PROF. DR. FRANK DE JONG

KNOWLEDGE IN^(TER)-ACTION

Responsive learning as knowledge building

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Prof. dr. Frank P.C.M. de Jong

Open Universiteit

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Colofon

Translated Public Inaugural lecture delivered in abbreviated form on Friday 15 November 2019 to mark the acceptance of the post of professor by special appointment in Responsive Learning and Knowledge Building, established at the Open University Heerlen by Aeres University of Applied Sciences Wageningen by Prof. Frank P.C.M. de Jong.

Graphic design translated version: Fanny Driessen, Open Universiteit

Cover design: Monique Vossen, Open Universiteit

Editors: John Arkenbout and Dimphy Smeets, Open Universiteit

Cover photo: Frank de Jong, Sidamo (Ethiopia) petroglyphs; KBDeX semantic social network analysis

Translation agency: Taaladvies Linguapolis

Translator: Annette Visser

Published By Aeres Hogeschool Wageningen In collaboration with the Open University, Heerlen the Netherlands.

ISBN/EAN: 978-90-78712-45-9

DOI: 10.46884/2020.2

Printed by Koninklijke Rijnja BV, Utrecht

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INTRODUCTION

Rector Magnificus, members of the Executive Board for this chair by special appointment, the Executive Board of Aeres, ladies and gentlemen,

I'm delighted that you have taken the time to be here today. I would like to tell you about my journey and my fondness for understanding what learning entails. While still a student at the lower retail trade school, I wrote in the school magazine that learning could be different and more democratic. My fondness was heightened at the Social Academy by my interest in philosophy and in particular phenomenology and existentialism. Even as an adolescent, I felt the attraction of Nietzsche's hammer. Thanks perhaps to his incisive psychological outlook, and the knowledge that I had to earn a living, I became immersed in cognitive psychology and the psychology of learning. That foundation, my research as an academic and my work in the semi-public sector, has led me to the understanding that knowledge emerges in action. A friend expressed this splendidly, in my opinion, during a dialogue about learning:

Asking questions of others; listening to the response you get (opinions, ideas), that's what I learn from it helps me to form my own opinions and ideas.

ADVANCE ORGANIZERS

- In the first part of this lecture, I will talk about the conceptualisation of 'knowledge emerges in action' and in particular in **in^(ter)-action** with the other and with the world.
- In the second part, I will take you on a journey of discovery through the semantic analysis of student **in^(ter)-action** in order to 'un-cover' the role that knowledge plays in the conceptual development of students.
- In the third part, I will concretise the resulting 'un-covering' that this generates for students and teachers as knowledge for **in^(ter)-action**.

1 KNOWLEDGE IN-(TER)-ACTION

CONCEPTUALISATION IN MY FIRST INAUGURAL LECTURE: 'DOING, LEARNING AND KNOWLEDGE CREATION'

In 2006, in my first inaugural lecture (De Jong, 2006) as professor at Aeres University of Applied Sciences Wageningen and Dronten, I spoke about 'Doing, learning and knowledge creation: understanding and competence'. Three worlds in one, merging in the 'understanding' of practice and ideas through doing; understanding as a form of focusing, stepping back from the activity in order to interpret its implicit experiences and to discover insights, to understand which ideas and theories work in practice and which ones do not; understanding as tangible conceptions (conceptual artefacts, Bereiter, 2002) that are a reflection of the theories you develop yourself based on knowledge experiences acquired in practice, existing (scientific) theories, experienced through art, music, theatre or ballet. It is the mind that develops by understanding the worlds of theory and practice through being active in them. This is not very different from building knowledge in a scientific process that goes from thesis, testing, analysis and interpretation to drawing a conclusion. Knowledge emerges through being active in the world, a world from which we also have to step back from time to time in order to understand our 'being there' (*Dasein*) (Störig, 1976, p. 256) (Heidegger, 1977). That's because, as a *Dasein*, we interact with these worlds as well as being part of them. Here, we say goodbye to Descartes, who saddled humanity with 'I think, therefore I am', with its dualistic impact of the eternal search for an 'I' separate from the world. Heidegger (1977), however, in *Sein und Zeit* (Being and Time), sees the 'I' as a being-in-the-world, as the basic constitution – an existence, an 'I', a being 'with others' (*Dasein is Mitwelt*, being-in is '*Mitsein*' (p. 118)). More than that, we *are* because of the other. Because as a *Dasein* we both interact with and are part of these worlds, interaction in our environment and with others in *Dasein* is critical to 'understanding'. I am beginning to understand more and more about the significance of Heidegger's *Dasein* and his ontological hermeneutics and existential analysis for 'my thinking' since the age of twenty. Increasingly, I understand that human existence is inextricably embedded in the world. The "*Substanz*' des Menschen' is not the mind as the synthesis of soul and body, but 'Existence' (Heidegger, 1977, p. 117). This implies that studying the human mind, cognition and psychology cannot be done in isolation from that world (Wheeler, 2005).

Thus, understanding is attained not by simplifying the whole into a world of subject and object, or reducing it to isolated facts – as we see in many textbooks – but by wanting to see the complex whole, the coherence, the relationships between facts in the entire ecology (De Jong, De Beus, Richardson, & Ruijters, 2013). Responsiveness, the reciprocity of this 'being', is seldom found in research methodology, statistical analysis, methods and curricula, which

are dominated by an objectivist epistemology of seeking *the* truth, by studying so-called independent, discrete variables, the results of which must then be reproduced in education. In order to bridge the theoretical dichotomy between the material versus the mental on the one hand and the social versus the individual on the other, we feel we need to view education as a reproductive learning process aimed at internalising knowledge. The material, the mental, the social and the individual are related in a being-in-the-world. 'Being' is not atomistic, but an ecology, a set of connections (De Jong, De Beus, Richardson, & Ruijters, 2013). Complexity is nothing other than the old principle of universal interdependence (Nicolescu, 2010).

CONCEPTUALISATION IN MY SECOND INAUGURAL LECTURE: 'UNDERSTANDING THE DIFFERENCE'

In 2005, in my second inaugural lecture (De Jong, 2015b) as professor in the 'Responsive learning and knowledge creation' Impact Chair, I made the point that learning is always a process of meaning-making, whether in the form of habituation, learning together or creating knowledge. It is a process of making-meaning, which leads to the building of understanding in order to fathom, to know 'what difference in understanding makes a difference'. That inaugural lecture was specifically – though not exclusively – placed in the context of a transition to a more sustainable world. The process of learning as meaning-making is not a process of defining, but one of transformation in which we use our ability to see the world differently than what we are used to. In this process, interaction with others is indispensable for building the knowledge and understanding that contribute to the 'good' in society. Our interactions with one another about our actions and phenomena in the world can give rise to an openness, a responsiveness '*by asking questions of the other or object and by listening*', by empathising with the other or object, whereby the implicit meaning of information (knowledge in the vernacular), codes, signals, signs, enters our understanding, allowing us to build on it '*to form our (own) ideas (knowledge)*'. This is the learning of experts, citizens, scientists. Knowledge, cognition, is embedded in our world. Knowing is situated (embedded) and cannot be understood separately from its environment.

Master's student of Learning and Innovation:

*'The teaching sessions, Knowledge Forum dialogues and Skype sessions were wonderful times, when I felt that my mindset was being extended and deepened. Sometimes I received confirmation that ideas were in alignment. Sometimes I needed to ask a question to arrive at a shared language, and to find a common focus and direction. Individual writing and collective learning and thinking are useful tools for me. They help me to gather my thoughts, making it easier for me to articulate them.'*¹

¹ A Master's student of Learning and Innovation at Aeres University of Applied Sciences Wageningen on their experience of knowledge building within the Knowledge Forum.

At school, learning often consists of nothing more than actions aimed at reproducing information, divorced from any context, the haphazard reconstruction of understanding, so-called deep-level learning. Building knowledge, creating knowledge, on the other hand, involves the development of understanding, ideas that students construct on the basis of knowledge experiences in their activities-in-the-world. This leads to improved or new ideas or insights. When this happens, we can speak in terms of understanding, of meaningful learning. If, in addition, consideration is given to what is good for practice, for society, nature, humankind, plants, animals, well-being and prosperity, we can speak in terms of responsive learning, responsive in that it connects and engages with what is happening in practice and with existing knowledge.

In the Appendix to my second inaugural lecture (De Jong, 2015b), I ended with coaching and didactic interventions to support principle-based knowledge building rather than ‘scripting’ (external directing and structuring in accordance with a set plan). To refine this further, I would like, in this public lecture, to examine more closely this process of building and creating knowledge collaboratively. In particular, I would like to focus on the development of cognition, understanding and the role of existing knowledge. This takes us beyond what education largely offers at present, namely existing knowledge, which in turn needs to be adapted every few years within a politically and socially recognised ‘curriculum’. Today’s world doesn’t wait eagerly for people with the ability to reproduce knowledge. The world of today needs graduates who know how to use information (existing knowledge). That’s why it is important to understand when and how students use existing knowledge, and how this helps them to develop their ideas, their insights, their understanding. Hopefully, this will support the transition to a type of education that helps to develop ‘responsive, ecological thinking’ in students, where the focus is not on simplifying and on reductive simplification, but on the complexity of the planet, people and prosperity. Before I can take you on this journey of discovery into knowledge in-^(ter)-action, I will first try to clarify what I mean by responsiveness and knowledge building.

THE RELEVANCE OF RESPONSIVENESS

A: ‘Responsive? Okay. Well, for me that conjures up associations of something, or someone, that responds well to stimuli, in a slightly clinical, analytical way In what context would you want to use it?’ [Frank: Responsive learning]

A: ‘I think it depends on what the incentives are supposed to act on For me, learning has more to do with ‘unlearning’. On that basis, I would approach ‘responsive’ [as meaning] going back to the beginning via a roundabout route, wiping the slate clean.’²

We've had enough

Young people are protesting about climate change, demonstrating for their future and for a fair, safe place on the planet for everyone.³ Following the example of 16-year-old Swedish student Greta Thunberg's *Skolstrejk för klimatet*, young people took to the streets in early 2019 and in recent months to let politicians know that they think the current climate regulations are inadequate, and demanding change and more responsibility from political leaders. They are warning the older generation not to burden young people with the mess that their parents and grandparents have created. In the US, young people have successfully filed lawsuits to enforce tougher climate goals for the protection of future generations.⁴ 'Does school make any sense without Earth?' students ask. Responses to the student climate strike were telling: the established order – in the person of the current Minister of Education – was *'opposed to school students skipping school to protest about the climate. He feels that they should do that in their spare time.'*⁵ The current Minister of Economic Affairs and Climate appeared genuinely angry⁶ that today's youth has the audacity to be concerned about the future of the planet. He believes that the *'best thing they can do for the climate is simply to go to school'*. He's right about one thing and that is the problem of having 'properly trained people to implement all these [climate measures]'. The world isn't standing still. The earthquake problem in Groningen as a result of gas extraction in the northern Netherlands, the nitrogen rulings of the Council of States, the UN special climate summit, the report of the Remkes Nitrogen Committee – in the autumn of 2019, all appear to have woken up politicians to the urgency of climate action. The current Prime Minister says that he 'understands the protesters well'. In the US, school students who take part in the protests won't be subject to sanctions, but teachers are not allowed to accompany them because that would be expressing a political opinion. Climate and nature aren't politics, they are our life source.

Old thinking

The role of education in the climate crisis barely features in the climate debate. At school, the student protesters who people are so keen to see in school have to learn and engage with theories and concepts that harbour old ways of thinking. They have to engage with implicit assumptions and worldviews that hark back to a time when people believed there was an endless supply of gas and other natural resources, when there was no awareness of the impact that intensive agriculture, industrialisation and business models aimed at

² In a dialogue about learning and responsiveness with a volunteer at De Vlierhof, a community where people live together with a common goal, not cut off from the world, but wanting to experience values in their lives such as personal growth, peace and non-violent communication.

³ <https://www.duurzamestudent.nl/2019/02/08/jonge-mensen-demonstreren-voor-het-klimaat/>

⁴ <https://www.nrc.nl/nieuws/2019/01/22/jeugd-wil-actie-voor-het-te-laat-is-a3651337>

⁵ <https://www.volkskrant.nl/nieuws-achtergrond/spijbelen-voor-een-beter-klimaat-is-ook-onderwijs-ba8dc873/>

⁶ <https://www.telegraaf.nl/video/3096828/wiebes-haalt-uit-naar-klimaatspijbelaars>

maximising profit would have on our living environment, threatening our survival. Even thinking that we can restore the destruction of the ecosystem can be a fiction, a product of the way we learned to think in our education. The philosopher Boudry (2014) wrote in an article in the Dutch newspaper, *De Volkskrant*, that technology, not reduced consumption, is the solution. This illustrates the almost inexhaustible belief that science and technology can provide a solution to every problem. It also shows a blindness to the fact that they also cause problems that threaten our society and human life on planet Earth by exhausting people, raw materials and nature.

