et al. 2001). It is essential for medical students to understand the mechanisms of diseases and the difference between normal and abnormal, health and disease, to become skilled clinicians. In addition, on this particular course several teaching and learning activities were used, e.g. lectures, formative assessments (Weurlander et al. 2012b), case seminars using surgically removed human organs (Weurlander et al. 2009), autopsies (Weurlander et al. 2012a), and seminars during which students discussed the microscopic picture of tissues. For these reasons, the pathology course provided a suitable context for our investigation.

The first two weeks of the nine-week course focused on general pathology, i.e. how cells and tissues are affected by stress or injury which in turn can cause reactions and diseases such as inflammation or tumors. This part of the course was lecture-based and ended with an individual, written formative assessment (for more details, see Weurlander et al. 2012b). Thereafter, the course focused on organ-specific pathology, where diseases in different organs such as the liver, kidney, and heart, were presented by different physicians who were experts in their respective fields. During this part of the course there was a mixture of teaching activities: lectures, different kinds of seminars (see above) and autopsies. After about seven weeks, there was a formative assessment in which students solved clinically relevant problems in groups. At the end of the course there were two summative assessments; one group and one individual written exam. In the teaching situation, teachers 'set the scene' and represent the subject in certain ways that in turn have influences on student learning (Selander 2008). In the pathology course, the 'scene' that was staged for students comprised fact-dense lectures or seminars where different organs and their diseases were presented by an expert, especially in the second part of the course. This way of structuring pathology, organ by organ, was also evident in the course literature. In addition, the case seminars and the autopsies gave students opportunities to learn pathology and rehearse anatomy in a clinical context. These activities also provided students with visual and tactile experiences from real organs. One of the formative assessments, an oral group assessment, also gave students the possibility to engage in clinically related problem-solving (Weurlander et al. 2012b).

Research Methodology

The epistemological stance taken in this research project is located within the constructivist research paradigm, which acknowledges learning and understanding as socially constructed knowledge about reality (Patton 2002; Lincoln and Guba 2003). In this paradigm, each individual's ideas, experiences, perceptions and understanding are valid, and data is seen as generated in interaction between the researcher and the participants (Garnham 2008). In addition, analysis is viewed as a process informed by the researchers' prior experiences and knowledge (Denzin and Lincoln 2003). Learning is regarded as both a process and a product and involves both individual and social aspects. The present study focuses on conceptual learning, which requires that the learner constructs his or her knowledge in interaction with the social and cultural context (Vygotsky 1978).

Participants

Seventy medical students enrolled in the pathology course were invited to participate in the research study. Seventeen (n=17) of these students volunteered to reflect in writing on their experiences and another group of seven students (n=7) participated in group interviews. A convenience sample was thus used, but the two groups of students varied in terms of gender (nine men and fifteen women), ethnic background, and age (19-38 years), which ensured a variation in their experiences and perceptions of teaching and learning. Of the seventeen students who wrote down their reflections, four were international exchange students taking this particular course at this university. The students who volunteered to participate in our study (N=24) were representative of the study population as a whole regarding gender, ethnical background and age.

