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ORIGINAL PAPER

Vocational Teachers' Craft Knowledge and Working-life Experiences in Building and Construction: a Narrative Study of Embodied and Tacit Learning

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Abstract

Vocational teachers in building and construction in upper secondary school deal with complex situations of an organisational, vocational, and social kind. Recent research has shown that the teacher is the single most important factor for students' learning in school. Teacher-student relationships and the teacher's repertoire of teaching practices can be more important for the student's learning than class size, the classroom environment, and the student's socio-economic background. Beyond passing the journeyman's test, we know little about the craft knowledge and working life experiences vocational teachers in the building and construction trades have acquired over many years in the construction industry, and thus, what knowledge and experiences they bring into the vocational teacher role. Learning in working life often takes place as an integrated part of work, and it is difficult to observe how learning happens. Craft knowledge is often tacit and personal. In this narrative, phenomenologically inspired study, learning is investigated as a bodily, internal process that simultaneously depends on the interaction with the material and social environment. Through narrative interviews with eleven vocational teachers in plumbing and carpentry, this study explores the teachers' backgrounds as vocational students and apprentices, and their extensive experience as craftsmen on different construction sites. The analysis shows that the building site drives craft-related actions and situations that generate a strong craft identity, professional working life experiences, and personal growth. Craftsmen at the construction site work under constant pressure in a social, physically, and mentally demanding work environment and consecutively solve problems. As professional craftsmen in the complex working environment, the teachers also acquired social and organisational expertise, which they intuitively transferred to their role as vocational teachers.

Keywords Personal craft knowledge · Embodied tacit knowledge · Vocational teachers · Building and construction · Vocational identity · Narrative

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Introduction

This study focuses on the professional background of vocational teachers in the building and construction programme in upper secondary schools in Norway. The purpose is to examine vocational teachers' craft knowledge and vocational identity, and thus to elucidate learning processes of significant importance. Vocational teachers are key actors in vocational education and training, and vital to the quality of the vocational education system and the success of its learners (see e.g., Andersson & Köpsèn, 2018; OECD, 2021; Schmid & Haukedal, 2022). In general, vocational teachers are qualified in vocational work and recruited from crafts, often after gaining considerable working-life experience (Misra, 2011; Sarastuen, 2019). Vocational teachers are diverse, but like other teachers, they are expected to be knowledgeable about the subject they teach. For vocational teachers, this means having craft knowledge as well as a vocational identity related to their specific vocational subject (Andersson & Köpsèn, 2018). The teacher must also be a good communicator and relationship-builder (Aspøy et al., 2017). Vocational teachers are rarely targeted in evaluations and studies of educational reforms (Alvunger, 2016). However, the craft knowledge and vocational identity that experienced craftsmen bring with them into the teacher role are acquired during years of working life, which makes them particularly interesting to study. In this study, I seek to explore vocational teachers' own learning histories, and the empirical material is based on narrative interviews with eleven vocational teachers in carpentry and plumbing.

People who use tools in authentic activities actively build an increasingly rich, implicit understanding of both the tools themselves and of the world in which they use those tools. Learning and acting are, as a result, interestingly indistinct, as learning is a continuous, lifelong process resulting from acting in situations (Brown et al., 1989, p. 4). In this study, learning processes and experiences are considered personal, embodied, and partly tacit, and the narratives are analysed in the language of phenomenological perspectives (Dreyfus & Dreyfus, 1980; Merleau-Ponty, 2005, 2012; Polanyi, 1958). The research question is as follows: How do vocational teachers in carpentry and plumbing reflect on the meaning of their embodied and tacit learning processes in relation to craft knowledge as vocational students at vocational school, apprentices in training enterprises, and craftsmen at the building site?

Narratives can catch and express complex learning, such as tacit and embodied knowledge, in situated and volatile processes. A narrative is the personal and sequential story of complex phenomena, such as personal embodied and tacit knowledge, developed in practice in situated craft work and in vocational cultures involving arenas, processes, and eras (Squire, 2008). Narrative analysis brings together different stories and collects many events into a new and condensed, chronologically connected story, thus providing rich access to the temporal dimension of human existence (Kvale & Brinkmann, 2015). This seems to be important to this study, since the vocational teachers' learning stories are based on sequential retrospective telling. The interviews in this study focused on

vocational teachers' initial backgrounds in building and construction, and their histories started with their vocational education, leading on to the apprenticeship period, followed by several years as craftsmen in the construction sector.

