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OPEN-ENDED EDUCATION:

HOW OPEN-ENDEDNESS MIGHT FOSTER AND PROMOTE TECHNOLOGICAL IMAGINATION, ENTERPRISING AND PARTICIPATION IN EDUCATION

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KEYWORDS

FUTURE EDUCATION, 21ST CENTURY LEARNING, OPEN-ENDED TECHNOLOGY, OPEN-ENDED PROJECTS, OPEN-ENDED INSTITUTIONS, DESIGN THINKING, CRITICAL PEDAGOGY, CODING PIRATES

ABSTRACT

THE ARTICLE DESCRIBES OPEN-ENDED EDUCATION FOR 21ST CENTURY LEARNING AS THE COMING TOGETHER OF OPEN-ENDED TECHNOLOGY, OPEN-ENDED PROJECTS, AND OPEN-ENDED INSTITUTIONS IN WAYS THAT FOSTER AND PROMOTE FUTURE EDUCATION FOR CITIZENSHIP IN SOCIETY.
THROUGH THE CASE OF THE CODING PIRATES FUTURE ISLAND, THE ARTICLE DEMONSTRATES HOW OPEN-ENDED EDUCATION CAN BE PRACTICED TO FOSTER AND PROMOTE TECHNOLOGICAL IMAGINATION, ENTERPRISING, AND PARTICIPATION. THIS PRACTICE IS THEN DEVELOPED INTO A THEORETICAL MODEL FOR THE CONCEPT OF OPEN-ENDED EDUCATION AS A WAY OF AND FRAMEWORK FOR PRACTICING FUTURE EDUCATION FOR 21ST CENTURY LEARNING WITH NEW TECHNOLOGIES.
THE ARTICLE PRESENTS AN ANSWER TO THE CALL FOR 21ST CENTURY LEARNING AS THOROUGHLY COLLABORATIVE, COMMUNICATIVE, CREATIVE, AND CRITICALLY REFLECTIVE THROUGH THE CASE AND THE CONCEPT OF OPEN-ENDED EDUCATION. IT OUTLINES THE IMPLICATIONS OF THIS CALL FOR EDUCATION AND HIGHLIGHTS THE FACT THAT THE EMPHASIS IN BLOOM'S REVISED TAXONOMY ON INGENUITY, ORIGINALITY, PARTICIPATION, AND ASPIRATION IMPACTS THE PRACTICE OF EDUCATION.

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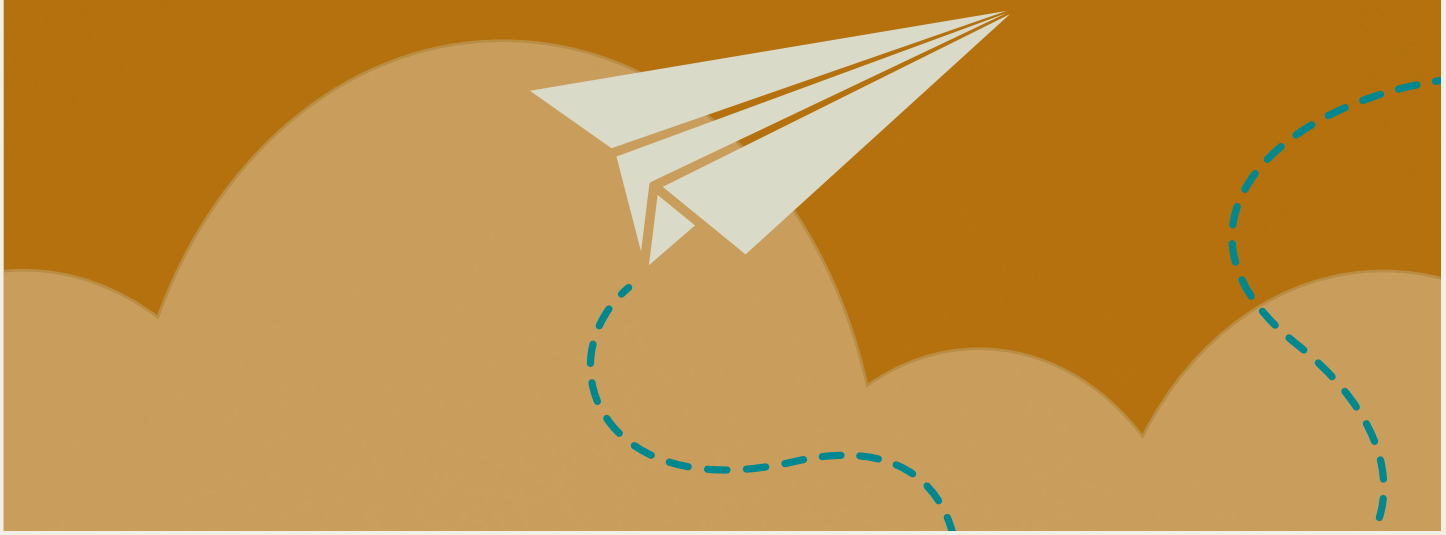
RIKKE BERGGREEN PAASKESEN IS CAND.PÆD.SOC AND HAS TAUGHT PEDAGOGY AND DIDACTICS AT VIA UNIVERSITY COLLEGE. CURRENTLY, SHE IS TEACHER AT GALTEN FRISKOLE AND KLANK EFTERSKOLE WHERE SHE TEACHES THROUGH OPEN-ENDED PROJECTS USING NEW TECHNOLOGIES, ESPECIALLY LEGO MINDSTORMS ROBOTS. RIKKE HAS BEEN HEAD OF THE DEPARTMENT OF CODING PIRATES AT DOKK1 IN 2015 AND IS VICE CHAIR IN THE LOCAL CODING PIRATES AARHUS. SHE HAS GIVEN TALKS ON OPEN-ENDED PROJECTS AT THE COUNTERPLAY'15 FESTIVAL (2015) AND ON OPEN-ENDED EDUCATION WITH RIKKE TOFT NØRGÅRD AT DANMARKS LÆRINGSFESTIVAL (2016).



Part 1: Future education
The call for 21st century learning

When reading about so-called 21st century learning within K12 education, there is a persistent demand for the development of imagination, enterprising and participation. In his seminal article "Educating for innovation" (2006), Keith Sawyer states: "analysts emphasize the importance of creativity, innovation, and ingenuity in the knowledge economy. In fact some scholars refer to today's economy as a *creative economy* […] powered by human creativity" (Sawyer 2006, p. 41, emphasis in original). The hope among stakeholders and decision-makers that future education will foster and promote such qualities is also echoed in leading reports and statements from the OECD (Organisation for Economic Co-operation and Development), NEA (National Education Association) and P21 (Partnership for 21st Century Learning). Deputy Director for the OECD Directorate of Education describes 21st century learning on the OECD Homepage as aiming for participatory citizenship:

> *Education today is much more about ways of thinking which involve* ***creative*** *and* ***critical*** *approaches to problem-solving and decision-making. It is also about ways of working, including* ***communication*** *and* ***collaboration****, as well as the tools they require, such as the capacity to recognise and exploit the potential of new technologies, or indeed, to avert their risks. And last but not least, education is about the capacity to live in a multi-faceted world as an active and engaged citizen. These citizens influence what they want to learn and how they want to learn it, and it is this that shapes the role of educators.* (Schleicher undated, unpaged, our emphasis)

The above-emphasized competencies are connected to citizenship, open-mindedness, interdisciplinarity, and innovation in future education for 21st century learning. Schleicher concludes by stating that the world needs "versatilists", i.e. citizens capable of adapting to challenges in open-ended ways and acting intentionally on the imagination through creating and participating in education and society in flexible democratic and collaborative ways.

In their report, *Preparing 21st Century Students for a Global Society – An educators guide to the 'Four Cs'*, the National Education Association systematizes and develops the call from the OECD into the 4 Cs of 21st century learning – *Collaboration, Communication, Creativity* and *Critical Thinking*. These 4 Cs of 21st century learning have then been developed into a framework for *Learning and Innovation Skills* by P21.