Study Design and Data Generation

The first author (MW) followed the pathology course and participated in many of the teaching sessions. Data were collected in two ways: group interviews and written accounts, as described above. Group interviews were held on five separate occasions spread out during the course. Another group of students, prompted by questions, reflected in writing on different aspects of their experiences of teaching and learning. Both questions and students' answers were sent via e-mail on five separate occasions during the course. This way of collecting data, from an authentic learning environment continuously throughout a course, has both advantages and limitations. Participating in teaching sessions gives the researcher a better understanding of the context. Conducting interviews directly after a teaching session when students are still in their learning environment might facilitate access to their experiences. However, following an authentic course which for this particular student group is only taught once, limits the possibility to gather additional data. The purpose of combining individual written accounts and group interviews was to obtain richer data and to triangulate data collection by gathering data of varying nature (spoken and written) and from two groups of students (Thurmond 2001). Group interviews have the advantage of stimulating interaction between participants (Patton 2002) and e-mail is an easy and adaptable way of gathering data during an ongoing course, and, it seems to be a 'friendly' and anti-hierarchal way of communicating (Selwyn and Robson 1998). The participants were asked to broadly describe their own experiences, in writing or during the interviews, of their learning during the course they participated in. We asked open questions to stimulate reflection both in writing and during the interview. The group interviews were recorded and later transcribed. The study followed national and international ethical guidelines on research involving human subjects (ethical approval 2007/1334-31/5 obtained from the local ethical board). Information about the research project was presented to the students at the beginning of the course, and written informed consent was obtained from all students prior to the data collection. Parts of the data have previously been analysed focusing on different aspects of the students' experiences, and reported elsewhere (Weurlander et al. 2012a, 2012b).

Data Analysis

The interview transcripts and written accounts, although different in character, were analysed as one data set, using an inductive thematic analysis (Braun and Clarke 2006;

Boyatzis 1998). Since data was gathered continuously throughout an authentic course, it was not possible, due to time constraints, to analyse the data in depth until after the course was finished. Therefore thematic analysis was chosen as a means of systematising the data as they were collected. Thematic analysis is a qualitative analysis method that aims at interpreting the meaning of textual data, and it fits well within a constructivist research methodology. The first author (MW) read the transcripts and written accounts several times to familiarise herself with the material and to get a sense of how students broadly experience the teaching and learning. The analysis focused on the interpretational level, which meant that the researchers went beyond the manifest content that was explicitly said and written, and interpreted the latent content, i.e. the underlying meaning (Braun and Clarke 2006; Boyatzis 1998). The next step in the analysis was to look for and code utterances in the data that were related to understanding in some way. The extracted data were further interpreted; aiming for a detailed and nuanced account of students' experiences of learning and understanding during the particular course. The themes were constructed in terms of different forms of understanding, and labelled with metaphors that captured the essential meaning of each form of understanding. The analysis was continuously discussed with all authors and documented in notes as a way of enhancing the transparency of the analysis process. The themes developed were discussed and agreed upon by all authors to ensure internal coherence and consistency, and a good fit between data and findings (Braun and Clarke 2006). The trustworthiness of the analysis was ensured by triangulation of data generation. This was done on several occasions during the course (five separate times), using two different methods (group interviews and written accounts) (Thurmond 2001). In addition, investigator triangulation was used since the authors had different professional backgrounds. One of the researchers is a senior consultant in pathology, experienced medical teacher and a researcher, another researcher in the team has a background as an educational developer and was the researcher who conducted the data collection in the project. The other two members of the research team are experienced educational researchers. This investigator triangulation enabled different perspectives and experiences to be incorporated in the analysis process. Together the researchers had both inside and outside perspectives of this particular course, which were valuable in both data collection and analysis. The senior consultant in pathology was one of the lecturers in the particular course. The other three authors were not involved in the teaching. To maintain confidentiality of the informants, all data was gathered by one of the researchers not involved in the teaching. Before analysis the data was anonymized.

Findings

The findings of the present study point to potential ways students might take towards gaining a deeper understanding of the subject matter. Students' experiences of understanding comprise four themes including a process dimension (referred to as learning) and a product dimension (referred to as understanding). The themes are: understanding as knowing the language (A), understanding as knowing the map (B), understanding as knowing the catalogue (C) and understanding as experiencing an integrated whole (D). The themes represent different forms of understanding. First, in the following section, each theme will be described and illustrated with representative quotes. Second, the development of understanding, in the form of potential ways during the course, is presented.