The fact that the world's politicians are still coming up with 'old-thinking' solutions such as building walls and introducing protectionist and nationalist measures, or that they regard climate action as too expensive, doesn't engender much confidence. History teaches us that these are pseudo-solutions.

It would be good if policymakers and educationalists were more aware that the environmental crisis is also a crisis of our thinking, and therefore a crisis of our education (Bowers, 2008, 2010, 2015; De Jong, 2015b; Lupinacci, 2012). Education is an important factor in the shaping of our thinking. In 2009, Sterling talked about denial of the ecological crisis. His conclusion was that education is barely responsive to the challenges associated with globalisation and sustainability. This is reflected in the lack of pronouncements about the changes needed in education in order to respond to the issues facing society. The 2019 student strike is a clear signal, but politicians don't interpret it as a need for an 'education for transition'. 'Education for transition' goes beyond including 'sustainability' in the new curriculum; it is also about how we teach and learn.

It's true that we need 'well'-educated people. But they need to have benefited from an education based on actively trying out and experiencing ideas in order to develop, to support change in themselves, in their way of thinking and in society. Education needs many more such 'active' knowledge-building learning environments.

Thinking differently

Topics such as 'sustainability', as proposed in the new curriculum, are therefore a step in the right direction, but they are not enough. The transition requires a different way of thinking (Beers et al., 2019; De Jong, 2015b). It has to be more ecological, focused on coherence and the complex whole, rather than high scores on tests involving the reproduction of information. Education can make a start by exploring the kind of learning needed for transition. This begins by asking what kind of thinking develops in the current form of learning. Is it suitable for the simplified world of testing or does it help to develop our world, good work, a good society, in balance with nature? The transition needed in the behaviour of consumers, politicians, scientists and entrepreneurs calls for a change in our minds and our thought processes – in other words, a change in how we have learned to

think and a change in the old way of thinking, which our children are still being taught. Fear of such a change in thinking is deeply rooted in Western history (Lakatos & Musgrave, 1978), which perhaps explains the rise of populist parties.

Thinking in terms of causality (if-then) or 'the effect of something' is an implicit – and at times explicit – feature of many textbooks and websites. In their research, Van Rossum and Hamer (2010) found that the logical, analytical 'if-then' paradigm dominates the pedagogical behaviour of teachers and therefore the conceptual thinking of students.

'Evidence-based' is what we call this 'logical' thinking based on the highly valued scientific method involving hypothesis, testing and prediction. Perhaps we expect too much of this positivist research method and way of thinking. As well as contributing immensely to the prosperity and well-being of our present-day society, this method has also added to the enormous problems in that same society and to global threats. Foucault (Fendler, 2010) wrote that all answers are contained in the hypothesis. He advocated a more archaic research method, aimed at understanding the relationship between different factors, why certain phenomena occur one way in one context and differently in another. Kant speculated as to whether we could truly know an object, or only as we can understand it. He therefore viewed perceptions not as facts, but as our interpretations. Knowledge is based on judgements; this lies a *posteriori* in experience and a *priori* in reason. Ideas (knowledge) are not an idea (properties) of existing realities (*Dinge an sich*) (Delfgaauw, 1975).

Epistemic skills

Thus, in education, which increasingly calls itself constructivist, students could be given greater opportunity for experience in order to develop their epistemic skills. This refers to the ability 'to identify and use different ways of knowing, to understand and use their different forms of expression and evaluation, and to take the perspective of others who are operating within a different epistemic framework' (Morrison & Collins, 1996). Epistemic fluency is essential for responsive learning and teaching that enables the education system to produce the 'well'-educated people, who are so desired by the current Minister of Economic Affairs, who can develop solutions to complex ecological problems in the post-truth, fake-facts era, or who are good at understanding interpretations of perceptions, as Kant would probably say. Or, like Mohr and Abdu (2018), who developed the educational implications of responsive learning into 'generative teaching practices' in which education goes further than content in that the core epistemic practices in a knowledge domain are also elucidated, as well as how these are manifested in different applications.

When designing the learning experiences that students need, teachers could start by identifying epistemic target practices and devising teaching practices that serve as a catalyst for developing students' understanding. It is not only 'critical learning', a focus in our current teaching, that is important here, but also 'design thinking'. By designing solutions or other possibilities and knowledge products, design thinking goes a step further than evaluative

‘critical thinking’ and simply establishing whether or not something is correct, ‘true’, sound or unsound. While critical and design thinking are both components of knowledge building, within learning and thinking of a knowledge-building nature, students also know why a designed insight, product or solution is better than an existing one, and why it is better in terms of ecology – in short, why a different (improved) idea or solution is better, or contributes more to the public good, ‘goodness’ and the preservation of life, the planet, nature, plants, animals and humans, local society and society as a whole.

Responsive learning is learning that addresses current, authentic problems and challenges facing society. It is learning in which the curriculum is not separate from society but tied directly to it and contributes to goodness in practice, to good work and good life in that society. This is achieved by developing a way of thinking and competencies in students whereby they acquire knowledge and develop understanding by fathoming issues together and hence building knowledge (active, warm knowledge) rather than ‘processing information’ by listening, drilling facts, learning by heart and reproducing (passive, cold knowledge).

KNOWLEDGE BUILDING

Master’s student of Learning and Innovation: *‘I have made a real shift from individual learning to social learning. I am truly convinced that learning starts with social learning, and by learning collectively, you also learn for yourself (and you can transform your own frame of reference). Without social learning [collective learning], there is no learning. Without the others, I couldn’t have arrived at my view of learning that I now have.’⁷*

In my previous inaugural lecture, I also elaborated on knowledge creation and knowledge building compared with collaborative learning. Given the general lack of familiarity with this pedagogical approach, it would be helpful to devote some time to it in this lecture as well. In the pedagogical approach to knowledge creation, the emphasis is on developing students’ ideas. This means that they work on developing their own theories, opinions, curiosity, questions and challenges by using existing information (knowledge) in books, on the internet, etc. and the knowledge of others, together with their experiences as to whether or not existing knowledge insights work in their own practice. A big difference from our highly individualised education is that knowledge creation is much more of a collective process and it takes place within a knowledge-building community.

⁷ A Master’s student of Learning and Innovation on their experience with ‘knowledge building’ (in: De Jong, 2015b).

As a teacher, you cannot simply design a knowledge-building group for students (Van Heijst, De Jong, Van Aalst, De Hoog, & Kirschner, 2019). A knowledge-building community is created around the needs, ideas, curiosities and goals that a group considers worthwhile (Barab, Makinster, & Scheckler, 2003). It is characterised by the following (Bereiter, 2002; Scardamalia, 2002; Bereiter & Scardamalia, 2006; Zhang, Olfman, & Ractham, 2007; Hong & Sullivan, 2009; Scardamalia & Bereiter, 2014):

- a focus on knowledge development as a collective effort
- a discourse in which insights, comprehension and ‘understanding’ emerge from a collective practice of idea development using authoritative sources from outside the community (books, experts, dissenting views);
- an environment (e-environment, physical classroom, working environment) that supports the discourse of knowledge building in the community;
- a community culture (common goals, meanings and practices) that emerge as the community develops through social consultation situations, interactions in the discourse.

The knowledge-creation process is not rooted in the completion of learning tasks, but in a dialogical (Ludvigsen & Mørch, 2010) and interactive activity with the world (Arievitch, 2017). The dialogical approach views knowledge building as an inter-mental process, in which new insights emerge from a dialogue that contains multiple (multivocal) perspectives (Koschmann, 1999; Wegerif et al., 2010). The dialogue concerns ‘interactivity with the world’ as the place of knowledge development and is therefore a ‘psychological’ process that centres on ‘interactively-active’ students as the sole knowledge-generating factor – a psychological process consisting of people’s activity with their environment, not a biological brain activity.

A dialogical conversation of this kind begins by making explicit and highlighting certain knowledge claims (views, opinions, ideas, questions). Next, the adoption of the intersubjective position vis-à-vis those claims is important for the development of new insights and ideas. Knowledge positions are produced when an individual introduces a proposition about a relevant topic or asks a question with an aim to introduce a new proposition. This adopting of intersubjective positions is a common process in which everyone participates (Hyland, 2005; Kärkkäinen, 2006; Martin & White, 2003). The process of adopting positions consists of simultaneously evaluating the knowledge claims, positioning the self and the group and aligning oneself to and with the other(s) (Du Bois, 2007). The multivocal nature of this process of knowledge creation entails accepting the multifaceted nature of dialogues, in which different voices or perspectives can coexist in the dialogue without having to reach consensus.

Thus, it is a process of wanting and being able to understand one another, of stepping back far enough to be able to take a stance. A process of 'wonder': you need to establish distance because the subject touches you and because it matters. The process requires 'looking further': not adhering to your first opinion, and being open, perhaps without words (language means norms and values, culture-laden), but certainly without prejudices so that you can see what is there. If you have these moments of contact with one another, if you feel mutual trust and a sense of security, the process is mature enough for the sharing and building of ideas.

LEARNING IS A PSYCHOLOGICAL OR 'MIND' PROCESS

'Experiences make the theory'⁸

As part of the celebrations to mark the 35th anniversary of Aeres University of Applied Sciences Wageningen, all staff took part in study activities in Vienna, such as educational visits and cultural activities. I joined in a city walking tour on Freud. The guide was a young woman who had studied psychology, but who had been put off by the positivist approach and had gone on to art school. In the tour, she painted a beautiful verbal picture of the birth of psychoanalysis, a product of the zeitgeist. She described life in Vienna at that time, family relationships, Freud's relationship with his mother and servants, the power relationships in society, the position of Jews, Freud's work as a doctor at the hospital and in his own practice, and his interest in art history. She summed it up powerfully by saying 'experiences make the theory'. Freud's work as a doctor, his dialogues, his taking 'hysterical' women seriously by listening to their stories, his (inter)activities in the world in order to understand them, by thinking about them, talking about them with his daughter Anna and the friends he corresponded with, and by writing for others: it is this in-ter-action that gave rise to the insights and knowledge that we now know of as psychoanalysis. It concerns interpretations of a reality, coloured by his experiences and infused with the zeitgeist, just as any insight is an 'interpretation' of an activity, or an experience in the world. We see this reflected in the burgeoning 4E cognition approach (4E = embodied, extended, embedded, enacted) (Flore, 2019). 4E Cognition concerns the fact that cognition doesn't just happen in your head; it emerges in in-ter-action with and through your body and your environment.

Neuro or mind?

It is not the physiological, chemical brain processes that produce psychoanalysis or any other type of knowledge in our world, but interpretations of our experiences. The latter is a psychological process, and not solely a neurological one. The neurological process enables

⁸ Gids in Wenen over Freuds ecologie en de geboorte van de psychoanalyse

the process of meaning-making but is not the cause of or the meaning process itself – just as our brain enables us to run, but doesn't constitute running, let alone winning a marathon. 'Our brain doesn't run' without our muscles, legs and experiences of movement. Studying the neural connections and activities as a biological substrate tells us nothing about the nature of a cycling race⁹. Memories of each walking experience are stored in our muscles and legs, and these – the result of walking activities in various environments and conditions – are activated when we move. Without physical activity as an interaction in the environment, I do not believe there is a basis for neurological connection. In the case of long-term sensory deprivation, such as exposure to a monotonous environment, people begin to hallucinate, lose their identity, become depressed and anxious, and display childlike emotional responses; their visual perception is distorted and their brain wave patterns change (Heron, 1957; Parreno, 2019).

'Mind is in the body, body is in the mind. Emotions, experiences and traumas become locked in your body, creating blockages. It's good to look at and listen to them. This changes you as a person: makes you more aware and more in touch with yourself.

*By feeling the blockages in your body as well as the emotions behind them, you can experience space. That space provides new insights and makes you freer, which allows you to live more freely and be closer to your origins. There is space in emptiness and there is energy in space.'*¹⁰

*'Brains, do not think, perceive, believe, and do not make decisions (and, one could add, neither do amygdalae "need" or "feel" anything). (...) It is **persons with brains** who do all these activities and therefore are responsible for the consequences of their decisions and actions.'*

Arievitch, 2017, p.11).

