Chapter

Are Teacher Students' Deep Learning and Critical Thinking at Risk of Being Limited in Digital Learning Environments?

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Abstract

The 21st century is quite different from the 20th in regard to the skills people need for work, citizenship, and self-actualisation. Proficiency in the 21st century differs primarily due to the emergence of sophisticated information and communication technologies. In this chapter, we will discuss whether teaching students are sufficiently prepared regarding the need for 21st century skills and how learning in a digital age affects the need for high-level critical thinking. Based on 20 in-depth interviews of Norwegian and New Zealand teaching educators, teaching students' low critical thinking skills seem to be understood as a global challenge and as connected to the digital revolution. Despite being from different sides of the globe, teaching educators from both countries expressed concern regarding students' in-depth learning and critical thinking skills in an educational where learning is influenced by digital technology. This article discusses the dilemmas regarding having easier access to greater amounts of information, which requires a different form of critical thinking. We question whether we are and have been preparing students sufficiently for this educational change.

Keywords: deep learning, critical thinking, digital technology, teacher education, digital learning

1. Introduction

The 21st century is, according to Dede [1], quite different from the 20th in regard to the skills people need for work, citizenship, and self-actualisation. Proficiency in the 21st century differs primarily due to the emergence of sophisticated information and communication technologies (ICTs). All over the world, ICT in education has been incorporated into formal national guidelines of the degree requirements of teacher education as an official policy. Digital technology in itself is often seen as a catalyst for educational change, and technology as a symbol for change is often understood as something positive, as investments in technology supports development in society [2].

Despite the fact that a fifth of the 21st century is behind us, it seems we are not up to speed regarding the skills anticipated as central for our digital era. Furthermore, there is a lack of clarity regarding what 21st century skills really are.

The digital revolution is part of the change making 21st century skills different from those learned in schooling through the 20th century. ICT is changing the nature of perennial skills that are valuable in the modern world, as well as creating new contextual skills necessary for digital societies [1]. The world has changed fundamentally in the last few decades, and in effect, the role of learning and education has changed. Many of the skills needed in past centuries, such as critical thinking and problem solving, are, according to Trilling and Fadel [3], even more relevant today. How these skills are learned and practiced in everyday life in the 21st century though, is rapidly shifting.

This chapter presents a critical perspective on how learners' information, media and technology skills can be understood, and how they are connected to learning and innovation skills. Data for this chapter is based on qualitative in-depth interviews of ten teaching educators at the University of Waikato in New Zealand and ten teaching educators from UiT, the Arctic University of Norway. Both countries are facing similar educational challenges when teaching in digital environments, as both must educate teaching students in digital-rich environments with high access to various ICTs and educational resources at home [4]. The universities are similar in size and student numbers.

This comparative study of Norwegian and New Zealand teaching education has led us to question how we educate students to meet the future and whether the educational systems are adapting sufficiently to new digital learning contexts. Is teaching students' deep learning and critical thinking at risk of being limited in digital learning environments? In short, are students sufficiently prepared for the future?

2. Different perspectives on skills

2.1 The 3Rs—Traditional education

There is widespread agreement among educators and the public about the importance of the traditional fundamental building blocks that underpin student learning. These skills are often referred to as the 3Rs—reading, writing and arithmetic [5]. These are important skills, but as Crockett et al. [6] have argued, for students to progress from the foundations of learning, teachers need to expand their thinking outside their 'primary focus and fixation on the Three Rs (3Rs)—beyond traditional literacy to an additional set of 21st century fluencies, skills that reflect the times we live in'.

2.2 The 4Cs as common ground for 21st century skills

The notion that the 3Rs are not sufficient when preparing students for the future is not a new idea. Broader skills are needed and have been discussed since the first half of the 20th century. One example is an informal meeting of college examiners attending the 1948 American Psychological Association Convention in Boston, which was the start of the development of the theoretical framework known as Bloom's taxonomy. This is a well-known and commonly used system of classifying the goals of the educational process beyond the 3Rs [7]. A common ground in the search for 21st century skills is by Keane, Keane and Blicbau [8] described as the 4Cs:

- Critical thinking
- Communication

- Collaboration
- Creativity

This understanding is based on three influential organisations associated with education, management, and industry developed definitions for 21st century learning. These organisations are the Ministerial Council for Education, Employment, Training and Youth Affairs (MCEETYA), the American Management Association (AMA), and AT21CS, a public and private partnership among governments, educators, academics, and industries [8]. While basic skills such as numeracy and literacy remain essential building blocks for learning, higher order skills such as the 4Cs are equally vital for learning and employment in the 21st century. Keane and Blicbau [5] write that 21st century skills are about fusing the 3Rs and the 4Cs, but the contextual aspect is also of great importance because context contributes to defining and affecting how different skills are used.

