



RESEARCH AND INNOVATION IN EDUCATION FOR SUSTAINABLE DEVELOPMENT

Wim Lambrechts / James Hindson (editors)

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A PEDAGOGY FOR UNCERTAIN TIMES

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ABSTRACT

Many scholars agree that it is essential in our rapidly changing world for young people to develop ‘uncertainty competences’ comprising specific sets of skills, knowledge, attitudes and capabilities needed to deal with uncertainty, ambiguity and complexity in diverse contexts. Learning to handle knowledge uncertainty requires learning environments tolerating, even inviting, uncertainty into the learning process. Terms describing this need have been used by Gordon (‘welcoming confusion, embracing uncertainty in learning’), Barnett (‘pedagogy for supercomplexity’), English (‘need for discontinuity in learning’) and Buckingham (‘need for optimally productive measure of epistemological chaos’) amongst others. Education for Sustainability (EFS) features subject areas such as ‘climate change’ hallmarked by complexity and uncertainty. Such topics can be difficult to deal with in the subject-delineated world of formal education. What does the ideal learning environment and teaching approach for the development of these competences look like? This paper will critically examine the literature and explore the dearth of coherent EFS-based empirical studies.

KEYWORDS

education for sustainability, knowledge uncertainty, uncertainty, uncertainty competences, 21st Century education

INTRODUCTION

21st Century: Age of Uncertainty

One of the urgent challenges facing society is related to the way in which humans address the ubiquitous nature, as well as the sheer amount of uncertain and ambiguous information about the state of our environment. This information is often incomplete, inconsistent and regularly contradictory. Influential bodies for example the IUCN (International Union for Conservation of Nature) and IPCC (Intergovernmental Panel on Climate Change) publish extensive reports about the severity and impact of habitat destruction (Baillie and Butcher, 2012) and the detrimental effects of ‘climate change’ (IPCC, 2014), based on state of the art scientific literature. Nonetheless, there remain many unanswered questions about these complex

processes. It is difficult for lay people, who may not speak the scientific language of probabilities and models, to know which expert to believe. Knowing how to deal with 'knowledge uncertainty' surrounding complex environmental challenges, and making value-based decisions, has never been more urgent (Goverse, 2013). Illustrations that humanity is entering 'post-normal times' filled with uncertainty, contested (scientific) knowledge, overwhelming complexity, and the need for re-assessment of our values (Funtowicz and Ravetz, 1993) pop-up from time to time in crisis headlines in the media. Education should foster the development of humans who when faced with uncertainty do not become paralysed, but on the contrary can act responsibly and constructively. Students should be prepared for making provisional decisions that are based on incomplete information, either because of the pressure of time or because insufficient evidence is to hand to fully warrant any particular decision, or because the outcomes are unpredictable (Barnett, 2012).

In discussing this so called 'Age of Uncertainty', Barnett (2012) makes a distinction between the concepts 'complexity' and 'supercomplexity'. With the former he points at the nature of systems, saying that the "interactions between their elements are unclear, uncertain and unpredictable" (ibid, pp.67-68). Although the challenge of fully understanding a system could in theory be resolved, in practice there is often too little time and too few resources. At the same time Barnett introduces another somewhat unsettling concept, namely that of 'supercomplexity'. He argues that the challenges of supercomplexity can never be completely resolved because of people's multiple and incompatible differences in interpreting the world. There is no one right answer to the complex questions of our time and therefore people need to accept that not everything is fully knowable. From his viewpoint, the world is not just radically unknowable, but is indescribable as well (ibid). It then becomes clear that students need to learn how to cope with uncertainty, ambiguity and indefinite questions (Bolhuis, 2003). Preparing young people for complex and supercomplex decision-making therefore requires developing 'uncertainty competences' that include specific sets of skills, knowledge, attitudes and capabilities needed to handle uncertainty, ambiguity and complexity in diverse contexts (Tauritz, 2012a). Being able to handle complex and uncertain knowledge is often seen as a premise for sustainable development (Mayer and Tschapka, 2008; Remmers, 2007), but experts generally offer limited guidance regarding how this can be achieved.