According to Arievitch, the brain's processes support learning and the functioning of the mind. However, neither of these come from the deep recesses of the brain, but from our interactions with the world. Arievitch refers to distinct ontological differences in causality. Neuroscience has a *mechanical* (physical and physiological) causality that applies to brain processes. Another type of causality is *qualitative* ('a sort of non-deterministic determinism', p. 11), 'which emerges in evolution with the advent of embodied active agents who (not their brains) consider various "reasons" for action and act upon them.' (p. 11).

If learning were purely neurological – a biological, physiological, chemical process (action-

⁹ 'The substance of mind is always [the individual's] external activity ... and the brain with its inborn structures is only its biological substrate. This is why studying the brain tells you as little about the mind as analyzing the physical properties of gold, silver or banknote paper tells you about the nature of money' Filosoof Evald Ilyenkov (Ilyenkov, 2002, p. 98 in Arievitch, 2017; cursivering in de originele versie)

¹⁰ In a dialogue on learning and responsiveness with a holistic masseur.

reaction based on stimuli) – there would be little knowledge development. We would never be able to change because biological processes are strongly based on action-reaction and therefore die out in a changing nature because they do not involve any creativity, any ‘designs’ for situations that have not previously occurred. Climate change, or a polluted environment, causes the extinction of countless insects, animals and plants because ‘adapting’ is a biological process that takes generations. Adapting is not a process of creativity, but one of survival and dying out. The creation of new solutions and insights – in other words, knowledge development – is a psychological process that has its foundations in being active in the world and giving meaning to the resulting experiences. According to Gergen (2010), our behaviour is not caused by our brains but by the world around us; for us humans it lies in our social and cultural world. Although the enormous plasticity of our brains (neurological system) makes all forms of cultural activity and behaviour possible, our brains are not responsible for our behaviour because they do not cause that behaviour and therefore do not bring about learning (Arievitch, p11).

Learning is a psychological process

Clearly, the thinking in this inaugural lecture is in line with that of Vygotsky, Leontiev and Gal’perin, to name just a few of the ‘giants’. Their insights tell us that reason and wisdom are not inherent and pre-programmed in biological and neurological processes. Living organisms and humans in particular have to develop all activities, actions, insights in the course of their lifetime. For example, although new-borns possess sucking reflexes and their mothers have breasts, this doesn’t mean that breastfeeding will be successful. Both child and mother learn to make a success of breastfeeding in their interactive actions with one another. We learn to be mindful, to remember, observe, receive situations and objects, and to focus attention on something by acting. This is never an individual matter. Learning and developing are always a shared activity with others, involving child-parents, student-peers-teachers, and cultural tools such as books, art, music, theatre, newspapers, TV, films, social media and the internet. In this sharing with others, a collective understanding gradually develops and with it an individual develops their understanding and personal competencies. According to Arievitch (2017, p. 27), psychological processes in Gal’perin’s theory are analysed as:

‘the evolutionary, new, non-automatic, that is, non-physiological forms [of] organism’s activity which dramatically increase the organism’s ability to act successfully in the unstable, shifting, and unpredictable environment. The entire organism’s physiological “arsenal” – both in the form of any hereditary mechanisms and previously acquired individual experiences – becomes insufficient at a certain point in evolution for dealing with the environment that contains new dynamic features and presents new challenges that the organism had not encountered in prior experience.’ (Arievitch, 2017, p. 27).

We find this same perspective in Kegan (2009) and Mezirow (2009), in their view of learning as a transformative process – a situation in which you find that everything you know, have

learned and acquired in the way of experiences no longer works. This creates a need for new, non-automatic, non-physiological action-reaction knowledge constructs that enable you to adapt and expand your repertoire of activities in order to cope with the new situation.

This is certainly what is happening in the environmental and cultural crisis in which humanity finds itself. It calls for a different kind of 'learning' and a different pedagogical approach within a different kind of education (Arbeek, 2019). We may find that the insights of those giants in the learning psychology of fifty-odd years ago are no longer part of this different education, that it's not enough to simply stand on their shoulders, and that we really need to build on their work or on other insights. The fact that much of today's education is not very different from fifty years ago demonstrates the need for responsiveness and change.

The rapid changes in our world, the dynamic coherence of nature, and of social and economic life demand a non-automatically learned responsiveness of thought and action because automatic responses to ever-changing situations are inadequate and ineffective. It requires a co-construction in shared activity with others. This responsiveness of thought is diametrically opposed to neuroscience, which would have us believe that all forms of behaviour and psychological processes can be derived from physiological processes of the brain. Without the psychological responsiveness of our activities in the world, learners are limited to their prior experiences – in other words, to carrying out standard, routine activities. This works as long as the situations are standard and familiar. But if the situation suddenly changes, these standard routines are no longer effective and will not lead to successful action. Being able to act successfully, with psychological responsiveness and going further than prior experiences – that is precisely what a responsively educated person is able to do. And it's also what is needed in our interactions with the environment, with its problems and situations. The material and the mental, subject and object, are united in this interaction by the 'active' actor, the student, the learner, the employee.

The psychological representations (interpretations of the world) of the *active in-the-world* actor (people and animals, and perhaps plants; Wohlleben, 2016) are emergent properties of the interactions by that actor-in-the-world (Gal'perin, 1976, 1998 in: Arieviditch 2017; Gal'perin, 1992). That emergence blurs and dissolves the whole body-mind and subject-object dualism into a being-in-the-world, as a *Dasein*. Understanding is therefore better understood as a psychological process. *'Psychological processes are not separate 'objects' but rather emergent properties of the agent's interactions with the world'*. They do not take place in the brain, beneath the skull, but in interactions in the world (Arieviditch, 2017, p. 40). In ecological psychology, we also see that Gibson (1979; 1978), for example, rejects any form of dualism between organism and environment and between perception and action. For Gibson, perception is neither in the head nor in the environment, but in the organism-environment system through which perception is emergent. It stems from the relationship between

organism and environment. We cannot observe the environment only in objective, absolute entities (Kadihasanoglu, 2018). It is the ‘affordance’, the quality of and the relationship with the object, that makes an action possible. Because these are embedded in the relationship, the being-in-the-world, we overcome the subject-object dilemma, and the subject or the body and environment in which it is, or in which the subject exists, are integral parts of cognition and understanding.

Knowledge is the emergence of (inter)action

Thus, emergence means that knowledge arises from action (such as reading, doing, experiencing, self-talk (aloud), inner speech, attentive listening) and hence from action in *inter-action*. Explaining the development of knowledge in interaction therefore fails if the explaining is done from a cause-effect perspective. Emergence involves complex interactions, the result of which is not determined in advance. Expressions of knowledge are embedded in successive contexts, related to specific actions and grounded in the dialogues and responses of dialogue partners. Heritage (2012) says that epistemic or knowledge positioning occurs in conversational turns through the actions in a dialogue. This contrasts with knowledge as a hidden individual, internal, mental action. Coulter, (1983, p. 128) had already argued that *‘people’s “mental” properties should be seen as originating from situated, constitutive (qualifying, conditioning and founding) practice’*. This knowledge positioning is calibrated in social interaction with others (recipient-designed), who monitor, actively test and respond to the stance taken (Mondada, 2019).

Although this view calls into question a purely internally focused cognitive psychology of learning, this needn’t mean that we are only left with a purely external approach. However, it does mean reconceptualising cognition not as an internal information-processing process but as being embedded in, extended to, enacted in the world and embodied in biology. Parada and Rossi (2018) see this reconceptualising as one of the frameworks that the development of psychological science needs in order to identify and study mechanisms that initiate outward-looking activities, facilitated by ever-present neurological, inward-looking activities. These mechanisms do not relate to reductionist, mechanistic if-then statements, but contemporary complex and dynamic learning mechanisms, focused on development and construction rather than ‘learning’ as information processing – in other words, the development, say, of consciousness, of identity and of knowledge in a complex brain/body-in-the-world ecology. With regard to knowledge development, a more hermeneutic approach is appropriate, one that examines intersubjective dialogue cycles in the teaching-learning process (León, 2001). Parada and Rossi (2018) even advocate strong network analyses in combined genetic, neural and sociocultural, functional levels in order to bridge the gap between biology and social sciences.

Time to take a look

Alongside *Dasein* and other philosophical concepts, my affection for ‘empirical’ research was also fuelled by Merleau-Ponty’s phenomenological look. Or as former racing driver Jody Scheckter put it in a dialogue I had with him during a research project on the potential of video-laser weapon interaction in shooting training for the police: *‘It’s better to have one good look in practice than spend ten hours talking about practice.’* This brings me to the point where I take you on a voyage of discovery, in which we look at the world of network analyses of knowledge construction in^{-(ter)}-actions!

2 KNOWLEDGE BUILDING IN-(TER)-ACTION

The focus in regular education is on telling or making existing knowledge available (passive, cold knowledge). Lectures, textbooks, research literature and the like are used for this purpose. However, knowledge cannot be reduced to a lesson, a treatise, or to knowledge information. As I have said, knowledge lies in the relationships between interactive actions (active, warm knowledge). Thus, for example, we see knowledge emerge in physical and interpersonal interactions, such as tasting an unknown cheese (Mondada, 2019). It is the process of learning to use knowledge, ‘knowing how’ rather than ‘knowing that’. And this occurs in the course of actions. Knowing how to perform knee surgery is not demonstrated by listing a host of medical facts and actions, but by the hands that make the right movements (Ryle, (1949) 2009). It is the same with ‘knowledge skills’, knowledge development, the creation of knowledge by students: this resides in being able to have a knowledge-building dialogues with each other. For teachers to be able to support the proficiency aspect of this process or indeed to support the process at all or to provide any other kind of support, more needs to be known about how knowledge building **in-(ter)-action** occurs. In this part of my lecture, I would like to look at dialogues by students engaged in developing their collective idea of learning and at the way in which concepts manifest themselves in these dialogues.

ROTATING STUDENT LEADERSHIP IN KNOWLEDGE IN-(TER)-ACTION

Ma, Matsuzawa and Scardamalia (2016) found patterns of temporary rotating leadership in their analyses of social networks in knowledge-building dialogues among primary school pupils. They discovered a relatively decentralised student network (fig. 1): the overlapping lines in Figure 1 show the phenomenon of rotating leadership. This means that the student with the highest centrality value (I’ll explain more about this later) leads the dialogue at some point. The figure shows that students often alternate. Of the 22 pupils (grade 4, about eight years of age), 20 took the lead at different times in the discourse by connecting unique, stand-alone ideas to the larger class dialogue. Four pupils introduced new concepts into the discourse in these situations. A fifth pupil made a contribution that kept them in a leading position for longer. All five pupils contributed to the development of the group’s collective knowledge by taking on a high levels of *epistemic agency* (knowledge-building principle; Scardamalia, 2002) and by connecting *diverse ideas* together (knowledge-building principle). At the same time, they brought that knowledge (these new ideas, insights) from small group dialogues into the larger class dialogue, thereby contributing to *symmetrical knowledge*

advancement (knowledge-building principle) in the group dialogues. They also exemplified a fourth knowledge-building principle – *democratising knowledge* (Scardamalia, 2002). We can conclude from this that knowledge-building dialogues occur in decentralised networks in which content leadership constantly switches between students. In principle, this means that students are more or less equally influential when it comes to knowledge building. It also shows that when teachers or educational supporters dare to share guidance and decision-making power with learners, learners as young as eight years of age are capable of organising themselves, their collaborative learning and their involvement in the interaction, thereby achieving their goal of collectively improving ideas and building knowledge.

FIGURE 1

Figure 1: KBDex visualisation of individual betweenness centralities across time, with overlapping lines showing the phenomenon of rotating leadership (from: Ma et al., 2016)

OPENNESS IN KNOWLEDGE IN-(TER)-ACTION

Van Heijst, De Jong, Van Aalst, De Hoog and Kirschner (2019) examined the socio-cognitive dynamics in knowledge-building discourse among Master of Education students (Learning and Innovation) from the perspective of openness. In general, a moderate degree of openness was expressed in the students' contributions to virtual dialogues, with social openness found to be much higher than cognitive openness (fig. 2).

FIGURE 2

The degree-of-openness scores for indicators of socio-cognitive openness, related to the total number of contributions (N=594) (from: van Heijst et al., 2019).

It is all the more striking that of the four social and four cognitive indicators of openness in the students' contributions, three of the cognitive openness indicators led to more follow-up contributions in the knowledge-building dialogues than the social openness indicators. The social openness indicators were found to have no bearing on the continuation of a conversation (see fig. 3).