After the introduction, I briefly present the organisation of the Norwegian building and construction craft, vocational education and training (VET) system, and working life. Next, I introduce what carpenters and plumbers do, followed by a presentation of the theoretical framework of the study and the research method. I then present the analysis and discussions in three chronological sequences. The first sequence contains the narrative analysis regarding the start at vocational upper secondary schools, the second refers to apprenticeship, and the third narrates the period of craftmanship. A summary of the discussion and conclusion are then presented.

The Building Site and What Carpenters and Plumbers do

Building and construction is a general term for all activities that are directly related to the construction, conversion, repair, maintenance, and demolition of buildings, as well as the construction and repair of facilities. Building projects depend upon several steps of construction and work tasks. Each step involves different crafts and occupational groups. To coordinate collaboration and logistics, all involved companies estimate the use of time and negotiate start dates and due dates into an obligational timeline. Any deviation triggers a domino effect that may put the entire project at risk. The actor who causes delays is financially responsible for the ripple effects; thus, even a small delay can lead to fatal economic consequences. The timeline is an abstract but ever-present part of the construction process and constitutes constant pressure on all actors at the building site.

Carpentry and plumbing are old crafts with strong vocational profiles. Measured by the number of ongoing apprenticeship contracts, carpentry is one of the largest trades in Norway, while plumbing is the second largest in the building and construction programme (Norwegian Directorate for Education and Training (NDET), 2023). Norwegian carpentry is visible in most of the Norwegian building heritage, of which the stave churches and Viking ships are good examples. The national carpentry curriculum includes building and rebuilding structures in wood, steel, and light metal. The plumbing trade was introduced in Norway by German plumbers and engineers in the middle of the nineteenth century. Climate, energy, and the environment require a sustainable infrastructure, and today, the plumbing industry plays a central role in modern society. The national curriculum in plumbing includes external and internal sanitary facilities, heating, and cooling technology, as well as sprinkler systems.

The Norwegian VET model can be classified as a dual model based on two initial years of upper secondary school including a share of common core subjects like Norwegian, Science, and Math, plus a share of workplace-based learning. Vocational schools are followed by two years of apprenticeships in a training enterprise (NDET, 2020). Authorised training enterprises and craftsmen with a journeyman's certificate play important roles in the provision of training (Lensjø, 2021; Nyen and Tønder, 2015). The Norwegian construction industry has been characterised as

'craft centred' and is associated with a considerable degree of worker autonomy and influence in decision making (Friberg & Haakestad, 2020). Permanent employment and collective wage bargaining systems between social partners form the core of the Norwegian working-life model. Statistics Norway (2019a, b) reported that 88 per cent of the national workforce is satisfied with their jobs, due to job security, psychosocial work environment, and physical work environment.

Theoretical Perspectives on Learning in Crafts and Craftsmanship

Several studies on learning in the workplace have investigated how knowledge is embedded in practice, routines and artefacts; it is procedural, technical, contextual, and situated (e.g. Billett, 2014; Lave & Wenger, 1991; Schön, 2009). Billett (2011) investigated how learning in workplaces takes place through everyday activities, interactions, and participation, and found that learning outcomes often are personal, based on activities and interactions in which individuals engage.

In this study, the view of knowledge is turned towards the human body. Inspired by phenomenological perspectives on learning, I examine how learning and work can be understood as individual, embodied, and tacit processes. This study takes the active and competent human body as its starting point, and learning is understood as both an internal bodily process and a parallel external process in which the person interacts with the material and social environment (Illeris, 2006, 2012).

The human body and the human capacity to do, perceive, act, and reflect are central to all craft trades. Our senses, feelings, memories, and ability to think logically; our fingers, hands, and bodily movements are actively involved in the more or less blurred learning process it takes to become a craftsman. Interacting with the material world means understanding things and their properties, their options, and their limitations. Merleau-Ponty (2012) argued that to perceive things, we need to live them. It is through the use and processing of the things that they reveal their inherent properties, potential, and limitations. With the help of our body—the always-given reference point—we always have the means of recognising objects (Merleau-Ponty, 2012, p. 352).

Through visual training within the practice (Grasseni, 2007), the craftsman gradually becomes capable of developing a professional gaze that recognises and critically assesses whether and how, for example, the plank or pipe part can be used/exploited in various situations. The professional gaze recognises more than meets the eye and is of great importance when the craftsman is involved in the ongoing process. The exact constituents of occupational aesthetics, in a craft context, have proven to be more difficult to elucidate (Gåfvels, 2016). The eye studies in detail what the craftsman does, and like the taste, smell, and hearing, the professional gaze can recognise elements that are important in the repertoire of knowledge that can arise in some contexts and situations (Merleau-Ponty, 2005, p. 380).