Experiences of Understanding

A. Understanding as 'Knowing the Language'

In this theme, understanding means to 'know the language'. Students mentioned that in every new course, they are exposed to new terminology and concepts that they had never heard of or reflected on before. The knowledge students focused on was basic processes and concepts that they felt they needed to understand in order to follow the lectures during the rest of the course. The learning process seemed to focus on studying and rehearsing the terminology, concepts and basic processes, in much the same way as one learns a new language. The understanding in this theme was rather limited and focused on grasping the meaning of key concepts and the basic processes. The students needed this understanding in order to proceed in their learning. The following quote illustrate this form of understanding:

'Some times, like especially in the beginning of courses, the terminology is new and so I use the core curriculum, "almost" like a dictionary (the work that I do is writing short explanations of the core concepts).' S8, written account

B. Understanding as 'Knowing the Map'

This theme is characterised by a notion of understanding as 'knowing the map', and involved a rather rough outline or brief overview of the content of the course. Students mentioned that they tried to get a structure and a sense of what the course was about. The learning process involved browsing through the course literature, and making mind-maps or other graphical tools in order to reach a sense of overview and 'see' the map. It could also involve listing the main points and learning the basic facts and concepts, but resulted in this sense of overview and rough map of the content. This superficial map seemed to help students to structure the course content, and they could more easily navigate through the vast amount of information they were exposed to during the course. Details and facts were continually added to this map as the students learned more.

'You mentioned the thing with overview, because we have never got that [...] I would like that... a lecture, from the beginning it should be some sort of mind map [...] The entire content of the course. And then you [the lecturer] say "now we will go into this, this part of the whole [...]. But now I know that I will not get this [overview] from the lecturer, so I have started to do this by myself and try to get an overall picture and then build from this.' Group interview

C. Understanding as 'Knowing the Catalogue'

Understanding in this theme is viewed as 'knowing the catalogue', and compared to the two previous themes this entails knowing a lot more details. The students described the learning as 'cramming', and focused on trying to learn as many details as possible. The students' experienced the knowledge as fragmented and it seemed to be organized in the form of a catalogue, focusing on each organ and its diseases. Some students expressed frustration over the vast amount of information they were required to learn, and seemed to give up on their endeavour to develop a deep understanding.

'It is a lot to learn and in most cases you cannot use pure logic. I try to study organ by organ, and follow my lecture notes and the core curriculum so that I don't focus on the wrong things.'

S17, written account

D. Understanding as 'Experiencing an Integrated Whole'

In this theme, understanding involves the development of an 'integrated whole', and is qualitatively different from the previous forms and represents a deeper and more comprehensive understanding.

The learning process in this theme, entails making connections between facts and concepts, between prior and new knowledge, and resulted in a sense of 'wholeness' and coherence. During learning, students mentioned that they looked for connections, similarities and differences, and tried to grasp how and why diseases occur in certain organs but not in others. Visual impressions and the opportunity to touch real organs (during practical exercises during the course) seemed to be important and facilitated the development of an integrated whole. Reality was in a way brought into theory to help students understand both theory and reality more deeply.

Thus, the students seemed to develop a deep understanding of the structure and function of the human body in all its complexity. They became aware of what could go wrong and how different diseases may develop in different organs. Students mentioned that they gained the ability to apply what they had learned to real life problems that they could understand 'from symptoms to diagnosis', which is how they would use their knowledge in their professional life. This was in contrast to how they learned the knowledge, which was from diagnosis (disease) to symptoms (in agreement with theme C, understanding as catalogue). This form of understanding is exemplified in the following quotes:

'I go through the material after the lectures and build on the skeleton of ideas that I got from the lecture. Since I feel that the lecturers (with a few exceptions) in this course don't focus on the bigger picture and the context, I have to work on that myself. Some of the work during the study period is to sort according to connections. The material is there, and it is then time to draw parallels between areas, summarize by drawing figures.' S8, written account

'I think it was fantastic to see how the fat is there [...] or how hard it (the blood vessel) becomes. [...] And then to really understand mechanically how the body works... there a vessel, it gets clogged... A much better sense of how things connect and interact, I think. It is very good, but it [the autopsy] is also very gruesome.' Group interview

Developing Understanding

In our findings there was also a time dimension. Starting a new course was described by the students as being thrown into chaos, and they felt that there were a lot of new concepts and terminology and they did not know what was most important to learn. They had trouble discerning critical features of the course content and as a result they could not see the overall picture and lacked a sense of orientation. To cope with this 'information chaos', the students seemed first to approach their learning with the intention of either learning the concepts and terminology (the 'language', theme A) or getting an overview of the course content (the

‘map’, theme B). By focusing primarily on either learning the concepts or getting an overview, they could learn the other. The need to be able to navigate through the course material and learn the basic concepts early in the course is salient in our data, and seemed to be the intention of all students in our study.