2.3 Twenty-first century skills and digital technology

Students in the 21st century live in a technology- and media-rich environment with access to a wide range of information, powerful digital tools, and the ability to collaborate and communicate with others. This affects what form of critical thinking is required. Fundamental to the development of 21st century skills is the importance of ICT for learning [8]. A discussion paper prepared for the European Union stated that information and communication technology (ICT) is at the core of 21st century skills. It is regarded as both an argument for the need for these skills, and a tool that can support the acquisition and assessment of them. The rapid development of ICT also requires a whole new set of competences related to ICT and technological literacy [9].

Keane, Keane, and Blicbau [8] write that using these technologies in education matter because students need to be prepared this digital world, in which they require a skillset that is broader than the traditional foundations of the 3Rs. Tucker and Courts [10] claim that teachers who mainly concentrate on a fixed curriculum that focuses on learning through repetition and memorisation find it difficult to connect new technologies to the traditional view of classroom learning.

To be effective, teachers and students need to be able to demonstrate both the 3Rs and the 4Cs in relation to an online world. Government policy has been somewhat based on the assumption that access to technology is the key to achieving success. However, simply providing students with digital technology will not lead to development of these skills. How the teacher utilises these devices in the classroom is important for improved student outcomes [5]. Dede [1] claims that we need to move from consensus about the vision of 21st century learning to a thorough understanding of and commitment to the outcomes of 21st century learning. In reality, he claims, the ability to use digital devices in no way means that students know anything about global awareness or health literacy, learning and innovation skills, life and career skills, or even media literacy skills.

There are new skills to master, and they must be understood intertwined with changing contextual skills. Trilling and Fadel [3] have an extended model, where the 4Cs are part of a skillset called learning and innovation skills. They propose two extended sets of skills: information, media and technology skills; and career and life skills (see **Table 1**).

It is important to keep in mind that digital technology in itself is just a tool. Keane and Blicblau [5] state that without an understanding of learning theory, the use of transformative technology may actually be ineffectual. So, to have digital

1. Learning and innovation skills	2. Information, media, and technology skills	3. Career and life skills
• Critical thinking • Communication and collaboration • Creativity and innovation	• Information literacy • Media literacy • ICT literacy	• Flexibility and adaptability • Initiative and self-direction • Social and cross-cultural interaction • Productivity and accountability • Leadership and responsibility

Table 1.
Three components of 21st century skills [3].

competence for learning, technological skills must be understood intertwined with other sets of skills and knowledge, like learning and innovation skills (the 4Cs).

2.4 Twenty-first century skills in today's education—are we there yet?

This has been an ongoing discussion for centuries, and yet it seems like educational practices and systems are having trouble adapting to the espoused learning theories, required formal policy, and understanding of the need for these skills [11]. Keane and Blicbau [5] criticise education for using technology in schools at the enhancement rather than the transformative stage, meaning that tasks could be completed satisfactorily without using technology, and without really changing the task. They claim we need to better provide the appropriate situations that will allow students to develop skills using the 4Cs. Lund [12] claims that schools either lack a view of technology or operate with a view of technology that is at best reductionist. A central control and management mechanism in schools is a standardised test. These tests provide some insight into students' learning outcomes, but if used unilaterally, may also risk the development of a limited dynamic practice. As Resnick [13] writes, when preparing children for the future, how learning outcomes are assessed must be reconsidered. We need to focus on what is most important for children to learn, not what is easiest to measure and evaluate. The same concern is expressed when discussing digital technology and education. If we are only concerned with measuring the effects of the use of technology, instead of examining how digital technology changes the school culture, we risk cultivating a reductionist approach and ignoring possibilities for innovation [12]. These challenges are not exclusively related to digital practices, as school traditions for learning have in general been criticised for being pacifying. Jordet [14] writes that Norwegian schools are characterised by sedentary activities where the students are placed in the role of passive recipients of handed down knowledge. Such educational practices give students few opportunities to unfold their relational, meaning-seeking, creative, exploratory, and intentional natures. He states that for schools to be able to contribute to children mastering their lives and becoming participants in work and society, the schools' traditions, thinking, and practices must be changed to better support students' self-realising and active natures. Oostveen, Oshawa, and Goodman [15] found that meaningful learning is far more likely if new technologies are recognised as providing transformative opportunities.