To say that we "grasp something" implies that we physically reach for it (Sennett, 2009). The fingers, palms, and hands grasp, touch, and recognise the plank, and assess its qualities:

> The calluses developed by people who use their hands professionally constitute a particular case of localized touch. In principle the thickened layer of skin should deaden touch; in practice, the reverse occurs. (Sennett, 2009, p. 153)

The whole body, with its intersensory capacities, is involved in the process, and while the professional hand holds and touches the surface of the plank, the professional gaze measures and critically assesses how exactly this plank will suit a specific task. This experience-based knowledge is embodied and partly tacit, and is what, in this paper, I choose to call craft knowledge. Dreyfus and Dreyfus (1980, p.12) argued that the level of expertise indicates that "the repertoire of experienced situations is so vast that normally each specific situation immediately dictates an intuitively appropriate action". Our bodies have the means of recognising objects and their properties, like their shape, colour, size, weight, and hardness. In addition, the body can perceive and assess the space and depth of a room, and is thus able to translate things into a three-dimensional perspective (Merleau-Ponty, 2012). An example of this is when the plumber studies the two-dimensional flow chart of the heating system and is internally able to visualise the pipe installations in a three-dimensional perspective. By observing the same phenomenon under different conditions, the eye is able to recognise and separate the richness and sharpness between different objects and their structures. According to Schön (2009), professional practice holds elements of situations and repetition, and a professional practitioner is a specialist, who again and again, is exposed to certain types of situations. Based on different contexts and situations, the practitioner develops a repertoire of pictures, techniques, actions, and expectations,—he knows what to look for and what to do about it (Schön, 2009). To acquire the meaning of a text, a message, a movement, or an object, is how we recognise, acknowledge, and immediately understand all of the empirical laws of the phenomenon, like the organisation of the field (Merleau-Ponty, 2012). To know, without being able to articulate the knowledge, is within the natural capacity of the human body. We say that such knowledge is tacit (Polanyi, 1958).

In a professional environment, such as a building site, craftsmen constantly interact and cooperate with other practitioners. Solving problems during work often means they try out and assess the outcomes. To get further they draw sketches, and tell stories that contain substantial, tacit, and recognisable content,—they analyse, discuss, try out and develop new and mutual knowledge (Lensjø, 2020). Lødding (2010) referred to the importance of experienced craftsmen as role models for young apprentices. Her study shows that the older craftsmen are precise, make use of the materials, and get the job done faster than the younger craftsmen, although apparently, the young ones maintain a higher pace. The older craftsmen have routines and can quickly correct small mistakes, instead of tearing down and starting again (Lødding, 2010). Lensjø (2020) claimed that craftsmen's personal knowledge and experiences about significant things and the rationale of the task can be essential to problem solving. The building process always looks different from the plan and the process on paper. To solve problems consecutively and in line with the time schedule, craftsmen share and exchange professional experiences in specific situations. As active participants in the same craft, they have a common, tacit understanding, and the communication between craftsmen can be partly tacit, and conveyed through

gestures in work, through sketches or stories that implicitly communicate important knowledge (Gamble, 2001; Lensjø, 2020).

Data and Method

In the spring of 2021, I contacted the school management and all vocational teachers in the building and construction programme at one large upper secondary school in Norway. At that time, the study was already evaluated and approved by the Norwegian Data Protection Authority. Along with information about the study, the teachers were asked to contribute as informants. Eleven vocational teachers responded positively. One week ahead of the interviews, the informants received a semi-structured interview guide with open questions related to the research questions: In retrospect, how do they reflect on the embodied and tacit learning processes in their vocational education and training as a student at a vocational school, as an apprentice in a training enterprise, and as a carpenter or a plumber at the building site. Before changing careers to teaching, the informants had worked between 15 and 30 years as craftsmen in plumbing and carpentry. The informants in this study did their vocational education and training during previous educational structures, however still within an education system like the current dual model. As experienced craftsmen, they had also worked as project managers, or self-employed entrepreneurs, responsible for both building projects and employees. The interviews started with open questions: 'Can you tell me about your time as a student at the vocational school, and the most important things you remember from that period?' Thereafter, the interview questions followed the same approach towards the informants' apprenticeship period and, lastly, towards their period as craftsmen.

Capturing embodied, tacit aspects through oral data collection, may imply contradictory challenges. Two factors contributed positively to the interview situation. First, the informants received the interview questions a week ahead of the interviews and were thus, able to reflect on their past and the upcoming interview situation. According to Schön (2009), reflections on and in practice may include tacit norms, a story, or a judgement, or on the strategies and theories implicit in a pattern of behaviour. The vocational teachers confirmed that the questions had prompted reflections, and they felt prepared and excited.