However, during the course, with more and more information to be learned, some students appeared to focus on learning as many details as possible about each disease, and ended up structuring their knowledge as a ‘catalogue’ (theme C). Other students made connections and wanted to know about similarities and differences between diseases, and had the intention of understanding on a deeper level. However, some students seemed to have the intention of integrating knowledge into a whole, but focused on learning the catalogue as a step towards gaining a deeper understanding. We also found that some students achieved a deep understanding (theme D) of some parts of the course content, but due to the sheer amount of information, they ended up knowing the ‘catalogue’ of other parts. This is illustrated by the following quote:

‘My goal is always to have control over the subject and be sure to pass the exam by a comfortable margin the day I take it. On this course, you have to prioritize some parts [...] But I don’t manage to prioritize well and feel that my knowledge is mostly fragmented.’

S6, written account

Developing Understanding - a Gradual Change or Sudden Insight

Students also expressed a development of understanding that grew slowly over time as they learned more. Sometimes they were not aware of what they had understood until they looked back and reflected on what they did not know at the beginning of the course.

‘Yesterday I read through the hand-out from the lecture on tumors. It was one of the first [lectures] we had, and some of my notes were so [...] basic. It was like, did I write this? It’s because you hear it over and over again, and after a while you have reached above the level you were at the beginning of the course. You don’t notice this development unless you go back and look at your own notes.’ Group interview

Understanding can also come as a sudden insight, an ‘aha’ experience. The students in our study appeared to have experienced ‘aha’ moments, often concerning knowledge from previous courses that suddenly fell into place. In order to have an ‘aha’ experience, according to the students in our study, one must be aware of what one does not yet understand, and one must have struggled to understand it. Then, one is susceptible to appreciating the explanation, or the missing piece of the puzzle, when it appears in lectures, books or discussions with peers.

‘I got real ‘aha’ experiences when we had the case seminar with organs from the gastrointestinal tract and above all looked at inflammatory diseases. It was the first time in my life that I got to see diseases macroscopically (with my own eyes). It was tremendously stimulating. [...] For me, the ‘aha’ experiences have almost always occurred during practical exercises [seminars] and autopsies.’ S7, written account

Discussion

The aim of the present study was to capture variations in the student 'journey' towards understanding during a course on an undergraduate medical program. The task medical students face, to learn a substantial amount of detail and integrate this into a coherent whole in a limited time frame, is demanding. Our findings suggest that students seek different kinds of understandings as they get to grips with their studies - understandings that point up potential ways students might take towards gaining a deeper understanding. The present study however, also shows clear parallels with previous research on student learning. Understanding as 'knowing the catalogue' resembles a surface approach and a reproduction-directed learning pattern with a focus on remembering as many details as possible, whereas understanding as 'experiencing an integrated whole', in which students focus on making connections, resembles a deep approach and meaning-directed learning pattern (Marton, Hounsell, and Entwistle 2005; Marton and Säljö 1976a, 1976b; Lonka and Lindblom-Ylänne 1996; Vermunt and Vermetteren 2004; Vermunt 2005). The research approach adopted in the present study in which we followed students during a nine-week course collecting data continually, made it possible to see how students gradually developed their understandings and to see the extent to which they achieved a deep understanding of the topics studied.

