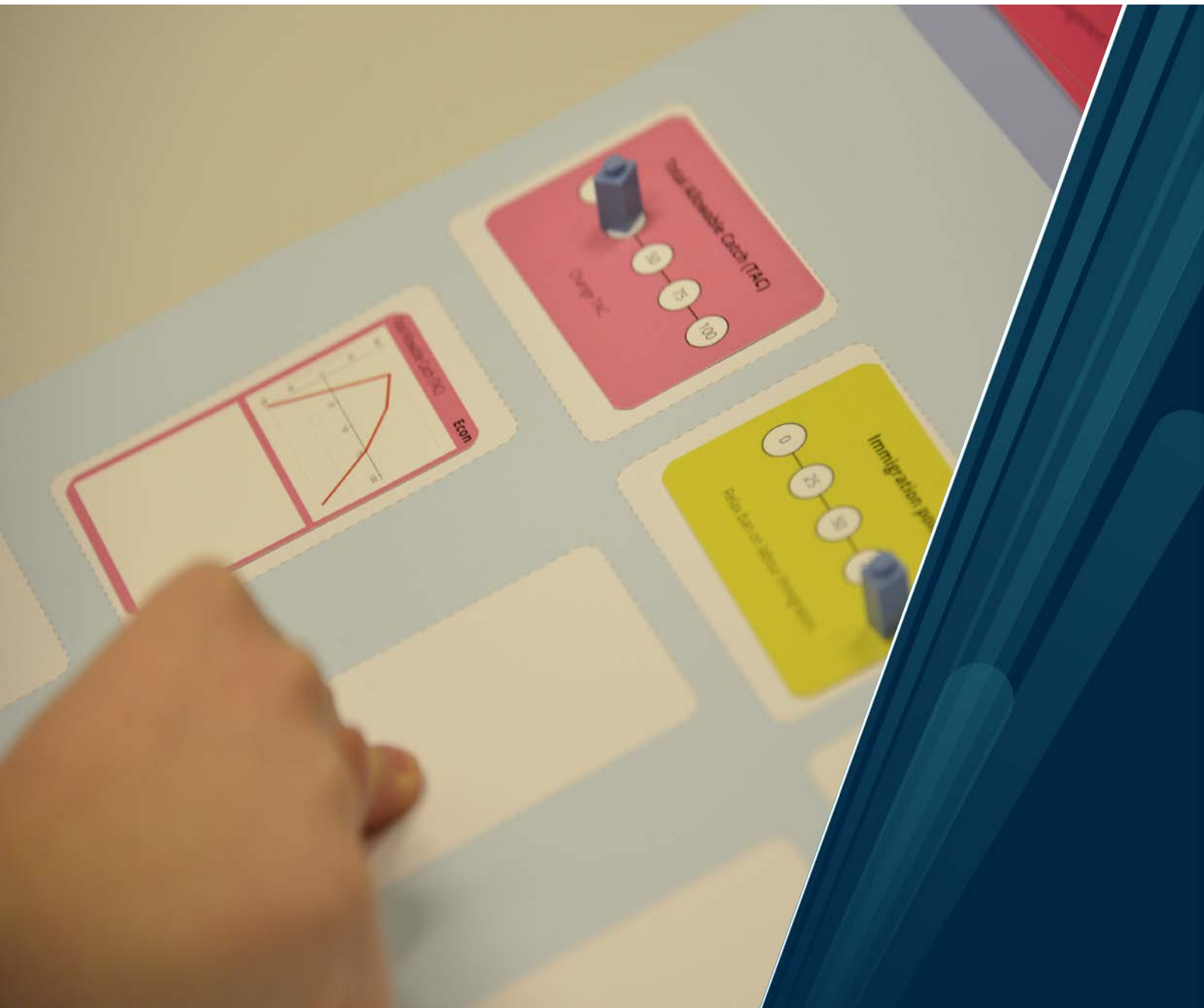Faculty of Biosciences, Fisheries and Economics

Game-based learning for marine resource management

Reflections on using games in the Bachelor of Science in Fisheries and Aquaculture

Jørn Weines

A dissertation for the degree of Philosophiae Doctor – March 2021

Table of Contents

List of Tables

List of Figures

Front page photo credit: Ørjan Garfjell

Foreword

Playing games, both analog and digital, has been an important part of my life for as long as I can remember. *Procedural generation* is a popular way of producing content for games. Very simply stated, it is stringing together different elements in a random fashion. Imagine a series of tables with different ingredients, and you roll a dice to select one from each table when you make a stew. The result can be great. It can also be terrible. I believe my first encounter with this approach was in the early 1990s, when I got a copy of the Norwegian translation of the Dungeons & Dragons Basic Set. I had great fun generating random dungeons, populating the rooms of the maps I drew by rolling on different tables. I seldom got to play, as the other kids who were interested lived on another island. I remember when I first played *The Elder Scrolls: Daggerfall* (1994) at a friend's house, and was amazed by the promise of infinite procedurally generated dungeons to explore in a videogame. By then we had moved to a larger city, and I had ample opportunities to play D&D and other roleplaying games with my friends. Few things in life are better than sitting around a table with friends, playing a game.

Sometimes I think my life must seem like a string of randomly generated events – but my dice rolls have served up a combination of results that fits quite well together. I have now spent four years researching the use of game-based learning in fishery studies. When I started this position, I expressed my surprise at researching the use of games in learning to my mother. If I remember correctly, her reply was that she was not surprised by this at all.

Abstract

This dissertation is a case study of the development and introduction of game-based learning in the Bachelor of Science in Fisheries and Aquaculture at the Norwegian College of Fishery Science.

The use of games in learning has long traditions, but is currently receiving increased attention from scholars in light of the increased focus on active learning in higher education institutions. The Norwegian College of Fishery Science at UiT The Arctic University of Norway established the SimFish-project to develop innovative interdisciplinary learning in fisheries and aquaculture. This thesis presents research produced in connection with this project, focusing on the case of game-based instruction loops for marine resource management in the Bachelor of Science in Fisheries and Aquaculture.

The case study is interdisciplinary, drawing on social science fisheries studies, active learning, game-based learning, and historical game studies. The included papers deal with different facets of these fields. The main aim in this thesis is to investigate how the underlying concepts of sustainable fisheries governance and core learning objectives in marine resource management can be integrated in game-based learning activities, and study the impacts the introduction of games as educational practice have had in the study program. The main focus of analysis is the qualitative data collected from students after game sessions, and an end of program evaluation for graduates of the program.

The results show that the game-based instruction loops have served to engage the students, and contributed to the attainment of the learning outcomes in marine resource management. The games have been both a positive learning experience, and provided simulated experience that the students find relevant for the real-world seafood industry and understanding issues related to sustainable fisheries management. The games have offered opportunities for the students to practice 21st Century skills, but the data collection has not been specific enough to contribute in-depth understanding. The results as a whole indicate that game-based learning has worked well for creating learning built on constructive alignment between the learning activities, learning outcomes and assessment. Debriefing, the structured integration of the game-experiences in the overall learning experience, has been an important factor.

As a whole, the findings indicate and contribute knowledge that can further the use of game-based learning in fisheries education and related fields.

List of papers

Paper 1:
Weines, J. (in review). Exploring fishery history in game form: "Never again April 18!"
Revised manuscript in review in *Rethinking History*.

Paper 2:
Weines, J. 2019. Promoting 21st Century skills with game-based learning in interdisciplinary fisheries education. *Proceedings of the 13th European conference on games-based learning*, University of Southern Denmark, Odense, Denmark, 3-4 October 2019, 933-942.

Paper 3:
Strandbu, A., Weines, J., Esaiassen, M. 2021: Spilt kunnskap på lektorutdanninga: Førsteårsstudentenes erfaringer med kunnskapsspillet. *Nordic Journal of STEM Education*. Vol. 4 No. 1. https://doi.org/10.5324/njsteme.v4i1.3426

Paper 4:
Weines, J., Borit, M. (in revision). Better game worlds by design: The GAS framework for designing games based on socio-ecological systems, demonstrated on Nusfjord (2017)
Manuscript submitted to *Games & Culture*.

Contributions

	Paper 1	Paper 2	Paper 3	Paper 4
Concept and idea	JW	JW	AS, JW, ME	JW, MB
Study design and methods	JW	JW	AS, JW, ME	JW, MB
Data gathering	JW	JW	AS	JW, MB
Data interpretation	JW	JW	AS, JW, ME	JW, MB
Manuscript preparation	JW	JW	AS, JW, ME	JW, MB

JW = Jørn Weines
AS = Astrid Strandbu
ME = Margrethe Esaiassen
MB = Melania Borit

Abbreviations

BFA: Bachelor of Science in Fisheries and Aquaculture

GBL: Game-based learning

ILO: Intended learning outcome

NCFS: Norwegian College of Fishery Science

SET: Student evaluation of teaching

UiT: UiT The Arctic University of Norway

INT. LARGE CLASSROOM.

WE OPEN in a large classroom, brightly lit. Several groups of
students are gathered around tables, listening to an instructor
presenting the rules of the game they are about to play.

CUT TO:

INT. LARGE CLASSROOM – CLOSE ON CORNER TABLE

A group of students are looking through the game materials,
examining the manual of management tools and game scenario
description.

"ALEX"
There's at least one tool we'll not use, the Resource Tax.
That doesn't solve any problems, it's just silly.

CUT TO:

MONTAGE OF STUDENTS PLAYING GAME
Students discuss strategy, choose management implements, adjust
settings, run simulations, and advance through game levels. Time
passes.

CUT TO:

INT. LARGE CLASSROOM – CLOSE ON CORNER TABLE

"BLAKE"
Our management plan was fine on the previous level, but our issue
now is to balance social sustainability with the other elements.
We're doing great on economy and environment.

"CAMERON"
We do have two simulations and three new management tools left, we
can try replacing something?

"ALEX" stands up, leans over the table and examines the game board.

"ALEX"
Folks. I think we need to consider implementing the Resource Tax.