Secondly, during the interviews, I was aware of my position as a former craftsman, vocational teacher, and ethnographic researcher in the field of building and construction and could sense a hint of a nexus between the retrospective narratives in this study and my former anthropological fieldwork, where the outreach fieldworker is interested in studying what is not obvious. The fieldwork involves "listening for the unsaid, looking for the visually unmarked, sensing the unrepresented" (Brinkmann and Tanggaard, 2010). Sometimes, during the interviews, I intuitively understood that the narratives could hold more meaning and knowledge than was told. I encouraged the participants to deepen and reflect further on situations and contexts that could enlighten tacit, embodied dimensions. To assist in elaboration, I added questions about the meaning of the learning environment in the community of practice, their relations to tools, materials, and

tasks, and the meaning of active, bodily participation, and embodied learning. I also asked them to depict their most important feelings and reactions, thoughts, ideas, and experiences from the three periods until they had nothing more to add. This approach generated rich and specific data on actions and embodied knowledge. The interviews were conducted face-to-face in a separate room at the vocational teachers' school. Each interview lasted approximately two hours. The interviews were audiotaped and transcribed verbatim, and then personal information was anonymised. The interviews were conducted in Norwegian. Quotations used in the results chapters were translated into English by the author. The quotations were linguistically normalised and assigned pseudonyms for identification purposes. Quotes presented in the analysis refer to pseudonyms.

In the first step, all interviews were read repeatedly. The next step was to gather data from the same period into three groups and then reread the text material for each period. Then, I condensed, coded, categorised, and thematised each of the texts groups (Alvesson & Sköldberg, 2011; Charmaz, 2014; Corbin & Strauss, 1990; Glaser & Strauss, 1967).

A narrative approach is subjective and seems well suited to questioning and analysing the teachers' retrospective perceptions of personal lived life, with the lens turned towards themselves as persons, in a given context and period. Stories of lived life will always be reflected by the narrator's subjectivity and perspectives; however, they are personal—not made up or untrue (Alvesson & Sköldberg, 2011; Johannessen et al., 2016). Retrospective stories of life are necessarily veiled by the optics of time, but also coloured by the informants' present role as vocational teachers. As pointed out, narrative studies are based on individuals' thoughts and feelings, actions, and personal life histories, and were attainable because of the informant's former presence in a specific field. However, reality can be perceived and described in many ways, thus, the narratives are unique and would be different if the informants were eleven other vocational teachers. The narratives would not be the same if the informants were still working as craftsmen, or engineers, project managers, in a trade or employer organisation, or as a manager in technological support or marketing, instead of vocational teachers.

Bruner (1990) characterised narratives as a series of events and states of mind and claimed that such a precise order is essential to understanding history and its conditions. In contrast, Laceulle (2018) captured our identity as a socio-culturally constituted phenomenon rather than an essential inner 'core self'. The complex lives we live and thus who we are, are integrated into the combinations of biological, psychological, social, and cultural factors in our human lives. According to Polkinghorne (1988), the narrative form of 'meaning-making' is individual sentences contained in a particular type of discourse, and together, they draw a higher order of meaning that discloses relationships among the states of affairs. In recent hermeneutics, time is central to the understanding of being—not just any time but meaningful time (Ruin, 1996). Clearly, the teachers' learning histories are authentic, but they are also a result of subjective and hermeneutic interpretations (Alvesson & Sköldberg, 2011).

Results and Analysis

In the following, I present the analysis organised into three chronological periods in the vocational teachers' life and learning stories. The first period is as a vocational student at a VET school, the next is as an apprentice in a training enterprise, and the last is as a craftsman at the building site. To maintain consistency between the analysis and the main question, the discussion is presented consecutively. To contextualise the research with existing knowledge, relevant literature was consulted and included in the discussion.

Getting Started

The carpentry and plumbing professions are crafts with a strong professional profile, and the analysis shows that the informants, in their early adolescence, felt a deep attraction to these crafts. Imagining themselves doing specific work tasks corresponding to their interests. More importantly, the picture of themselves being carpenters or plumbers became an impetus that nurtured a deep identity-formation process connected to their future career choice. To some, the vocational choice felt like a calling. After years of mainly abstract and sedentary schooling, entering vocational school felt like discovering a new world with the opportunity to move, use their whole body, become involved with materials, tools, and drawings, and make concrete and useful things:

> *Entering VET school felt like a revelation! I discovered that woodwork was my thing. I felt that my life had restarted from thereon. I had a wonderful time.* (James)

To the young vocational students, the VET school appeared to be an arena consisting of professional tools and materials where the novices could involve their senses, feelings, and thoughts. To touch and use materials, try out, and learn to use their fingers to handle tools and materials released feelings of 'coming home' to finally be able to do what they longed for.