2.5 Digital natives and digital immigrants

Elstad [16] claims that young people born after 1980 have digital capabilities and are therefore regarded as digital natives, in contrast to older teachers who are

described as digital immigrants when born earlier than 1980 [17]. Digital immigrants are in governing positions in education, both as policymakers and educators. Could important stakeholders' lack of digital technology be the reason education is not keeping up to date with new learning theories? Most teaching students referenced in this study were born in 1980 or later and are considered digital natives. Prensky describes digital natives as 'native speakers of technology, fluent in the digital language of computers, video games, and the internet' [18]. In this chapter, we present teaching educators' evaluations of their students and their learning processes. In other words, so-called digital immigrants are evaluating digital natives, but it is not merely their technological skills being evaluated. As mentioned, these skills must be understood as intertwined. Students' learning and innovation skills, like critical thinking, are intertwined with their information, media, and technology skills, and both sets of skills must be trained. Combined, it creates the need for new contextual skills. Keane, Keane, and Blicblau [8] write that simply using technology does not guarantee that deep learning will occur. The use of technology needs to align and adapt with our knowledge of learning to be able to operate in a transformative space.

A study of teaching students and their educators showed that teaching educators scored higher on professional digital competence than their students, but were more critical towards the technology in educational contexts than their students [2]. The differences between teaching educators and teaching students in this study were mostly unrelated to being digital immigrants or natives. They were connected to the complex competence gained through professional practice, regarding the interaction of content knowledge, pedagogical knowledge, and technological knowledge [19].

Knowledge of technology is only one critical component of teachers' use of technology in their practice; they also need to know how to use it for successful integration in teaching and student learning. Being critical is not necessarily about being behind and not up to date, but about taking steps aside to gain a deeper perspective. Successful teaching is not only about finding the right technology, but also the values, norms, and attitudes that reside within the academic staff in teacher training organisations [2].

One group of digital natives is defined as Generation Z. Tucker and Courts describe Generation Z as those who were born after 1990 [10]. This generation is described as 'technically savvy, well adapted at communicating via the internet, and used to instant action due to the internet technology they have always known'. The traditional education model has, according to Tucker and Courts [10], been slow to adapt to the learning styles of these students, and researchers across the globe seem to agree on this. What seems more unclear is an understanding of what form of adaptation is needed, and how we get there. How do Generation Z's learning styles and strategies affect learning processes in education?

2.6 Deep learning and critical thinking

Deep learning involves paying attention to underlying meaning. It is associated with the use of analytic skills, cross-referencing, imaginative reconstruction, and independent thinking. In contrast, surface learning strategies typically place more emphasis on rote learning and simple descriptions [20]. Deep approaches differ from surface approaches, where reproducing knowledge and syllabus-bounded practices is central. A third approach is the strategic approach, which is based on a competitive form of motivation and attempts to maximise academic achievement with minimum effort [21]. One tool for understanding deep learning is Biggs and Collis' [22] developed structure of observed learning outcomes (SOLO), which

form the basis of the SOLO taxonomy. The SOLO taxonomy focuses on the development of surface understanding to deep understanding, with a continuum of complexity and response to learning across the hierarchy of its levels of understanding. The SOLO taxonomy illustrates different levels of understanding:

1. Prestructural understanding is described as incompetence.

2. Unistructural understanding where relevant aspects can be identified.

3. Multistructural understanding where aspects are combined and described.

4. Relational understanding integrated in multistructural understandings. Being able to analyse, apply, argue, and compare aspects of one's understanding.

5. Extended abstract is when the learner is able to create, formulate, generate, hypothesise, reflect, and theorise based on a relational understanding.

The higher the levels of understanding in the SOLO taxonomy, the higher the level of critical thinking, creativity, and communication. Critical thinking is the discipline of actively and skilfully conceptualising, applying, analysing, synthesising, and/or evaluating information gathered from, or generated by observation, experience, reflection, reasoning, or communication [5, 8]. All these aspects are central for 21st century skills and deep learning.

When teaching educators are asked about students' learning processes, there is great concern regarding their ability to apply deep learning approaches. This is a complex field with a range of perceptions and understandings. Many of the teaching educators expressed conflicting views, where they addressed challenges and described how digital technology was fostering learning. In this chapter, we focus on the challenges of teaching with digital technology, and not so much on the benefits, which are many.