Dimension	Discourse Act	Component	
Cognitive	Building Knowledge BK=0 → less FU, $p<0.1$	Connecting claims	$p<.01$
		Justifying of claim	$p<.01$
	Expression of Uncertainty for EU=2, $p<0.1$	Epistemic stance	$p<.01$
		Inviting response	
Social	Community Orientation for CO=2, $p<.01$	Transactivity	$p<.01$
		Ownership	
	Expression of Self	Positioning towards claim	
		Authority	$p<.01$

FIGURE 3

Relationship between expressions of cognitive and social openness in contributions and building on a contribution with a follow-up contribution (from: Van Heijst et al., 2019).

THE ROLE OF INFORMATION, VALID ‘KNOWLEDGE’ SOURCES IN IN-(TER)-ACTION

Ma et al.’s (2016) research shows us that the connecting role played by students with regard to content is important and therefore that a teacher sharing ‘agency’ in this process with students is a prerequisite for knowledge-building discourse. The research by Van Heijst et al. (2019) shows that content-based openness expressed in the contributions promotes the advancement of knowledge-building discourse. This openness manifests itself in uncertainty about the content, by connecting new ideas to earlier contributions while at the same time inviting others to refine them.

We still understand little about how knowledge information is used within knowledge-building activities in knowledge-building discourse – in other words, the use of knowledge information that we offer in our teaching, or ‘valid knowledge sources’ (scientific and specialist literature, experts). The use of valid knowledge sources is another principle of knowledge building (Bereiter, 2002; Paavola & Hakkarainen, 2005; Scardamalia, 2002; Scardamalia & Bereiter, 2014). To explore this gap in knowledge, I will take you on a journey

to the hidden depths of student dialogues, using network analyses of how Master of Education students (Learning and Innovation) used 'curriculum' literature in their knowledge-building dialogues. My tour is driven by curiosity, including questions such as:

- How do concepts that students 'appropriate' into their conceptual thinking blend with concepts that they have encountered in the literature? Which concepts are these? Do groups differ in this respect? In the present case, it concerns the literature on a theme in the Master of Learning and Innovation at Aeres University of Applied Sciences Wageningen that students were obliged to study.
- Do topic terms also take on a 'rotating leadership' role in (Ma et al., 2016), thereby constituting links in the process of connecting and supporting dialogues, which ultimately lead to a coherent knowledge insight created by students?
- What role does this information (i.e. topics, concepts, words that cover the topics in the literature (topic terms)) play in the in-ter-action through which students arrive at the conceptual artefact? In this case, what view of learning do they present in their papers? What is the nature of the actions in which the topic terms perform their connecting function during the discourse?
- What does this teach us about in-ter-action and the process of knowledge emergence?

The data

The data comes from online discourse contributions in Master's student in-ter-actions during a trimester component on the theme of Learning. The course instructions suggest that this was more of an 'idea-centred' than a 'task-centred' activity (Themahandleiding MLI, 2018): '(...) *knowledge creation is the key starting point. The fact that teachers want to enter into a knowledge-creation process with them leads to collective and individual insights, insights that arise from a design mode for dealing with information (...).*' This indicates that the aim is not to elicit the best possible representation of theories, but an elaboration of ideas that students have acquired through reading about and playing with those theories. '(...) *Of course, this requires a good understanding. Scardamalia (2001) calls this the "constructive use of authoritative sources". It is a process that goes from the "collective idea" to your own ideas and vice versa.*' Another important starting point for this theme is that it concerns '(...) *describing "learning" as a phenomenon, as a process. To this end, it is not only useful to gain many insights, but also necessary to know and test your own vision and ideas about learning, which you will be encouraged to do.*'

Two subgroups that were the most active in online discourse were selected from a year cohort. Each subgroup comprised three women and one man between the ages of 26 and 55.

Social network analysis (SNA)

The first vehicle for the voyage of discovery is semantic social network analysis (SSNA).

The second is more of a content analysis of online discourse contributions in relation to a connecting topic term. This 'constructive, connecting' function of topic terms (more on this later) can be envisaged as particular notes that occupy a connecting position in a piece of music because they form the link between two parts in the piece (see fig. 4). In the same way, some knowledge terms in dialogues can also occupy a leading position in connecting small group dialogues.

FIGURE 4

Piano music: 'The music box'

To analyse the constructive connections, we used KBDeX (Knowledge Building Discourse eXplorer), a content-based social and temporal network analysis tool (Oshima, Oshima, & Matsuzawa, 2012). Typical social network analyses examine the network of social relationships that students construct when sending and receiving messages. The present analyses concern the relationships between the semantic, social topic terms that have been created. They concern relationships that arise as students build on one another's input – in other words, shared ideas through the co-occurrence of topic terms in discourse contributions. Or, as a teacher once described it, 'words doing it with words'. The advantage of using KBDeX and co-occurring terms is that it makes the form of the connection transparent, thus making it easier for users such as teachers and students to investigate the semantic connections in their network of the dialogue. This maximises the transparency of knowledge-building processes for all users, not just for researchers. Other studies have also used co-occurring term concepts via semantic analyses to test knowledge development (Hong & Scardamalia, 2014; Ma et al., 2016; Matsuzawa, Oshima, Oshima, Niihara, & Sakai, 2011).

The SSNA method was crucial in the analysis because our data source was the Knowledge Forum dialogues conducted by the Master of Learning and Innovation students within the Learning theme with a view to arriving at a collective vision of learning. Students shared their ideas in the Knowledge Forum (see fig. 5) by posting contributions in a two-dimensional, virtual, collective workspace. In earlier times, the equivalent of today's virtual forums were the public, collective spaces where concepts were visualised in drawings or reliefs. We see this in the Great Rift Valley, where representations of cows with udders are found, emphasising the importance of milk (see cover illustration, probably before the time of the Zebu, during the first millennium BC).

FIGURE 5
Screenshot of
Knowledge Forum 6

KNOWLEDGE BUILDING DISCOURSE EXPLORER (KBDEX)

The students' online discourse dialogues were imported into KBDeX (top left in fig. 6) in order to perform the content-based network analysis. KBDeX visualises three network structures in the Knowledge Forum discourse (see fig. 6) in bipartite fields (De Jong, 2015b; Ma et al., 2016; Matsuzawa et al., 2011).

- At the top right, we see the network structure of participants who share at least one selected key term in their contributions (discourse units). The thickness of the lines shows the strength of connection between students' ideas at the term level (Oshima, Matsuzawa, Oshima, & Niihara, 2013).
- At the bottom left, we see a discourse unit network (network of phrases or entire 'notes'), based on the simultaneous occurrence of selected key terms in the units.
- At the bottom right is the word network of selected key terms, based on the simultaneous occurrence of those terms in the same discourse unit. Two discourse units (sentences or entire 'notes') are connected if they share more than one term. This network shows how students' knowledge ideas contribute to knowledge building (Oshima et al., 2013).

FIGURE 6
KBDex window:
The thickness of the
lines shows the
strength of the
relationships,
calculated by the
number of
discourse-paired units
that share a term.

Centrality as a measure of contribution to knowledge building

KBDex allows us to investigate discourse in real time. For example, if you click on a key term in the word network, the discourse units in the discourse unit network in which the key terms simultaneously occur will also show up in red, and so too will the authors of the discourse units. This functionality was used to investigate the discourse in depth as a way of validating the strength of the betweenness centrality value, based on Natural Language Processing (NLP), topic modelling and topic terms (more on this later).

‘Centrality’ indicates the importance of a discourse unit, a term (concept) or an individual in the contribution to and the strength of the network (see also Ma et al. (2016) and Oshima et al. (2013)). We can distinguish three centralities:

- The degree centrality shows the number of connections. A high degree centrality means that a discourse unit is at the centre of the network or cluster of units in the network.
- The strength of the betweenness centrality of a discourse unit, term or individual is determined by the number of connections (node pairs) whose shortest path passes through a selected key term (or discourse unit or person). A high betweenness centrality means that the term (or person or discourse unit) is highly influential, a key mediator in the meaning-making of the other terms, discourse units or people in the knowledge being constructed. At the group level, the betweenness centrality indicates the extent to which a network is centralised. A network is centralised (i.e. has a betweenness centrality value of 1) if some terms (people or discourse units) exert a strong integrating influence. Thus, decentralisation (a low centrality value) means that there is greater decentralisation and more equal influence of terms (people or discourse units).
- The strength of the closeness centrality is determined by the number of steps or connections that are needed between one term and another (discourse unit or person) – in other words, how close they are to each other. It indicates the cumulative path length by which each discourse unit is connected to others in the network.

As I have said, the higher the centrality value, the stronger the contribution to the network’s development. A centrality value of 1 means that the influence, proximity, or contribution to the network – depending on the type of centrality we are talking about – is high, whereas a value of 0 means that there is no influence or proximity, or that no contribution is made. Thus, if a discourse unit integrates previous ideas, it contributes more to proximity and degrees of centrality coefficients than ones that integrate fewer or no ideas.

Like Ma et al. (2016), this journey of discovery also made use of the lifetime function in KBDex, which offers a ‘viewing window’ to create a temporal network during the period of time zoomed in on, thereby revealing short-term trends in the discourse. Without this lifetime

function, you would see the cumulative results of the discourse. For example, at time 100, discourse units 0 to 100 are used to create the network. If the lifetime is set at 40, discourse units 60 to 100 are used at $t=100$ to create the network. The lifetime, our binoculars on this journey, was set at 12, which is three times the number of group members in the discourse ($3 \times N + 4 = 12$), because initial contributions were followed up on average by three build-ons.

ROTATING STRENGTH OF CONNECTION OF TOPIC TERMS

Knowledge-building productivity and creativity are indicated by a decentralised network structure and by a strong leading core of topic terms. Like the phenomenon of rotating leadership in a social network (Ma et al., 2016), we can assume that oscillating patterns of betweenness centrality of the topic terms available in authoritative sources also play a role in interaction. Topic terms that remain on the discourse periphery contribute little, whereas ones that regularly switch from the periphery to the core contribute greatly to productivity and creativity and hence to the success of knowledge development in the $\text{in-}^{(\text{ter})}$ -action.

Selecting topic terms: natural language processing (NLP) and topic modelling

The first problem in semantic social network analyses (SSNA) based on words indicating a concept or topic (i.e. topic terms used in discourse, the knowledge-building dialogue) is deciding which topic terms to select for the analysis. Should they be the most common, the key terms that the teacher or students regard as an expression of certain concepts, or the terms that an expert has identified as being key? We have long known from research (Van Hout Wolters, 1986) that there are significant differences between students, teachers and experts, and between experts themselves, when it comes to selecting core components. A combination of artificial intelligence (AI) and linguistics in the form of natural language processing (NLP) and topic modelling offer another possibility. In this instance, the latter technique, topic modelling, was used. It is a probabilistic technique used in machine learning (ML) and natural language processing (NLP) to find one or more topics in a collection of documents. Topic modelling treats the text as a 'bag of words': it only establishes the frequency of the words and takes no account of syntactic information. A topic represents a group of words that have a high likelihood of occurring together in a document (Ignatow & Mihalcea, 2016).

The rationale behind topic modelling is that meanings are relational (Joseph, 2011). Topics are associated with a group of words that occur frequently (Ignatow & Mihalcea, 2016). The resulting group of words can also be interpreted as lexical fields, groups of words whose meanings depend on each other; together, they form a conceptual structure that is part of a particular activity or specialist field (Geeraerts, 2010; Saeed, 2015), such as a lexical field

associated with school (e.g. teacher, book, notebook, pencil, student, etc.).

Topic modelling is a non-supervised method, which means that no prior annotation is required before the technique can be applied. This is useful for instances where annotation is not possible. Finding the correct number of topics is based on inspection. Topic selection is usually based on two criteria:

1. there should be little overlap between topics;
2. the topic should be logical; it should be meaningful to both assessor and user.

On this journey of discovery, topic models were generated for the terms with the greatest likelihood of representing an underlying core topic in the text, based on the frequency of terms (in this case, verbs and nouns) in the valid knowledge sources.

We took the core literature from the set texts, namely Illeris' (2009) *Contemporary theories of learning*. The students were asked to study Chapters 1 (Illeris), 2 (Jarvis), 4 (Engeström) and 10 (Tennant) for the second session in the first month and Chapters 3 (Kegan), 6 (Mezirow), 15 (Lave & Wenger) and 16 (Wildemeersch) for the third Learning theme session in the second month. These chapters were subjected to an NLP topic modelling analysis (see fig. 7).

FIGURE 7

NLP topic modelling of chapters in Illeris, *Contemporary theories of learning*. Blue shows the overall frequency and red the estimated frequency of the term within the selected topic.

For the SSNA used in KBDeX, for each chapter, we selected the most frequent terms in all topics in the chapter. For the analyses, we selected two chapters that students were asked to study for the second session (Chapters 1 and 10) and two (Chapters 3 and 15) for the third session. Chapter 1 was chosen because it sets out Illeris' overall theory and all students were likely to have read it. The other chapters were selected because they closely aligned with the visions of two selected subgroups of students. This also created a balance between the first and second periods of study, and in the distribution of chapters across the book.