This study shows that finding a vocational direction that reflects personal interests and identity can release a feeling of coming home, in the sense of finally becoming the person one wants to be. The analysis emphasises how occupational choice can reflect and reinforce vocational students' interests and identity in an ongoing process that unfolds during the years from childhood to adolescence and finally crystalises personal factors that will bear on a career choice.

Sawing planks or cutting pipe threads made it possible to study at a close range how the materials reacted to different tools and, conversely, how the tool reacted to different materials. The informants explain how their senses, muscles, hands, and fingers gradually realised that visually identical materials could contain diverse qualities and properties. During the use of tools and materials, such as pipe parts or wooden planks, and simultaneously studying the processes, the participants discovered that their bodies responded to the different characteristics, such as their sound,

resilience, or weight. How pipe threads fitted together, and how heartwood and knots in the wood changed the property of the plank. Through involvement, their bodies learned how to adjust to the tools and materials—changing the angle of the upper body to put more or less pressure on the saw or changing the angle of the saw or the grip of the pipe wrench to overcome the material resistance. By working on small, context-free features in the school workshop, they gradually learned that *things* contained hidden properties. To discover their properties, they had to use and study things in different situations and contexts. In and between their hands, they learned that materials possessed their own rules and conditions.

At vocational school, the informants started their vocational education by doing small, non-situational tasks, like measuring, sawing, and doing simple joining techniques in wood or metal. The purpose of this first stage was to train manual dexterities, learn to be accurate, and become familiar with tools and materials. The analysis reveals that even non-situational, and context-free practical tasks in the school workshop involve the human body and its composite ability to study, touch and hold, feel, and reflect in action. The analysis emphasises the importance of vocational school training in providing ample opportunities for novices to involve themselves physically through vocationally relevant practical tasks where they can use tools and materials. Through involvement in school workshops, they were, as individuals, consecutively able to do, perceive, recall, compare, and learn more about this new world. In the beginning, the tool felt clumsy in their hand. Gradually, the hand learned how to hold and use the tool and through months of practice, the tool started to feel like an existential part of the novice's body language and actions. Through the use of tools, they learned that the gaze did not follow their hands or the tool. Rather, the gaze followed the material and the process. To the novices, their vocational teachers appeared as both teachers and craftsmen—the craft constituting a part of the vocational teachers' identity. To be a craftsman expresses something significant about the teacher as a person—the certainty of possessing special action-based knowledge, something to be proud of. A positive impression was left on the vocational students when the teachers talked about the craft and profession with respect:

> *We understood that it was crucial to learn accuracy and thoroughness, and also to know what, how, and why we had to do things in a special way.* (Carl)

Through their teachers' behaviours and attitudes, the novices realised that quality in crafts had a high status among craftsmen and professionals in the world of work. The novices soon discovered that what looked easy between the experienced hands of the teachers was difficult between their own inexperienced hands. Making a small piece of work perfectly accurate could require days and sometimes weeks of practice. Discovering one's lack of abilities increased respect for the teacher's craft knowledge. The teachers' strong craft identities made them authentic and credible role models for the vocational students.

> *To become an expert craftsman, it is not enough to do a bit of screwing and carpentry on your own; there is so much more behind it. Our vocational teacher's professional pride shaped us positively. Because of him,*

it was important for us students to do our best. It was clear to us that he performed his craft with deep respect. Through him, we understood that it was important to be exact and concentrated. We worked hard to learn and to show him that we were serious too. (Carl)

However, the informants emphasised that personal relations between teachers and students were crucial for their well-being and learning outcomes as young students. The analysis of the informants' stories about their own teachers shows that student–teacher relationships have been of decisive importance for the informants' learning process. Whereas some teachers communicated through humour and showed interest in the students, others communicated through discipline and cynicism:

My vocational teachers were nice people. They saw each one of us, and they cared. They were funny. It was such a good atmosphere. (James)

Conversely, John remembered how his vocational teachers' unpredictable behaviour established an unsafe learning environment:

The teacher could sneak up on us, and he started to shout and yell if we had made a mistake. We weren't allowed to talk to each other about the tasks or work. We were stressed and scared. Because of him, I realised how important it is to create a safe learning environment for my own students; they must feel safe and welcome. (John)

The informants' own experiences as students have left lasting traces, and the personality of their own teachers has largely influenced the formation of the informants' own teaching role.