3. Method

3.1 First phase: the survey

This study is based on an explanatory sequential design, in which a conducted survey comprises the first phase of a sequence of methods. It is a comparative study involving 64 Norwegian participants from UiT, the Arctic University of Troms, and 44 New Zealand participants from the University of Waikato, with a response rate of 83.8% and 73.4%, respectively. The survey builds on Argyris and Schön's theory of action [23] and consists of three main constructs: professional digital competence, professional attitudes towards digital technology in education, and professional application of digital tools.

Based on their results, ten participants from each university were invited to participate in an in-depth qualitative interview.

3.2 Second phase: the interview

The first step in strategically selecting interview participants was to ensure that all participants had *high digital competence*, with the aim of gathering informed opinions regarding the use of technology in educational contexts. The second step

was to select participants within this group of digitally skilled teaching educators based on maximum variation sampling. Maximum variation sampling is a purposeful selection of participants with different perspectives on a phenomenon [24]. As Creswell [24] explains, the maximum variation sampling strategy requires defining a category that produces different responses to paint a varied picture of the participants. The category *attitudes towards digital technology* was used to select five participants who responded more critically and five participants who responded more positively towards digital technology within each country (**Figures 1** and **2**).

A total of 20 semi-structured interviews were conducted to understand and elaborate upon the results of the survey. The transcribed interviews were subsequently analysed using NVivo. One must consider the uncertainty arising when

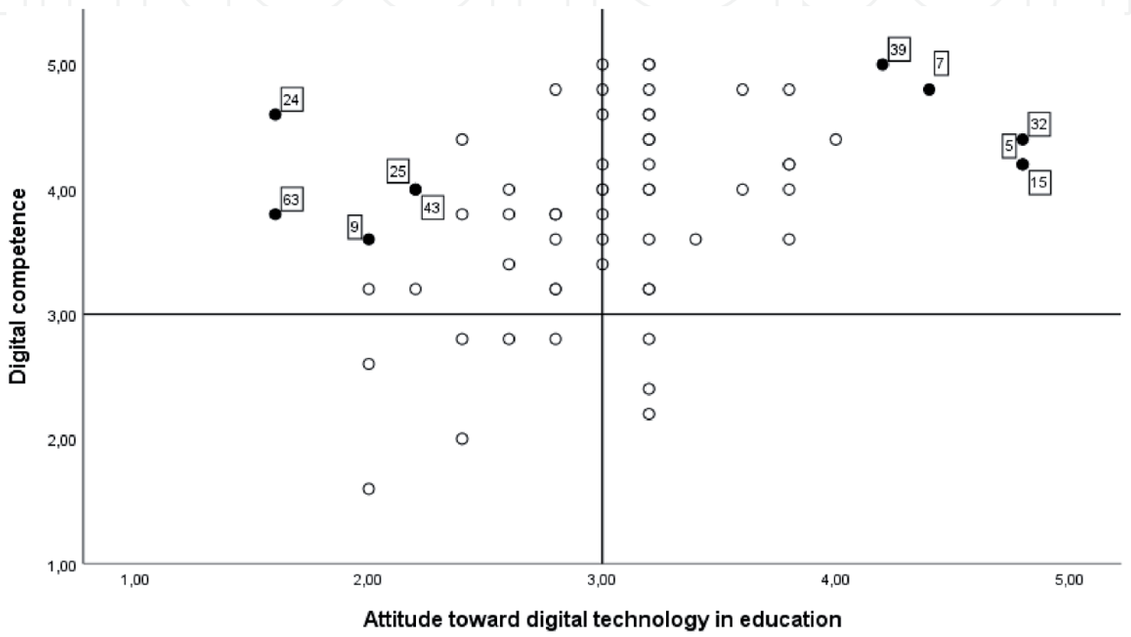

Figure 1.
Selection of Norwegian teaching educators.