Scottish Curriculum for Excellence

In many countries schools focus on standardized testing (Longo, 2010). This approach often leads to teachers teaching to the test. The teachers feel time pressure

when working to a strictly standardized curriculum and so often skim over materials (Moon et al., 2007). This results in less time for learners to learn how to critically and creatively analyse content. Test-driven education focuses on students giving the right answer and can be said to be based on the existence of certainties. Teachers in test-driven systems often avoid an open teaching process in which there are multiple 'right' answers. There are, however, a few countries such as Scotland where efforts are being made to move away from an absolute focus on test-driven education and redesign the educational system.

In 2004 the Scottish government published a document titled 'A Curriculum for Excellence' (Scottish Executive, 2004), with the intention to provide all learners between the ages of 3 and 18 with the education needed to prepare them for the 21st Century. This document identified the following four key purposes of education, often referred to as the four capacities, which should enable each child and young person "to be a successful learner, a confident individual, a responsible citizen and an effective contributor" (ibid, p.12). Instead of a more contemporary content driven curriculum, the Scottish government aimed and continues to aim for a curriculum that ensures the development of the knowledge, skills, attributes and capabilities needed to flourish in life, both privately and professionally.

UNCERTAINTY COMPETENCES

Teaching beyond content-knowledge

The importance of the development of attributes and capabilities, rather than focussing primarily on content knowledge, is recognised by many contemporary scholars. Some assert that in order to handle our complex and uncertain world, learners need to develop the ability to creatively and spontaneously use uncertain information (Langer et al., 1989). Others variously describe the need for:

- strategies and skills for dealing with uncertainty (Hall, 2010);
- reflective thinking skills (English, 2013);
- capabilities – the ability to adapt to change, generate new knowledge, and continuously improve performance (Fraser and Greenhalgh, 2001);
- critical thinking skills and moral fortitude (Gordon, 2006);
- integrated thinking, problem solving, and personal and social skills (Higgins, 2001);
- an authentic identity, a capacity to choose from conflicting evidence and a preparedness to revise in light of new insights (Kreber, 2009);

- dispositions – durable determination to work things out in one’s own way, and qualities – the form those dispositions take (Barnett, 2007; 2012);
- uncertainty competences (Tauritz, 2012a).

There are a myriad of definitions regarding competences, skills, abilities and capabilities, attributes and dispositions in the literature. For practical reasons ‘uncertainty competences’ is used here as an umbrella term encompassing competences, (generic and specific) skills, strategies, knowledge, attitudes and capabilities needed to manage knowledge uncertainty.

Overview of uncertainty competences

Uncertainty competences are competences needed to support learning about and managing uncertain information and situations. While not being exclusive to the context of uncertainty, they are vital to handling complex and uncertain knowledge. There is an increasing imperative that primary, secondary and tertiary education institutions not only acknowledge the significance of acquiring such competences, but also take action in order to incorporate them appropriately into their practices. It is encouraging to see that there are governments, such as the Scottish Government, that stimulate and support schools (at least in the ‘Broad General Education’ phase – 5 to 13) in their efforts to focus on competence development for the 21st century. Although uncertainty competences are not specifically mentioned in the list of the four capacities, they are referred to using other words, such as ‘link and apply different kinds of learning in new situations’, ‘assess risk and make informed decisions’, ‘understand different beliefs and cultures’ and ‘develop informed, ethical views of complex issues’ (Scottish Executive, 2004).

Uncertainty competences can be divided into three categories: the competences needed to cherish, to tolerate and to reduce uncertainty and ambiguity. An extensive list of the competences (Tauritz, 2012a) is provided in Table 1.