1 Introduction

The previous page shows a stylized example of bachelor students playing a game about making a fisheries management plan, in a course about marine resource management. It is an example of how students can arrive at reconsidering their preconceptions after having experimented with different variables in a simulation of resource management planning. Through the experience of trying to solve a complex problem with no simple solution, the student is open to consider a previously dismissed management implement in order to meet the overall goals of the management plan. This thesis is about the implementation of game-based learning in fisheries education, and explores how games can contribute to making fisheries governance come alive in the classroom.

1.1 Aims and scope

Games are a popular medium. The most recent study of Norwegian media use from Statistics Norway[1] shows that 35% of the population plays digital games on an average day. For the age group 16-24, the rate is 55%. Globally, non-digital games are also experiencing a renaissance in popularity, but are not as visible in statistics or media studies (Booth, 2018). Game elements are also present in the everyday lives of those who do not identify as game-players, through gamified systems such as customer loyalty programs (Schrape, 2014). Education is another field where games have been present for a long while, but are gaining more attention. This thesis presents theoretical work on the use of games for learning about fisheries, and a case study of the impacts the development and integration of games have had on a bachelor program in fisheries and aquaculture science.

The perspective from which I have written this thesis is that of a historian with an interest in historical methods and theory, stakeholder perspectives and human–nature interaction in marine resource use (Weines, 2016). The didactics of history and learning in general have also played a large role in my training as a historian. In addition, I have had a lifelong passion for games, digital and analog. Through this PhD I have been given the opportunity to combine these interests. This dissertation and the included papers form an interdisciplinary study, drawing on social-science fisheries studies, game-based learning, and historical game studies. My stay as a visiting scholar at the BGNLab[2] at Wilfrid Laurier University was instrumental in seeing the points of contact and divides between the different fields of game studies, gamification and educational games. The aim of this thesis is to contribute to our understanding of how central elements of fisheries education can be integrated in game-based learning (GBL), and evaluate the impact of the game-based instruction loop in the Bachelor of Science

---

[1] https://www.ssb.no/kultur-og-fritid/statistikker/medie

[2] http://bgnlab.ca/about-the-bgnlab/

in Fisheries and Aquaculture (BFA) at the Norwegian College of Fisheries Science (NCFS). The research in this thesis is connected to the research group Marine Resource Management and Development[3], and focuses on three games that have been used in classes on marine resource management and sustainable fisheries (described in section 2.3). The development of GBL came as a response to a greater overall commitment to active learning, and this thesis is a result of my work as a participant in the SimFish project, described in section 1.3.

The main research questions of this thesis and the included papers are:

- How can game-based learning impart the underlying concepts of sustainable fisheries governance (including the historical development of management)?
- How can core learning objectives in marine resource management be integrated in game-based learning activities?
- What impacts have games as educational practice had on the Bachelor of Science in Fisheries and Aquaculture?

1.2 Increased focus on active learning in higher education

The background for this thesis is, in part, the turn towards active learning at UiT The Arctic University of Norway (UiT). Bonwell and Eison (1991)'s book is an influential work in the field. Active learning is seen in contrast to the idea of passive learning, where students are recipients of teaching. Bonwell and Eison frame active learning as a continuum of classroom activities that facilitate students' involvement in the process of learning. They provide a concise working definition as "anything that 'involves students in doing things and thinking about the things they are doing'" (ibid.: 19). The spectrum of possible activities is wide, for example collaborative, cooperative and problem-based learning, in-class discussions, peer teaching, or simulations and games. There are several arguments for why facilitating student activity is beneficial for learning. Biggs and Tang (2011) rank approaches to learning based on the cognitive level of the learning activity, from low (surface approach) to high (deep approach). A central challenge in effective teaching is to encourage deep learning approaches by providing activities that support higher level thinking. Throughout their book, Bonwell and Eison draw on research-based studies to show how engaging students in complex activities promotes their use of higher-order thinking (such as analysis, synthesis and evaluation), and the development of intellectual skills and reflection on their own attitudes and values. Prince's (2004) review of active, collaborative, cooperative and problem-based learning finds support for the effectiveness of these methods.

---

[3] https://uit.no/research/mara-en

The effort to develop and introduce GBL in the programs at the NCFS has been built on the foundation of active learning. The central driver has been constructive alignment, meaning the idea that students create understanding through learning activities that are matched with relevant learning and assessment activities for achieving the intended learning outcomes (Biggs and Tang, 2011). Using games offer opportunities for combining elements of different types of active learning. Paper two and three considers constructive alignment and active learning in relation to the games studied in this thesis.

A 2017 government white paper titled "Culture for quality in higher education" (my translation) (NOU 2016-17:16) put forth guidelines for the Norwegian higher education institutions on the expectations for their educational programs. Areas of focus are active learning, culture for quality, integration of students in the academic community, and cooperation with the labor market. With the expressed ambitions of the Ministry of Education, there was a drive to strengthen such measures at UiT. The central shift relates to the paradigm changing from focusing on teaching to focusing on learning, and that the teaching should be based on defined learning outcomes. The SimFish project represents one of the NCFS's efforts in the turn towards active learning.

1.3 The Norwegian College of Fishery Science and the SimFish-project

The Norwegian College of Fishery Science[4] was established in 1972[5], and is UiT's unit for research and education on Norwegian and international fisheries and aquaculture. The college is a department at the Faculty of Biosciences, Fisheries and Economics, which in total has approximately 500 employees and 3000 students spread across three departments; NCFS, the School of Business and Economics and the Department of Arctic and Marine Biology. The NCFS's research groups cover a broad, interdisciplinary spectrum of marine sciences, developing relevant, complete and innovative knowledge for all facets of the marine sectors, including the environment, industry and society. NCFS offers several study programs on the bachelor and master levels, in fisheries and aquaculture science, marine biotechnology, aqua medicine and international fisheries management.

This thesis was funded as part of the SimFish project, which aimed to develop innovative interdisciplinary learning in fisheries and aquaculture.[6] The project group encompassed academic staff from several disciplines; history, social science, biology and seafood production, as well as administrative staff and students. SimFish built on an earlier initiative that implemented an internship

---

[4] https://uit.no/enhet/nfh/

[5] Handegård (2010) gives an overview of the processes leading up to the establishment of the NCFS.

[6] Funded through UiT's program for educational quality development.

component in the BFA, and had support from several industry and government partners. The overarching goal of the project was to combine three elements in creating an interdisciplinary learning arena: Active learning in collaboration with industry and society; research-based and ICT-enhanced learning; and an interactive community of learning. The main objective was to conceptualize the *SimFish model* of vocational education and training, built on student active learning and research-based education. Assisted by ICT, the model would integrate blended learning, problem-based learning, simulations and games in the implementation of a six-semester spanning *SimFish Game* (SimFish project description, 2015).

The development efforts, however, shifted from a single, integrating game to implementing the use of different simulations and games in some of the program courses, primarily analog games with some degree of ICT-support. The games examined in this thesis are *Fish Banks Ltd.* (a commercially available serious game), and two games developed by SimFish participants: *Green Grouper Game* and *Go n' Fish – Fishing for Knowledge*, described in detail in section 2.3. Throughout the project, other games and simulations have been in development and tried out, but they are beyond the scope of this thesis.

The project included a collaboration with the Dutch game-based learning company TXchange[7] for the technical implementation of the envisioned *SimFish Game*. Efforts to build a community of practice around the *SimFish model* was a specific objective, and the project members participated in dissemination of the work at UiT and other departments. Paper three is a result of the effort to build a community of practice, as UiT's teacher's education program introduced *Go n' Fish* in one of their courses. The collaboration with Strandbu and Esaiassen offered an opportunity to examine the impacts *Go n' Fish* from a sociocultural learning perspective based on a more extensive data than the one collected of the game's use in the BFA.

1.4 Bachelor of Science in Fisheries and Aquaculture

At the NCFS, the flagship program for sustainable fisheries and aquaculture is the Bachelor of Science in Fisheries and Aquaculture (BFA).[8] This is a three year program that combines biology, social science, economics and technology. In 2018 the program increased its admission by approximately 10, enrolling between 50 and 60 new students per year. The program aims to be interdisciplinary and oriented towards application in the seafood industry, blending academic content and training in practical skills. Instruction makes use of several student active learning approaches, including research

---

[7] TXCHANGE was a company for game-based learning solution based on a cooperation between the University of Delft and the Thales Group. Website: https://www.txchange.nl/

[8] https://uit.no/utdanning/program/268899/fiskeri-_og_havbruksvitenskap_-_bachelor?p_document_id=268899

cruises, lab and internships in the seafood industry – and now also games. The program was revised in 2016 with the aim of integrating the different disciplines in thematic semesters. The common thread throughout the program is sustainable fisheries and aquaculture, and the first year of introductory courses in biology, chemistry, economics, fishery science, mathematics and statistics is followed by thematic semesters focusing on sustainable fisheries, sustainable aquaculture and sustainable seafood production.

The focus of this thesis is primarily the use of GBL in the marine resource management topics that are covered in the first integrated semester, which deals with sustainable fisheries. This semester covers issues relating to the sustainable use of wild marine resources: The core concepts of fisheries governance, including fish biology, catch technology, resource economics, marine resource management and social science. Graduates of the program have a broad set of competencies and skills, aimed at employment in the fisheries and aquaculture industry both in Norway and abroad.