The 'Journey' towards Understanding

Previous research has shown that the different approaches to learning that students adopt in relation to their studies, are fundamentally dependent on their intentions, i.e. whether they wish to memorise or reproduce learning material in the upcoming exam, or seek meaning and develop a personal understanding of the learning material (Entwistle and Peterson 2004; Entwistle 2009). The findings presented here in relation to medical students' learning of pathology suggest an even more complex picture in which the intention to understand may actually involve different kinds of understandings on the way to develop a deep form of understanding. We found that early in the course it seemed necessary for students to understand the subject-specific *language* (A) and to get a sense of a road *map* (B) of the course content. Without this understanding, students experienced difficulties in keeping up with their course work and profiting from the teaching. These two forms of understandings - primarily focused on coming to grips with the terminological and structural aspects of the subject area, seemed to be essential for further learning and understanding of the new material and appeared to work as gateways to the course content, regardless of their overall learning pattern. As the weeks went by and students continued their studies, their intentions seemed to focus on how to manage the vast amount of information. The experiences of understanding that students expressed at this point involved understanding as *knowing the catalogue* (C) and understanding as an *integrated whole* (D). These two forms of understanding both entail a greater depth and breadth of knowledge compared to the previous forms, but they appear to differ considerably regarding how the knowledge structure is developed and how the details are related to the whole. In the form where understanding is catalogue-like, the structure is adopted from lectures and textbooks, and students seem to focus on the details, and comprehend the mechanisms of individual diseases in each organ. The whole that is developed, comprises this catalogue and the details are related to this structure. In contrast, understanding experienced as an integrated whole involves interconnections beyond this organ-focused structure, and students seemed to make an effort to relate their knowledge to similar diseases in different organs, and to their visual and tactile sensations. This structure

appears to reflect a personal understanding and the parts are related to a more integrated whole, rich in interconnections. A similar difference regarding the structure developed in different forms of understanding have been found in relation to revising for exams (Entwistle and Entwistle 1992; Entwistle and Entwistle 1991). According to the students in the present study, understanding in the form of a catalogue was believed to be sufficient to pass the assessment requirements. Nonetheless, the students seemed to want to reach a deeper, more integrated understanding, although they sometimes gave up due to lack of time.

There was a qualitative shift from ‘understanding as knowing the catalogue’ to ‘understanding as an integrated whole’, and this shift involved a transformation where students ‘saw’ how theory and reality fitted together, making it possible for students to use their theoretical knowledge in real life cases, and bring reality into the subject to make it relevant. When students had reached this form of understanding they seemed to start being able to reason both from diseases to symptoms, and the other way around. This shift bears a resemblance to the changes that occur in relation to threshold concepts, which are transformative, integrative and probably irreversible and unlikely to be forgotten (Meyer and Land 2005). The understanding *“is not just integrated, it becomes actively integrative, as it pulls in additional related ideas to create an enlarged understanding.”* (Entwistle 2009).

Understanding in Medicine

The medical students in our study struggled to understand and make meaning in different ways. Wilhelmsson (2010) found that students created meaning when studying anatomy in different ways, i.e. relating the anatomical structures to their function, or to the importance of knowing the anatomy of the human body for their future profession. In our study, the visual and tactile experiences during practical course activities seemed to be important for students to make meaning of the theoretical knowledge. Our findings also reveal two qualitatively different notions of learning pathology: one involving learning about different organs and their related diseases in a catalogue-like manner, and one where learning is about understanding the human body as a complex system, understanding how and why diseases occur, and how disease is manifested in different organs. The latter notion involves an understanding as an integrated whole and a realisation that diseases in one organ affect the body as a whole.

Our findings are in agreement with previous research suggesting that learning is highly contextual and students do not only learn and understand subject-specific concepts and processes. They also learn appropriate ways of thinking and practising in the discipline (Anderson and Hounsell 2007; Scheja and Bonnevier 2010). It is common in medicine, natural sciences and engineering that learning involves the acquisition of a substantial quantity of facts and details. Newton and colleagues (1998) found that conceptions of understanding differed between history and science graduates, indicating disciplinary differences in what understanding involves. The forms of understanding presented in this study may typically be found in medical education and similar disciplines in which students need to develop strategies to cope with information overload in order to be successful.