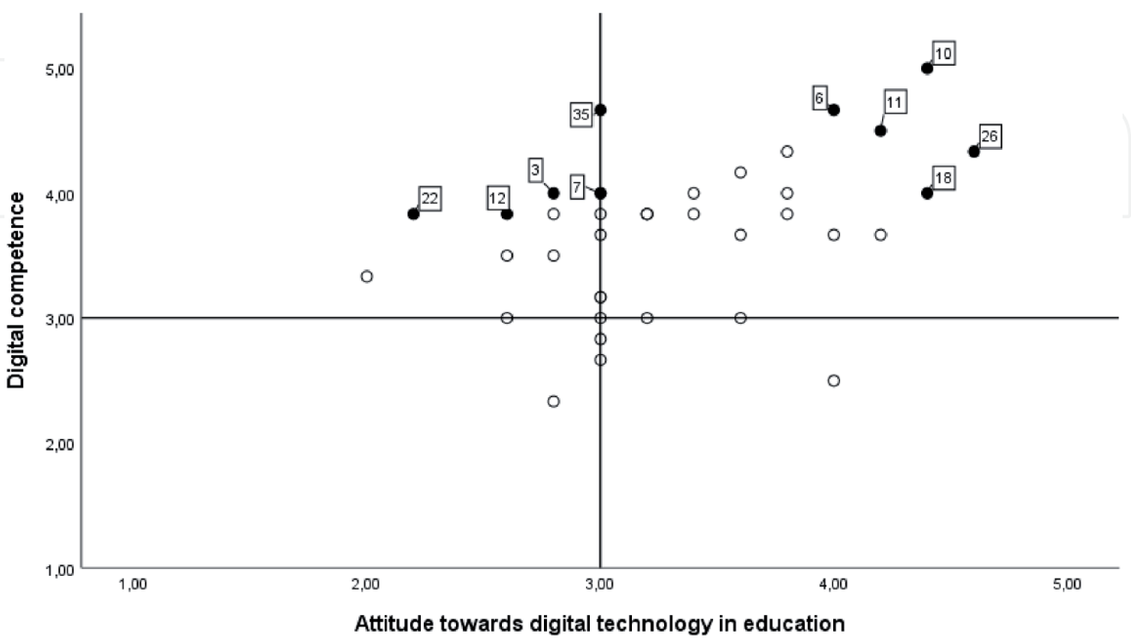

Figure 2.
Selection of New Zealand teaching educators.

translating from one language to another. The survey, interview guide, and participant statements were translated from Norwegian to English. There are nuances when translating and analysing that may be lost, and these could have influenced the results. An ongoing collaboration with New Zealand researchers throughout the process was very helpful in concept- and language-related clarifications.

4. Deep learning and critical thinking in a digital learning environment

This builds on a comparative study, but findings showed that the challenges experienced were evident in both countries. Despite being from different sides of the globe, teaching educators from both Norway and New Zealand expressed a concern regarding students' learning in digital contexts. Overall, 13 of the 20 interviewed teaching educators expressed a concern regarding students' deep learning, critical thinking, and source criticism. They link the students' lack of learning and innovation skills with their level of digital literacy skills (cf. Trilling and Fadels' model of 21st century skills). If their learning and innovation skills are not high enough, their use of digital technology seems to be at risk of not being used at a transformative level, and in some instances limits the quality of their learning processes.

4.1 Deep learning?

4.1.1 Norwegian teaching educators' perception of students' level of learning and learning approaches

One of the teaching educators was quite astonished that students could be very technically competent without being able to search the web for knowledge. He explained that he had bachelor students not able to find literature, and when he demonstrated, the students were blown away as if it was magic. The ability to make use of keywords when searching for information and relevant articles was poor among students, he said, and he was surprised by the fact that they were not able to use the knowledge they ought to have attained during their education.

Another teaching educator claimed that the students' learning approaches were superficial and based on surface learning. She explained the reason was that they had not learned or practiced deep learning processes. 'When asked to read a text, they do not extract what is important and relevant. They just dutifully read to complete the task'. She said it was fine that they were using Google when studying, but the worry was that the content seemed to move straight from the screen and out of their mouths, bypassing the students' own relevant reflections. Another teaching educator claimed that there was an evident difference between students who had studied media and communication at the senior level in school and those who had not. They understood that there was quite a lot of work involved in being able to utilise the digital tools in a productive way, while the rest was basing their learning processes on a copy-paste strategy. She explained that students tended to express a strategy of searching for readymade abstracts online. This was very unfortunate because the type of learning we want to promote in our teacher education is largely based on reflection, not just reproduction of readymade connections between levels of understanding.

I asked the teaching educators if it was a challenge to get students to engage in deep learning when readymade answers were easily assessable online. The teaching educator replied, 'Of course'. He explained how he had noticed that students were often using online references instead of the syllabus. 'It can be the same keywords as is described in our syllabus, but they would rather google it. So, that is when I question what source criticism they have applied to secure their information'. He

explained that the students were not concerned with this, and uncritically used this on tests and exams. One critical question to be asked was: When using a traditional lens when assessing the students, what are we measuring as new tools and contexts for learning have transformed learning activities and outcomes? Do we have practices for evaluation that aligns with the new learning activities and intended outcome?

The same teaching educator's experience with digital tools was that they were not always helpful. Furthermore, he felt it somewhat distorted/disabled the learning processes. This understanding was confirmed by another educator who explained that she thought of digital technology as a detour. 'Sometimes we use digital technology like PowerPoint, when traditional methods like using a black board can work as a better tool'. She explained that students expressed their preference for educators using PowerPoint, as they found it better not having to write everything down.