The idea of "sustainable fisheries" is complex, and is closely tied to developments in the field of fisheries management. The management of eco-systems is often considered a wicked problem; "inherently resistant to clear definitions and easily identifiable, predefined solutions" (DeFries and Nagendra, 2017). Fisheries management, especially management of small-scale fisheries, has also been described as wicked (Jentoft and Chuenpagdee, 2009). The foundational principles of fisheries management build on several fields. These include the overall national and international juridical frameworks, and the practical and theoretical frameworks of resource management. Issues relating to common pool resources and governance of socio-ecological systems are central, such as the discourse on the "tragedy of the commons", meaning the problems that can arise when there is open access to a shared resource with no coordination to hinder unsustainable exploitation (Hardin, 1968; McCay and Jentoft, 1998; Ostrom, 2009). Modern fisheries are normally managed through quota systems, which are regulated by both national policies and international agreements. The *Total Allowable Catch* is the underlying premise, resulting from an extensive cycle of scientific stock assessments, management advice, quota allocations and catch regulations (Standal and Hersoug, 2014). Significant effort has been expended in integrating stakeholder participation in the governance of marine resources, but the "TAC-machine" of top-down management has proven hard to escape (Holm et al, 2020). As harvest of fish is the material basis for communities and industry, governance relates not only to the management of resources, but also people. The seafood industry and management consist of numerous stakeholders, which activates questions of the relationship between those who make regulations and those who are regulated (Jentoft and Johnsen, 2015). The management of Norwegian fisheries is thoroughly organized, with strong coordination between business, government and non-governmental organizations (Jentoft and Finstad, 2018). The corporative fisheries-political complex is not static, and while the focus has turned toward sustainable management over the past decades, public perceptions

are informed and reinforced by Norway's long history of fishing (Holm and Finstad, 2020). Likewise, the participants in the fisheries are also diverse and changing, which must be taken into account for fisheries policies to be relevant for the currently employed adaptations in the fisheries sector (Sønvisen, 2014).

As this brief description of "sustainable fisheries" shows, there are many dimensions involved. In addition, the fisheries are connected to other marine developments (such as aquaculture) and the seafood production industry. Although the focus of this thesis is on fisheries, some of the reflections are transferable to other parts of the marine sector. Papers one, two and four discuss different aspect related to sustainable fisheries education in relation to GBL and games.

1.4.1 Intended leaning outcomes in the BFA

Scholars have given significant attention to effective teaching and learning. Hattie (2011) points out that clearly communicated learning intentions and assessment criteria are effective strategies for successful teaching. In the BFA, the learning intentions are operationalized as intended learning outcomes (ILOs) on the program and course levels, indicating the level of understanding and performance the graduates are expected to achieve from the teaching and learning activities (Biggs and Tang, 2011). There are several approaches to defining levels of understanding, and taxonomies to describe the intended learning activities (verbs) and structure their content and context. Biggs and Tang discuss the SOLO-taxonomy, and note how the well-known revised Bloom's taxonomy is useful for verbs to describe a wide variety of learning activities. In essence, these taxonomies are ways of grouping different performances of understanding in tiers or hierarchies. Verbs that focus on surface learning are oriented towards reproduction of knowledge and concepts, while verbs focusing on deeper knowledge are oriented towards application and relation, as well as creation, of knowledge. As deep learning approaches also activate the lower levels of cognitive activity, Biggs and Tang discourage the use of surface-focused verbs.

The program learning outcomes are presented in Table 1. On the course level, more detailed ILOs are defined. The current ILOs were developed as part of the 2016 revision of the program. The knowledge and competencies required from graduates were discussed in collaboration with a reference panel of stakeholders in the seafood industry and management. The mandate for the revision highlighted that the new study plan should facilitate internships, student active research and interdisciplinary problem-solving (BFA study plan proposal dated April 2016). The use of GBL in marine resource management have had a particular focus on interdisciplinary problem solving.

The first paper relates ILOs for modern Norwegian fisheries history to historical thinking perspectives in a proposed educational game. The second paper presents the detailed ILOs for resource management connected to the games used in the BFA, and preliminary program evaluation data on

learning activities based on learning outcomes. Section 4.2 provides updated data based on collection from students after game sessions, field notes and program evaluations from two additional student cohorts.

The ILOs presented in Table 1 cover the overall interdisciplinary knowledge and skills that graduates of the BFA are expected to attain. The goals for the thematic semester on sustainable fisheries are shown in Table 2.

One of the expectations from higher education institutions is to provide graduates with the skills that are necessary in the workforce, such as collaboration, communication, creativity and critical thinking. Skills like these are often called "21st Century Skills" (Binkley et al, 2012). Development of these skills are tied to deep learning and the use of the higher order thinking learning. Some of these are expressed explicitly in the program and semester ILOs. The second paper relates the use games used in the BFA to the skills collaboration, communication, critical thinking and problem-solving.

Table 1 Intended Learning Outcomes in the BFA (translated from Norwegian)

AFTER COMPLETED STUDY AND ATTAINMENT OF DEGREE, THE CANDIDATE SHALL HAVE AQCUIRED THE FOLLOWING LEARNING OUTCOME:		
KNOWLEDGE	**SKILLS**	**GENERAL COMPETENCIES**
•Has broad, interdisciplinary knowledge in biology, technology, economy and social science about the use of aquatic resources and ecological and social consequences, and the interactions between different parts of the value chain in the seafood industry. •Knows about research and development in fisheries and aquaculture science. •Is able to update and acquire new knowledge in fisheries and aquaculture science. •Has knowledge of the fishery- and aquaculture industries' history, traditions, distinctiveness, sustainability and impact on society and environment.	•Can apply relevant theories, methods and techniques in biology, technology, economy and social science to solve practical and theoretical problems in the fisheries- and aquaculture industries. •Can reflect over on and evaluate their own academic performance and, under supervision, adjust it. •Can find, evaluate, refer and utilize information and academic literature in biology, technology, economy and social science, and present it in relation to interdisciplinary issues in the fisheries- and aquaculture industries.	•Has insight in relevant issues and challenges in Norwegian and international fisheries- and aquaculture industry, including understanding of sustainability and environment. •Is able to plan and complete tasks on several levels in the fisheries and aquaculture industries, both individually and in cooperation with others, in accordance to ethical guidelines. •Can, through different forms of expression, disseminate fisheries and aquaculture-related knowledge in the fields they are working. •Can exchange professionally justified views and experiences in several fields relevant to the seafood industry, and through this contribute to good practice.

Table 2 ILOs for the Sustainable Fisheries semester (translated from Norwegian)

AFTER COMPLETED COURSE, THE CANDIDATE SHALL HAVE AQCUIRED THE FOLLOWING LEARNING OUTCOME:		
KNOWLEDGE	**SKILLS**	**GENERAL COMPETENCIES**
•Has interdisciplinary knowledge about sustainable management of wild marine resources and fisheries. •Has broad knowledge in fish biology, catch technology, resource economics and social science. •Has knowledge on research and development in fishery science. •Can update and acquire new knowledge in fishery science •Has knowledge of the fishing industry's distinctiveness, sustainability, and impact on society and environment.	• Can apply relevant theories, methods and techniques in biology, technology, economy and social science to solve practical and theoretical problems in fisheries management. •Can explain the principles for Norwegian fisheries management. •Can reflect on and evaluate own academic performance. •Can find, evaluate, refer and utilize information and academic literature in biology, technology, economy and social science, and present it in relation to interdisciplinary issues in fisheries management. •Can collaborate in groups to prepare joint academic reports.	• Has insight in relevant issues and challenges in Norwegian and international fisheries management and industry, including understanding of sustainability and environment. •Is able to plan and complete tasks on several levels in fisheries management, both individually and in cooperation with others, in accordance to ethical guidelines. •Can disseminate scientific knowledge of fisheries management. •Can exchange professionally justified views and experiences in fisheries relevant fields, and through this contribute to good practice

1.5 Structure of thesis

The rest of this thesis follows this structure:

Chapter 2 presents the theoretical perspectives of the thesis, and the GBL-instruction loop in the BFA.

Chapter 3 presents the methodological considerations and materials used.

Chapter 4 gives a summary of the four papers included in this thesis, and presents the expanded results from the data collection.

Chapter 5 discusses the results in light of the theoretical perspectives, and implications for further research on the use of games in fisheries education.

Papers included following the appendix.

2 Theoretical perspectives

This chapter presents the theoretical perspectives this thesis builds on; GBL, historical game studies, and how these inform the implementation of GBL for sustainable fisheries in the BFA.

2.1 Game-based learning

Academic study of the use of games and simulations in education has long traditions. I will present a broad overview of the field before discussing the implications for the use of games in the BFA. Wilkinson (2016) provides a thorough review of the field, from the early theories of children learning through play, to modern studies of serious games. He calls attention to the points of contact between games for learning and other uses of games, such as military simulations, marketing and healthcare, and the cognitive mechanisms of motivation games can tap into. There are a multitude of terms used to describe different approaches; serious games, simulations, or persuasive games to mention a few. Crookall (2010) discusses the different terms utilized within the field, pointing out that placing restrictions on terminology can be counter-productive. For the purpose of this thesis, I have chosen to use the term game-based learning (GBL), as it highlights both the use of games and the focus on learning. At its core, GBL combines educational content and game elements. Several frameworks have been proposed to illustrate how these elements are combined. An often cited article is Garris et al (2002), which presents an input-outcome instructional model for games. Instructional content and game characteristics are combined in a game-cycle process that learners experience, before relating the experience to real-world contexts and linking it to learning outcomes. Plass et al (2015) gives a comprehensive overview of the foundations of GBL, offering perspectives on the cognitive, motivational, affective, and sociocultural elements that play a part in connecting games and learning. They assert that the basic structure of a game is a loop of challenges, responses and feedback around a core of game design features ("The Magic Circle"). The playfulness of these characteristics, in combination with the learning theory informing them, is what transforms the learning experience. They argue that it is not possible to understand game-based learning from just one perspective of learning, but that an integrated approach is necessary.

Debriefing is a central concept in GBL, and has been a point of focus in the work done by the SimFish project. Debriefing is the systematic integration of reflection after a game or simulation has been used in instruction. Crookall (2010: 907) concisely describes it as "the occasion and activity for the reflection on and the sharing of the game experience to turn it into learning", and warns that neglecting debriefing puts the legitimacy of game-based learning at risk. Nicholson (2012) looks at different models of debriefing, and points out three features that should receive attention in any debriefing design: what was done in the activity, how well it worked for the learner, and how the learning can be applied. Pavlov et al (2015) explore structural debriefing, which focuses on advancing learning of concepts in system dynamics. Some scholars, like Clapper (2018) states that while

debriefing improves on a learning experience, they consider the learning experience itself to have the highest importance.