Learning to cherish uncertainty

1. Being able to use uncertainty as a catalyst for creative action
2. Being able to empathise with people with different perspectives
3. Being able to 'entertain' an enquiring mind

Learning to tolerate uncertainty

4. Being able to accept not knowing what will happen
5. Being able to reflect on and change one's beliefs regarding uncertainty
6. Being able to employ lateral thinking

Learning to reduce uncertainty

7. Being able to prioritise ('triage') among many urgent issues
8. Being able to find, evaluate and utilise information (specific knowledge)
9. Being able to judge the credibility and cognitive authority of information sources
10. Being able to reason (inductive and deductive reasoning)
11. Being able to respond in accordance with the underlying probabilities
12. Being able to employ previous experience
13. Being able to assess one's own ability to achieve a desired outcome
14. Being able to engage a supportive network
15. Being able to formulate a plan of action to deal with uncertainty
16. Being able to work in, and contribute to, teams with mixed skills and experience
17. Being able to use one's intuition as a source of information

Table 1: Uncertainty competences (Adapted from Tauritz, 2012a)

A PEDAGOGY FOR UNCERTAIN TIMES

Education for Sustainability: The playground of uncertainty

Learning to handle knowledge uncertainty and developing the necessary competences requires a learning environment tolerating and even inviting uncertainty into the learning process. So what does the ideal learning environment and teaching approach for the development of these competences look like? Gordon (2007) promotes embracing rather than minimising the complexities, ambiguities, and risks that are inherent in the field of education. Terms describing this need have been

used by, amongst others, Gordon (2006) who writes about ‘welcoming confusion, embracing uncertainty in learning’, Schwartz (2011) who stresses the importance of ‘productive stupidity’, Hall (2010) who refers to a ‘pedagogy of uncertainty’ and ‘a state of liminality’ (2014), Barnett (2012) who coined the term ‘pedagogy for super-complexity’, English (2013) who speaks of the ‘need for discontinuity in learning’ and Buckingham (2014) who suggests the ‘need for an optimally productive measure of epistemological chaos’.

Education for Sustainability (Efs) offers interesting possibilities as ‘a playground of uncertainty’. It “seeks to enable citizens around the globe to deal with the complexities, controversies and inequities rising out of issues relevant to environment, natural heritage, culture, society and economy” (Wals, 2012; p.10). The topics explored in Efs tend to involve many complex and uncertain earth system processes, as well as multiple actors with diverging interests, values and perspectives (Wals, 2003; Rebich and Gautier, 2005; Hall, 2010). In addition, learners are often unable to comprehend the significance of their own actions and the degree to which changing their behaviour will have any substantial effect on these complex issues (Higgins, 2010). Examples of suitable topics include: the effects of climate change, the loss of biodiversity, the risks of using nuclear power and the potential dangers of fracking. Even though several Efs researchers have mentioned the confrontation with uncertainty and pluralism within the context of Efs (e.g. Higgins, 2009; Sterling, 2010; Wals, 2010), there has been very little empirical research to date that aims to further explicate the concept of teaching students how to handle this uncertainty in Efs. Hall (2006; 2010) comes closest with his analysis of climate change education at academic institutions. He uses Perkins’ (1999) theories of troublesome knowledge and Meyer and Land’s (2003) theories of threshold concepts to discuss the implications of uncertainty for teaching and learning. He posits a pedagogy for teaching uncertainty whereby the concept of uncertainty is taught explicitly through student-centred approaches.

The following paragraph discusses some of the general design principles found in the education literature regarding teaching learners how to handle uncertainty.

General design principles for a pedagogy for uncertain times

Various authors have listed and described design principles for an educational approach that acknowledges uncertainty as an essential driving force in teaching, that creates a space for perplexity and uncertainty, one where students can explore new possibilities for thought and action with the goal of fostering citizens able to

cope in an uncertain world (Floden and Buchmann, 1993; Gordon, 2006; English, 2013). This 'space' is referred to as the 'twilight zone of inquiry' by Dewey (1916) and the 'in-between realm of experience and learning' by English (2013). English describes experiencing doubt as a break between the past and the present, where one's previously held knowledge and experience no longer suffice to deal with the present situation. She refers to this interruption as a 'discontinuity in experience'. This discontinuity can create a 'prereflective beginning' to learning. When learners view the interruption as an issue to be addressed they can then choose to transform it into a 'reflective experience' stimulating reconsideration of previously held beliefs, knowledge and actions.