The vocational teacher's craft identity and occupational pride can be substantial factors in the communication between the teacher and the students. However, the teacher's personality and ability to establish a safe learning environment—or the opposite, contributing to insecurity through dominant control and cynicism—have a strong influence on students' self-confidence and professional development. The analysis in this study shows that a teacher's behaviour can leave a strong mark on young people—a mark that can last throughout life. In the student–teacher relationship, the teacher has a superior position as an adult, and with an associated mandate with the power of sanctioning and assessment. Although the Norwegian Education Act states that 'The school must have zero tolerance for violations such as bullying, violence, discrimination, and harassment' (section 9A3), this study shows that it can be difficult for students to report negative behaviour and harassment caused by the teacher. In addition, teaching often takes place behind closed doors, with the students as the only witnesses. The teacher's position of power means that any report of negative teacher behaviour risks being rejected by the school management, which can lead to a further worsening of the teacher's negative behaviour towards the students.

Apprenticeship – Entering a New World

Two issues dominate the narrative of apprenticeship. One is the pace at the building site. The other is interdependence in the community of practice regarding social loyalty and professional quality. The informants' consensus depiction of the transition from the VET school to the building site was the feeling of 'entering a different world'.

The analysis shows that the newcomers were immediately involved in real work tasks, and as participants in the community of practice, they immediately faced the pace and pressure of the timeline. As young and untrained students, they had to mobilise strength and work discipline to endure long working days in all kinds of weather. The informants referred to the transition from school to the workplace as transformative:

> *We started at 7:00 am, and I got the hammer in my hand. Stood in the scorching sun. It was terribly hot that day. The first break was at 11:00 am. Half an hour's lunch. Then, we worked for another four hours without a break. The sun was roasting. When I came home, I had supper and took a nap. But I didn't wake up until the next morning. So, I won't forget that. It was a completely different world.* (Michael)

Close to the craftsmen, the advanced newcomers were able to observe the carpenters and plumbers and ask questions regarding the materials, tools, and work tasks. They soon learned that there was no such thing as a lower standard of work. The craftsmen expected the apprentices' work to maintain high quality. Poorly executed work could cause problems for posterity. Any tardiness and truancy increased the pressure on the community and was interpreted as collegial disrespect, and was thus not tolerated. As insiders, the apprentices were able to observe, learn routines, and learn to fit in as part of the workplace. As active participants in the work, the apprentices learned to select, use, and adjust materials for different contexts and situations. Through participation in work, the apprentices developed thoroughness, physical strength, and resilience. As participants in the community, it was motivating to be included in real work tasks and to listen to how the craftsmen reflected on their actions and construction.

> *Even if you are young, you are a human being. It is important to feel that you're part of the community. It makes a difference to be included in the team and to know what is going on in the project.* (William)

Through analysis of the narratives, it became clear that the older craftsmen at the building site were proud of their expertise and craft. Their call for quality made it clear to the apprentices that all jobs had to be solidly and aesthetically done. The pervasive professional pride grew upon the advanced beginners. This finding emphasises how older colleagues are important role models to the apprentices. However, learning to use tools was far more than imitation. Carl described how the use of tools depends on the individual body's physique and experience:

First, you'll learn how to use the tool by looking at others or someone telling you. But the strength and length of your fingers, hands, and arms affect how the tool is in your hand. All people walk and move a bit differently. So is work - how you hold the hammer and hit the nail. The tool becomes a part of your hand, in a way. (Carl)

The hand and its fingers' ability to touch, grip, hold, and let go, to lift and turn, are examples of the body's comprehensive complexity. Most craftsmen pick their favourite tools, the one that fits their hands, and with a weight and design that makes work easier. A heavy hammer hits harder than a light hammer, and a long pipe wrench has more torque than a short one. The length and strength of the arms, combined with the properties of the material, determine which tools the craftsman prefers to use.

When nailing a wood beam, there's a limit to how far out on the edge you can put the nail without cracking the beam. Knowing where that line goes in different thicknesses and different types of woods is experience-based tacit knowledge. (Daniel)

Several details influence how the carpenter holds and swings the hammer. The hammer stroke depends on the size of the nail head, and the hardness, length, and thickness of the nail. The resistance of the individual wood material has an impact on the grip of the hand and the force and angle with which the hammer should hit the nail. When the experienced carpenter's hammer hits the nail without bending the nail or leaving marks on the panel, it is precision-shaped after millions of hammer blows. Individually, the vocational teachers depicted how they automatically changed their grip and the strength of the hammer blow to hit each nail with just the right angle and power: *'You can't explain it; you just do it.'*

The body's internal collaboration and ability to coordinate senses, hands, memory, and logical thinking release a stream of information about significant things, contexts, and situations. In addition to techniques and manual dexterities, the apprentices learned to read technical drawings and calculate, saw, and join materials at angles and simple constructions. Working side by side with the older craftsmen, the apprentices learned to recognise longer sequences of the building process. Then, they tried to plan the next step in the ongoing work process, while realising their plans were not without risk. Any independent action had to be thoroughly thought out to ensure that the task was performed correctly in the current context and situation. Breaking out of their regular role involved an emotional challenge. To fail in front of their senior colleagues would release a feeling of loss of recognition. Succeeding, by contrast, could release feelings of mastery and self-confidence and could be a breakthrough in one's own learning process (Lensjø, 2020).