GBL is often seen as distinct from gamification of learning, although several scholars use the terms interchangeably (Wiggins, 2016). Gamification is understood as using commonplace video-game elements (such as badges, levels, achievements, points and leaderboards) in other contexts in order to drive motivation and behavior (Nicholson, 2015). Proulx et al (2017) investigates learning and game mechanics from the perspective of self-determination theory. Landers (2014) reviews the links between serious games and gamification of learning, proposing a theory of gamified learning. Landers claims serious games typically provides instructional content to learners, while gamification focuses on augmenting existing instructional content. While one of the games studied in this thesis, *Go n' Fish*, can be argued to draw on elements of gamified learning, its integration in the instruction loop makes it more than an application of gamification (see paper 3). As several studies consider both GBL and gamification, literature on gamification will also be applied when required.

There have been several literature reviews and meta-studies on the empirical studies of games in education. Many studies focus on the use of digital games, and look at both GBL and gamified education. Connolly et al (2012) points at the need for more qualitative studies examining the nature of engagement in games. Wouters et al (2013) finds serious games to be more effective than conventional teaching, for knowledge and cognitive skills, but not more motivating. Bellotti et al (2013) finds that GBL is effective for motivation and learning in the lower levels of Bloom's taxonomy of learning, but advises caution in regards to claims of advanced learning, calling for more studies of assessment of user learning. Ariffin et al (2014) finds that user backgrounds influence motivation and performance in GBL. Tobias et al (2014) finds that people learn from games, but that more work is needed on processes for making games that reliably achieve the intended learning outcomes. Jabbar and Felicia (2015) finds GBL can provide opportunities to develop skills and knowledge, and that engagement is related to students' cognitive and emotional involvement, pointing out the importance of considering the diverse elements that can foster engagement. Dicheva et al (2015) points out that a majority of research on gamified education focuses on some game mechanics and their possible use, but that there is little focus on empirical research on the effectiveness in learning environments. They therefore call for more focused empirical research. Boyle et al (2016) finds that GBL has been used to promote knowledge acquisition in several fields, and to a lesser extent skills and behavior change. They observe a move from using commercially available games to custom games designed for specific learning objectives, noting that the design of these games can be complex and costly. Dichev and Dicheva (2017) confirms that research on gamified education is diverse, but with a focus on empirical studies (in particular on college students) and not on theoretical considerations. They note that there is a lack of conclusive evidence for valid claims about effectivity,

calling for more systematical experimentation in order to confirm the educational benefits of gamification. Vlachopoulos and Makri (2017) confirms that games and simulations contribute to cognitive learning outcomes (such as knowledge acquisition, conceptual application, content understanding and action-directed learning), especially when incorporated in the overall instruction. They also point at the costs involved as a challenge. Subhash and Cudney (2018), with the qualifier that some of the studies reviews were quasi-experimental, finds encouraging support for gamified learning in higher education. Significant benefits were in student attitudes, engagement, and performance. Qian and Clark (2016) reviews GBL in the context of development of 21st Century skills. They conclude that GBL has potential of promoting skill acquisition, especially in games where the players are engaged with design elements.

While several of the reviews find evidence supporting the opportunities of using GBL, some express critical concerns, and doubts about the basis for claims of the benefits offered. There have been several works exploring the challenges of GBL in depth. Berg Marklund's (2015) dissertation is a comprehensive work exploring the complexities of developing and implementing digital games for learning, in particular the logistical challenges of integrating games in formal learning settings. He calls for researchers to focus on necessary, practical ground-work that takes into account the logistical challenges of using GBL in practice. Linderoth (2012) looks at the concept of affordances in games (i.e. the different ways of acting offered to the player by the specific elements in the game). By exploring how players learn to see and utilize the affordances in games, he challenges the assumption of many GBL scholars that games (as complex systems) have inherent qualities that promote learning. Furthermore, he asserts that the connection between games and learning must be considered an empirical question, and avoid mistaking the illusion of learning through progressing through a game as actual learning. Linderoth and Sjöblom (2019) conclude that lack of pedagogical content knowledge can lead to deficiencies in the design and implementation of GBL.

Based on the current state of scholarship on GBL, this thesis makes the assumption that games can work well in the context of fisheries education, providing playful learning experiences that can be related to the curriculum and real-world contexts through structured debriefing. In the context of the shift towards an active learning paradigm, GBL activities match well with the principles of constructive alignment. Games can serve to engage students, but the primary goal is to strengthen learning outcomes by aligning the learning activities with the course objectives and assessment. The concept of the "magic circle" is important in this regard, with playful learning experiences connected to game activities that serve to further the course learning goals. In addition to serving as processes where learners can engage with the moving pieces of resource management, their activities in the games also allows for practice in skills. These opportunities are not without challenges, as shown by several of the scholars referred to above. Development and implementation is costly and time-

11

consuming, and proper links to ILOs must be considered in regards to not only what students are intended to learn, but how they learn it, and how the learning is assessed. GBL is not meant to replace all other teaching activities that promote learning, but is an educational practice that exists in relation to the other parts in the overarching instruction design, and built on the same pedagogical basis as other instruction. One of the critical concerns is that the games themselves are not a source of learning, but a tool. In light of the BFA program and fishery semester ILOs, the explicitly stated goals relating to collaboration, communication and problem-solving align with GBL activities that provides the players with systemic contexts and engaging challenges for the actions they take during gameplay, which will be discussed further below. There appears to be a consensus that reflection through debriefing is critical for GBL to succeed in these cases. Other ILOs are more general, defining broad sets of knowledge. GBL to achieve these outcomes can be designed to provide playful gamified activities for knowledge acquisition. In addition to discussing marine resource management in relation to the theoretical developments in the GBL-field, this study also explores the impact of the use of GBL in the BFA in light of the empirical data that has been collected about the student's experiences, adding to the understanding of how games can contribute to learning.

2.2 Historical games and relevance for fisheries learning

The academic study of games has rapidly been established alongside studies of other media, to the point of the interdisciplinary ambitions of the early pioneers having fractured into different subfields (Deterding, 2017). It is beyond the scope of this thesis to engage with the entirety of the game studies field, but historical game studies is of particular relevance for this study. The first paper includes a review of the state of the field of historical game studies, and relates it to a case from Norwegian fisheries history. The fourth paper draws on historical game studies in its analysis of the board game Nusfjord (2017). For clarity, I will briefly summarize the main elements and expand on the relevance of the field in the context of fisheries education.

Chapman et al (2017) define historical game studies as:

> *'The study of games that in some way represent the past or relate to discourses about it, the potential applications of such games to different domains of activity and knowledge, and the practices, motivations and interpretations of players of these games and other stakeholders involved in their production or consumption' (ibid.: 362).*

Kapell and Elliot (2013) and Chapman (2016) are two of the most comprehensive scientific works that discuss the relationship between games and history. Scholars in the field have argued how the media of games not only disseminates history, but can create historical arguments and give players opportunities to question history (Spring, 2015), or promote historical empathy (Hoy, 2018). How games present historical events can serve to reinforce or challenge established historical perspectives

(Fron et al, 2007; Hammar, 2018). McCall (2016) calls attention to the opportunities games offer in teaching history, by allowing players to experience systemic contexts for their actions. Apperley (2013) and Chapman (2016) show how games can make use of counterfactual thinking, and promote historical reflection and interrogation of alternative outcomes of past events. This can be useful for understanding not only the past, but also current events and future possibilities.

In the context of the learning goals of the BFA, understanding the historical background and development of Norwegian (and international) fisheries management is important. In broad terms, recent history has been characterized by major changes to the status quo of Norwegian fisheries. Arguably the most dramatic is the change from the paradigm of an open common to a closed fishery managed by quotas after the resource crises in the 1970s and 1980s (Holm et al, 2014). Another is the changes and adaptations in the seafood industry towards the demands in the national and international markets (Finstad, 2014). The institution of Norwegian fisheries management is involved, with a diverse set of stakeholders and established structures. Scientific management of fish stocks in Norway has roots dating back to the mid nineteenth century (Schwach, 2013). Current Norwegian governance of marine resources involves actors on several levels, from the diverse fishing fleet, the seafood processing industry, scientific managers and government officials. As a socio-ecological system, the structures and actors in the fisheries sector are in constant change. Adaptations to new developments, in regards to fish stocks, technology, markets and regulations, are common. Concerns about sustainable fisheries are a driver, with the protection of the fish stocks from overfishing being the driving management objective for the past three decades (Holm and Finstad, 2020). The social and economic dimensions of sustainability are also important, with recent government white papers considering topics such as the quota system and its implications for local communities (NOU 2016: 26) and the economic conditions in the processing industry (NOU 2014:16). Seen as an example of institutional politics, the deliberations between stakeholders can be simplified and presented in game form, as discussed in the first paper. The effects of different management choices on stakeholder groups and components of the fisheries sector can be displayed through discrete actions in games. By allowing players to make choices in a systematic context where their decisions can cause adverse effects, they can experience both factual and counterfactual consequences of mismanagement based on wrong management practices and assumptions. Relevant topics from Norwegian fishery history are conflicts about rights to quotas (small-scale fishers vs. industrial trawlers, or the indigenous Sami people), or requirements to deliver catch to landing stations close to the fishing grounds. Issues like these represent key narratives in current and historical discourse about Norwegian fisheries. The corporative Norwegian system of fisheries management has created laws and institutions that have served to protect the coastal fishers, which in turn is the lens through which discourse on fisheries is framed and understood in the public eye. An example of this is the recent "coastal uprising" which protested the current government's fisheries policy (Johnsen and Finstad, 2020). Through debriefing,

the game experience can be reflected through comparison with historical cases, illustrating how the developments in the governance system and relationships between the actors represent continuity and change.

2.3 GBL for sustainable marine resource management

The seafood industry depends on the harvest of marine resources, making it a socio-ecological system (Charles, 2001; Broderstad and Eythórsson, 2014; Brattland et al 2019). Human activity is coupled with the bio-physical world. This section gives a brief description of the games that have been used in the BA program, and the learning outcomes they are tied to, as well as presenting the game-based instruction loop for sustainable marine resource management in the BFA. There have been several studies that examine elements that grant insight on how games can illustrate mechanics of systems and sustainability, or explore people's understanding of the environment they live in. These can provide insight on how games can contribute to game-based instruction loops for teaching system thinking and sustainability in marine resource management. Three of the papers in this thesis explore different facets of the relationship between games and sustainable fisheries management. The first paper discusses how a historical resource crisis can be presented in game form. The second paper gives a full presentation of the three games used in the BFA and the link between learning outcomes, skills and in game activities. The fourth paper presents a framework for designing and analyzing games through considering the socio-ecological systems that are present in the game's world.