The design principles found in the literature can be divided into three main groups (see Table 2):

1. Prerequisite for uncertainty in the learning process
2. Allowing uncertainty into the learning process
3. Making uncertainty negotiable in the learning process.

- **Prerequisite for uncertainty in the learning process**

In focussing on uncertainty in the learning process teachers are confronted with a conundrum: the seemingly unsolvable antithesis of a safe learning environment versus an uncertain learning environment. A learning environment in this context refers to the totality of the physical (or virtual) setting, in which a learner finds him- or herself trying to make sense out of things. Learners working together are both affected by and receive support from their co-learners. They are influenced by, and under the active facilitation of a teacher as well as being guided by institutions such as cultural routines. All this takes place in the pursuit of individual or group learning goals within an organized and co-designed learning process (Tauritz, 2012b). A safe learning environment is one in which the individual learners can discuss different perspectives, is tolerant to students holding different views and opinions, and where judgment both by teachers and students regarding these clashing views is suspended. In such an environment, students can experience a sufficient degree of safety to learn and change their ideas and perspectives. In the presence of uncertainty, learners need to feel safe enough to take part fully and permit themselves to share their perspectives, enter into conflicts, display vulnerability and develop uncertainty competences (Forrest et al., 2012). The teacher's presence, guidance and reflection on the teaching process are critical. There is another prerequisite for developing uncertainty competences and that is the openness and willingness of the teacher as well as the learner to overtly accept the concept of uncertainty (Hall, 2014).

1. Prerequisite for uncertainty in the learning process

Safe learning environment

Teacher's and learner's openness and willingness to accept the concept of uncertainty

2. Allowing uncertainty into the learning process

Process-oriented /open-ended/student-centred teaching approach

Dynamic and emergent curriculum

Inter-disciplinary/holistic topics

Problem based education approach

Scaffolding change within the context of uncertainty

Teachers and students willing contextually to reverse roles

Increased student responsibility for the learning/teaching process

Expose students to conflicting frames of reference

Teamwork in small groups

Stimulating students to clarify, elaborate, extrapolate and explain their ideas

Active student participation

3. Making uncertainty negotiable in the learning process

Recognise uncertainty explicitly

Identify and capture the variation among students' personal conceptions of uncertainty

Teachers use conditional instruction

Model to students that uncertainty needs to be embraced

Communicate how to effectively deal with uncertainty

Table 2: Design principles for 'a pedagogy for uncertain times'

- **Allowing uncertainty into the learning process**

There are various design principles that allow uncertainty to enter the learning environment. A teaching approach that is not focussed on narrow learning outcomes (content-orientated), but rather emphasises the learning process of the students, creates space for uncertainty on the part of the teacher as well as the learner (Bolhuis, 2003). A dynamic and emergent curriculum is one in which the teacher responds to input from the learner as it emerges during the evolving teaching process (Morrison, 2008). As teachers don't always know how learners will respond, they

have to deal with a substantive amount of uncertainty themselves (Shulman, 2005). Raab (2004) discusses the virtue of the teacher resisting giving all the answers and instead becoming 'an expert in not knowing' and trusting that more valuable insights and conceptualisations will emerge from the group of learners. The teacher will have to combat his or her own feelings of anxiety about the open-endedness of the teaching process.

Problem-based learning can further stimulate the development of coping with uncertainty (Koh et al., 2008). Effective facilitators can help learners realise that by holding on to current ideas, models and theories, they are in effect avoiding uncertainty and change (Nel et al., 2008).

Teaching how to deal with complex problems requires an inter-disciplinary and holistic education process (Morrison, 2008; Hall, 2014). An inter-disciplinary approach implies looking at separate subjects and subsequently uniting them; integrating knowledge is necessary to provide answers to complex problems. A holistic approach refers to the experience of the topic in its totality. This shift in thinking encourages incorporating many sources of knowledge including creativity and intuition.