Chapter 1 has a strong constructivist, cognitivist orientation. In chapter 10, Tennant emphasises a strong postmodernist view of eliminating the dualism between object and subject and post-humanist 'self'-orientation. Chapter 3 presents Kegan's strongly epistemic transformative vision of learning. Chapter 15 deals with the social learning theory of Wenger's communities of practice (COP).

Also included in the SNA alongside the topic model terms for each subgroup were terms that the group 'appropriated', as shown in the visualisation of the vision of learning, the conceptual artefacts (see fig. 8).

FIGURE 8

Visualisations of the collective vision of learning for each of the two discourse subgroups

RESULTS

The data analysis was carried out in two stages to discover information that could help answer the main questions. The first SNA stage was a quantitative analysis at group level to determine the network patterns that emerged through selected topic terms with a connecting, knowledge-building contribution to student knowledge development during the discourse. The second stage was a qualitative analysis that examined the content and context of the knowledge-building, connecting topic terms to determine the nature of the connection.

STAGE ONE: QUANTITATIVE GROUP ANALYSIS

Temporal network analysis

First, we looked at the extent to which the word network was centralised around certain topic terms. The average betweenness centrality (see fig. 9) shows that this was fairly low, which means that the word network was relatively decentralised and that the topic terms were more or less equally influential in knowledge building. For Group B, the average centrality was slightly higher (see Table 1), which means that certain topic terms may have been a little more influential than in Group A. An analysis of variance on the average centrality value shows that the groups differed significantly in terms of how influential the topic terms were in the knowledge-building online dialogue activity (see Table 2).

FIGURE 9

The average betweenness centrality for Group A (left) is slightly higher than for Group B (right).
The topic terms appear to be more or less equally influential in knowledge building.

TABLE 1

Average betweenness centrality value of each group

	group	N	Mean	Std. Deviation	Std. Error Mean
avgbetweenness centrality	1.00	100	,0134	,00823	,00082
	2.00	91	,0105	,00790	,00083

TABLE 2

Results of the t-test analysis of variance of the betweenness centrality value, showing significant differences between Group A and Group B

		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference Lower Upper
avgbetweenness centrality	Equal variances assumed	,224	,636	2,513	189	,013	,00294	,00117	,00063 ,00525
	Equal variances not assumed			2,518	188,461	,013	,00294	,00117	,00064 ,00524

Next, we analysed the total betweenness centrality. This was significantly higher in Group A (see Tables 3 and 4), which means that this network was more cohesive than Group B and therefore that a certain number of topic terms were more strongly connected than others in the knowledge building, or in developing the group's vision of learning. The absence of such topic terms can considerably disrupt knowledge building because so many relationships

(geodesic paths) continue on to other topic terms. There was less centralisation in Group B and a looser or less cohesive relationship between a number of topic terms. Topic terms also had a more diffuse influence in knowledge building – that is, the vision collectively developed by the group.

TABLE 3
Average total betweenness centrality per group

Group Statistics				
	group	N	Mean	Std. Deviation
Totalbetweenness centrality	1,00	100	,7054	,14289
	2,00	91	,5353	,10260

TABLE 4
T-test analysis of the total betweenness centrality per group, showing that Group A achieved a significantly higher value than Group B.

Independent Samples Test									
		Levene's Test for Equality of Variances		t-test for Equality of Means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference
Totalbetweenness centrality	Equal variances assumed	,793	,374	9,372	189	,000	,17016	,01816	,13434 ,20597
	Equal variances not assumed			9,514	179,558	,000	,17016	,01788	,13487 ,20545

The betweenness centrality was then examined at topic-term level for each group. In Figure 10, the y-axis shows the betweenness centrality value and the x-axis shows the time. Each topic term is represented by a coloured line. The oscillation of coloured, overlapping lines shows the rotating strength of connection of topic terms. This means that the connecting term concept with the highest centrality value at any given time changes frequently during the discourse.

FIGURE 10

The betweenness centrality at term level in Group A's word network

Of the 117 term concepts in the analysis of Group A, 13 function to a greater or lesser extent in a constructive, connecting position. Of these, six have a maximum betweenness centrality of more than 0.10: Knowledge (v) 0.353, Result (t1) 0.198, Organisation (t15/v) 0.188, Community (t15) 0.184, Team (v) 0.116 and Position (t10) 0.112.

This means that these topic terms had a 'connecting' function during the discourse, or knowledge-building dialogue. The other somewhat connecting terms had centrality values of < 0.067 and > 0.035, or even zero (see Appendix 1).

FIGURE 11

De tussen-centraliteit op topic-termniveau in het woordnetwerk voor groep B.

Of the 118 term concepts in the analyses of Group B, 11 function to a greater or lesser extent in a constructive, connecting position (see fig. 11), two of which have a centrality value of more than 0.1: Way (t3, t10, t15) 0.484 and Notion (t10) 0.243. This means that these two topic terms were the most 'connecting' during the discourse, i.e. the knowledge-building dialogue. The other topic terms had centrality values between < 0.076 and > 0.043 , or even zero (see Appendix 1).

If we look at Figures 10 and 11, we see that both groups are indeed heavily influenced by certain topic terms in the initial phase of the discourse. In the subsequent dialogue, Group A was more heavily influenced by certain topic terms that connected the small group dialogues than Group B. The two groups appear more equal in the activities at the end of the discourse. We also see this in the visualisation of topic terms in Figure 8, where group B is much more diffuse in its topic terms and group A uses more compact topic terms in its vision construct. In addition, we see that the two groups use only two of the same topic terms in their discourse: Position (t10) and Process (t1 t10 t15).

The differences in the visual inspection were confirmed by a MANOVA analysis, with betweenness centrality as the dependent factor and groups A and B as the group factor. A significant effect was found in the betweenness centrality of the overall topic terms, which means that not all concepts are equal in terms of their connective strength in the discourse. There was also a significant effect in the betweenness centrality between groups A and B (see Table 5).

Multivariate Tests ^a								
Effect	Value	F	Hypothesis df	Error df	Sig.	Partial Eta Squared	Noncent. Parameter	Observed Power ^c
Intercept	Pillai's Trace	,889	16,493 ^b	62,000	128,000	,000	,889	1022,583
	Wilks' Lambda	,111	16,493 ^b	62,000	128,000	,000	,889	1022,583
	Hotelling's Trace	7,989	16,493 ^b	62,000	128,000	,000	,889	1022,583
	Roy's Largest Root	7,989	16,493 ^b	62,000	128,000	,000	,889	1022,583
group	Pillai's Trace	,884	15,707 ^b	62,000	128,000	,000	,884	973,840
	Wilks' Lambda	,116	15,707 ^b	62,000	128,000	,000	,884	973,840
	Hotelling's Trace	7,608	15,707 ^b	62,000	128,000	,000	,884	973,840
	Roy's Largest Root	7,608	15,707 ^b	62,000	128,000	,000	,884	973,840

a. Design: Intercept + group

b. Exact statistic

c. Computed using alpha =

TABLE 5

MANOVA results with the betweenness centrality values as the within factor and group as the between factor

STAGE TWO: QUALITATIVE ANALYSIS

The level of topic terms in the context of student contributions

The next step on the journey of discovery is the search for the connecting, integrating role of topic terms that contribute to coherence and centrality in knowledge-building discourse, where t stands for a particular chapter (t10 = chapter 10) and v for the group's own vision term in their visualised group vision.

Group A

In the start-up activity, the dialogue in group A centred on the words Knowledge (v), Team (v) and Community (t15). The first two are the group's 'own' words that are also reflected in their vision; the third is a topic term from the literature. We see the following progression (see fig. 12). First, the concepts Community and Team are part of a network. Team, and later Community, increase in centrality, connecting the first dialogue network with another, in which Knowledge also occurs. The topic term Knowledge then makes a strong connection between two large dialogue networks.

FIGURE 12

The successive dialogue steps show a high betweenness centrality for the term Knowledge. This term originated from the group, not as a topic term from the literature.

If we look at the discourse unit containing the topic term Community, we see that both Students Three and Four made a contribution. Student Four integrated (the activity) in turn 4, in particular with Community and the topic terms Team (v), Structure (t15), School (t1 t13) and Knowledge (v) (fig. 13).

FIGURE 13
Student Four's turn,
with a high betweenness
centrality for Community
and Team

Student Three integrated (the activity) in turn 2, in particular with Community (t15) and the concepts Question (t10), Team (v), Self (t3, t10) and Process (t1, t10, t15) (see fig. 14). Both students also contributed in relation to the topic term Team (v) in their turns (2 and 30).

FIGURE 14
 Student Three's turn,
 with a high betweenness
 centrality for Community
 and Team

A little later, Knowledge (v) played a connecting role in the turns of students One and Four. This had already happened with Student Four (turn 30), who, when describing their innovation in their work context, integrated in particular (cognitive) Knowledge (v) with Community (t15), Team (v), Structure (t15), School (t1 t13) and Practice (t10 t15) (see figs 15 and 17).

FIGURE 15
The betweenness centrality
of Knowledge in the
discourse

In turn 45, in which they describe their ambition to innovate, Student One integrates with (metacognitive) Knowledge as the connecting topic term, the other topic terms Organisation (t15 v), Position (t10), Development (t10), Identity (t1, t10 v), Skills (v) and Work (t13) (see fig. 16).

In the start-up activities, we see a strong conceptualisation from the students' own work and experience practice and the use of terms that also appear as 'appropriated' terms in their vision. The turns are dominated by orientation towards one another, matching and group forming, in which the topic term Knowledge plays a connecting role.

FIGURE 16
Student One's turn, in which
Knowledge has a high
betweenness centrality

FIGURE 17
Student Four's turn,
showing the moment at
which Knowledge acquires
a high betweenness
centrality

In a subsequent period, Result (t1), Knowledge (v) and in particular Organisation (t15, v) played a connecting role in the discourse for a longer period of time. In Student Two's turn (96), Result (t1) played a connecting role through integration with Context (t1), Resistance (t1), Process (t1, t10, t15) and Area (t1) based on a description of their idea of learning at that time (see fig. 18).

FIGURE 18
Student Two's turn (96), in which the topic term Result (t1) has a high betweenness centrality in the description of their idea of learning

In a subsequent joint discourse unit (110) involving all four students, in which Result (t1) has a high betweenness centrality, the focus and aim of the first collective idea are formulated by integrating the topic terms Community (t15), Field (t1), Team (v), Development (t10), Identity (t1, t10, v), Focus (t15), Work (t3) and Nature (t15) (fig. 19).

What we see here is a shift away from a personal perspective to a collective one.

FIGURE 19
Collective discourse unit 110,
in which the goal, focus and
collective idea emerge, with
Result as the connecting topic
term. The content connection
between the group members
increases, as shown by the thick
lines (see green circle).

Building on discourse unit 110, there is deeper dialogue about certain topic terms (in seven turns: 113, 114, 116, 117, 119, 120 and 121). These in-depth discourse units relate to what the students collectively understand by certain concepts (a process of grounding), in which Organisation (t15, v) has a strong connecting role for a period time. At the same time, we see a significant increase in the semantic connection between the group members (see fig. 20).

FIGURE 20

Several student turns display grounding, with Organisation (t15, v) as the connecting topic term. In the green circle, we see a strong connection between students as a result of the deepening activity.

The deeper dialogue occurs by giving the topic terms meaning, explaining them and establishing relationships in which they play a connecting role. For example, the deeper meaning of Change (t1, t13) is explored in relation to Organisation (t15, v); and 'not being able to change an organisation' is called into question later in the dialogue; the dialogue is also broadened to include Nature (t15), People (t1, t3, t10, t15), Society (t1, v), Structure (t15)

and other topic terms. The discourse continues with the dialogue of an article and a deepening of the adaptive aspect of their model by an in-depth look at 'responsive learning', Nature (t15) or the 'nature' of learning.

A little later, the topic term Concern (t15) acquires a connecting position for a short period (in group discourse unit 174). There, the group 'brings together their knowledge' and integrates Process (t1, t10, t15), Person (t10), Experience (t10), Nature (t15), Life (t3, t10, t15), Self (t3, t10), Mind (t3), Notion (t10), Knowledge (v), Identity (t1, t10, v), Context (t1), Relationship (t3, t10), Sense (t10, t15), Issue (t15), Development (t10), Critique (t10) and Organisation (t15, v). This is a description of their guiding principles regarding their vision of learning, based on their initial orientation involving assigning a clear meaning to the concept of learning.