The Autonomous Craftsman

The analysis reveals that craftsmen consecutively acquired large amounts of diverse information by using pipes and parts while simultaneously studying the reactions of the material during the action. Evaluating the quality of a surface by touching

with the fingers and recognising the sound in a wood beam or the temperature of a pipe are examples of sensory knowledge that can be trained and are central to the craftsman's work. The ability to estimate length and depth in a room or a specific space suggests that our senses can be trained to recognise certain (familiar) sizes and volumes. Sensing that something is wrong might indicate that your body somehow remembers something from a former situation, like an intuition.

> *It's easy to say that it's just the head that remembers, but the body remembers too. It recognises and assesses temperatures, weight, movements, and situations. I do a lot of things automatically, things that I tell myself that I can't do or don't remember. But then, in the situation, I just do it.* (Michael)

People who use tools in authentic activity actively build an increasingly rich implicit understanding of the tools, and of the world in which they use those tools. Practitioners' understanding, initially narrow, is continually broadened through use. The use of tools and materials requires professional expertise and skills that can be time-consuming to learn. As tacit knowledge is acquired, it is embodied and is the most natural and easy thing to use and, from there, is taken for granted:

> *It's not like I reflect on what to do; I just do it. It's in my fingers.* (Thomas)

Thomas described how his hand gripped the wallpaper knife without him thinking about how. When his students asked why Thomas held the knife just like that, he became aware of how he stood, held the knife, and angled it towards the plasterboard. After years of practice, Thomas knew that this was the best way to do it.

> *Cutting a plank, it's easy. Yea, everyone thinks so, until they try. But it's not easy; you need to practice a lot before you manage to cut straight. Gradually, you find a way to do it. A way that works well for you.*

The body's combined senses and movements recognise and respond intuitively to faces, situations, objects, and contexts without always being able to accurately describe or justify the recognition. The analysis of the narratives emphasises how craft involves the whole body in a tacit interaction between movements, senses, emotions, and thinking. The human body's ability to remember and compare very different actions, situations, objects, and contexts in space and time forms an infinite network of insights and experiences. Building craftsmanship is about abstracting and utilising one's insight, knowledge, and experiences in present- and future-oriented action-based critical thinking. The analysis shows that the practice of craftsmanship contains values that interact with the practitioner's self. Building a heating system or a perfect building structure, from the craftsman's point of view, involves artisanal and personally chosen details that accommodate both function and aesthetics, which is a concrete testimony of craftsmanship. A concrete product is the result of a process. Craftsmen do similar tasks in slightly different ways. It could be a twist or detail that is easier to make, more solid, or aesthetically pleasing to look at. To a trained eye, each part of the product says something about the craftsman's knowledge, attitudes, handiwork, and aesthetic qualities. Handing over a product not only shows your professionalism but also who you are as a person:

Things that fall easily on the eye to me can be unappealing to other craftsmen. Aesthetic preferences and the way you choose to do things are a craftsman's signature. (John)

The product embodies the professionalism and identity of the performing craftsman. As an artist is personally connected to his or her art, the craftsman is connected to his craft. Every step of the process, whether it is a roof structure or a pipe run, holds a personal imprint of technical and aesthetic choices that the craftsman identifies with:

I've built 50 or 60 houses. Building a house completely without flaws is not easy. But I've tried as far as I can. My motivation has always been to build without any errors. It's not the money. The goal is to build something quite perfect. (John)

The building process depends on the craftsmen's craft knowledge and working-life experiences and, thus, their ability to plan, negotiate and execute. In the narratives, the informants depicted how they, as craftsmen, visualised the upcoming work in imaginary pictures, often supplied by sketches. By studying the building drawings, while their eyes measure the building in the void intended for the upcoming construction, craftsmen use their professional gaze and transfer the building drawings into real-sized processual images. The construction and process are played out as an inner movie, step by step—where to start, where conflicts and collisions can arise, how to avoid problems, and how to implement practical improvements. Based on their own experiences as craftsmen, the informants embodied a large repertoire of processes, situations, and contexts that are intuitively and consecutively implemented in the upcoming plan.