4.1.2 New Zealand educators' perception of students' level of learning and learning approaches

In New Zealand, teaching educators were also vocal regarding this challenge. One teaching educator explained how she had noticed that students were increasingly entering search words in Google to access what she referred to as 'easy takeaway knowledge'. The consequence, she explained, was that the students did not have to engage deeply or really work with the content. 'Students can access it very easily, and it almost replaces thorough research, like reading academic articles,' she said. She explained how this availability of a lot of information on the internet undermined students' capacity to read critically, do research, and read academic journals or chapters. She elaborated that this aspect of availability, quick easy access, was undermining the development of academic capacities and serious research for assignments. A critical selection of information takes more time. 'You have to actually digest those harder articles, and it seems to me that students read less of those [...] even if they use them in their assignment it is superficial.' Another one supported this perception and explained: 'the easiness of technology creates a false notion of what learning is about, that you don't have to work for knowledge. I don't think that's true. If you look at anyone who is good at something, they have put in a lot of work and practice. I think digital technologies might be kind of responsible for this notion of learning'.

Some research shows that students who often use technology tend to do worse when compared with students who use less of such tools [4, 25–27]. Mueller and Oppenheimer [28] conducted a study in which they concluded that the use of a laptop negatively affected the students' test results. They focused on the students' use of laptops instead of traditional writing during lectures. They argued that note taking by hand calls for different cognitive processes than writing on a laptop. One can write faster on a laptop and take more notes. 'Although more notes are beneficial, at least to a point, if the notes are taken indiscriminately or by mindlessly transcribing content, as is more likely the case on a laptop than when notes are taken longhand, the benefit disappears' [28]. Writing by hand is slower, and one cannot take verbatim notes in the same way as with a laptop. Instead, students listen, digest, and summarise so that they can succinctly capture the essence of the information. Taking notes by hand forces the brain to engage in deeper learning, which fosters comprehension and retention [29–31]. As May points out, 'even when technology allows us to do more in less time, it does not always foster learning'. This is in line with the teaching educator who claimed that that learning has a tendency to be too easy. When students are copying and pasting from the internet and using

digital technology uncritically, they miss out on the constituting process of struggling with individual concepts and developing their 21st century skills, like reflecting, generating, being creative, theorising different concepts, and communicating independent ideas. It seemed like the teaching educators had trouble engaging students in deep learning processes as digital technology created a learning environment that fostered the strategic approach, and they experienced challenges where students attempted to maximise academic achievement with minimum effort. Perhaps they did this unaware of the consequences these approaches could have on their potential learning outcomes.

Deep learning strategies cannot be externally imposed and must be interest-led. Interest can be stimulated by placing less emphasis on curriculum content and more on contextual interpretation, in other words, the 4Cs [20]. Learning activities need to be interesting and engaging and allow critical reflection and dialogue with peers and mentors [32].

4.2 Critical thinking?

4.2.1 Norwegian teaching educators' perception of students' level of critical thinking

Critical thinking is vital for problem solving, but one teaching educator explained that students' critical thinking skills were virtually non-existent, and that a lot of effort was put into trying to develop those skills alongside their digital skills. Another explained that as much as digital tools were creating opportunities in teaching, they were also creating challenges. Those challenges were related to teaching students to be critical. When is it useful to use it, and what resources are usable in academic settings?

> *'The students' ability to use and utilise digital tools shocks me, because it is very poor. They are consumers; they are not producers. The job we do here is about making them able to become producers as well, so that they can utilise the learning resources available. They need to be prepared better through high school in relation to the critical use of digital tools; there are many who have major shortcomings. I think it has gotten worse really, because it's like if it's not on Facebook or Google, then it does not exist. It's a little scary. It seems that they are becoming less and less aware that it is just a person who has written this, and that information could have been written with underlying agendas. The critical reflections are something we have to work quite a lot with, and more for each new class just the three years I have been here.' (translated from interview).*

One teaching educator related the challenge to the fact that it was very easy to retrieve information, without necessarily understanding what it means. One can just type in a word or look something up, 'then you just read exactly what comes out, because you typed in a word'. The problem, she explained, was that the students were not able to see the whole picture. It was noticed in their presentation on exams, or in things they wrote, that they did not fully understand the concepts they were writing about. Their presentation was really just reformulation of something copied from the internet, and was not coherent.