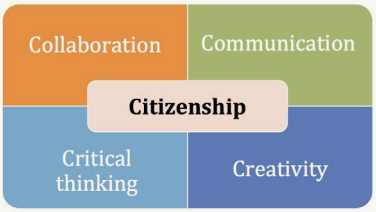
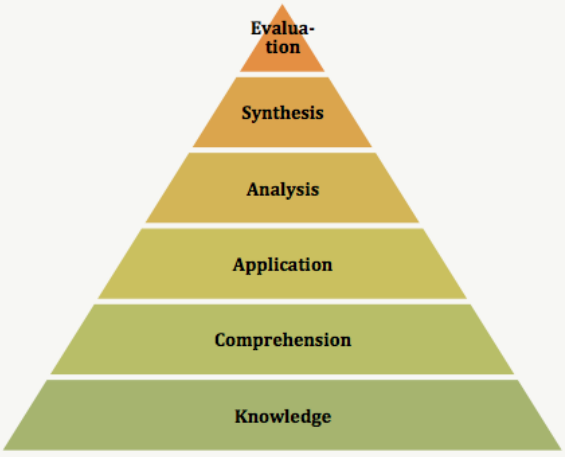
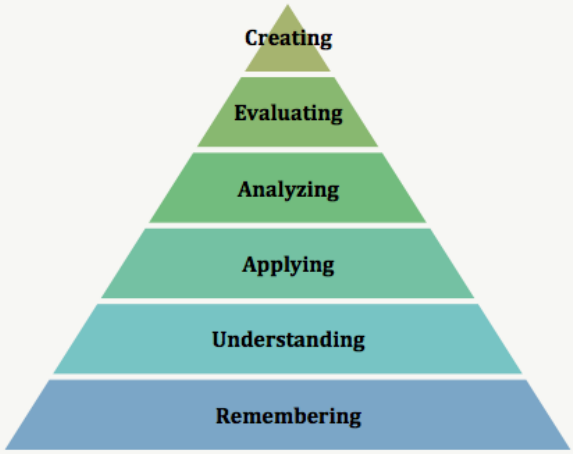


Figure 1: Core competencies in 21st century learning

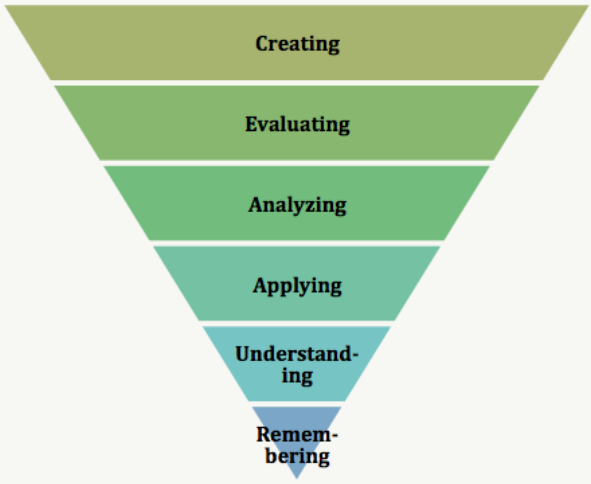
These competencies should form the core of future education to foster open-minded and open-ended citizenship for and in an open society. Future education is then connected with *Information, Media* and *Technology Skills* given that "[t]o be effective in the 21st century, citizens and workers must be able to create, evaluate and effectively utilize information, media, and technology" (P21 undated, unpaged). Most importantly, this must be done through fostering and promoting the imaginative, enterprising and participatory – or one could perhaps say playful – attitude emphasized by Schleicher from OECD.



Bloom's original taxonomy



Bloom's revised taxonomy



Bloom's revised & inverted taxonomy

This emphasis on creativity and innovation is furthermore accentuated through the revision and inversion of Bloom's taxonomy in 2001 where a completely new category – "creating" – was placed at the top tier of the pyramid. Subsequently, the pyramid was inverted to additionally place emphasis on the creative, constructionist, enterprising, and participatory aspects of learning and education. The inversion was performed to circumvent the perception that the majority of learning going on in education should take place in the lower levels, simply because these levels the most voluminous (extensive?) and thus perceptually come off as constituting the majority of learning activities.

This revision and inversion of Bloom's educational taxonomy has been carried out to move teaching and learning away from its prior "heavy emphasis on objectives requiring only recognition or recall of information" (Krathwohl 2002). Instead, *creating* as a competency is placed as the highest-order thinking task, thus making *analyzing* and *evaluating* something carried out in order to create. Finally, in "New blooms in established fields" (2005), Peggy Dettmer has developed the level of creating within the revised and Bloom's inverted taxonomy as "ideational learning" characterized by original construction and production through innovation that is *facilitated* by educators and *generated* by learners, where "content is novel, process is open-ended, and the domain supports uniqueness. Diverse outcomes of accomplishment are anticipated and encouragement is offered to enable learner fulfillment" (Dettmer 2005, p. 73). The below concepts contained within "ideational learning" (encircled with a red box) expound the heart of Bloom's highest level of thinking and are encapsulated in 21st century learning for future citizenship as described by the OECD, NEA, and P21. These are also at the center of open-ended education and encapsulated in the terms *technological imagination, enterprising,* and *participation in education*.

Figure 2: Bloom's original, revised, and inverted taxonomy. Based on (Andersen & Krathwohl 2001)

BASIC LEARNING: Phases 1 and 2 with near (low-road) transfer of learning. Characterized by **REALISM** (What should learners know?)

Essential

ACQUISITION. Rudimentary. Is requisite for all learners. Educator teaches, learner masters. The content is necessary, the process is structured, and the context domain designates the standard(s). Time is provided for mastery and compensatory alternatives are supplied as needed if mastery is not possible.

Baseline	Cognizant	Sentient	Conscious	Aware	**Viable**
Phase 1	Know	Receive	Observe	Relate	**Perceive**
Phase 2	Comprehend	Respond	React	Communicate	**Understand**

APPLIED LEARNING: Phases 3, 4, 5 with far (high-road) transfer of learning. Characterized by **PRAGMATISM** (What can learners do?)

Developmental

UTILIZATION. Complex. Is to be individualized for each learner. Educator guides, learner grows. The content is important, the process is flexible, and the context domain determines suitability. Variable stages of achievement are expected and learning opportunities are provided that challenge every student.

Phase 3	Apply	Value	Act	Participate	**Use**
Phase 4	Analyze	Organize	Adapt	Negotiate	**Differentiate**
Phase 5	Evaluate	Internalize	Authenticate	Adjudicate	**Validate**

IDEATIONAL LEARNING: Phases 6, 7, 8 with original construction/production. Characterized by **IDEALISM** (To what do learners aspire?)

Generative

INNOVATION. New. Is to be personalized for every learner. Educator facilitates, learner generates. The content is novel, the process is open ended, and the domain supports uniqueness. Diverse outcomes of accomplishment are anticipated and encouragement is offered to enable learner fulfillment.

Phase 6	Synthesize	Characterize	Harmonize	Collaborate	**Integrate**
Phase 7	Imagine	Wonder	Improvise	Initiate	**Venture**
Phase 8	Create	Aspire	Innovate	Convert	**Originate**

Figure 3 Dettmer (2005), p. 73.

The aim of this article is to explicate how such competencies can be fostered and promoted through open-ended technology (part 3), open-ended projects (part 4), and open-ended institutions (part 5) in ways that support new educational futures and future education for citizenship in society (part 6).

Future education between the rule-bound and free-form

To be imaginative, enterprising, and participatory requires a playful attitude and approach in education; what Mitchel Resnick calls *Kindergarten-style learning* (Resnick 2007, p. 1) and Dan Dixon characterizes as Dionysian (Dixon 2009). But, importantly, future education simultaneously requires the ability to have a reflective, critical, and synthesizing attitude, or what Dan Dixon calls Apollonian. As such, future education for the 21st century should occupy a third space between free-form Dionysian playing and rule-bound Apollonian gaming.

Within this third space, between the Apollonian, systematic, synthesizing, and reflective and the Dionysian, imaginative, improvisational, and creative, lies what we name open-ended education. It is a concept that shares affinity with Miguel Sicart's description of playfulness as the ability to juggle order and chaos through open-ended movement: "To play is to be in the world. Playing is a form of understanding what surrounds us and who we are, and a way of engaging with others. Play is a mode of being human […] Play is a movement between order and chaos" (Sicart 2014, p. 3). Consequently, open-ended education emerges through a superposition of the Apollonian and the Dionysian as reflection & intuition, rationality & passion, intentional & improvisational, individual & communal, thinking & tinkering become interlocked, entangled, and fused. What traditionally has

tended to be a dichotomy between free-form affective tinkering and rule-bound cerebral thinking is merged in open-ended education without becoming trapped in either domain.

However, looking at present practices and the ability to educate for imagination, enterprising, and participation through harnessing the potentials of new technologies, the road towards future education appears impeded in several ways. The next section describes four such central impediments to future education.

Challenges for future education

When reading through literature on barriers for and oppositions to future education with technologies, at least four general impediments or challenges emerge.

1) *The challenge of the aggressive opposition war* between the Dionysian and the Apollonian opinion-former camps in education. From the Apollonian camp there is fierce opposition towards anything that seems too chaotic, fluffy, disorderly, or playful. Education must be systematic and serious. Conversely, the Dionysian camp accuses the Apollonian camp of rigid, controlling, measuring, and lifeless education. Education should be playful and fun. These debates tend to quickly escalate and turn into unproductive, dichotomist straw man arguments between practices that seek to liberate people through unrestricted play or enhance learning through clear rules.

2) *The challenge of teaching future education*. In "Innovating for education" (2006) Sawyer emphasizes that "students are taught that knowledge is static and complete, and they become experts in consuming knowledge rather than producing knowledge" (Sawyer 2006, p. 47). This claim is backed by Craft et al. who state that students are still being taught in predefined, controllable, and testable ways (Craft et al. 2014, p. 18-19). Here, we have the challenge that educational practices and institutions are too traditional and fixed in the bottom of Bloom's taxonomy. Under this traditionalist regime, creative participation in education ends up being subdued while "creating coherence in the classroom" (Roehl 2012, p. 111), and ensuring "learning outcomes in tests and monitoring and controlling pupils" (Arrezola & Bozalongo 2014, p. 258) becomes of pivotal importance. Here, teachers are "focusing on correct responses, reproduction of knowledge, and obedience and fear that encouraging creativity in the classroom will lead to [Dionysian] chaos" (Ranjan & Gabora 2013, p. 11).