2.3.1 Fish Banks Ltd.

Fish Banks Ltd. (Meadows et al, 1993) is a commercially available serious game where teams of players run fishing companies that invest in vessels and harvest two fish stocks. The goal of the fishing companies is to generate the most profit, and the underlying stock simulation is built to ensure that the tragedy of the commons will happen when the fishing pressure exceeds the regeneration of the fish stocks. When played as designed, the game strongly emphasize profit as the main motivation for players. In the BFA, the game was modified after the first years in order to offer more opportunities for negotiations between the teams to make voluntary agreements to prevent the fish stocks from collapsing, while still having a relative passive state (embodied by the game master) without access to strong regulatory measures or sanctions. Qudrat-Ullah (2007) considers the importance of systematic debriefing for a game based on *Fish Banks Ltd.*, finding that it can contribute better understanding of system changes in fisheries and decision making in management. The ILOs tied to the use of *Fish Banks Ltd.* further operationalize the overall learning goals of the BFA program and sustainable fisheries semester:

- Attain insight in central challenges in marine resource management, and the most important international developments in the field;

14

- Be able to reflect over choice of management methods; Be able to work with practical challenges in marine resource management;
- Account, orally and in writing, for ecological, economic and social consequences of management measures;
- Evaluate when and how management measures should be implemented.

2.3.2 Green Grouper Game

The Green Grouper Game was developed by participants in the SimFish project, assisted by TXchange. An early version of the game is presented in Weines et al (2017). Teams of players act as fishery management consultants participating in a competition to make the best plan for sustainable management of the imaginary fish species "Green Grouper" in the fictional country Simnesia. The players are given a scenario description that outlines the country, the history of the fishery, and the different national and regional stakeholders with interests in the fishery. Players are also provided with a manual of the different management implements that are available in the game. In making their proposed management plan, the players have to balance the economic, environmental and social dimensions of sustainability, and feedback from the stakeholder groups. The game is a combination of roleplaying and board game, with a web-interface that provide players with feedback on their plans. The earlier version of the game required an instructor running the game for each team. Players advance through levels where they get access to more advanced management instruments and must adapt their proposed plan by adding additional instruments and solve more complex problems. In the final phase of the plan, the teams must present their proposed plan and argue why it is the best choice, with an instructor serving as Simnesia's minister of fisheries deciding if any of the plans win. As with *Fish Banks Ltd.* the game ILOs for the *Green Grouper Game* operationalize aspects of the overall learning goals:

- Experiment with the interdisciplinary complexities in making and implementing management plans, and explain the basics about marine resource management;
- appreciate the interdependence between the management actions and the three sustainability pillars (economic, environmental and social sustainability);
- and experiment and explain that no perfect management plan exists, but many possibly viable solutions do.

2.3.3 Go n' Fish – Fishing for Knowledge

This game was also developed by participants in the SimFish project. *Go n' Fish* is presented in the format of a knowledge game, where teams of players compete to answer questions in four different categories. However, the questions are made by the students throughout the semester, and there is no list of correct answers – the other teams must decide if an answer is correct. After each section of a

course, students must send in questions based on the curriculum that they think are relevant for the learning outcomes. The course instructor selects which questions will be used. The game works as a flexible multi-tool that can be used in any subject, and mixes knowledge with playfulness, engaging students in working with the curriculum throughout the semester, and during all stages of gameplay. The third paper discusses the game in terms of sociocultural learning theory and learning strategies, based on data from its use in UiT's teacher education program. Borit and Stangvaltaite-Mouhat (2020) presents a study of the game adapted to flipped-classroom use in dentistry education. The game serves as a tool to acquire the broad interdisciplinary knowledge and communication general competencies ILOs in the program description.

2.3.4 Game-based instruction loops for sustainable fisheries management

As discussed in section 1.4, "sustainable fisheries" is a multifaceted concept. In the field of game studies, the manners in which games frame the environment or human-nature interaction have gotten a lot of attention by scholars. Some examples are: Kaplan's (2010) dissertation examines the virtual worlds of online games through a lens of eco-criticism, and discusses the environmental ethical dimensions and opportunities of virtual worlds. Bell-Gawne et al (2013) explores the use of video-game simulations for environmental policy research. Kelly and Nardi (2014) discuss how games can use resource scarcity to illustrate sustainability science. However, "sustainability" is a widely used term, and the full ramifications of the term can be hard to grasp. As Purvis et al (2018) find in their search for the origin of the concept, sustainability is generally seen as a balance between the economic, environmental and social dimensions, with some frameworks also making the concept of institutional sustainability explicit. Blanchard and Buchs (2015) looks at how role-playing games can be used to clarify understanding of sustainable developments. They note how terms with widespread use exhibit semantic instability, i.e. it is hard to grasp the full implications, which can make in-depth understanding of concepts harder. They find that role-play, with debriefing, has substantial added value for deepening knowledge on sustainable development. This reflection has particular relevance for games for sustainable marine resource management. Sustainable fisheries management is not only about keeping the fish stocks at a size that can provide the maximum sustainable yield, but also the economic well-being of the seafood industry, and provide for the communities that are built on the use of marine resources.

The implementation of games in the BFA was developed and refined through several iterations. As subject matter experts and experienced instructors, the course instructors were instrumental in the integration and development of the games. Student representatives also participated in the design workshops, and modifications were made based on student feedback. At the start, *Go n' Fish* and *Fish Banks Ltd.* were used in some courses, and *Green Grouper Game* was developed and iterated after the

first games were taken into use.[9] Over time, the games were more strongly integrated into the instruction, with the idea of the simulation games having a logical sequence.

Figure 1 illustrates the instruction loop integrating the three games when used to teach marine resource management. As course coordinator for the marine resource management, Professor Petter Holm was the driving force in the design and implementation of the instruction loop, and operationalization of the ILOs to align the game activity with the learning goals. This model updates the version presented in paper two, showing more clearly how structural debriefing of the game experience is integrated throughout the semester as part of the reflection process of the games' relationship to the ILOs. Furthermore, the use of the game experience as the basis for take-home assignments, and the *Go n' Fish* questions made by the students as part of oral exam, represents a significant change in how the students are assessed. From the perspective of the learning paradigm, this can be seen as constructive alignment by involving the students in the assessment process as a part of their construction of knowledge and attainment of the ILOs.
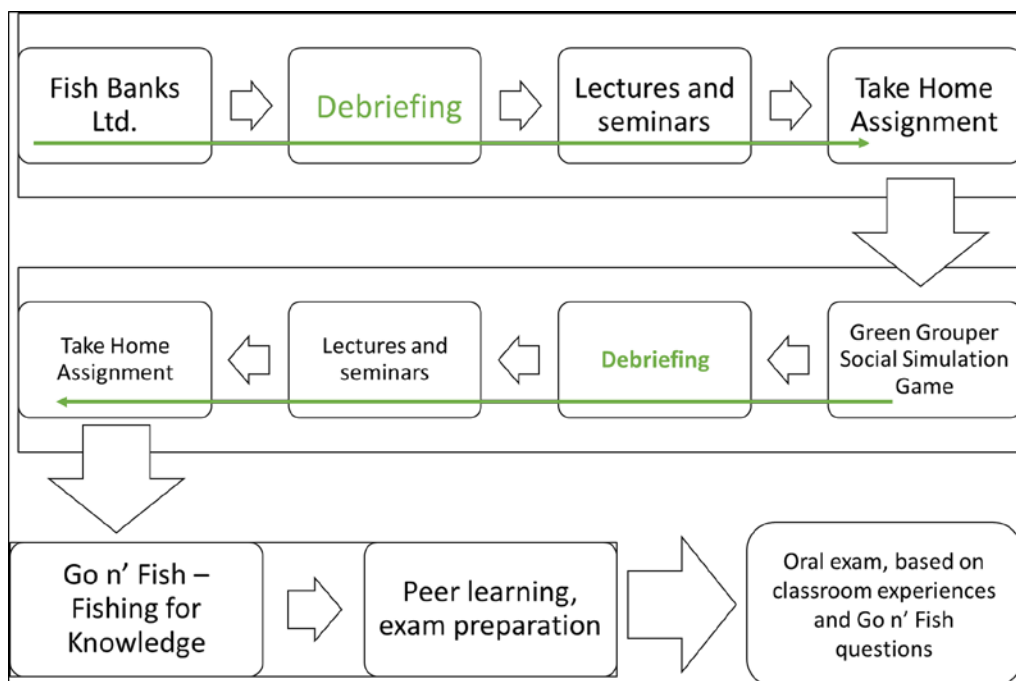
Figure 1 Instruction loop integrating the games in marine resource management

The concept of structured debriefing, as discussed in section 2.1, was a key driver in the implementation of *Fish Banks Ltd.* and *Green Grouper Game*. During a kick-off seminar in 2016, the

---

[9] Other GBL activities have seen limited trial (e.g. an aquaculture-focused version of the Green Grouper Game and a coastal zone planning role-playing activity), and some instructors have used online quiz applications. These activities are outside the scope of this thesis.

SimFish project group held a workshop with David Crookall[10], where he introduced and ran *Fish Banks Ltd.* for the participating staff in the SimFish project and students. This was a watershed experience for many of the participants, both as the first experience with a serious game, but also with debriefing as a way to bring the activity into context. Considering that the event that transpired was highly trained fisheries management experts having willingly driven the two fish stocks beyond the brink of collapse, the debriefing that followed was important for unpacking the potential of GBL in the BFA. This experience informed the key vision for the use of the games in the program: A method of providing students with learning experiences that would be turned into subject knowledge through post-game reflection, not standalone activities intended mainly to provide variation in the teaching. In the first year, debriefing sessions and debriefing forms after the game sessions were used after each game session. In later years, the focus shifted to debriefing via discussions in the seminars following the game-sessions, and take-home assignments that included reflections on the game experience.