Summarising Discussion

This study explored vocational building teachers' lifelong learning processes from vocational students to apprenticeship and craftsmanship. The analysis draws attention to personal craft knowledge, learning, and identity development in vocational school and at the building site—in different roles as vocational students, apprentices, and craftsmen—and over periods of time. These aspects are important to learning and thus to vocational education and training at school, training in apprenticeship, and vocational teacher education. This study elucidates craft knowledge and brings new knowledge to the debate regarding emphasising embodied and tacit knowledge.

The analyses of early experiences as vocational students emphasise that their early career choices were well-considered and based on personal interests. At the vocational school, the young students were allowed to use tools and materials that confirmed and strengthened their future dream of becoming craftsmen. Even small and context-free tasks allowed the vocational students to become familiar with tools and materials, and to use their bodies while completing tasks that were meaningful to them. The analysis highlights that the behaviour of the informants' vocational

teachers—good or bad—left deep traces in the young students, traces that have shaped the informants' role as parents, instructors, and vocational teachers.

Starting to work as apprentices was something the informants longed for. The transition from school to working life, however, turned out to be a shocking experience for some of the young students. The physical work and the construction site's ever-present timeline required a high pace for which the apprentices were not physically prepared. The responsibility for progress affected each individual craftsman and reinforced the mutual dependence, and thus the relationships between the members of the community of practice. In the beginning, the apprentices struggled to train their own strength and endurance to complete the tasks they were assigned. Side by side with the craftsmen, their progress was rapid. In parallel with doing their own work, they could watch how the craftsmen worked, talked together, and solved different tasks. In parallel, the craftsmen were positioned side by side with the apprentices and were able to observe, correct, show, and guide them continuously. By using tools and materials within this professional environment, the apprentices learned that the body's senses, movements, and thoughts constantly revolved around the qualities of work. While studying their own and their colleagues' work, they acquired tacit knowledge about the people on the construction site and about significant things, processes, situations, and contexts. As active participants, the result of their own work was important to them and the community; therefore, it was necessary to follow along, and seek out knowledge. Gradually, they began to trust their own choices, and break out of the role of an apprentice.

This analysis of the craftsmen's narratives reveals that, through active participation, they obtain, recognise and analyse large amounts of data from different situations and contexts. Through the body's unique senses and movements, and the ability to train, remember, and reason, knowledge is automated through our language and actions (Brown et al., 1989). Myriads of things and actions, contexts, and situations provide a basis for comparisons and hence the opportunity to logically analyse and understand similar things and actions, contexts, and situations. Large parts of craft knowledge are personal and tacit and are characterised by individual attitudes and choices connected to aesthetics, methods, and techniques. For experienced craftsmen, the goal is to build 'something that is perfect'. The ambitious goal of building a perfect building or pipe system requires more than doing a job. It requires personal involvement from yourself as a person. The final product expresses the craftsman's personal craft knowledge and the quality of his work and is thus strongly connected to the craftsman's professional pride and vocational identity. However, the myriad of experienced, trained, and resourceful choices and actions made by the craftsman during the process are hardly visible in the product. The vocational teacher's craft knowledge is personal, embodied, tacit, and strongly connected to the craftsman's individual attitudes towards professionalism and quality. The craftsman's relationship to quality in his own work is significant for the experience of professional pride and vocational identity. The study indicates that craftsmanship and working life experience hold a wide range of qualifications. The fact that practical knowledge is embodied and tacit may be one of the reasons why it is largely underestimated, perhaps even ignored. Working-life knowledge contains social and professional expertise that is valuable and relevant to transferring to other contexts

and different parts of the working life, for example from the construction sector to vocational school.

This narrative study turns the optic toward vocational students, apprentices, and craftsmen to track their histories of learning in different life stages. The article highlights the meaning of active participation and personal involvement. The results indicate that active participation in professional, practical environments holds a learning potential that deserves more attention in the education system—as well as in society. Practical craft knowledge, in its tacit form, holds skills and expertise the society depends upon. Vocational schools, workplaces, or university programmes for vocational teacher training, should strive to develop more practice-based training and facilitate active participation and physical involvement in meeting with significant others, with essential materials, tools, and tasks. The tacit and embedded knowledge in materials, their properties, and the rationale in the craft are mainly learned through action, where the human body's personal senses, emotions, and capacity to think, always is the reference point.

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Declarations

Ethics Approval and Consent to Participate All procedures performed in studies involving human participants are in accordance with the ethical standards of the Norwegian Centre for Research Data.

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