3) *The challenge of new technologies in education*. In "Interacting with … what?" Dicks explicates that the opposite position – education through free-form technological play – is equally impeding in relation to future education. Building on the case example of interactive science museums, she argues that arbitrariness permeates the experience to such an extent that no education takes place: "Analysis revealed how children were using exhibits primarily as (1) sensory stimuli and (2) props in the acting out of peer group relations […] social and sensory dimensions were so dominant for children as to eclipse thoughts of science, how things worked or what the exhibit showed" (Dicks 2013, p. 303). "The Center's many projectors, microphones, mirrors and screens enable multiple public self-displays, orientating the children's co-participation to the creation of repertoires of [Dionysian] spectacles rather than directing it towards the [Apollonian] technological means of making them. This begs the question of what actors co-participate *in*" (Dicks 2013, p. 317). Such Dionysian participation accentuating tumultuous free movement, frivolous diversion, voluntary interaction, spectacle, and non-regulation is also found within free-form makerspaces with unsystematic technological tinkering. It is participation in the form of engaged Dionysian play with technologies, but it cannot be considered 21st century learning for future education and citizenship.

4) *The challenge of harnessing and transferring* technological engagement, empowerment and emancipation from makerspaces to education. Educational FabLabs, Makerspaces, and Codeclubs are all

> firmly placed within the STEM paradigm of education (Science, Technology, Engineering, Mathematics) aiming for computational thinking, problem-solving, solution-making, technological understanding, and engineering (Walter-Hermann & Büching 2013). This gives rise to challenges such as *programming for the sake of programming*, *products without learning process,* and *the keychain syndrome*. This means that technologies in education are cast in rule-bound Apollonian systematic STEM ways. This is evident in the keychain syndrome described by Blikstein (2013), denoting the unimaginative, reproductive, and non-participatory act of just copying and following the instructions, which results in a 3D printing keychain sweatshop factory: "Unless educational designers unveil the real incentive system at play in the classroom, teachers who reward students based on quick completion times, quality of solution, and efficiency might actually be fostering classrooms in which students rarely venture outside what they already know [or are instructed to do]" (Blikstein 2013, p. 212) such as 3D printing the same keychain over and over again.

These are some of the challenges facing us when trying to utilize new technologies in education. Importantly, this challenge must be met in ways that transgress the current STEM proprietorship of new technologies as underlined by Zakaria 2015 and Ottino & Morson 2016. The present STEMification of technologies in education presents clear and present dangers: firstly, STEM's intrusion into and suppression of the humanities, and, secondly, the disinclination towards and absence of new technologies within the humanities (Zakaria 2015; Ottino & Morson 2016). Consequently, the article makes the case of not only open-ended technological imagination, enterprising, and participation in education, but also extends beyond the STEM humanities divide. As mentioned already, one possible way forward is to invoke and apply the concept of *open-endedness* to transcend these challenges, dichotomies, and oppositions.

Part 2: Open-endedness

Education cannot be truly free-form, anarchistic, voluntary, or improvisational – it cannot *become play* – without simultaneously seizing to *be education*. To educate is always to have certain values, pathways, and aspirations – an educator is always educating *for something*. On the other hand, this *something* cannot be entirely rule-bound, dictated, pre-determined, or rigid – it cannot *be fixed* – then it would equally seize to be education (Freire 1974; Freire & Macedo 1987). Consequently, if we want to educate for technological imagination, participation, and innovation in institutions and society, we need to foster, promote, and occupy a third space between the free-form and rule-bound, and a third field beyond the STEM humanities divide. Here, the concept of open-endedness might prove fruitful.

The concept of open-endedness

In the present article, the concept of open-endedness is derived from works on *technological playfulness* (Valk, Bekker & Eggen 2013), *divergent thinking* (Kwon, Park & Park 2006), *creative practice* (Resnick 2007) *innovation* (Sarpong & Maclean 2011), and *technology-rich innovative learning environments* (Groff 2013). These authors all explicitly use the term *open-ended* when describing central potentials for future learning within their respective fields. So, what is open-endedness and how can it be a way forward? Below is a condensed conceptualization of *open-endedness* derived from these works applied to the educational fields of technology, projects, and institutions:

1) *Open-ended technology*. (Valk, Bekker & Eggen 2013) describes open-ended technologies as artifacts with a composition that, on the one hand, allows for children to construct their own rules, goals, meanings, and interpretations, and, on the other hand, offers artifacts with specific design intentions, procedures, and modalities: "On the one hand, the design should not be too open. At one point it will

be nothing anymore, no real design. On the other hand, too many interaction rules will make it too complex [...] finding a balance between directing play and emergent play" (Valk et all 2013, p. 97). Open-ended technologies are processual, emergent, modular, reconfigurable, transmutable, and constructible. Open-ended technology will be described in depth in part 4.

2) *Open-ended projects*. (Resnick 2007; Sarpong & Maclean 2011; Kwon, Park & Park 2006) all stress open-endedness when discussing how to foster creativity, innovation, and divergent thinking through projects. Resnick highlight the iterative experiential cycle of "imagine, create, play, share, reflect" as quintessential to open-ended projects (Resnick 2013, p. 1). Sarpong and Maclean are concerned with open-ended projects from the domain of innovation and enterprising where they describe open-ended projects as follows: "Experimentation with new possibilities, it can be argued, is imperative to understand technologies better and identify opportunities for innovation in the present and future. Thus, teams' understanding of their spaces and possibilities may play an important role in defining the extent to which emergence and open-endedness may help them identify opportunities for innovation" (Sarpong & Maclean 2011, p. 1161). Finally, Kwon, Park, and Park identify the following core traits of open-ended projects: open assignments, exploration of diverse ideas, multiple approaches, divergent thinking, flexibility, and curiosity are important when designing for enterprising and innovation (Kwon, Park & Park 2006, p.57-58). Open-ended projects will be described in depth in part 5.

3) *Open-ended institutions*. In the OECD paper "Technology-rich innovative learning environments" (2013) Groff points out that future institutions should assess learning in open-ended, project-based ways that foster and promote experimentation, transformation and participation rather than transmission and reception of knowledge. Institutions should be open-ended through an iterative cycle of "reframe – redesign – reinvent" (Groff 2013, p. 19) where open-endedness through connectedness, collaboration, criticality, participation, and citizenship is accentuated (Groff 2013, p. 24-25). Open-ended institutions will be described in depth in part 6.

The three dimensions described above run together to create opportunities for future education and citizenship.

However, to enhance the possibility for future education and educational futures through 21st century learning in open-ended education, we have through our yearlong research and practice found that certain conceptual compositions, practitioner approaches, and educational attitudes work better than others when aiming for open-ended education. Through our educational research, development, and practice we have iteratively refined and developed a specific theoretical-methodological approach and attitude aiming for future education through open-ended technologies, open-ended projects, and open-ended institutions. This attitude and approach and practice have been developed into a conceptual framework for open-ended education through four iterations of the open-ended project *The Coding Pirates Future Island* within the open-ended institution *Coding Pirates Denmark* through the use of open-ended technological set-ups. This concrete case of open-ended education for future citizenship is outlined in the following section.

Part 3: Coding Pirates Future Island as open-ended education

Coding Pirates Denmark

The concrete case takes place within the non-profit association Coding Pirates Denmark (www.codingpirates.dk). Coding Pirates Denmark is based on volunteer work and has a national board as well as local departments across Denmark. The association that has experienced exponential growth since its launch in 2014. As of now, it has over 250 volunteers, 900 children, and 30 unique departments. Volunteers come from different sectors and

professions, but a large part of them are university students within STEM and digital design, professional practitioners within education and pedagogy, software developers, engineers, and others interested in designing, constructing, and coding with new technologies together with children and youngsters (7-17 years).

Figure 4: Coding Pirates Denmark webpage banner from www.codingpirates.dk

According to the *Coding Pirates Foundation Manifesto* (2016), the mission of Coding Pirates Denmark is to create a network of departments across the country where volunteers and children come together to construct, code, and create in open-ended projects. Coding Pirates Denmark is an acknowledged association working for the good of society, and the association receives funding from the Danish Youth Council, which supports democratic organizations that foster and promote the participation of children and youngsters in institutions and society (www.duf.dk).

Within this framework, Coding Pirates Denmark aims to cultivate technological imagination, enterprising, and participation in co-creative, dialogic, and democratic ways. This approach is formulated in the *Coding Pirates Foundation Manifesto* (2016) as maker philosophy, design thinking, and democratic participatory culture for open-ended education in an open society. The objectives of the *Coding Pirates Foundation Manifesto* are realized through concrete courses, workshops, and events in the various Coding Pirates departments. *The Coding Pirates Future Island* constitutes one such example.

The Coding Pirates Future Island

Until now, the Coding Pirates Future Island has had four run-throughs: a two-day Design Workshop in Vejle in February 2015, a Coding Pirates Course during the spring of 2015, a two-day Play Workshop at the CounterPlay '15 Festival in April 2015, and a one-day Design Event for the FabLab@School.dk Conference in May 2015.