The act of participating actively in a non-sustainable fishery can be a powerful experience. Dieleman and Huisingh (2006) explores the relevance of games for sustainability through the lens of Kolb's cycle of experiential learning. The cycle consists of four phases; concrete experiences, reflective observation, abstract conceptualization and active experimentation. As learners move between the phases, they gain different types of knowledge; adapting to existing contexts, adapting to new contexts, change within a context, and changing the context. Dieleman and Huisingh find that games are a good tool for practicing with contextual and paradigm changes, and offer opportunities for learning experiences in all four phases (and in particular for active experimentation). When played in sequence, *Fish Banks Ltd.* and the *Green Grouper Game* mirror the historical development of Norwegian marine management, allowing the students to move between the phases of Kolb's cycle. Players first learn about the previous system of marine governance and the lack of international regulations, experiencing how a fishery could be subjected to unsustainable catch pressure. Following this experience, they get to experience the problems of managing fisheries under the new law of the sea regime which was implemented in the last part of the 1970s in the wake of a serious resource crisis in the herring stock (Christensen, 2014). The use of these games, and their ILOs, are designed with the idea of constructive alignment in mind. Through analyzing the state of the game, making choices and adapting to feedback form the game, the learners construct their understanding of how management works (or don't work). In this way, the use of GBL is seen as a form of simulated praxis in the classroom. As the students play the games and reflect on them both during the activity and in debriefing, they are afforded metacognitive control of their learning. The activities performed in the

---

[10] Long serving editor of Simulation & Gaming who is a key figure in the discourse on debreiefing, member of the SimFish Reference panel. Retired, previously at Université de Nice Sophia Antipolis, France.

game, i.e. solving the challenges that are presented, can be seen as a form of reflective learning (Biggs and Tang 2011: 60, 176-177), where the students adapt the knowledge they have acquired to their current situation.

There is some evidence that handing the hard work of making sense of stock simulations to students is not ideal. Ameerbakhsh et al (2019) presents a case study that compares two approaches for teaching marine ecology with games in higher education; active experimentation with a quota simulation without teacher involvement and passive viewing of an expert demonstrating the simulation. They find that the learning effectiveness was higher when the simulation was demonstrated by the teacher. However, many of the participants expressed a preference for having a combination of the two tested approaches. In the case of the use of *Fish Banks Ltd.* and the *Green Grouper Game*, the use of debriefing and integration with the rest of the course makes the approach closer to the combined approach that was not tested by Ameerbakhsh et al. In addition, as will be shown later, the data from our evaluation points at the students appreciating the experimental elements of the games.

Simulated experience with quota management can also be useful for understanding the stakes involved. Barnabè (2015) discusses mismanagement due to focus on short-term goals in relation to simulation games. He tests three models of a fishing quota simulation, finding that balanced and multidimensional performance indicators are an effective way of lessening the impact of short-term focus. *Fish Banks Ltd.* provides an experience where the lack of quotas (and other regulations) cause problems, while the *Green Grouper Game* illustrates that the entire sustainability of a fishery cannot be solved with just a single regulatory measure. Sustainable management requires reflection on ethics, and deeper knowledge of what concepts like "sustainability" entails. In *Fish Banks Ltd.*, the players are confronted with unsustainable (and profitable) fishing having no consequences. In the *Green Grouper Game*, the players have to consider all the complex dimensions of sustainability and weighing the interests of different stakeholders against each other and environmental and economic concerns.

Go n' Fish was developed as a way to activate students throughout the semester by working with the curriculum to prepare questions for the game, and provide a playful setting for discussing course topics. It can be seen as a more instrumental tool than the sequence of fishery management games. It serves to activate the students through discussions while playing, as they act as judges for the other teams and have to consider if an answer is good enough to be accepted. The game was also used by students for exam preparation after the play sessions organized by instructors. In the later years, the questions from the game were also included as part of the oral examination in several courses. The use of this game in UiT's teacher education program is discussed extensively in paper three, including how it can be seen in light of the retrieval practice learning strategy, where students exert effort in order to recall information rather than restudying. Recent research shows that this learning strategy

can have positive impacts on knowledge retention (Agarwal et al., 2012; Karpicke & Grimaldi, 2012; Lun et al., 2018). While paper three is not focused on fisheries or the BFA, the in-depth discussion of the game's impact is relevant for this thesis as it examines the game's use in a learning situation. *Go n' Fish* has been used as the only GBL activity in several courses, and is integrated throughout the semester.

Figure 2 illustrates how the game is integrated in any course.
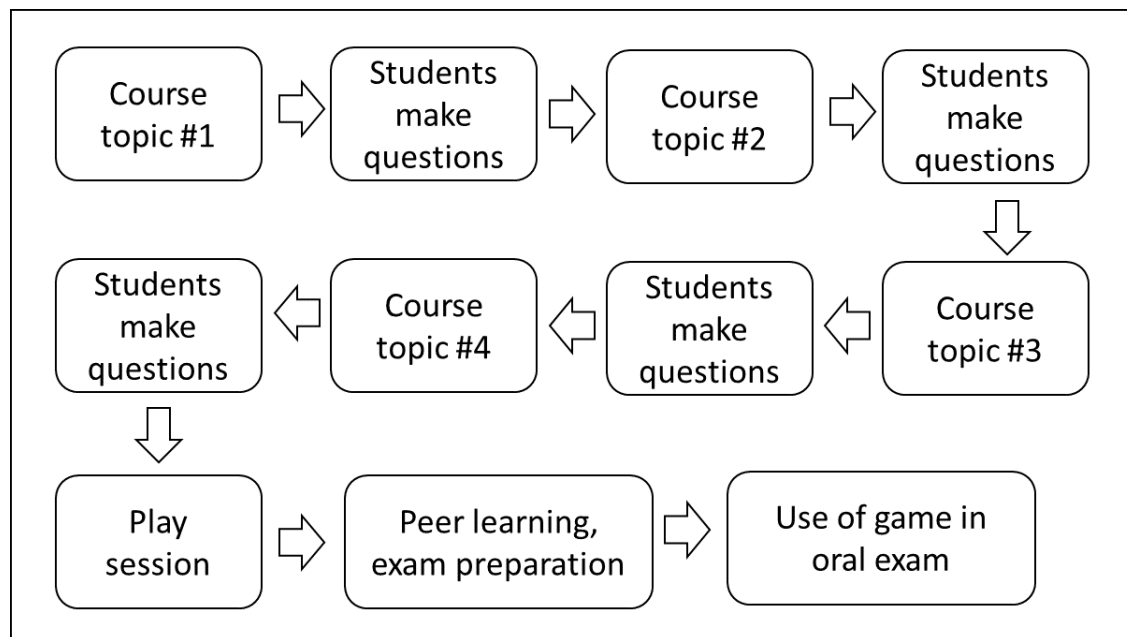
Figure 2 Integration of Go n' Fish in any course

As described in the previous section, the games presented here are tied to specific course and program ILOs. During the period the SimFish project was active, there was an increased focus on 21st Century skills as a framework for the competencies attained by the graduates. The NCFS participated in an application for a Centre of Excellence in Teaching focusing on 21st Century Skills.[11] Only some of these skills are made explicit in the program or semester ILOs as they are written, but are a central topic in discourse on both higher education pedagogy for the active learning paradigm, and primary and secondary education (Binkley et al, 2012; Kivunja, 2014; Hanghøj et al, 2019). Throughout the game activities, the players have opportunities to practice different skills in connection with working in teams, communication (negotiating with other teams, presenting plans), analyzing the situation, taking decisions and solving problems. Paper two presents how the learning outcomes of *Fish Banks Ltd.* and *Green Grouper Game* are tied to these game activities. Paper three discusses the

---

[11] C21Enhance website: https://uit.no/c21

communication and reflection skill components of *Go n' Fish* as it was used in the UiT teacher's education program.

3 Methods and materials

This thesis aims to do two things: Discuss the theoretical considerations in the included papers in relation to learning, as well as examining the quantitative and qualitative data from the BFA end of program evaluation and debriefing forms from the tested games. The case is the use of games to provide learning experiences for marine resource management. This chapter will discuss general methodological considerations, and specifically discuss the use of student evaluations. Some of the methodical considerations in this section are reworked and expanded from a paper delivered as an exam in a course in qualitative methodology at UiT (SVF-8400, spring 2017).

3.1 Case studies and qualitative research of good quality

The empirical part of this thesis is a case study of the use of games in the BFA. Case studies typically examine a large amount of information from a selection of few samples, aiming to understand the particular characteristics of the case (Thagaard, 2013: 56). In this study, the data is sampled from different cohorts of a study program, which have had varied exposure to and experiences with GBL. The GBL activities are the three abovementioned games, as well as the overall instruction loop they are part of. This means the different aspects of the case that are studied are instrumental (the individual games), collective (the games as a whole) and intrinsic (the instruction loop the games are integrated in). Each GBL situation has many moving parts, from the learning outcomes, participants, mechanics, aesthetic, and so on. The process of introducing GBL in the BFA has been a cycle of trials and revisions, which has also influenced the research on the process. In some ways, this mirrors an abductive research approach, positioned between theory and empiricism. Thomas (2010) offers insight on how the value of interpretations from case studies can come from exemplary knowledge and not generalization. In his attempt at solving the "nomothetic-ideographic dilemma"[12], he notes how abduction can provide "ways of analyzing complexity that may not provide watertight guarantees of success in providing for explanation or predication but are unpretentious in their assumptions of fallibility and provisionality" (ibid.: 577). This can be a fruitful position for analysis of the qualitative data in the case of GBL in the BFA, both for relating the data to the program evaluation, as well as for combining data, analysis and interpretations from other cases. In addition, this might also serve to more clearly explore the use of GBL in BFA as an educational practice, and not only as theory in research.

---

[12] Focus on the general and universal versus in-depth studies of unique cases.