Maintaining a 'healthy' and ethical level of uncertainty in the educational process requires the introduction of scaffolding, in other words gradual changes in the level of uncertainty creating conditions for the learner's uncertainty competences and experience to develop (Morrison, 2008; Forrest et al., 2012). As the roles of teachers and learners alternate, teachers become learners and learners become teachers. The responsibility of the learners in the educational process increases, confronting them with opportunities to enhance their uncertainty competences. However, teachers must never abdicate their responsibility in facilitating the learning process of the students (Raab, 2004; Shulman, 2005).

It is important for learners to be exposed to conflicting frames of references (Kreber, 2009) and the realisation that for most complex problems there is no one right answer. Through working in small groups learners are further confronted with differing ideas and perspectives. Learners should be stimulated to clarify, doubt, evaluate, extrapolate, explain their ideas and re-examine their beliefs in order to gain genuine knowledge (Shulman, 2005; Gordon, 2006). Through a process of active participation and communication learners are not only made accountable to their teacher, but also to their peers.

- **Making uncertainty negotiable in the learning process**

In general the concept of uncertainty is not made explicit in teaching multi-disciplinary topics, such as the effects of climate change. Hall (2010; 2014) suggests that this comes about either because the concept of uncertainty is complex and difficult to teach and is therefore avoided, or simply because it is seen as intrinsic to the discussion of multi-disciplinary topics. For a sound understanding of the concept of uncertainty, however, it is essential to make it clearly visible in the educational context (Forrest et al., 2012; Hall, 2010).

Hall (2010) asserts the importance of identifying the students' personal concept of uncertainty by encouraging them to reflect on their own conceptions and to discuss these explicitly with their peers. It may be necessary to revisit the concept of uncertainty frequently during the teaching process in order for students to become comfortable with it.

Further, teachers should employ conditional instruction, in other words what is generally regarded as a fact is presented as a probability statement, rather than an absolute truth (Langer, 1989). Information presented in this way leads to an enhanced willingness to remain open to alternative interpretations, and when on a later date the circumstances change, to be able to question the information, and use it creatively and mindfully. Some argue that learners become insecure when confronted with an uncertain world that does not follow strict 'Newtonian rules'. One could also argue that children who are used to being taught conditionally actually feel more secure as they are better prepared for an uncertain and ambiguous world. When a confident teacher employs conditional language it implies that uncertainty is an attribute of the information and not an attribute of the teacher (ibid). It sends the message that a person can remain confident when faced with knowledge uncertainty.

To be able to use uncertainty as an instigator of learning it is important to learn to cherish uncertainty. Gordon (2006) talks about embracing uncertainty, confusion and doubt as it may result in a deeper understanding of oneself and the world we are part of. Buckingham (2014) coined the term 'epistemological chaos' referring to an educational context in which knowing and not-knowing, and certainty and uncertainty swirl around each other chaotically. He asserts that teaching shouldn't be about eliminating this chaos, but should instead focus on communicating how to handle uncertainty and use it effectively. How to accomplish handling uncertainty effectively needs far more attention from researchers.

Barnett's framework for transformational education

In this final paragraph the need for developing different uncertainty competences will be reflected upon using Barnett's framework for transformational education (2012). Barnett constructed a two-axes framework that distinguishes between four different educational approaches and the potential educational 'outcomes' they produce. The horizontal axis represents a design that ranges from 'no risk' (negligible amount of uncertainty) to 'high risk' (ample amount of uncertainty). The vertical axis ranges from education that emphasises educational development to transformational education.