During an activity with a much lower betweenness centrality in the final months of the discourse, we see the following topic terms playing a role: Process (t1, t10, t15), Work (t3), Transformation (t3) and World (t15). Student Three's turn (156) is a translation of Tennant's Chapter 10, which confirms that this was an important artefact for the group's viewpoint at that time. Following a guest lecture on 'good work', Student Four broadens the perspective on practice and life in turn 162 by integrating the topic terms Life (t3, t10, t15), Practice (t10, t15), Transformation (t3) and Sense (t10, t15). Here we see the beginnings of an accommodation of the collective and the individual perspective.

Reflecting

Group A's discourse is characterised by the use of many 'authoritative' sources. From their focus on Illeris, it is mainly chapters 1, 3, 10 and 15, and the students' own concepts from their vision, such as Knowledge, that played a connecting, constructive role from the beginning in developing their vision of learning. At the start of the discourse, we see a strong conceptualisation based on their own work and experience practice. This transforms into an activity from a collective focus, in which students acquired an interest in shifting from a personal to a collective perspective. This is followed by a grounding activity in which the students deepened the concepts and made them explicit. This 'deepening' occurred through the use of authoritative literature. A contribution involving 'bringing our knowledge together' introduced the final stage of the discourse, in which concepts were increasingly integrated and authoritative sources expanded. This occurred with a strong focus on a clear collective, as well as individual, accommodation of ideas in the creation of their collective concept of 'learning' and their vision as a conceptual artefact: *'The circular or elliptical movement in our model represents the phase of chaos (searching), the phase of defining, redefining, dialogue, testing and adjusting the frame of reference, new epistemologies, or transition.'* "Learning" is essentially making meaning'. *'Our vision thus includes the paradigm of meaningful interactions of wholeness (the external and internal learning process is one and the same spectrum of "learning")'.*

The connecting role played by topic terms serves various activities in Group A's knowledge building (see fig. 21):

1. identifying a socio-cognitive match;
2. shifting away from an egocentric perspective and engaging in a collective knowledge-building dialogue;
3. a deeper understanding through grounding: 'What does someone mean by a term?'
4. a moment of 'bringing our knowledge together';
5. a 'deepening' final accommodation activity, creating a collective and a personal idea.

FIGURE 21

The betweenness centrality at term level in Group A's word network

Group B

The next stop on this voyage of discovery is finding out whether topic terms play a similar connecting role in Group B's knowledge-building in_(ter)-action.

We immediately see in Group B that topic terms from the literature are reflected in the dialogue. The term Way (t3, t10, t15) assumes a high betweenness centrality. A little later, Notion (t10), Position (t10) and Self (t3, t10) take on a connecting (or integrating) function. It is conspicuous that it is mainly concepts from the literature (Chapters 3 and 10) that play this role in Group B and that the group integrates strongly in terms of Tennant's postmodernist viewpoint.

The dialogue is gradually interspersed with a more personal sense of how meaningful the group finds it. A final contribution concerns the creation of their collective idea about 'learning', culminating in a rise-above, and 'bringing our knowledge together' as the basis for their 'pitch'. That turn (186) integrates the following terms: Work (t3, (v), Collective (v), Context (t1, v), Learner (t1, t3), Theory (t1, t3, t15), Adult (t3, t10), Community (t15), Question (t10), Development (t10), Position t10), Transformation (t13, v), Change (t1, t3), Experience (t10, v) and Self (t3,t10).

Reflecting

Group B's discourse is characterised by a brief activity that moves from individual to collective engagement (fig. 23), as well as by a very lengthy grounding activity that continues until the end. This involves summarising the theory and guest lectures and, towards the end, alternating or parallel personal opinion-forming and meaning-making (about what they felt was meaningful) and the creation of their collective vision. Thus, in the final 'bringing our knowledge together/rise-above' we see more topic terms that also appear in the conceptual artefact. Group B adheres closely to the literature in their discourse and in their description of their vision of 'learning'.

FIGURE 23

The betweenness centrality at term level in Group B's word network

WHAT DO WE UN-COVER?

As also shown in Figures 21 and 23, we can identify different activity patterns in the knowledge-building process (De Jong, 2015b; Harashim, 2017; Vogel & Weinberger, 2019), in which topic terms play an instrumental, connecting role:

- *group forming*: the collective knowledge-building process begins with an activity in which the insights ‘acquired’ by everyone are shared and a socio-cognitive content-based match is sought, giving rise to group forming through a sense of connection in relation to content.
- *collective engagement*: this is a process of moving away from one’s own egocentric perspective and engaging in a collective knowledge-building dialogue. The purpose of reading information changes from seeking confirmation of one’s own ideas to looking for what helps to find an answer to a collective question, testing promising collective ideas (theory), curiosity or solving a problem.
- *grounding*: a ‘dialogue’ about what exactly everyone means by seemingly clear terms in everyday use. Both groups did this by delving into the literature and discussing it with one another. It is a zone of non-resistance, where students come together, overcome their prejudices and recognise their interdependence in order to arrive at a shared transdisciplinary understanding (Brockwell, 2019).
- *integration and construction*: accommodation, creation of collective and therefore individual ideas by integrating and connecting ideas that rise above prior understanding; ultimately writing or creating a conceptual artefact.

The transition from one activity to another appears to be supported by rise-aboves that bring knowledge together. These are contributions in which students take stock and establish relationships between topic terms and their own idea at that time.

In these activities, knowledge experiences (experiences in practice, literature study, dialogues, etc.) are transformed into images, concepts and, ultimately, theoretical understanding. The collective activity in the knowledge-building process is what drives the development of their new insights, with the emergence of their conceptual artefact as a reflection of their new psychological functioning, of looking at the world and their responsiveness and relationship with others and their surroundings.

I hope that in this journey of discovery I have given you some idea of how knowledge emerges in and from the actions in a dialogue – actions such as making experiences explicit, summarising, integrating, establishing relationships between topics, extracting information

from valid sources and from one's own knowledge experience in practice, actions such as adapting individual and collective ideas in order to improve them during a process of interaction, cross-pollination, symbiosis in the conceptual network between participants, the literature and their practice in the discourse.

3 SUPPORTING KNOWLEDGE IN-(TER)-ACTION

The four ‘un-covered’ knowledge-building activities are a starting point for the kind of support for these activities. It is important to remember that building knowledge takes you directly to the process of knowledge creation as the basis of education. Building knowledge is ‘*acquiring competence in knowledge creation by actually doing it*’ (Scardamalia & Bereiter, 2014, p. 399). You do not achieve this by dividing tasks up and bringing them back together later, but by discovering that the goal is not to answer questions like ‘What is soil salinisation?’ Instead, the goal is to work on such questions as ‘How does soil salinisation occur and what impact does it have on a host of other things? How can we tackle it?’ Or ‘What are responsible solutions?’

In other words, it is not about hammering home definitions, but knowing how something works so that students can collectively explain why the ideas they are building on a particular subject have become better, deeper and richer. It is a process of discovering what is ‘hidden and covered, the being of being and the meaning of being’ (Pöggeler on Heidegger, 1969, p. 81) in relation to, say, climate change or the energy crisis. It is an interaction process involving – in an almost phenomenological sense – letting ‘that which shows itself be seen from the way it shows itself’ (Heidegger, 1977, p. 34).

This process occurs within Vygotsky’s zone of proximal development. Interaction, as a social dimension of the zone of proximal development, is important here (Vygotsky, 1978, 1981, 1986). Interaction with older people, experts and peers is important through embedding and the spread of psychological functioning in the community. Abstract thought and other higher mental functioning are seen as being rooted in social life (Baker-Sennett, Rogoff, Bell, & Wertsch, 1992; Wertsch, 1998). Language and social life play a major role in knowledge building because of the experiential immediacy of life. Body language expresses the emotional and the social, and people find ways within language to express their rich world of experience (Cresswell & Teucher, 2011) and hence meaning-making. Gal’perin, one of the last Russian psychologists to have had personal dialogues with Vygotsky, the founder of social constructivism, built on Vygotsky’s attention to speech, signs and symbols (their semiotically mediated meaning-making) and Leontiev’s notion of ‘activity’ as the basis for developing the meaning of these semiotic tools. According to Leontiev, the human mind had its origins in external activity from which it transformed. Thus, the human mind is not something relative to external activity. For him, human cognition and external activity are products of one another (Engeness & Lund, 2018).

Gal'perin's many years of research with teachers and students on the teaching-learning process and mental development go further than the acquisition of knowledge. He conceptualised the teaching-learning process as a psychological ideal activity, which begins in the external plane of the material form during social activities and then transforms into an internal psychological form (Engeness & Lund, 2018). Gal'perin developed a teaching-learning model that centred around mediation, internalisation and activity. Practical activity and meaningful learning are the cornerstones of this model, as opposed to reductionist simplifications and discrete, isolated learning exercises that take into account the limited capacity, in Atkinson and Shiffrin's view, of our working memory. Psychological functioning emerges on the psychological plane in interaction with social ecology (Umwelt) (Vygotsky, 1981, p. 163), and then perhaps on the neurological plane as a consequence of (inter)actions (Vygotsky, 1978, pp. 58-57).

As I have said, Gal'perin developed a development model of mental activities as a teaching-learning process, of which an action is always a part. These activities could involve feeding animals, or decorating a room, as well as doing an arithmetic sum, using a concept (theory), etc. Activities can occur at four levels:

- 1) the *material level*, involving physical objects or their representations, such as models, graphs, drawings;
- 2) the *perceptual level*, involving information storage in images, such as mentally moving objects in a classroom prior to rearranging it;
- 3) the *verbal level*, for example, when speaking and thinking aloud;
- 4) the *mental level*, such as 'inner speech'.

In addition to an activity's level of abstraction, Gal'perin uses parameters for the quality of action: degree of generalisation, abbreviation and mastery. He also describes four steps: orientation, communication, dialogical thinking and acting mentally (appropriation and conceptual embodiment).

Orientation is an important basis. Here, learners must have all the information at their disposal in order to carry out a new activity. This is the orienting basis of an action (OBA) (Haenen, 2001).

This step is often described as a stage in mastery learning in education involving the 'acquisition' of existing knowledge. De Haenen (2001) describes Gal'perin's 'orienting basis of an action' (OBA) and the 'scheme of a complete orienting basis of an action' (SCOBA) as a process in which the learner must adapt their OBA to the SCOBA. Whereas OBA refers to the whole set of orienting elements, SCOBA refers to the complete set of conditions to be taken into account. As we might expect, SCOBA is a scheme that is externally presented, perhaps by a teacher or the literature. OBA closely resembles the use of (automatically) generated student concept maps. Students compare their maps with those of the teacher (the expert

concept map/SCOBA), after which they enter an adaptation process (Wunnasri, Pailai, Hayashi, & Hirashima, 2018a; 2018b).

While this may appear consistent with the thinking about the existing teaching-learning process, involving knowledge transfer and the acquisition of available knowledge, in responsive education, 'learning' goes beyond knowledge acquisition or 'knowing that'. A responsive teaching-learning process involves knowledge development and knowing how to use that knowledge in situations, problems and issues for which there is not yet a solution, or for which there is a constant search for better insights and solutions vis-à-vis nature, humankind, animals, plants, well-being and prosperity. In this respect, Vygotsky's statement on development-oriented education – that it 'moves ahead of development' – is hugely important (Vygotsky, 1978). Thus, education can go beyond the simple teaching and acquisition of existing knowledge. This 'going beyond' involves several key aspects that we already see in Gal'perin's viewpoint:

- it is based on a 'meaningful whole as the learning content' and therefore not on learning tasks that reduce reality to unrelated, stripped-back exercises;
- the steps do not have a fixed sequence but depend on the momentum during the teaching-learning process;
- the 'initial idea' (opinion, question, curiosity or someone's theory about something) is constructing an OBA in terms of knowledge; in terms of cognitive-psychological education, it is a kind of 'prior knowledge' or 'advance organiser';
- SCOBA is a 'concept map' that students develop and construct themselves on the basis of existing knowledge, or in terms of knowledge building: 'improving your idea because all ideas are improvable.

Gal'perin's studies of the teaching-learning process show that even young pupils can cope with holistic, non-simplified, separated tasks if they are given the right tools. For example, his many experiments show that learning handwriting is not about presenting pupils with graphemes. It is about equipping them with the right expert tools at different stages so that, as with learning to form letters, they learn to make an inventory of indices themselves by analysing the shapes of graphemes (Haenen, 2001, p. 166; Arieivitch, 2017). Learners were given observation tools in order to identify the basic characteristics of what they needed to study or master. From Gal'perin's point of view, in the case of graphemes, the unity of the shape can be found in 'a segment of continuous movement' – i.e. where the line begins or changes direction. By added indices, each segment has a discrete value between two indices (fig. 24; Engeness & Lund, 2018).