The case study includes elements of participatory action research. I have been an "insider" who followed and participated in the process of trying out, designing, and modifying the games and their use in the BFA program. Action research entails certain challenges and opportunities – assessing an ongoing pedagogical change involves being very close to the object of study, which can make the findings very dependent on the context, and not explicit or transparent as they are tied to the ongoing reflective process (Gibbs et al, 2017; Laudania et al, 2018). This means that the expertise of the instructors in conducting the game sessions has improved as the project period progressed, which might have impact on the responses from the students. The study is also limited by the time period and structure of teaching; the possibilities of playing the games are tied to the placement of the courses in the program. The integration of debriefing into the seminars following the game sessions has also changed over time, including the making parts of the structured debriefing written assignments. While this has strengthened the integration of debriefing, it has moved it into the domain of course evaluation and grading, and made it inaccessible as data.

Transparency is another key concept for achieving quality. Both in regards to the process of how data is generated and analyzed, as well as awareness of the methodological implications of how research is planned and conducted. By reflecting on this, the researcher is ideally better equipped to avoid making obvious errors (Seale, 1999: 475). Seale discusses triangulation as a craft skill for qualitative researchers, and I find this especially relevant in the context of GBL as a research context where data of several types is generated and collected. Applying several methodological perspectives when approaching the data – or when moving out from it – during analysis, can strengthen concurrent findings. In the case of this study, the data from debriefing forms are combined with the program evaluations. Transparency is also important in Thagaard's discussion of reliability and replicability in qualitative research. Through rigorous documentation of how the data was collected and analyzed, the result can be made credible. This has implications for the methodological process, which must be transparent, and demands methodological reflection on the choices made in the research process (Thagaard 2013: 201-203). The validity of qualitative research is connected to the credibility of the interpretations in the context of the study. However, it is not only internal validity (within the context of a given study) that is important, but external validity (the generalizability of the findings to other contexts) should also be considered. Thagaard points out that a common basis for validity amongst qualitative researchers is transparency. This can be achieved through critical reflection on the analysis and interpretation of the data, and how inform the researcher's conclusions, if possible in comparison with alternative interpretations (ibid.: 204–206). As noted by Prince (2004: 224), some readers dismiss improvements from active learning as a result of novelty. This study analyzes and interprets data gathered both immediately after game sessions and the program, examining several dimensions of the impact the use of games have had on the learning process.

Tracy (2010) proposes eight "big-tent" criteria for excellence in qualitative research; worthy topic, rich rigor, sincerity, credibility, resonance, significant contribution, ethics and meaningful coherence. As I understand Tracy, the overall main lesson is that "Criteria serve as shorthand about the core values of a certain craft" (ibid.: 828). This means that there are several approaches that can be used, but that attention to quality throughout the research process is what is key. Adherence to Tracy's quality criteria can assist in making different GBL-cases comparative and relatable within and between fields – not only in terms of (theoretical) generalization, but case-based approaches can have more general objective than in-depth studies, which can contribute to generalization between contexts (ibid.: 214). Meaningful coherence, as articulated by Tracy, can serve to articulate an overall aspiration:

> *"Meaningfully coherent studies (a) achieve their stated purpose; (b) accomplish what*
> *they espouse to be about; (c) use methods and representation practices that partner well*
> *with espoused theories and paradigms; and (d) attentively interconnect literature*
> *reviewed with research foci, methods, and findings" (ibid: 848).*

As I see this, in order for case-based research on GBL to have meaningful coherence, the researcher must make sure to harmonize the differences in all parts of the study – both within cases (i.e. the design of games and their integration in instruction), and when comparing different cases. This requires the data and analysis to be accountable and transparent, and bring forth findings about the interactions in GBL and how they relate to what can be found out through studying other parts of the learning context or with different methods. Furthermore, through attention to the exemplary knowledge in the different cases, it can better contribute to giving insight into how to understand and interpret the interactions that takes place between teachers, learners and the learning objectives. Finally, the research must relate to the current research on learning, and arenas where learning takes place.

3.2 Making use of student evaluation of teaching

The third paper discusses the usefulness of student evaluations of teaching (SET) in the context of the *Go n' Fish* game. These reflections are relevant for this thesis, and will thus be discussed in greater detail. Spooren et al (2013) gives a comprehensive review of the literature on SET. They point out that the field is controversial, and identify several areas in relation to validity. Lack of common conceptual frameworks for evaluating effective teaching has implications for content-related validity. SET instruments must be updated in order to be applicable for changes in teaching paradigm, such as from instructor-centered to student-centered teaching. The variance in characteristics of teachers, students and courses as well as the particular settings and instruments that are evaluated makes generalization on a global scale difficult. There is support for criterion-related validity, meaning that there is a positive correlation between SET scores and indicators of teaching quality. Online collection systems

results in more students providing comments. However, there are disadvantages related to low response rates, self-selection of respondents, and the impact of teacher characteristics (for SET where students rate individual teachers). Overall, Spooren et al concludes that the utility and validity of SET should be considered critically, and considered fragile for evaluating the effectiveness of individual teachers. A recent study by Esarey and Valdes (2020) also calls into question the use of SET to evaluate teachers, pointing out that even SETs that are reliable and unbiased can have unfair outcomes. Uttl et al (2017) conducted a meta-study on SET ratings and the teaching effectiveness of faculty, and find that previous positive correlations can be attributed to artefacts of small sample sizes. They argue that current research does not provide evidence in support of the view that students learn more from instructors who score well on SETs.

The goal of the BFA program evaluation that provided some of the data for this thesis was to collect information on a variety of changes in the program, including GBL and other forms of active learning. The BFA evaluation does not gather evaluations of individual instructors, and the questions are worded to make the respondents reflect on and evaluate their perceived contributions to achievement of learning outcomes, and the different forms of learning. As shown in Table 3, the response rates for several of the BFA evaluations are low. Wang and Williamson (2020) examines course evaluation instruments in relation to student grades. They comment on two of the hypotheses that are common in literature on the field; leniency (students give higher scores when they get good grades, incentivizing lenient grading) and validity (whether evaluations indicate teaching quality or grade satisfaction). They note that there is positive correlation between grades and course evaluation scores, but that there is little evidence that attributes the relationship to leniency or validity. For quality design of course evaluation, the authors recommend that there is a clear separation between questions focusing on instructors and those related to the course. Furthermore, they advise that attention is paid to qualitative feedback from students. The BFA program evaluation is not connected to grade statistics, or individual courses. There are several open questions that gather qualitative feedback from the respondents. The responses from both the closed and open questions are presented in chapter four and discussed in chapter five.

3.3 Materials

Qualitative data has been collected after game session of *Fish Banks Ltd.* and *Green Grouper Game*. The students were asked to fill in forms with open questions immediately after the games concluded, mirroring Chin et al (2009)'s advice for post-activity assessments to capture impressions from individual players before plenary debriefing. The forms were filled in anonymously, and contain no personal information. The debriefing forms were developed through iteration, based on a form for debriefing *Fish Banks Ltd.* provided by David Crookall. The form used for *Fish Banks Ltd.* is extensive, with 12 questions allowing students to reflect on their feelings during the game and after,

the events that transpired during the game, their teammates' attitudes, differences and similarities with the real world, what themselves and their teams could do better in the future, what they learned and wish to learn more about, and what they did not understand during the game. The debriefing form for *Green Grouper Game* was identical to the form used for debriefing *Fish Banks Ltd*, but the 2017 one included an extra question about teamwork. The forms from the game sessions have been analyzed, and the main trends of the students' comments have been summarized in section 4.2.1. The forms are supplemented with field notes from participating observation. In 2018, debriefing forms were not used after the games as the debriefing was integrated in the seminars following the game sessions. In the 2019 game sessions, the forms were used in addition to the integrated debriefing for the purpose of data collection. The comments in the forms (and qualitative material from the program evaluation) have been analyzed and coded as positive, contingent positive, neutral, contingent negative and negative.

One of the work packages in the SimFish project focused on evaluation, and the main output was an end-of program evaluation for BFA graduates. This evaluation replaced the previous system where each course had its own evaluation. The evaluation was in the form of a comprehensive questionnaire about the entire six semester BFA, and contains aggregated data not tied to the recipients. The evaluation is managed by the NCFS, and the responses are anonymized and do not contain personal data. Several of the questions relate to active learning, the use of games, and learning outcomes. Paper two presents preliminary results of the three cohorts that answered the program evaluation. The expanded results, with responses from the 2019 and 2020 cohorts, are presented in the Appendix. The evaluation contained both closed and open questions.

The selection are students who finished the BFA program in the period 2017-2020, and the students who participated in the GBL-activities as part of the instruction in that period.

Table 3 shows the number of respondents, return rate, and gender distribution. The first set of responses are from students that started the program in 2013 and 2014, before significant use of GBL was introduced. The second set of respondents were students who started in 2015, and includes students where approximately one third were not exposed to the games in this study. The third and fourth set of respondents are students that entered the BFA in 2016 and 2017, and have followed the revised program where games were more fully integrated. A total of 69 students responded to the evaluation across four cohorts. In the three first years there were a small number of respondents (four in total) that had partially completed the BFA earlier but graduated in the year the evaluation was sent out.

The evaluation included open questions where students could enter comments on their experience on the impact of active learning methods for their learning, examples of positive learning experiences,

general experiences with games during the program, comments on their learning outcomes from games, and examples of good experiences with games throughout the program. The open answers that relate to GBL, and the feedback in the debriefing forms, have been categorized and coded as positive, neutral or conditionally positive, or negative. The coded data has informed the analysis in identifying the trends in the data that are discussed in the results section.

4 Results

In this chapter, I will present the main findings of the included papers, and provide expanded results from the data collection on the use of games in the BFA.

4.1 Summary of papers

4.1.1 Paper 1: Exploring fishery history in game form: "Never again April 18!"

This manuscript is a revised paper submitted to *Rethinking History*. The revised paper is currently in review. This paper presents reflections on how the historical case of the 1989 closure of the Norwegian coastal cod commons ("April 18") can be presented in the format of a game. The paper is rooted in historical game studies, and presents a literature review on the current state of the field. The game presents a possible design for a serious game for exploring the closure of the commons in the context of historical thinking (establishing significance, identify continuity and change, analyze causes and consequences, develop historical empathy and consider the complexity of the past) and learning outcomes tied to the history of Norwegian fisheries management. Furthermore, the paper discusses theoretical considerations in presenting a resource crisis like April 18 in any game format. In doing this, the paper explores theoretical considerations to how concepts of sustainability can be operationalized through player agency in in assembling historical narratives. In the context of a resource crisis, exploring the perspectives of multiple stakeholders makes it possible to question social institutions such as resource management, and games can provide authentic experiences where players can engage with historical actors in contexts that are not framed by the currently dominant perspectives.