One challenge is related to what extent they understand the concepts they are writing about; another is whether the source is trustworthy. The students were warned both in writing and orally, one teaching educator explained, not to use bloggers' opinions and secondary interpretations as a basis for academic writing. The students still handed in papers with hardly any syllabus literature or academic

references. One teaching educator explained that she had been teaching for so long that she remembered well the time when education was much more book centred.

> *'One had to search for and order different articles at the library, and so on. Now it is all online, and that is great. It makes things easier. From that perspective, the students have accepted the possibilities online, and that is good. Nevertheless, there is a negative side to this. I do not find that students' source criticism has developed or increased according to this change. For instance, I do not accept references to Wikipedia in my papers, even if there is a lot sensible information written there. I encourage them to start there to get an overview. It can function as a platform for relevant references. But they have to be critical regarding what they are basing their arguments on, and the skills to do this are lacking.'*

4.2.2 New Zealand teaching educators' perception of students' level of critical thinking

The same perception is widespread among the New Zealand teaching educators. One explained that one of the things they were focusing on was critical analysis and information literacy. He said, 'The information is at our fingertips, but we need to really think about when we're using it and how it's being used, and be able to seek out robust information for what we need, and understand exactly what we're using'. Another participant explained that she had noticed that there was an overreliance on inaccurate media rather than knowing that they could go to a particular resource and have more valid information.

'So they can't make those kind of judgements about what is valid and what isn't valid to cite, because there's been no role models for them to look at and learn from. So the whole concept to any kind of academic approach to writing, whether it is through social media or other aspects of writing, is a very big learning curve for them... they struggle.'

The same challenge was exemplified by an interaction with another teaching educator and a student.

'One of my postgraduate students this week wanted to know what I meant by "doing critical review", which is an instruction for an assignment. And she copied something in, and I said: Where did you get this from? She said: Oh, I got it off Mr. Google, and I'm sort of thinking is this really, you know... This is a postgraduate student who is saying that, and doing that. That is actually pretty problematic. So, you can't make too many assumptions about where people are at.'

She explained that the biggest challenge was that the students needed to develop their critical perspectives on what they were seeing, and referred to this as 'very patchy'. She was trying to encourage academic writing, thinking, and discussion, to make students extract knowledge and the underpinning ideas. To 'have the students in the position where they can tell the good from the bad, the useful from the not so useful information. That has been a problem.'

One teaching educator challenged the notion of students as superficial in their learning because of digital technology; she claimed that the challenge was about the need for a different set of skills.

> *'I certainly don't feel that students are more superficial because they're using them, or because they can access Wikipedia or... I think they need to learn a different set of skills, but I think that once you have developed those skills, I think you can actually get into deeper learning, and I think digital technology enhances those skills. I think we can be superficial in whatever we do. But, it's not because of digital technology we become superficial.'*

Based on what the teaching educators explained, it seems like digital learning environments are enabling advanced multi-structural learning at such a high level that their lack of relational understanding and ability to create extended abstracts have been overlooked. Digital tools make students appear skilled in handling information as they can copy ready-made text online by googling keywords. This apparent skill in writing could be misleading for teachers in their assessment of the student. When students reach higher education, they are perceived as unskilled and uncritical, as higher education reveals a worrying lack of learning strategies that would enable them to reach deeper levels of understanding [22]. It seems that through primary and secondary education, they develop an imbalance between learning and innovation skills, and information, media, and technology skills [3]. Furthermore, this imbalance seems to create an asymmetrical reinforcing effect as digital environments make it easy to present multi-structural understanding at a high level, which can disguise the need to work with students' ability to think critically, a central part of the higher order of thinking in the SOLO taxonomy.

5. What to think of future teacher education?

That 'everything used to be better' is a claim made by all generations. One teaching educator pointed out that 'students in the past have also written things they do not understand themselves. I do not think that is new. Everyone just wants to find the easiest way to a good grade, maybe.' However, if seeking the easiest way is a fundamental human trait, it is a challenge for teaching and learning now that knowledge is more easily accessible and presented, without engaging critical thinking and deeper cognitive processes. Wajcman [33] states that 'Rather than simply saving time, technologies change the nature and meaning of tasks and work activities, as well as creating new material and cultural practices'. We need to adapt to these changing practices and learning activities, and adjust how we educate our students to be prepared in this new learning context. The teaching educators in this study had some suggestions.