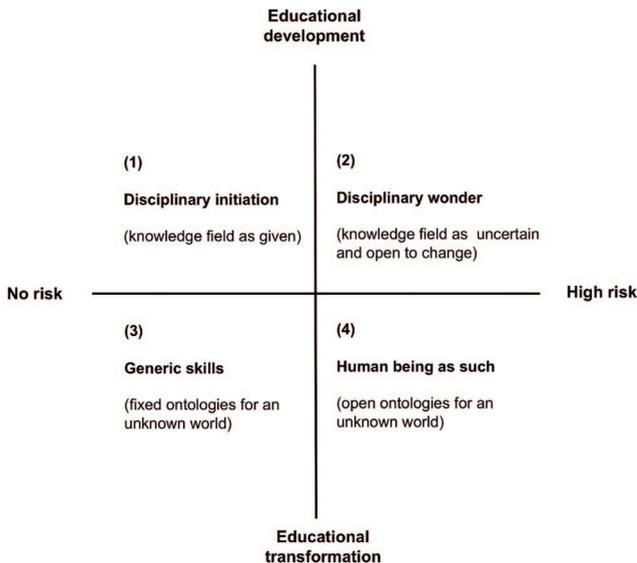


Figure 1: Barnett's framework for transformation education (2012)

Quadrant 1 is characterised by pre-existing aims and objectives. Uncertainties are kept to a minimum. Students develop understanding and specific skills. **Quadrant 2** is characterised by uncertainty and imaginative curricula designed to prepare students for a complex world. **Quadrant 3** focuses on the development of specified (generic) skills and transforming students into people who are more adequately equipped for an uncertain world. However, these learning environments are relatively risk-free, and therefore limited in their capacity to teach learners how to handle high-risk situations full of uncertainty. **Quadrant 4** represents education that is both high-risk and transformational in order to prepare learners for an unknown

world, what Barnett refers to as 'transformation of human being'. Central to this quadrant is living and working in a supercomplex world. People are confronted with multiple descriptions of the world and a confrontation with previously unknown dilemmas and uncertainties. Current knowledge and skills are not adequate for handling these situations and therefore require humans that have, for example, the ability and willingness to continuously learn, show empathy, engagement, and can handle and perhaps even celebrate uncertainty.

Barnett emphasises the importance of education that is appropriate to Quadrant 4, as it is his belief that predetermined learning outcomes are not sufficient for dealing with 'the unknown'. However, it seems irresponsible to frame the development of specific skills and competences as being inferior to the development of dispositions and qualities as discussed by Barnett. Education should ensure the development of the broad spectrum of uncertainty competences discussed in this chapter. Nonetheless, Barnett's framework is useful as a reflective tool.

Referring to Table 1 we can see how particular uncertainty competences can be placed in Barnett's quadrants. For example, 'Being able to judge the credibility and cognitive authority of information sources' fits into Quadrant 1. 'Being able to respond in accordance with the underlying probabilities' fits into Quadrant 2. 'Being able to reason' fits into Quadrant 3. Finally, there are uncertainty competences that are not typically emphasised by educators, but which are critical for handling uncertain knowledge and fit clearly into Barnett's essential Quadrant 4: 'Being able to accept not knowing what will happen', 'Being able to use uncertainty as a catalyst for creative action' and 'Being able to use one's intuition as a source of information'. Barnett's framework emphasises the different kinds of learning environments required during an educational career to develop all the 'uncertainty competences' that will assist people in navigating our uncertain and (super)complex world.

CONCLUSION

If we want to be able to provide our children and young people with an education that prepares them for a successful life in the 21st Century, we will need a radical change to the way we engage them pedagogically. Scotland is one of the countries that is, on a political level, starting to acknowledge the significance of this notion. However, the changes needed to our education system are immense and we have barely made a beginning. Research into the teaching of uncertainty competences is still in its infancy. We know very little about the ways in which teachers can improve their students' competences for handling uncertainty and (super)com-

plexity. This is even more so with regard to learners in primary and secondary education. Furthermore, guidance from what we do know is often not implemented. Some key issues that should be addressed by researchers in cooperation with the educational sector are: How should teachers communicate about uncertainty in a developmentally appropriate manner? What do concrete, age-appropriate and effective teaching methods for teaching specific uncertainty competences look like? Do outdoor education and education for sustainability offer specific opportunities for the development of uncertainty competences in relation to environmental challenges? And what are useful instruments to assess the development of uncertainty competences?

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