All four run-throughs of the construction of a Coding Pirates Future Island have involved 20-30 children between 7 and 12 in age working together with 8-10 volunteers. The Future Island is conceptualized, developed, and organized by Nørgård, and has been run by Nørgård and Paaskesen together with volunteers from Coding Pirates Aarhus. A video showcasing a concrete example of how a Future Island might look can be found here: http://codingpirates.dk/fremtidsoe-i-vejle/

Through workshops, courses, and events, we have iteratively developed the Coding Pirates Future Island as a design format where children's visions for a future society come alive under the pirate flag. Here, children construct their own future island through the use of mixed materials, technologies, and media such as cardboard

boxes, glue guns, LEGO Mindstorms and Ozobot robots, LEGO WeDo, and Bristlebot creatures, MakeyMakey input devices, LittleBit machines and 3D prints, GoPro time lapses and smartphone videos, photo collages, and YouTube stories.

The Coding Pirates children's vision is materialized through different sub-projects that allow them to form individual group answers to the core question: *What future world and society would you construct if you were given the chance?* In this way, children are given the opportunity to be future-makers and society-makers through the creation of a future island that is then presented to parents and educational practitioners, stakeholders, and decision-makers such as teachers, pedagogues, headmasters, institution-makers, politicians, researchers, and corporations within education.

The participants within each sub-project have to work together to find ways to express their sub-project's specific dream. Here, children develop their own thematic structures for the communal future island such as "traps and alarms to keep the island safe", "bio-diversity to populate the island", "sound and vision to make the island vibrant", "robots saving creatures", and "purposeful mechanical beings". In the end, such different sub-projects come together to compose a shared future island.

Through the four iterations of the Coding Pirates Future Island, we developed our understanding of and model for open-ended education. Hence, the Coding Pirates Future Island functions as an exemplary case and test-bed. Importantly, for open-ended education to take place, something more than open-ended technology is needed. Technology needs to be integrated within an open-ended project that iteratively, gelatinously, and open-endedly moves forward through imaginative and co-creative design processes towards a communal collaborative construction of a future society, in this case the Coding Pirates Future Island. Accordingly, open-ended projects are something that we design and construct collectively, in groups and individually through dialogically and democratically moving through *discovering* how we will approach it, *interpreting* how we will understand it, *ideating* what to create, *experimenting* with how to build it, and *improving* our shared Coding Pirates Future Island through iterative evolution. Open-ended education requires open-ended technology integrated into open-ended projects taking the form of staged open-ended design processes such as the below.

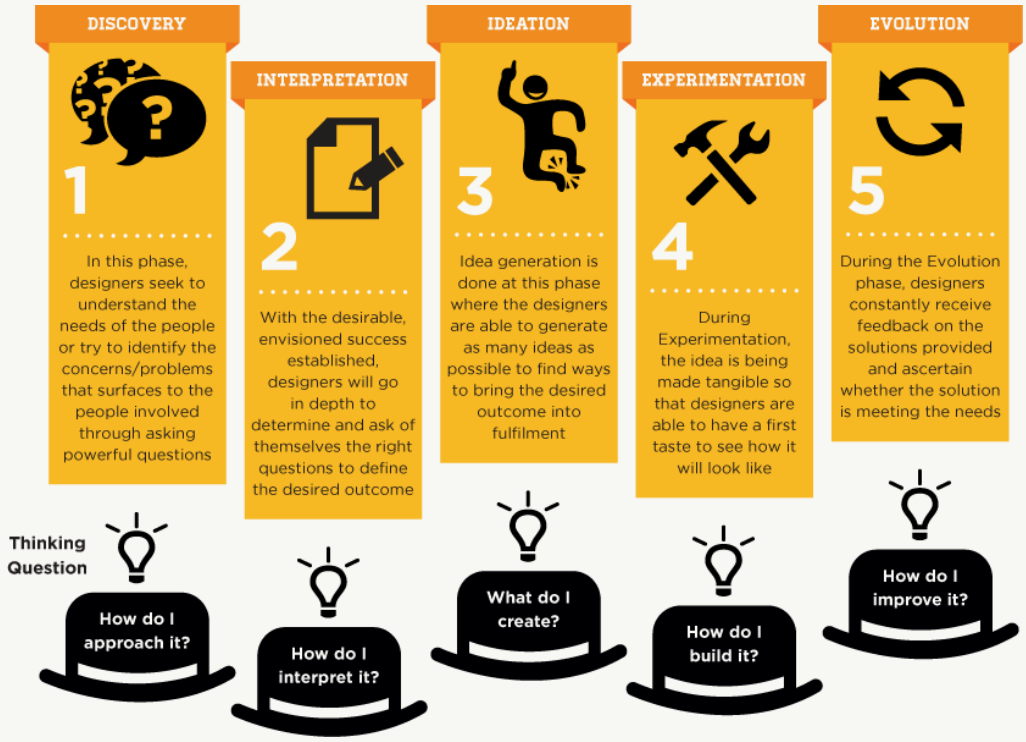


Figure 5: retrieved from http://www.lifeskills-enrichment.com.sg/portfolio/designthinking/

Finally, for open-ended education to happen, such open-ended projects with open-ended technological set-ups and materials need to take place in open-ended institutional settings. That is, institutions that aspire to be democratic, dialogic, empowering, and participatory: "Education is communication and dialogue. It is not the transference of knowledge, but the encounter of subjects in dialogue in search of the significance of the object of knowing and thinking" (Freire 1974, p. 124). Following Freire, in order for imagination, enterprising, and participation to occur – for open-ended education to take place – institutions need to shift from education as an instrument of domination or transmission of knowledge to education as the constant search for liberation or transformation of being (Freire 1974, p. 133). That is, the purpose of education is empowerment and emancipation for future citizenship. Hence, the teacher cannot transmit knowledge, lead the way, or instruct the students about what they need to know in order to live and learn in the 21st century. They need to go there *together*.

Below, we will outline the core process of technological imagining, enterprising, and participating within the format of Coding Pirates Future Island, before moving on to explicating and developing a model for the conceptual framework underlining such an attitude, approach, and practice.

1.

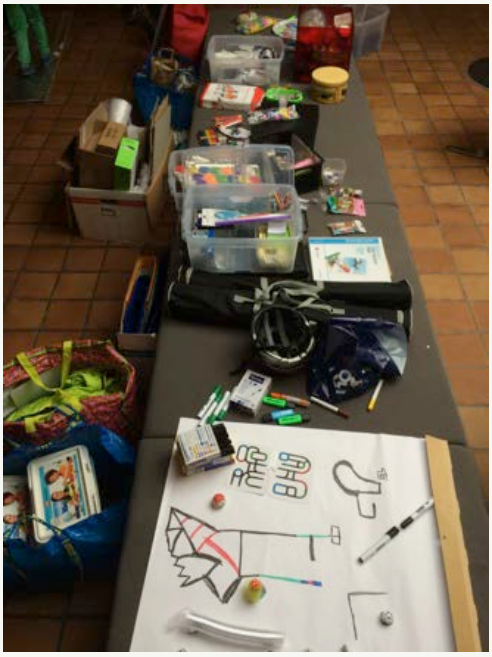
The Coding Pirates Future Island starts out as a collection of differently seized cardboard boxes and a pile of differently colored blankets or other fabric. Through an iterative constructing and reconstructing process the children collaborate to erect an island that has the shape and structure they want (layout of boxes). Often this process begins with a haphazard collection of piled-up boxes. But through discussion, argumentation, and critical reflection the island slowly finds its form. Questions such as: "Do we need caves?", "Should there be inland lakes?", "Do we need flat surfaces for roads?", and "Should there be a mountain or do we use the boxes for a harbor?" are at the center of this process. The structuring of the island generally takes 3-4 iterations and collaborative rounds of discussions amongst the children before the communal island is settled in the world.

2.

When the Future Island has materialized in form, fabric is then used to create different kinds of surfaces such as grass, water, and lava (layout of blankets). Here, children often draw on their *Minecraft* knowledge given the blocky form of the cardboard boxes. Thus, the island often ends out having a volcano spewing lava, fields of green grass, blue waterfalls, and lakes with a surrounding ocean. Adding other colors such as grey (stone) or yellow (sand/wheat) would of course make for differently textured islands. The surface of the island is completed through discussing and designing in small groups. Again, this process ends with a communal discussion about the feasibility of the finished island: "Do we need water somewhere else and where do we then take it from?", "Is there too much lava?", "Do we need green flat fields for transportation and living?" All in all, the layout and texture of the communal island come to form the first iteration of the participatory design process.

3.

To the collaboratively formed Future Island an open-ended creative constructionist collection of mixed materials and technologies is added. The children then sign up for specific thematic workshops – like constructing alarms, creating bio-diversity, or coding robots for a rescue mission. Each group has access to a collection of mixed material and technologies. The communal collection contains a wide variety of different materials like glue guns, markers, paper, pipe cleaners, feathers, fabric, stickers, LEGO, cardboard, paint, and so on, as well as technologies like Scratch, LEGO Mindstorms, LittleBits, Makey Makey, and 3D printers. Taken together, this open-ended modular material-technological set-up constitutes the launch pad for the children's participatory ideation and design process.



4.