5.1 How to adapt, and what not to adapt?

Teaching educators in this study expressed a worry regarding the digital format versus traditional books. As information is more easily accessible, students tend not to read the books and research the greater context information it was gathered from. In a book, you often have to read larger sections to get a grasp of the concepts. When googling keywords, it is easy to find a lot of 'hits,' and then mix a selection of copied sections. This can apparently look like a reasonable text, but it is surface learning and without deep understanding of the content. Reading a book will perhaps create deeper learning, even though the text produced is less polished than a copy-paste text from already digested sections online.

> *'I mean obviously, students have different skills, but I am thinking that critical thinking skills, reading hard information is definitely undermined, that is what I am thinking. I am noticing that with students.' (New Zealand teaching educator)*

> *'I do not think their digital skills have become any higher in the last five years, I think almost on the contrary. They are very good at watching videos and looking for things online, but I do not think they are good at retrieving relevant information. They are not as source-critical as I would like. We probably have a job to do to make them able and skilled.' (Norwegian teaching educator)*

The two skillsets, learning and innovation skills and digital skills, are connected. Students will not flourish in their digital skills if they are not intertwined with the 4Cs. Digital natives and Generation Z have a good technical understanding, but integrating that with the skills of being creative and critical is central to achieving deep learning processes in digital learning environments.

> *'They (students) are not able to transfer those skills and understandings into their learning environment. I would say the key thing again here is that the students might come in with skills and abilities, but not necessarily pedagogical understanding of how to actually implement that in their teaching practice. I think that's the key thing that we, initial teacher education lecturers, need to really focus on, and I think we need to come up to the plate and think about the digital literacies our students have... and actually think about being responsive to those as well.' (New Zealand teaching educator)*

One teaching educator who perceived students as getting shallower in their learning was vocal about the value of structuring education around the use of books as well as digital devices.

> *'I require them to read a textbook, because I think that doing lectures actually, online, is actually not a satisfactory way to get one's point across. So instead, what I do is I weave my points across all the ways that I teach each week, so all the things I present, all of my interactions and discussion groups and... I think it works up to a point, but I'm expecting them to read the textbook quite well, really.'*

To round up this chapter, I leave the final word to one of the New Zealand teaching educators who summed up most of the main findings in our study.

> *'I think digital technology can be a lot more passive at times, and in terms of students, I think they just see technology as providing the answer. I think it is important to challenge them and say, "There may not be an exact answer to the question; you have to keep challenging and questioning." I sometimes believe they have become a lot more passive, and just accepting what comes via the technology as being the one and only, or the right way of doing things. Rather than challenging. I think it is due to the way the world has shifted. Where it is a lot easier for them to go online and get something, rather than physically having to go somewhere and think about it, like a library or hunt out a book, or... Everything is right there. Therefore, I think that passive learning most probably happens a lot more because of the technology, because they can just access wherever they are. In terms of preparation, coming through from high school, yes, I think there are some definite skills in terms of being critical of information that needs to be taught, prior to coming into higher education. Particularly in the sense of questioning the information they are accepting. I believe some disadvantages are that most probably the students do not challenge enough, they just accept technology, and I think that might be the way technology has been introduced over the years. "Here it is, here is the answer." "If you don't know, just google it, and you'll get something." So that passive, not questioning, not challenging... I think is a real disadvantage.'*

6. Conclusion

It seems that students' development of critical thinking and deep learning is challenged in digital learning environments. A high level of ICT literacy seems

to challenge the lens traditionally used to assess students' capabilities and needs. Furthermore, ICT skills and learning and innovation skills seem to mutually influence each other, as low learning and innovation skills make the students' ICT skills stagnate when assessing their critical use of online resources. We find that learning in a digital environment complicates the development of critical thinking, but we also believe that this can be corrected by redefining what it takes to prepare students for the future. For a long time, the focus has been on developing their digital skills. However, it would seem like we have not paid enough attention to what the digital transformation requires of interwoven aspects related to learning in digital societies. We need to develop the traditions in education, where the focus has been on technical skills more than on interdisciplinary competencies. If we are able to better secure and develop students' abilities to be critical and creative, and to collaborate and communicate, digital learning environments could act as learning resources for all students. Without this skillset, there is a risk of students using digital resources in a way that prohibits deep learning and the development of higher order thinking. Based on the input of the teaching educators, it is essential that education is structured in a way that a lack of the 4Cs is noticed by educators and teachers, and that learning is structured to develop such skills. It is unfortunate if students acquire a high degree of information, media, and technology skills, as digital immigrants do, without the learning and innovation skills required to manoeuvre constructively in the overwhelming and easily accessible landscape of digital learning. Education needs to structure learning that challenges students to connect different skillsets, so new contextual skills and knowledge are developed. Just like critical thinking in digital spaces.

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