FIGURE 24

Example of an 'orienting chart' used to introduce the principle of analysing graphemes in the teaching of handwriting in Dutch primary schools (Engeness & Lund, 2018).

As well as the fact that pupils aged five or six could understand conceptual issues when provided with the right thinking tools, Gal'perin also concluded in his lectures (Engeness & Lund, 2018) that this resulted in a much higher number of high-performing pupils than Vygotsky had suggested. Moreover, the learning process proceeded more rapidly and smoothly. It did not involve memorisation and pupils were able to use the concepts in different contexts. In other words, they transferred their learning from one situation to another!

This suggests that the teacher's role is to help students by presenting them with and teaching them what is essential, for example during activities such as observation in an orientation phase (orientation), dialogue with each other (communication) and dialogical and responsive thinking, such as 'good moves' (effective knowledge-building activities in a dialogue, Bereiter & Scardamalia, (2016)), and learning how to test ideas and ultimately to develop a way to act (mentally) that has been shaped in collective conceptual development, and derived from this, personal conceptual development.

The strength of this approach lies in teachers helping students to orient themselves to a real, non-simplified problem by identifying essential distinctive patterns and characteristics, by communicating about them and thinking dialogically in order to arrive at 'acting mentally' – i.e. at abstraction, understanding and conceptualisation. Thus, it is much more about teaching 'general principles (of analysis) in a particular context' than adapting to 'an expert's SCOPA', in order to improve their orientation skills. This is done by strengthening the observational and analytical skills of pupils and students, as well as their collective

conversation and dialogical thinking skills.

If we look at the knowledge-building teaching-learning process, Gal'perin's approach would mean that the teacher supports a group's orientation and problem analysis by starting with the group's own ideas, identifying ones with considerable potential and forming groups on that basis. The teacher also supports communication during the grounding activity through dialogue rather than debate, for example by encouraging 'good moves' in the knowledge-building dialogues. In addition, the teacher can encourage dialogical and constructive thinking during the 'deepening' activity by providing tools for arriving at a group understanding and arguments within existing knowledge and experiences as to why particular insights, solutions or practices are better than existing or other ones, in the context of contributing to the good of society. Here, providing tools such as integration and establishing connections is important for the activity of 'bringing our knowledge together' and for 'rising above'.

Knowledge-building principles can be seen as tools for leading this process of collective dialogue and knowledge building (Scardamalia & Bereiter, 2014; Scardamalia, 2002). This is in contrast to planning and writing out a lesson in full in the form of minute-by-minute lesson plans or scripts. It shows the difference between treating students as 'learners' or approaching them as 'investigative dialogue partners' who are part of a knowledge-building community. 'Principles-based' knowledge-building education focuses on the development of 'ideas' by working with the students' own theories, through curiosity, questions and wonder (the epistemic agency of the knowledge-building principle by students (Scardamalia, 2002)).

Student knowledge development is created by doing and by experiencing collective thinking in order to achieve understanding, insight and wisdom. Building knowledge is central to this idea development, provided that:

- The student is responsive and has 'agency' of the content. This means that the content should be connected to and the action should relate to matters that are important for practice and the community, and that students can work on their own questions, curiosity, ideas, etc. rather than simply reproduce information.
- The aim is a shared rather than an individual achievement.
- The aim is to improve ideas, rather than find a fictitious, absolute truth.
- It is a process that leads to (active, warm) knowledge *of*, as opposed to (passive, cold) knowledge *about*.
- The discourse entails solving a problem collaboratively rather than debating arguments with each other in order to win some kind of contest.
- It is a process involving the constructive use of authoritative information (existing scientific insights and insights of expert practitioners).
- Insights are tested through action in practice.

- Understanding is an emergent process that arises spontaneously from the interaction between theory and practice, individual and collective.

KNOWLEDGE-BUILDING IN-(TER)-ACTION MODEL

Bearing in mind Gal'perin's approach and the 'un-covering' that emerges following the above analysis of authoritative sources, we can generate a 'knowledge-building in-(ter)-action model' as shown in Figure 25. By taking into account the above principles and starting points, we can develop a practical model with guidelines for teachers, students and technical support.

The model will serve as a basis and guide for future research in this chair, which seeks to contribute to knowledge building as responsive learning in education in general and at the Open University and Aeres in particular.

The model is based on 'un-covered' activities, which may be sequential, although not necessarily. Instead, they are moments in the discourse. Activities are described in terms of actions. On that basis, student activities are described as constructive actions, partly based on 'good moves'. The model then describes actions that teachers can use to support 'educational' technology. Finally, related knowledge-building principles are identified.

FIGURE 25

Knowledge-building in-(ter)-action model as a basis for developing guidelines for students, teachers, technology and future research

Elaborating the knowledge-building in-(ter)-action model

Activity: course introduction and responsiveness	
Action	Connecting curriculum content to a current issue in practice/the life of the student(s), society or (future) profession
Student actions	Students describe what they think about a specific subject, issue, problem within the curriculum frameworks. They then describe, in terms of opinion, curiosity, questions, their own theories, solutions, etc., what they would like to work on with others in order to gain more insight or to work out a solution.
Constructive action ¹¹	Students write down, without constraints, whatever comes to mind.
Teacher support actions	<p>The teacher has a good connection with what is happening in current/future practice; they select relevant literature and establish the link with compulsory curriculum content. Interdisciplinary collaboration is an option here.</p> <p>The teacher makes it clear to students that all ideas are good and improvable. Students don't have to think in terms of a complete, fully developed product before expressing their ideas.</p> <p>The teacher creates a socially safe environment in which 'open minds' can flourish.</p>
Assistive technology	<p>Technology provides an environment in which students can work both virtually and time-independently as well as face-to-face and in a collective knowledge-building fashion, or in combinations of these, and equipped with useful analytical tools that can assist the process, such as Knowledge Forum and its analytical tools.</p> <p>Students can also work with video blogs instead of writing.</p> <p>Analytical tools as an indication of the conceptual starting point: what concepts and terms do students use at the start (word cloud, frequency word list, semantic analysis)?</p>

¹¹ The constructive actions are based on 'good moves' (Bereiter & Scardamalia, 2016).

Knowledge-building principles	<p>Authenticity of real issues.</p> <p>Any idea can be improved.</p> <p>Epistemic (content) agency rests with the students, so that they can explore what they are interested in within the framework of the curriculum content/goals</p> <p>Democratising knowledge: everyone has valuable insights and experiences; all students are legitimate actors in their contribution to the group's collective knowledge development.</p> <p>Initial orientation to the problem and activation of prior knowledge and motivation</p>
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Activity: group forming and collective engagement

Action	<p>Sharing everyone's 'acquired' insights and finding a content-based socio-cognitive match, whereby groups are formed through a sense of connection in relation to content.</p> <p>Moving away from one's own egocentric orientation to phenomena and engaging in a collective knowledge-building dialogue.</p>
Student actions	<p>Exchanging ideas and curiosities, face-to-face or by reading contributions from others in a forum.</p> <p>Conducting 'small-group dialogues' about each other's ideas to find out whether there is a common interest that they want to work on together as a group.</p> <p>Conducting 'small-group dialogues' to find the most promising idea (question, curiosity, solution, etc.) to develop further together.</p>
Constructive action	<p>Analysing and defining the problem; clarifying the essence of the challenge, why it is important and why the idea has not emerged earlier.</p> <p>Reading information, not to confirm one's own ideas, but to look for what helps to answer a collective question, testing (promising) collective ideas (theory), curiosity or solving a problem.</p> <p>Evaluating 'promising ideas' by considering which one has more potential for a solution; developing an understanding of the subject, understanding it, theory development and how the idea relates to alternatives.</p>

Teacher support actions	<p>Connecting with students' own practices and environment (Umwelt), so that they work on real ideas, authentic problems, issues or challenges in their environment or community, based on the 'promising' collective idea and goal.</p> <p>The teacher creates virtual and physical spaces where groups can form and subsequently work.</p> <p>The teacher gives the students tools to effectively analyse authentic topics, to determine what the problem is and to define why an idea may be promising.</p> <p>Analysis of the core concepts, concept map, (individual) word clouds and word clouds based on the relevant literature.</p> <p>Finding and supporting common interests.</p>
Assistive technology	<p>Proximity analysis of how semantically close students are to each other.</p> <p>Individual word cloud or (automatically generated) concept maps of individuals.</p> <p>Keyword tracking: to show the growth of concept terms based on a teacher analysis of keywords; can be used as feedback.</p> <p>Semantic network analyses to show semantic coherence and conceptual keywords relating to essential group concepts and to use as feedback.</p>
Knowledge-building principles	<p>Collective knowledge development and responsibility for the knowledge development of the group as a whole.</p> <p>Working on authentic problems, issues, challenges.</p> <p>Finding promising ideas.</p> <p>Using idea diversity and multiple perspectives.</p> <p>Contributing to the 'good' in practice and society.</p>

Activity: Grounding; introducing and using authoritative resources

Action	<p>Information input by studying (curriculum) literature; lectures and guest lectures, practical knowledge experiences, expert teachers of other subjects.</p> <p>Conducting a dialogue about what exactly everyone means by seemingly clear terms in everyday use.</p>
Student actions	<p>Discussing the literature together, in-depth exploration of terms that the group uses to find out what each individual and the group as a whole understands by the term.</p> <p>Putting forward useful ideas for the group or group members. Assuming shared responsibility for the group's knowledge development (shared metacognition).</p> <p>Reading and building on the contributions of others by asking questions, providing new information, bringing information together and 'rising above'.</p>
Constructive action	<p>Looking beyond one's own practice or problem by studying similar problems and solutions and bringing them to the dialogue; crossing boundaries by connecting ideas from other groups, practices and problems.</p> <p>Reflecting on the discourse, evaluating progress, recognising individual contributions and group performance, and complimenting one another. Solving problems if the discourse goes astray in terms of content or socially.</p>
Teacher support actions	<p>Providing adequate and authoritative literature or helping students to develop effective searching skills.</p> <p>Promoting in-depth dialogues by inviting experts to give guest lectures, from both a theoretical and practical perspective; contributing one's own expertise, organising face-to-face-meetings to discuss the literature.</p> <p>Creating situations that promote cross-boundary encounters between practices and groups.</p> <p>Reflecting with expert on group's conceptual ideas.</p>
Assistive technology	<p>Subgroup's word clouds or concept maps and those of experts or topic models based on the literature to reflect content and stimulate dialogue.</p> <p>Word-growth tracking to analysis the increase in the use of keywords related to core curriculum concepts.</p> <p>Sending semantic analyses, for example with KBDeX, as feedback to students and developing their awareness by providing them with a visualisation of the content coherence between the group members and in their dialogue.</p>

Knowledge-building principles	<p>Utilising a variety of ideas, multiple perspectives.</p> <p>Using authoritative resources.</p> <p>Linking practice and theory by working on authentic issues.</p> <p>Preparing a knowledge-building dialogue.</p>
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Activity: integration and construction through design thinking, improving ideas, knowledge advancement

Action	Accommodation, the creation of collective and hence individual ideas, through integration and connection of ideas, rising above the information offered and discussed. Ultimately writing or creating a conceptual artefact.
Student actions	<p>Integrating knowledge by establishing relationships and connections, bringing together and rising above the group's knowledge, reasoning and arguing as to why certain ideas and solutions are better than earlier ones – the latter also in relation to sustainability for people, nature and society. How do the ideas contribute (or not), and why, to the 'good' in practice – that is, society?</p> <p>Collaborating by reading, appreciating, building on, bringing together and rising above each other's contributions, with a focus on the group's shared collective goals.</p>
Constructive action	<p>Collaborating on the development of an idea, vision, theory, solution, etc. that can be applied to, but also goes beyond, the intended problem area.</p> <p>Working towards more inclusive principles and higher-level (more abstract) problems. Rising above (over)simplifications and trivialities and thinking beyond the current 'best' or 'good' (practical) case studies.</p> <p>Meta-dialogue, reflecting on the discourse, evaluating its progress, recognising and complimenting individual contributions and group performance. Solving problems if the discourse is going astray in terms of content or socially.</p>

Teacher support actions	<p>Supporting design thinking: brainstorming, bringing information together, creating, testing, evaluating, rising above and properly substantiating ideas.</p> <p>Helping students to rise above the information that they have gathered. Explaining the difference between summarising, integrating and establishing relationships, and how searching for patterns can help.</p> <p>Pointing out important 'sources', viewpoints, theories that have been overlooked.</p> <p>Encouraging students to think beyond the current problem situation, more future-focused as well as environmentally sound or understanding the impact, longer-term consequences for the well-being and prosperity of nature, people, animals, plants, the organisation and society.</p>
Assistive technology	<p>Word-growth tracking to analyse the increase in the use of keywords related to core curriculum concepts.</p> <p>Sending semantic analyses, for example with KBDeX, as feedback to students and developing their awareness by providing them with a visualisation of the content coherence between the group members and in their dialogue.</p>
Knowledge-building principles	<p>Rising above.</p> <p>Knowledge advancement, knowledge development.</p> <p>Democratising knowledge.</p>

Activity: going public with the end result	
Action	Sharing insights with practitioners and society.
Student actions	Presenting the assignment; sharing insights in presentations, assessments, videoblogs, on social media, in their own practice, <i>Umwelt</i> . Writing papers, creating visualisations, preparing appearances.
Constructive action	Including direct practice in the discourse from the outset, giving a voice; entering into co-creation with fellow students, colleagues, people from your living environment about the insights and how they think these can contribute to their practice.
Teacher support actions	Providing a platform for the dissemination of insights; co-publications; co-creation sessions with practitioners, etc.
Assistive technology	Open source journals. YouTube. Facebook and other social media.