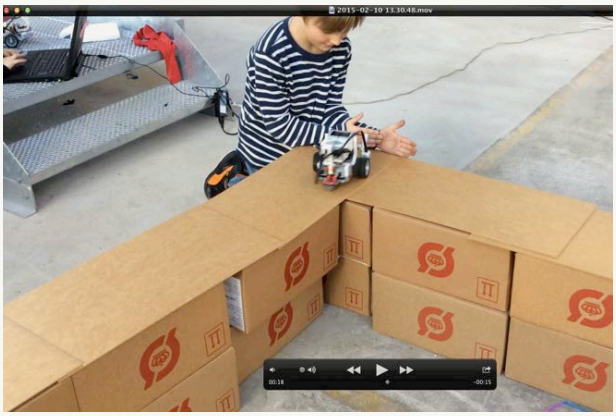
Children work in workshops with different challenges – e.g. constructing LEGO WeDo creatures and coding them to cry out for help in various ways (Morse sound, smoke signals, and motion), because they are trapped in lava. Another group workshop is occupied with constructing and coding LEGO Mindstorms robots to go on a rescue mission to save the trapped WeDo creatures, while still another group is engaged with 3D printing trees and plants for the island to create more than a barren lava landscape. Here, children are involved in trans-group processes, making individual designs (coding a Mindstorms robot), and having an individual group project (rescue mission), but as part of the communal Future Island shared across groups and individuals.

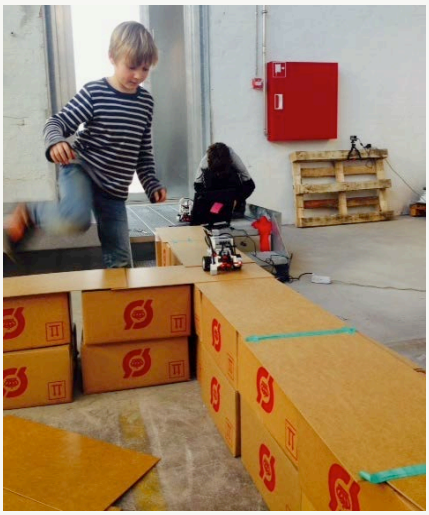
5.

In the workshops the children have to figure out what they want to do (e.g. which kind of trap), why they want to do it (e.g. how does the trap fit the communal future island), and how they can do it (e.g. which specific material-technological collection can be used to construct and code the trap). In this way they move through a design process of *discovery* (what trap is my good idea?), *interpretation* (how can I make this trap valuable and meaningful in relation to the future island?), *ideation* (how can I create it on the grounds of the available materials and technologies?), *experimentation* (how do I make the trap function and integrate it into the island?), and *evolution* (how do I iteratively adjust it to make a perfect fit with the island and the other groups' contributions?).

6.

As they work their way through the process towards their design in the open-ended project, they take their constructions to the island and modify and improve the fit, functionality, and fiction of their design. For example, the children in the Mindstorms rescue mission workshop built a ledge for the island so that the robots were able to drive to the island to save the trapped WeDo creatures. Then they program the rescue robots to move across the dangerous ledge, which was risky business, as the robots could easily fall off and break apart if the coding went awry. The children iteratively modify the ledge and code to create a good fit between layout and functionality. When a final operational design materializes, the children compose a fiction that tells the story of the heroic Mindstorms robots coming to rescue the trapped WeDos. A movie is shot, complete with voice-over, robot impersonations, and a compelling storyline. When the communal island is finished, this story then interconnects with other fits, functionalities, and fictions on the island to create a communal master fiction.





7.

The design process reaches its climax as all workshop groups come together to implement their specific contribution to the Future Island. The resulting communal society, its interconnected-ness, and appropriateness are then put up for discussion. Each group reflects on their contribution to the society, its fit, functionality, and fiction. They discuss how the different workshops can connect to create a joint society. From this, an open-ended narrative emerges. This narrative is then recorded and turned into a YouTube movie. Before packing up, the surrounding society is invited to the future island. In the four iterations, conference community, parents, stakeholders, and other visitors are invited to experience the Future Island and hear the children's thoughts behind the society they have created.

Figure 6: All pictures taken by Nørgård with informed consent

Through the iterations of the Coding Pirates Future Island it has become clear that the viability of the format as open-ended education hinges on three intertwined frameworks: open-ended technologies, open-ended projects, and open-ended institutions. These frameworks are outlined and described in the following sections before being conjoined to a compound model for open-ended education and citizenship in the last concluding section of the article.

Part 3: Open-ended technologies

Based on the development and practice of the Coding Pirates Future Island it has become clear that if we want technological imaginative education to happen, an open-ended technological set-up and technology need to be present. Here, open-ended technology refers to the structure and functionality of the set-up and tools that are employed to foster and promote technological imagination (Toft & Nørgård 2016). An open-ended technological set-up and technology exist in and emerge from the nexus of "distributed constructionism", "modularity & tinkerability", and "technological imagination".

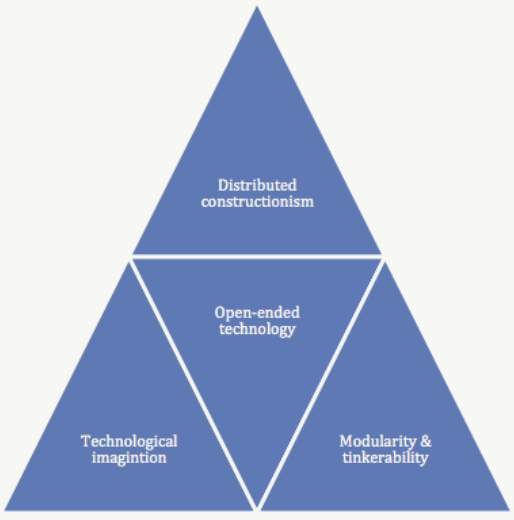


Figure 7: Framework for open-ended technology

Following Papert 1991 and Resnick 1996), *technological* constructionism accentuates that "[p]eople don't *get* ideas; they *make* them. To this, constructionism adds the idea that people construct new knowledge with particular effectiveness when they are engaged in constructing personally-meaningful products" (Resnick 1996, p. 281). *Distributed* technological constructionism then moves this theory from the individual and personal to the collective and communal. It uses technologies to support "knowledge-building communities" in which people co-construct through what Resnick calls "tinkerability": "In designing Scratch, one of our key goals was "tinkerability" – that is, we wanted to make it easy for children to playfully put together fragments of computer programs, try them out, take them apart, and recombine them […] it is easy to 'play with your code,' testing out new ideas incrementally and iteratively" (Resnick 2007, p. 4). Resnick singles

out three major categories for distributed constructionism and tinkerability that align with the way the open-ended technology set-up was designed and used in the Coding Pirates Future Island: 1) discussing constructions, 2) sharing constructions, and 3) collaborating on constructions (Resnick 1996, p. 281). Importantly, this technological set-up for distributed constructionism must be open-ended, or modular (Lund & Thorsteinsson 2011). That is, the technologies also need to be constructible, tinkerable, reconfigurable, flexible, and undetermined in their own structures and functionalities. Children engaged with building, adjusting, and reconfiguring the structures and functionalities of their emerging LEGO WeDo creatures show how "seemingly simple and open-ended creativity toys were often the most fun, inferring that creativity tools should enable the creation of complex products with simple tools, and that systems should be open-ended and not constrain the user more than necessary" (Hornecker 2007, unpaged).

Consequently, technologies with a fixed structure and functionality, such as a pre-programmed doll, a step-by-step programming tool, or a closed task, such as printing a pre-defined product on a 3D printer do not cultivate technological imagination. Technological imagination arises from the interplay between open-ended modular technology, tinkerability, and distributed constructions where subjects, through a process of collaboration, experience that their technological imagination matters and has a genuine impact on the outcome. It is not free-form play or rule-bound production, but an emergence of technological imagination as a reflective conversation with open-ended technology that talks back to the child through the specific structure and functionality in accordance with the present situation and the design vision (Bamberger & Schön 1983). In this way, children's tinkering with open-ended technologies fluctuates between "directing and emergent" design (Valk, Bekker & Eggen 20013, p. 97). Technological imagination comes to the fore as children construct their way forward with open-ended technologies in hand through discussing questions of "what if…?" and "how might we…?" (Toft & Nørgård 2016).

Part 4: Open-ended projects

However, these questions can only realize their educational potential if open-ended technology is embedded within open-ended projects. Technological imagination needs to be externalized as technological enterprising and expressed as hands-on idea-making. Through the Coding Pirates Future Island, we found that for children to enterprise they need imagination, but for the imagination to produce fruitful, worthwhile, creative, and reflective products, it needs to take place within open-ended projects. Here, the concept open-ended projects refers to emerging explorative "idea-generating processes" through "vision-driven design thinking" by "crafty enterprising" with open-ended technology. That is, projects where outcomes are undetermined but intentional (Nelson & Stolterman 2012) and where every product is "an ultimate particular", because the situation and design process are uniquely based on the specific context, communication, and collaboration at hand.