Influence of the Learning Environment

Perhaps it is not surprising that students developed the notion that pathology involves knowing many details about diseases in different organs. Medical students are more likely to be externally regulated and focus on reproduction of knowledge than, for instance, psychology students (Lonka and Lindblom-Ylänne 1996). It may also be a reflection of how teachers and course leaders presented the subject pathology. The teaching and the literature mainly represented the subject as a catalogue, organ by organ, presented by different experts, and when students use the structure given they end up with an understanding of pathology as knowing the catalogue. There were, however, students who expressed dissatisfaction with this approach to learning. They seemed to aim for a deep understanding but due to the vast amount of information they had to learn they gave up this ambition. Other researchers have reported a similar dissonance between students' intentions and their actual approach to learning (Meyer 2000; Lindblom-Ylänne and Lonka 2000). However, some students achieved a deep understanding, despite how the subject was represented in the course. These students struggled to develop their own structure, and actively made interconnections. Practical exercises, i.e. case seminars with organs and autopsies, seemed to help students develop connections and place the theoretical knowledge in a relevant context. The opportunity to examine organs, visually and tactile, may be important for learning, which has also been found by other researchers (Preece et al. 2013, Saltarelli et al 2014, Turunen Olsson et al, in press).

The curriculum, which constituted the context of the present study, was a traditional curriculum. Students in a problem-based curriculum, designed to help them integrate knowledge and relate to real-life context, might to a lesser extent develop understanding in the form of 'knowing the catalogue'. However, studies of medical students' learning in PBL contexts show that students have different conceptions of learning and understanding (Fyrenius et al. 2007a; Bergman et al. 2013) suggesting that the interplay between the design of the learning environment and students' learning is complex.

Students testified to experiences of understanding as something happening gradually over time, but sometimes as a sudden 'aha' experience. Early in the course, the 'aha' experiences often concerned understanding of content from previous courses that suddenly fell into place. This could happen during a lecture that provided a clear and easily accessible explanation, or during the practical parts of the course, or in discussions with peers. The understanding that suddenly fell into place was delayed in relation to the curriculum, since it was part of the content of a previous course. Looking at students' 'journey' during the whole curriculum, understanding is something that seems to develop gradually, and topics reappear which facilitate 'aha' experiences now and then. Apparently, medical students are comfortable with this delay in understanding and show trust in the system, believing that eventually things will fall into place (Scheja and Bonnevier 2010). This is in contrast to engineering students, who were frustrated and experienced this delayed understanding as an obstacle to learning (Scheja 2006).

Limitations of the Study

This is a small scale study in a particular context and the findings should be viewed as contextual. Moreover, the findings represent the students' perspective, their view of their

learning and learning environment. The research reported here did not attempt to capture students' level of knowledge or score on the final exam. Nevertheless, this study provides valuable insights into the struggle students experience when finding ways to learn and develop understanding during a demanding course at university level. We believe that these findings are relevant not only to medical curricula, but also for similar disciplines putting similar demands on students.

Conclusions

Students do struggle to understand. The present study shed light on potential ways to conceptual understanding that students may take during their studies on an undergraduate medical course. The intention to understand may vary during a course and the way the subject is represented in the teaching may have a major influence. Understanding is a complex phenomenon, and more research is needed in order to explore its process and discover how, through teaching, students can bring it to a deeper, more integrated level. Based on our findings, we conclude that students' development of understanding is highly contextual and in order to understand students' learning we need to understand the learning environment. Implications for the teaching practice may be that when courses and modules are designed, care should be given to how the subject is presented to students and what kinds of understandings students should develop. It seems important to include activities that explicitly help students make connections and relate theoretical knowledge to real-life contexts. We suggest that the curriculum should not only convey what *knowledge* students should acquire, but also which *forms of understandings* students should develop.

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