Knowledge-building principles	<p>Knowledge development.</p> <p>Contributing to progress and the 'good' in practice and society.</p> <p>Embedded assessment: the process and going public will already have revealed the quality of the end result, thereby making separate, stand-alone assessment unnecessary.</p>
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THE ROLE OF TEACHERS

Teachers play an important role in these activities. Their job is to develop and provide thinking tools for knowledge building and to guide the process by which students move from a naïve, egocentric, appearance-oriented approach of the subject matter to an essence-oriented or scientific approach to thinking (Davydov, 2008; Gal'perin, 1969; Haenen, 2001). Thinking tools relate to problem analysis, in which students, based on their own ideas and experiences, discriminate and identify relevant characteristics of the situation, and discover patterns, specific and generic principles by comparing different practices and perspectives. Observing and analysing are important tools here.

Thinking tools support the 'design mode' (Bereiter & Scardamalia, 2003; Scardamalia & Bereiter, 2008), in which students work on discovering patterns, specific and generic principles and explore the usefulness, potential, explanatory power and improvability of ideas and theories. This means that teachers can develop thinking tools to support the structuring and analysis of theories, objects, phenomena and events relating to challenges, authentic problems and issues in practice or in society.

Naturally, these are also tools that help determine why certain ideas or solutions are better than the original ideas or alternatives.

IN CONCLUSION

In responsive knowledge-building programmes, the learning process is based on the active and collective exploration and understanding of the deeper essence of things. Students master powerful conceptual skills to think critically, independently but also collectively, and to develop perspectives, insights and ideas that contribute to the design of ecologically sound solutions. This helps students develop their analytical, historical, linguistic and social thinking, and their epistemic skills in such a way that they become wiser, as do those around them.

Such programmes are attractive for students, because of their role as knowledge workers and knowledge designers in collaboration with one another, and because they get to work on

improving their ideas. Knowledge building is much more than simply completing learning tasks. It is a process that contributes to the social 'good'. It means holding each other close in order to live together wisely and survive ecologically instead of fighting one another – hence the responsive nature of the knowledge-building approach to pedagogy.

Thus, the research within this chair seeks to gain a deeper understanding of the processes of knowledge-building dialogues as a basis for developing thinking tools, as well as a deeper understanding of the use of semantic analysis tools that teachers and students can use in their knowledge development process as part of their own development. In this way, the chair wishes to contribute to a transition in 'learning' within teaching practice that will not betray the future of the young people being educated.

The knowledge that I have presented in this lecture has been created in my interactions about 'learning' as a responsive knowledge-building process with friends, strangers, colleagues at home and abroad, researchers and research group members. It builds on my previous inaugural lectures and on the studies conducted at those times, on my interactions with the literature, presentations and questions at conferences. In recent months, this has involved interactions with the computer screen when typing out ideas, integrating, being receptive, introducing new information, moving it around, summarising it, bringing it together and rising above it, analysing student interactions, and rising above – always rising above... All that remains is for me to thank the people who took part with confidence in this knowledge-building process, or who observed it or were confident in advance about the success of this journey of discovery.

ACKNOWLEDGEMENTS

With this inaugural lecture I accept my chair at the Open University, which I see as a natural extension of my chairs in 'Ecological thinking and knowledge creation' and in 'Responsive Education', completed this year at the Aeres University of Applied Sciences Wageningen. It will allow me, in collaboration with my new colleagues from the new department of Social Learning at the Open University, to further develop responsive knowledge-building education for implementation in practice, for example in the Master's in Learning and Innovation at Aeres University of Applied Sciences, as well as in the teaching at the Open University, where 'learning together' is an important aspect of pedagogy.

There are a number of people I would like to thank. First of all, thank you to the Executive Board of the Open University, the dean of the Faculty of Psychology and Educational Sciences and the chair's Board of Governors for the faith they have placed in me. I would not be here without the support, trust and confidence of two people. They are my dear wife Hanneke

Santegoets, who has supported me in every way possible, and Madelon de Beus, the director of Aeres University of Applied Sciences Wageningen, who understands what research means for a university of applied sciences and for a professorship, and who organised the funding. But she couldn't have arranged the latter without the cooperation of the Aeres Executive Board, who I also wish to thank.

The previous dean, Saskia Brand-Gruwel, and Rob Martens read an initial structural report for this chair by special appointment, for which I thank Paul Kirschner, and they were immediately enthusiastic about its revised profile. And yes, I too am someone who advocates a 'different kind of education', despite being well-versed in the theories of the giants of cognitive learning psychology, for which I am indebted to my PhD supervisors and friends Len de Klerk and Robert-Jan Simons. The kind of education suggested by these giants may no longer be adequate for training the responsively capable people that the world needs today. It is time to rise above the giants. In the decades since their time, knowledge development within educational sciences has not stopped moving. In the words of Vygotsky, education 'moves ahead of development'. I wish to thank Karel Kreijns, Renate de Groot, Jan van Bruggen, Marjan Vermeulen and many others for our substantive dialogues – I look forward to working with them.

This chair could also not have been possible without the enthusiasm of managers Hanneke de Laat and Lia Speeuwenberg and without the lecturers in the Master of Education team in Learning and Innovation at Aeres University of Applied Sciences Wageningen. Together, we have been using the knowledge-building approach for more than ten years and have succeeded in making this Master's in Learning and Innovation a unique, leading degree programme. I would not be here without the support of the knowledge-building community across the globe, and in particular Marlene Scardamalia, Carl Bereiter of OISE, University of Toronto in Canada, Jan van Aalst of Hong Kong University, and many others. Over the past year, that community has taught me a great deal about KBDeX analytics and topic modelling, and I am indebted to Yoshiaki Matsuzawa of Aoyama Gakuin University in Japan, Erick Velazquez, Sylvie Ratté of the École de technologie supérieure, Montreal (Quebec University) in Canada and Leanne Ma of OISE, University of Toronto in Canada. And of course I also owe a debt of gratitude to my PhD student, Hennie van Heijst, and research group members Pieter Seuneke (Aeres), Ine Sturkenboom (Terra AOC), Marije Bent (Aeres), Caroline Ermers (Master of Education alumnus, Learning and Innovation, Aeres) and Rik van Steenbergen (Aeres) for the knowledge-creation process of the past year in terms of what does and doesn't work in knowledge-building practice, something that we can happily continue for another year. Ine, good luck with setting up the Responsive Education 'practoraat'. Of course, I would also like to thank my fellow lecturers Niek, Mauro and Manon for their support and the, at times, very intense conversations that have forced me to keep an open mind. I would like to express my gratitude to those who read this address in advance, thereby preventing me from saying things that are too incomprehensible. Above all, I wish to thank friends and others for the

fascinating, in-depth dialogues sparked by my questions ‘What does “learning” mean to you?’, and ‘What did you learn from the most in your life, and when?’

Danielle, the management assistant at the Open University, Shadna, my own management assistant, and Inge from PR at Aeres University of Applied Sciences Wageningen, Vivian, Jeroen, Inge, Dimphy, John, Sandra, Sonja, Wendy, Monique, Jacqueline and Ralph who provided so much help with the preparations – thank you all. And, of course, thanks too to all those who have taken the trouble to attend via live streaming or to be physically present here in Heerlen.

I also cannot stand here today without thanking my parents, Piet and Jo – I know they would be proud. Alas, as my mother subtly commented to me in her final days, I didn’t have ‘enough proper publications yet’. But Mum and Dad, here I am, a tailor’s son and a professor.

Last but not least, I would like to thank my family: Hanneke once again, and of course Linn, Odde, Ive, Erik, Georgie, Victor and Cas. Without the sense of familial warmth and understanding that they give me, I would never have succeeded in devoting so much time and energy to writing a speech and travelling so much for my work. I would also like to thank them for the enjoyable times we have spent chatting, cycling, sitting on the beach, with a glass and a bite to eat, watching the sun sink into the sea, or celebrating, which is certainly something we are ready to do now.

Thank You.

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APPENDIX 1

DESCRIPTIVE STATISTICS FOR THE BETWEENNESS CENTRALITY VALUES OF TOPIC TERMS

(yellow Group A, blue Group B and green topic term in both groups)

	N	Minimum	Maximum	Sum	Mean	Std. Deviation	Activiteit Groep A	Activiteit Groep B
way t3t10t15	191	0,000	0,484	4,581	0,02398	0,068816		1, 2
knowledge v	191	0,000	0,353	4,369	0,02287	0,072997	1, 2	
organization t15v	191	0,000	0,188	3,140	0,01644	0,041948	2	
notion t10	191	0,000	0,243	2,886	0,01511	0,043238		1
position t10	191	0,000	0,112	1,967	0,01030	0,021375	2	1
context t1	191	0,000	0,081	1,956	0,01024	0,012826		3
self t3t10	191	0,000	0,054	1,860	0,00974	0,012965		2, 3
community t15	191	0,000	0,184	1,822	0,00954	0,031958	1	
team v	191	0,000	0,116	1,676	0,00877	0,026513	1	
question t10	191	0,000	0,075	1,608	0,00842	0,018074		3
process t1t10t15	191	0,000	0,066	1,500	0,00785	0,010975	2	2
learner t1t3	191	0,000	0,112	1,322	0,00692	0,016101		2
education t10	191	0,000	0,075	1,199	0,00628	0,016743		1
nature t15	191	0,000	0,066	1,156	0,00605	0,012182	2	
theory t1t3t15	191	0,000	0,046	1,105	0,00579	0,009907		3
development t10	191	0,000	0,063	1,102	0,00577	0,013613		
change t1t3	191	0,000	0,098	1,009	0,00528	0,017413		
sense t10t15	191	0,000	0,062	0,991	0,00519	0,010069		
experience t10	191	0,000	0,029	0,974	0,00510	0,008433		
transformation t3	191	0,000	0,040	0,967	0,00506	0,009890	3	2
relationship t3t10	191	0,000	0,066	0,938	0,00491	0,013158		
practice t10t15	191	0,000	0,054	0,925	0,00484	0,008420		
identity t1t10v	191	0,000	0,056	0,800	0,00419	0,010284		

form t3	191	0,000	0,036	0,745	0,00390	0,006861	3
result t1	191	0,000	0,198	0,727	0,00381	0,021357	2
work t3	191	0,000	0,048	0,718	0,00376	0,008856	3
world t15	191	0,000	0,057	0,695	0,00364	0,010348	3
people t1t3t10t15	191	0,000	0,030	0,624	0,00327	0,006904	
concern t15	191	0,000	0,049	0,448	0,00235	0,006832	2
resistance t1	191	0,000	0,048	0,405	0,00212	0,006708	

Knowledge in-(ter)-action

Responsive learning as knowledge building

"We've had enough": young people skip class for the climate. "However, the environmental crisis is also a crisis of our thinking, and therefore a crisis in our education. Facing the complex ecological and economic challenges, "old thinking"-solutions are not very helpfully.

The challenges call for people who can think less atomistical and more ecologically about how things influencing each other and how they are interconnected. Learning to think critically is not enough. Learning to think in a design-oriented way and building new knowledge and understanding together is crucial.

Many see learning as a neurological or cognitive information processing. Learning is primarily a psychological process from which knowledge in-(ter)action emerge. In this book, the theorem is conceptually discussed and substantiated with semantic, social network analyses of students' interactions. The book ends with practical guidelines for students and teachers for knowledge building responsive to challenges in our world.