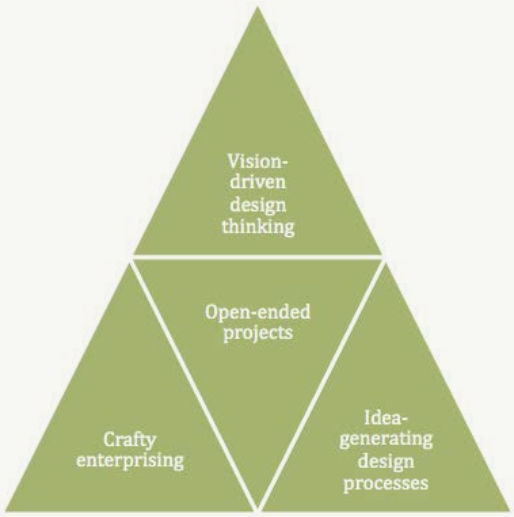


Figure 8: Framework for open-ended projects

Vision-driven design thinking is the primary motor in open-ended projects and is characterized by "inquiry *for* action. Actions creating the right thing, for the right people, at the right time, in the right place, in the right way, for the right reasons" (Nelson & Stolterman 2012, p. 217). Within design thinking, *inquiry for action* connotes the coming together of idea and product through design processes: the ability to generate powerful ideas through inquiry and intentional design processes, and crafty enterprising (Nelson & Stolterman 2012; Collins, Joseph & Bielaczyc 2009). Importantly, the quote also underlines the necessity of "gelatinous" open-ended projects (Bengtsen & Nørgård 2014), as every design situation constitutes an "ultimate particular" – a unique situation, requiring a unique process and product, that forces both educator and learner to be in a state of dialogic wondering where there are multiple ways of looking, multiple ways of thinking, and, thus, multiple ways of answering:

> *Every design process is a process of inquiry, and every inquiry is unique. Design inquiry is therefore a process that begins with unlearning old answers and starting with a new mind or beginner's mind open to new learning, exciting new possibilities, and rewarding new insights – in other words, starting with a letting go […] They are called to open up to new ideas, new ways of seeing things, altered directions and surprising outcomes, by letting go of their previous experience and design solutions. (Nelson & Stolterman 2012, p. 242)*

Looking at "Vejledning for faget dansk" and the revised course guideline for K12 education, it now states that teachers must educate for entrepreneurship and innovation: "Educators must work systematically with designing innovative learning processes for the educatees […] There must be a spotlight on the course's creative and constructionist elements. The task is not just to teach innovation, but to educate in innovative learning activities that has as an objective to develop the educatees' innovation competence."1 We have found that open-ended projects with open-ended technology are distinctly suitable for this.

If we want to encourage people to discover and innovate within the educational system (Schumpeter 1934), to give people the ability to be inventors instead of knowledge consumers, then we need to support the educators in fostering and promoting future education. What is needed is an understanding of processes for enterprising wherein people emerge as playful explorers, idea-generating experimenters, and vision-driven entrepreneurs (Saywer 2012). This requires both a creative design thinking attitude and approach as well as an enterprising design thinking process. To accomplish this, in the Coding Pirates Future Island we adopted an approach and attitude resembling what Seymor Papert calls a "peadogy of ideas" (Papert 2000, p. 721) and Mitchel Resnick calls "the kindergarten approach to learning" (Resnick 2007). This approach was then embedded in a vision-driven idea-generating design process in an effort to reach the "creating" level of Bloom's revised taxonomy:

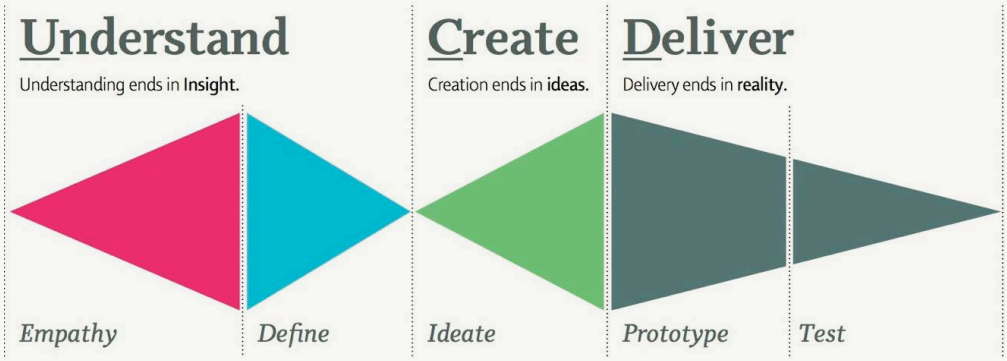


Figure 9: Design process (retrieved from http://designthinking.co.nz/design-thinking-for-government/)

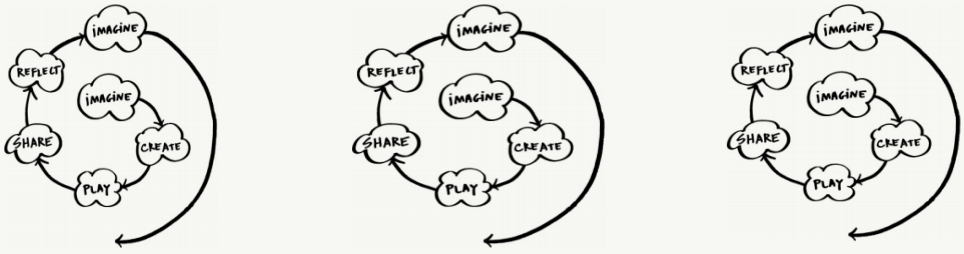


Figure 10: The Kindergarten approach to learning (Resnick 2007, p. 2)

Resnick's constructionist kindergarten approach to learning, which consists of iterative cycles of imagine-create-play-share-reflect, captures the spirit of open-ended projects and open-ended education, as it resembles an entrepreneurial "growth mindset" (Dweck 2006), "open-ended interaction" (Valk, Bekker & Eggen 2013;Dixon 2009), as well as "intentional change in an unpredictable world" (Bamberger & Schön 1983; Nelson & Stolterman 2012):

1 http://www.emu.dk/modul/vejledning-faget-dansk#afsnit-3-3-innovation-og-entreprenoerskab

> *I think of it* [the 'kindergarten approach to learning'] *as a spiraling process in which children* **imagine** *what they want to do,* **create** *a project based on their ideas,* **play** *with their creations,* **share** *their ideas and creations with others,* **reflect** *on their experiences – all of which leads them to imagine new ideas and new projects.* (Resnick 2007, p. 1-2, emphasis in original)

However, technological imagination and enterprising most often do not happen in these projects if educators in the classroom set up predesigned step-wise building instructions and coding schemes and subsequently grade their students on the performance of their robots that are built based on such fixed instructions and schemes. In this case ideas, processes, thinking, and enterprising coagulate and become rigid.

But, if we want innovation through open-ended projects to become more than a potentiality within the course guideline of K12 education, if we want educators and learners to become imaginative and enterprising kindergarten thinkers and tinkerers (Resnick 2007, p. 2), we need open-ended interactions and experiences in open-ended institutions with the educator as a "gelatinous pedagogue" (Bengtsen and Nørgård 2014). We need projects where educators and learners work *together* within a "participatory academic community" based on dialogue, democracy, and co-creating (Aaen & Nørgård 2015).

Part 5: Open-ended institutions

Finally, if we want open-ended education to occur through open-ended projects with open-ended technology, then we need open-ended institutions. Technological imagination and enterprising needs to be experienced as genuinely participatory before the potentials of future education can be realized. That is, enterprising needs to have an impact on the institutional setting, which needs to be flexible, adaptable, democratic, and disruptable rather than the other way around. Based on the setting of the Coding Pirates Future Island, Coding Pirates Denmark, and the various departments of the Coding Pirates we have been responsible for, we have found that for children to experience participation they need space, time and processes for enterprising and imagination. But for participation to result in education for future citizenship it needs to take place within open-ended institutions. Here, the concept open-ended institutions refers to the "creative practice" of educators aiming for "dialogic participation" through "liberatory critical pedagogy". That is, institutions based on the academic virtues of sincerity, attentiveness, compassion, autonomy, and care (Nixon 2008) to foster and promote citizenship in and for society (Nørgård & Bengtsen 2016), where education is open and institutions are something we build and shape *together* through forming participatory academic communities (Aaen & Nørgård 2015).

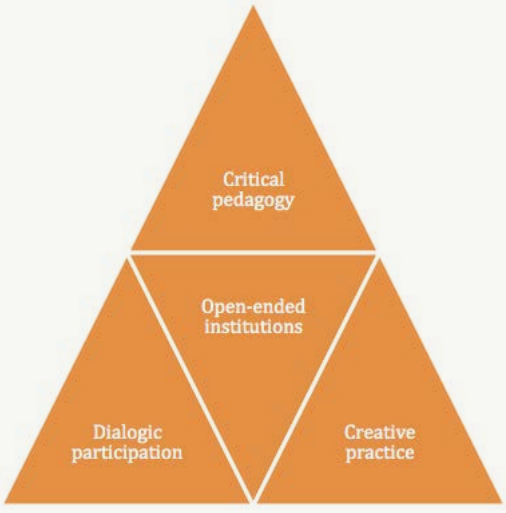


Figure 11: Framework for open-ended institutions

Fostering and promoting technological imagination and enterprising in education, having the courage to have new ideas, to risk falling or being wrong, to try out and construct with new technologies, to enter the unknown in thinking and tinkering, to feel at home in education and society – all this requires institutions to foster and promote experiences of personal worth and value, and of genuine participation and dialogue (Aaen & Nørgård 2015; Nørgård & Bengtssen 2016). It is an institutional shift from the uniform, verifiable, and secure towards the multifarious, emerging, and improvisational approach (Sawyer 2006, p. 42). In open-ended institutions aiming for the top-tier of Bloom's taxonomy, educational activities and formats are co-designed, open to re-design, and strike a balance between learner-initiated and educator-led activities (Craft et al 2013, p. 23). In "[c]reative primary schools: developing and maintaining

pedagogy for creativity", there are three characteristics of pedagogy for creativity: 1) Co-construction where teachers work with children to generate new ways of understanding, doing, and engaging through striking a balance between child-initiated and teacher-guided activities in open-ended exploratory contexts; 2) Children's agency and ownership where participation is encouraged through dialogue and critical reflection supporting creative aspirations and innovations; 3) The teacher's high expectations of children's creative capabilities, engagement in education and ability to imagine, enterprise, and participate (Craft et al. 2013, p. 22-27). Taken together, it is evident how open-ended institutions with a decidedly democratic, dialogic, and participatory bent have close affinities to the liberatory, empowering, and emancipatory enterprise of Paulo Freire's critical pedagogy (Freire 1974; Freire & Macedo 1987). Furthermore, reading literature on educating for imaginative, enterprising, and participatory educational futures (Gregorson et al. 2013; Craft et al. 2013; Sawyer 2006), it becomes clear that open-ended institutions, projects, and technologies are prerequisite for reaching the top of Bloom's revised taxonomy and practicing what Dettmer (2005, p. 73) calls "ideational learning". It is within ideational learning that we find the ability to be creative, innovative, and entrepreneurial, and the practice is characterized by open-ended processes and institutions that support uniqueness, diverse outcomes, and learner fulfillment (Dettmer 2005, p. 73):

BASIC LEARNING: Phases 1 and 2 with near (low-road) transfer of learning. Characterized by **REALISM** (What should learners know?)

Essential

ACQUISITION. Rudimentary. Is requisite for all learners. Educator teaches, learner masters. The content is necessary, the process is structured, and the context domain designates the standard(s). Time is provided for mastery and compensatory alternatives are supplied as needed if mastery is not possible.

Baseline	Cognizant	Sentient	Conscious	Aware	**Viable**
Phase 1	Know	Receive	Observe	Relate	**Perceive**
Phase 2	Comprehend	Respond	React	Communicate	**Understand**

APPLIED LEARNING: Phases 3, 4, 5 with far (high-road) transfer of learning. Characterized by **PRAGMATISM** (What can learners do?)

Developmental

UTILIZATION. Complex. Is to be individualized for each learner. Educator guides, learner grows. The content is important, the process is flexible, and the context domain determines suitability. Variable stages of achievement are expected and learning opportunities are provided that challenge every student.

Phase 3	Apply	Value	Act	Participate	**Use**
Phase 4	Analyze	Organize	Adapt	Negotiate	**Differentiate**
Phase 5	Evaluate	Internalize	Authenticate	Adjudicate	**Validate**

IDEATIONAL LEARNING: Phases 6, 7, 8 with original construction/production. Characterized by **IDEALISM** (To what do learners aspire?)

Generative

INNOVATION. New. Is to be personalized for every learner. Educator facilitates, learner generates. The content is novel, the process is open ended, and the domain supports uniqueness. Diverse outcomes of accomplishment are anticipated and encouragement is offered to enable learner fulfillment.

Phase 6	Synthesize	Characterize	Harmonize	Collaborate	**Integrate**
Phase 7	Imagine	Wonder	Improvise	Initiate	**Venture**
Phase 8	Create	Aspire	Innovate	Convert	**Originate**

Figure 12: Essential, applied, and ideational learning (Dettmer 2005, p. 73)

Consequently, if we want to make creativity, innovation, or enterprising possible, then we need open-ended projects within open-ended institutions (Bear 2013; Daniels 2013).

This is practiced in the Coding Pirates Future Island through crucial and meaningful storytelling that takes children's values, visions, and dreams seriously. Here, children become their own society-makers as they playfully construct a communal island, society, and story together with the educators. Children, youngsters, and educators work together in open-ended environments where unruly imagination, explorative enterprising, and dialogic participation are guided through modular technologies, design processes, and critical pedagogy. The Dionysian and Apollonian qualities of Bloom's "creating" and Dettmer's "ideational learning" become superimposed in open-ended institutions. Here, educators cannot teach to prescribed outcomes or be the ones in control (Sawyer 2006; Craft et al 2014). Here, open-ended attitudes and processes work together with open-ended technologies to make technological imagination, enterprising, and participation come into being as open-ended education for future citizenship.

Part 6: Open-ended education for future citizenship

In this article we have described open-ended education for 21st century learning as the coming together of open-ended technology, projects, and institutions. Through the case of the Coding Pirates Future Island, we have shown how this is practiced to support and foster technological imagination, enterprising, and participation. And in the following section, we outline the theoretical framework for this practice.

Through trying to 1) answer the call for 21st century learning as collaboration, communication creativity, and reflective thinking for future citizenship and 2) acknowledge the emphasis in Bloom's top tier and ideational learning on imagination, wonderment, enterprising, innovating, participation, and aspiration for personalized diverse original constructions, through our practice and research it has become clear that open-ended technologies, projects, and institutions are prerequisites for such answers and acknowledgement. Below is a compound model for the coming together of open-ended institutions for 21st century learning, open-ended projects with new technologies at the top-tier of Bloom's taxonomy through processes for open-ended education.

Figure 13: Compound model for open-ended education

In the model we see how the different components of the article come together to form open-ended education practiced through formats such as the Coding Pirates Future Island. Institutions need to be open-ended in order to promote and foster collaboration, communication, creativity, and critical thinking for participatory citizenship. Projects need to be open-ended to support ideational learning through processes promoting and fostering innovation. And enterprising and technology need to be open-ended to support creating, evaluating, and analyzing beyond itself and foster and promote technological imagination beyond technology itself. Finally, the arrow indicates that educational values and open-endedness are prerequisite for significant and decisive open-ended projects that again are prerequisite for valuable and meaningful use of technology.

Taken together, open-ended education becomes the communal being, doing, and knowing across institutions, educators, and learners that aim for participatory citizenship and community (Freire 1974; Aaen & Nørgård 2015). Through the balancing of the free-form and the rule-bound and through aiming for academic citizenship *within* society (Nørgård & Bengtsen 2016) education becomes a dialogue about and with the world; a project of integration through engagement, empowerment, and emancipation (Freire & Macedo 1987). In education, the boundaries of solutions and ideas are examined and discussed in an effort to transcend them through playful

future making. To be in open-ended education is to learn in an almost Nietzschian way that fosters an open-ended attitude to education and life itself (Nietzsche 1999). Following this Nietzschian attitude, through the case of the Coding Pirates Future Island and the developed theoretical framework, the article has shown that, looking into creativity, innovation, and enterprising with new technologies, there needs to be a fusion of Dionysian and Nietzschian attitudes and STEM and humanistic approaches in education.

Aiming for imaginative society and enterprising citizenship, we need education that embraces the complexity of messy but intentional interactions, playful but serious disruptions, critical but communal discussions, systematic but emerging processes and improvisational but deliberate products emerging from transformative experiences and transgressing interactions. Such dialectics is at the core of open-ended technology, projects, and institutions. Here, educators should be "meddling in the middle as children develop their creative ideas" (Craft et al. 2014, p. 28), because "the most important creative insights typically emerge from collaborative teams and creative circles" (Sawyer 2006, p. 42). Consequently, education needs to be performed *together* on an *even* playing field. We need to be *in* education together, to think and tinker *with* and *through* education, and to be educated *in* and *for* society where "education is a liberatory enterprise, one in which teachers and students help each other overcome their respective weaknesses and build on their respective strengths, in order to create a new and better understanding of the world, an understanding they can share" (Beckett 2013, p. 60). This is what we have tried to achieve and embody in the Coding Pirates Future Island and explicate in the theoretical framework as a way of *doing future education for 21st century learning*.

Creativity, imagination, and playfulness require a dialogue between idea-generating and problem-solving, and, as such, form the basis for developing our society socially, culturally, politically, and economically. Importantly, this is not *creatio ex nihilo*, but designing based on educational values, visions, and inquiry for open-ended education. In this way, open-ended education not only shares a basis with Sicart's playfulness (2013), Rescnick's kindergarten approach (2007), and Freire's liberatory pedagogy (1974), but also with Schumpeters innovation (1934).

Open-ended education is not so much about being full of ideas as it is about giving form to ideas and then critically reflecting upon them. It is ideas merging and put to the test through collaboration, communication, creativity, and critical thinking with new technologies. This requires the ability to imagine, to try out, and to fail as well as to fabulate and reflect creatively together with others in spirit and body.

We need participation and open-ended education if we want to promote an innovative idea-generating attitude to practical, technical, and societal problems, like water pollution, waste of food, energy consumption, and other solutions to the challenges we face today and in the future. Let children's participation be open-ended – let them play with the future, with problems, and try out multiple ideas. Let them feel that not only *Play Matters* (Sicart 2013), but also that *Education Matters*. That participation in education is something relevant and meaningful to us and to the world we participate in.

In conclusion, open-ended education is about opening education up to future making, possible futures, and potent participations (Zittoun and Cherchia 2013). According to John Abbott, director of the 21st Century Learning Initiative, it is essential to view learning as a total community responsibility. Children need to be integrated, fully contributing members of the broader community: "On a practical level, the most powerful level for change", Abbott says, is people coming together to "rethink the role of community in the learning process" (Abbott 2014).

This will require new attitudes, approaches, practices, and frameworks in education. We suggest that the concept of open-ended education is a step in this direction.

References

Aaen, J. & Nørgård, R. T. (2015). Participatory Academic Communities: a transdiciplinary perspective on participation in education beyond the institution. *Conjunctions. Transdiciplinary Journal of Cultural Participation*, Vol. 2, No. 2, p. 67-98.

Abbott, J. (2014). *To advance Education, We Must First Reimagine Society*. Luba Vangevola.

Anderson, L. W. & Krathwohl D. R. (eds.) (2001). *A Taxonomy for Learning, Teaching, and Assessing: A Revision of Bloom's Taxonomy of Educational Objectives*. New York: Longman

Arrazola, B.V. & Bozalongo, J.S. (2014). Teaching practices and teachers' perceptions of group creative practices in inclusive rural schools. *Ethnography and Education*, Vol. 9, No. 3, p. 253-269.

Bamberger, J. & Schön, D.A. (1983). Learning as reflective conversation with materials: Notes from Work in Progress. *Art Education*, Vol. 6, No. 2, p. 68-73.

Baer, J. (2013). Teaching for creativity. Domains and divergent thinking, intrinsic motivation, and evaluation. In: *Teaching creatively and teaching for creativity*. Eds. M.B. Gregerson, H.T. Snyder and J.C. Kaufman (eds). London: Springer, p. 175-181.

Beckett, K.S. 2013. Paulo Freire and the concept of education. *Educational Philosophy and Theory*, Vol. 45, No. 1, p. 49-62.

Bengtsen, S. & Nørgård, R. T. (2014). Becoming Jelly: a call for gelatinous pedagogy within higher education. Conference paper published in: Bayne S, Jones C, de Laat M, Ryberg T & Sinclair C. (Eds.) *Proceedings of the 9th International Conference on Networked Learning 2014*, p. 17-24.

Blikstein, P. (2013). Digital fabrication and 'making' in education: the democratization of invention. In: Walter-Herrmann, J. & Büching, C. (eds.). *FabLab: Of machines, makers and inventors*. Bielefeld: transcript Verlag.

Coding Pirates Foundation Manifesto (2015). Retrieved from: https://codingpirates.dk/manifesto/.

Craft, A., T. Cremin, P. Hay and J. Clack. (2004). Creative primary schools. Developing and maintaining pedagogy for creativity. *Ethnography and Education*, Vol. 9, No. 1, p. 16-34.

Collins, A., Jospeh, D. & Bielaczyc, K. (2004). Design research: Theoretical and methodological issues. *The Journal of the Learning Sciences*, Vol. 13, No. 1, p. 15-42.

Daniels, S. (2013). Facilitating creativity in the classroom. Professional development for K12 teachers. In: *Teaching creatively and teaching for creativity*. Eds. M.B. Gregerson, H.T. Snyder and J.C. Kaufman (eds). London: Springer, p. 3-14.

Dettmer, P. (2005). New blooms in established fields: Four domains of learning and doing. *Roeper Review*, Vol. 28, No. 2, p. 70-78.

Dicks, B. (2013). Interacting with...what? Exploring children's social and sensory practices in a science discovery centre. *Ethnography and Education*, Vol. 8., No. 3, p. 301-322.

Dixon, D. (2009). Nietzsche contra Caillois: Beyond play and games. In *The Philosophy of Computer Games Conference*, University of Oslo, retrieved from: http://www.hf.uio.no/ifikk/english/research/projects/thirdplace/Conferences/proceedings/Dixon%20Dan%202009%20-%20Nietzsche%20contra%20Caillois%20Beyond%20Play%20and%20Games.pdf

Dweck, C. (2006). *Mindset: The new psychology of success*. Ballentine Books: New York.

Freire, P. (1974). *Education for Critical Consciousness*. London: Bloomsbury.

Freire, P. & Macedo, D. (1987). *Literacy: Reading the word and the world*. London: Routledge.

Gregorson, M. B., Snyder, H. T. & Kaufman J. C. (eds.) (2013). *Teaching creatively & teaching creativity*. New York: Springer.

Groff, J. (2013). Technology rich innovative learning environments. Working paper for OECD CERI innovative learning environments project. Retrived from: http://www.oecd.org/edu/ceri/Technology-Rich%20Innovative%20Learning%20Environments%20by%20Jennifer%20Groff.pdf

Hornecker, E. (2007). Learning about interactivity from physical toys. *Nordes: Nordic design research*. Vol 2, unpaged.

Krathwohl, D. R. (2002). A Revision of Bloom's Taxonomy: An overview. *Theory Into Practice*, Vol. 41, No. 4, p. 212-218.

Kwon, O. N., Park, J. S. & Park, J. H. (2006). Cultivating divergent thinking in mathematics through an påen-ended approach. *Asia Pacific Education Review*, Vol. 7, No. 1, p. 51-61.

Lund, H. H. & Thorsteinsson, A. T. (2011). Adaptive play in physical play. In: *Proceedings of the 6th International Conference on Foundations of Digital Games (FDG'11)*. New York: ACM, p. 271-273

National Education Association. *Preparing 21st century students for a global society: An educators guide to the 'four Cs.'* Retrieved from: http://www.nea.org/assets/docs/A-Guide-to-Four-Cs.pdf

Nelson, H. G. & Stolterman, E. (2012). *The design way: Intentional change in an unpredictable world*. Cambridge: The MIT Press.

Nietzcsche, F. W. (1999). *Således talte Zarathustra*. Det lille Forlag.

Nixon, J. (2008). *Towards the virtuous university: The moral bases of academic professionalism*. London: Routledge.

Nørgård, R. T. & Bengtsen, S. (2016). Academic Citizenship beyond the Campus: a call for the placeful university. *Higher Education Research & Development*, Vol. 35, No. 1, p. 4-16.

Ottino, J. M. & Morson, G. S. (2016). Building a bridge between engineering and humanities. *The Chronicle of Higher Education*, February 14, retrieved from: http://chronicle.com/article/Building-a-Bridge-Between/235305.

Papert, S. (2000). What is the big idea? Toward a pedagogy of idea power. *IBM Systems Journal*, Vol. 39, No. 3&4, p. 720-729.

P21: Partnership for 21st Century Learning (www.p21.org)

Ranjan, A. & Gabora. L. (2013). Creative ideas for actualizing student potential. In *Teaching creatively and teaching for creativity*. Eds. M.B. Gregerson, H.T. Snyder and J.C. Kaufman. London: Springer, p. 119-131.

Resnick, M. (2007). All I really need to know (about creative thinking) I learned (by studying how children learn) in kindergarten. In *Proceedings of the 6th ACM SIGCHI conference on Creativity & cognition (C&C '07)*. ACM, New York, NY, USA, p. 1-6.

Resnick, M. (1998). Technologies for lifelong kindergarten. *Educational Research & Development*. Vol. 46, No 4, p. 1-18.

Resnick, M. (1996). Distributed constructionism. In *Proceedings of the 1996 international conference on Learning sciences (ICLS '96)*, Daniel C. Edelson and Eric A. Domeshek (Eds.*). International Society of the Learning Sciences*, p. 280-284.

Roehl, T. (2012). Disassembling the classroom – an ethnographic approach to the materiality of education. *Ethnography & Ethnography*. Vol. 7, No. 1, p. 109-126.

Sarpong, D. & Maclean, M. (2011). Scenario thinking: A practice-based approach for the identification of opportunities for innovation. *Futures*. Vol 43, p. 1154-1163.

Sawyer, R. K. (2012). *Explaining creativity: the science of human innovation*. Oxford: Oxford University Press.

Sawyer, R.K. (2006). Educating for Innovation. *Thinking Skills and Creativity.* Vol. 1, p. 41-48.

Schleicher, A. (undated). The case for 21st-century learning. Retrieved from: http://www.oecd.org/general/thecasefor21st-centurylearning.htm

Schumpeter, J.A. (1934). *The Theory of Economic Development*. Harvard University Press, MA.

Sicart, M. (2014). *Play Matters*. Cambridge Mass.:The MIT Press.

Toft, H. & Nørgård, R. T. (2016). Pla(y)ceskabelse: når børn og robotteknologi mødes (Pla(y)cemaking: when children and robotics meet). *Læring og Medier* (Learning & Media), No. 14, p. 1-31.

Valk, L., Bekker, L. & Eggen, B. (2013). Leaving room for improvisation: towards a design approach for open-ended play. *Proceedings of the 12th International Conference on Interaction Design and Children* (IDC '13), 92-101. ACM, New York

Westhead, P. and Wright, M. (2013). *Entrepreneurship*. Oxford University Press.

Vejledning for faget dansk: New course guideline for public school subjects. retrieved from: http://emu.dk/modul/vejledning-faget-dansk#fsnit-3-3-innovation-og-entreprenoerskab, section 3,3 (in Danish)

Walter-Herrmann, J. & Büching, C. (eds.) (2013). *FabLab: Of machines, makers and inventors*. Bielefeld: transcript Verlag.

Zakaria, F. (2015). Why America's obsession with STEM education is dangerous. *The Washington Post*, March 26, retrieved from: https://www.washingtonpost.com/opinions/why-stem-wont-make-us-successful/2015/03/26/5f4604f2-d2a5-11e4-ab77-9646eea6a4c7_story.html.

Zittoun, T. & Cerchia, F. (2013). Imagination as Expansion of Experience. *Integrative Psychological and Behavioral Science*, p. 303-324.