4.1.2 Paper 2: Promoting 21st Century skills with game-based learning in interdisciplinary fisheries education

This paper was presented at the 2019 European Conference on Game-Based Learning[13] and published in the proceedings. The paper presents the three games used in the BFA, and preliminary findings on the use of games in the instruction loop of the BFA, focusing on how the games facilitate students'

---

[13] Awarded a certificate of merit for best PhD-paper and presentation.

practice of 21st Century skills. The underlying models for the design and integration of the games, constructive alignment and serious games, are discussed and related to the integration of games and debriefing with the rest of the course. The students generally report that they are positive to the use of GBL, and that the games have contributed to their understanding of the concept of the tragedy of the commons and the process of fisheries management. The students also report that they think games provide practical examples that are useful for understanding the curriculum, as well as fostering discussions between the students. Several responses point out that the *Green Grouper Game* is well suited to illustrate the difficulties involved in trying to appease different stakeholders. The paper does not include the evaluations from 2019 and 2020, or analysis of the qualitative data from debriefing forms and course evaluations presented in section 4.2. The main results from this paper is the illustration of the instructional loop for implementation of games in the context of fisheries management, and the discussion of the learning outcomes can be tied to the practice of 21st Century skills through the games.

4.1.3 Paper 3: Spilt kunnskap på lektorutdanninga: Førsteårsstudentenes erfaringer med kunnskapsspillet.

The third paper is a result of a collaboration with Astrid Strandbu at the Department of Education, UiT, and Margrethe Esaiassen at NCFS. The paper is published in the Nordic Journal of STEM Education. The paper is based on survey data from students using a modified version of *Go n' Fish* at UiT's teacher education program (an integrated master's program leading to official teacher certification). This paper presents the use of a knowledge game in light of sociocultural learning theory. Two central topics are discussed. First, the process of using a game as a flexible multi-tool to structure students' independent work with curriculum. Second, as a method to facilitate improved learning through retrieval practice and exam preparation. The student-reported experiences are analyzed and used to formulate three "quality dimensions" that emerge from the use of the game: *learning outcome*, *meaningful coherence* and *joy, wellbeing and safety*. In the context of this thesis, the main findings in this survey are two-fold: The sociocultural perspective on the use of games in learning and what it contributes to the students' experience, and the method of analyzing student responses to formulate the quality dimensions that emerge from the use of games in learning. The data for this article is also more extensive than the one collected on the use of *Go n' Fish* in the BFA, providing more insight on the impacts of the game.

4.1.4 Paper 4: Better game worlds by design: The GAS framework for designing games based on socio-ecological systems, demonstrated on Nusfjord (2017)

This manuscript is a paper submitted to *Games and Culture*. The paper is currently being revised for resubmission, enhancing the focus on socio-ecological systems and discussion of using the framework in game design. It is written in collaboration with Melania Borit, NCFS. It presents a framework for

design and analysis of games through focusing on the socio-ecological systems, which we have named the *Game World Design and Analysis for Socio-Ecological Systems* (GAS) framework. The article's focus is on critical game design, but the case relates to historical game studies. By considering the accuracy, comprehensiveness and balance of the socio-ecological systems presented in games, it is possible to gauge the consistency of the game world, informing critical reflection on the game's embedded values and mental models, and how players experience them. As a case, the article demonstrates how the framework can be used for analysis on the commercial board game *Nusfjord* (2017). The analysis shows how the game world's socio-ecological system has elements that are internally consistent, but as a whole is not representative of the historical setting of the Lofoten fishery the game draws inspiration from.

The article aims to make a contribution to the field of game design and studies by providing a tool for design or analysis of game worlds enhances reflection about the socio-ecological systems in games. As the meaning players will extract from a game is tied to the designed game world, awareness of the implicit mental models are embedded is important. In the context of this thesis, these findings are relevant for how GBL operationalizes socio-ecological systems in GBL for governance and resource management.

4.2 Results from debriefing forms, field notes and program evaluation

This section presents results from the collected debriefing forms and program evaluations.

4.2.1 Debriefing forms and field notes

Qualitative data has been collected through debriefing forms. These were filled out by students individually before plenary debriefing discussions. This section presents summaries of the debriefing forms, supplemented by debriefing notes from participatory observation.

4.2.1.1 Fish Banks Ltd.

38 debriefing forms were collected from students in the BFA from two game sessions, one in 2017 (12 questions) and one in 2019 (12 questions). When asked about their feelings during play, the students mainly reported positive feelings (achievement, fun, excitement, joy), often in combination with frustration. One student stated it was ("stressing, but good"). Another noted that "it's fun and involving, and you get to experience how frustrating it is to have no rules". Some students reported tiredness and competitiveness. Only one student commented on the game feeling long-winded. Reporting on their feelings after the game was over, the main feelings were positive (happiness and satisfaction, achievement). Some expressed tiredness, anger or disappointment that they didn't win. A few expressed happiness that the game was over. Summarizing the events that happened during the game, students called attention to discussions and negotiations. Some added quarrels, confrontation

and high temperature in the interactions with other teams. Some mentioned that deals were broken, and commented on greed being a driver. Students mainly perceived the attitudes of their team members to have been positive, and many mentioned competitive spirit. Many respondents did not enter an answer when asked for their explanations of the events and team attitudes, but those who did called attention to competitive spirit, and a wish to win no matter the consequences. Some expressed frustration over competitors not adhering to deals, and some framed disagreement and engagement as a driver.

In comparing the game experience with the real world, many students said they thought it was similar. The most recurring comments related to the discussions between stakeholders in the seafood industry, and several students noted that such interaction is necessary for good solutions. Several respondents made comments on profit focus as a driver in the real world, and that it can be hard to assess the consequences of overfishing. Some commented that without regulations and sanctions, there will be overfishing, drawing parallels to the tragedy of the commons. The main comments on how the game is different related to the game being simplified and less complex, especially in regard to economic operations and the lack of government intervention and sanctions when deals are broken. One student noted "We have an actual regulatory authority".

Assessing what they could do better themselves and as teams in the future, many commented on being better prepared, or participating more actively. Some expressed being more sustainable, less greedy and destructive. Some comments dealt with strategy regarding the rules of the game. Several students did not enter answers on these questions. When asked what they learned from the game there were some comments about the goal of the game, and how people are greedy and that is rewarded, expressing anger over the winners disregarding the environment. Many expressed they learned much, without mentioning specific topics. Some specified the importance of regulations for sustainable fisheries, with some mentioning the tragedy of the commons. Some commented on listening to others in discussions and teamwork. Several respondents did not enter answers for what they did not understand during the game. Most of the feedback was connected to the game rules. Some commented on the game's lack of focus on sustainability and enforceable regulations. The final question asked students to say what they were interested in learning more about. Many students left this question blank. There were some comments dealing with strategies relating to the game. Several expressed that they want to lean about different aspect of real-world fisheries management, and regulations for sustainable fisheries.

4.2.1.2 The Green Grouper Game

32 debriefing forms were collected from students after three game sessions, two in 2017 (13 questions) and one in 2019 (12 questions). Students mainly reported positive feelings (achievement, happiness, excitement, curiosity, joy of learning) when playing. Frustration was reported in

combination with positive feelings. One student commented on confusion in the beginning of the game, but noted that it disappeared as they got into the game. Post-game, students mainly reported happiness, satisfaction, feeling of learning and achievement. Some mention frustration, often tied to not winning (or that there was no winner in the game). Discussions, communication and cooperation were the main events students reported took place during the games. The students mainly commented that the attitudes of their teammates were positive, mentioning satisfaction, engagement and eagerness. Some commented on problem-solving. Several students did not give explanations for the events and attitudes. Some called attention to group dynamics (levels of engagement, knowledge, and disagreement). Some linked the events to the game being well-designed.

Comparing the game to the real-world, the majority expressed that they though the game appeared realistic, one commenting that "it illustrates the challenges of sustainable fishing, with many uncertainties". Some did not enter comments on these questions. Many expressed the lack of perfect solutions as similar to the real world. Some commented on the difficulties in pleasing all the stakeholder groups, and that real-world fisheries management is also not static. Some noted that the game was simplified and less complex, one expressing that it is possible to try measures without consequences, and another that you get more information in the game than in the real world.

Regarding what they could do better as individuals and teams in the future, students commented on group dynamics (participating and letting others participate), and being better prepared. Some noted the importance of looking more at the bigger picture. The responses on what the students think they learned revolved around fisheries management being complex, and the difficulty of making decisions when there are uncertainties. Several mentioned the interactions between economic, environmental and social factors, and that was is hard to please everyone with one plan. One student wrote "planning requires information". In one of the game sessions I observed as game master, the students realized that the plan they had constructed closely mirrored the current Norwegian management scheme, prompting them to experiment with other management instruments. Some expressed that cooperation and discussions were useful. The majority did not enter answers on what they didn't understand, with most of the comments relating to the game components or rules. The students stated they wanted to learn more about the consequences and interactions in the real-world, as well as more about the different management instruments. One student expressed "facts for the exam".

4.2.2 BFA program evaluation, 2017-2020

As the results from the 2017 cohort had few respondents who answered the questions related to games, the results of that year's program evaluation are only commented on when appropriate. The evaluation included open questions on some topics, where students could enter an answer. Answering these questions were not required. There was no word limit, but several of the answers are names of games

without further qualifiers. Across the program evaluations, a total of 200 comments were entered by the respondents for the questions examined in this thesis.

Table 4 shows the students' views on the program as a whole, operationalized as questions on how the different fields were integrated, how they perceived the courses built on each other, and if they had acquired practical skills from the program. These questions can be seen as proxies for the students' perceived interdisciplinary integration and (to some extent) attainment of 21st Century skills. There is little difference between the pre-GBL cohort and the later cohorts when it comes to interdisciplinary integration. The majority agrees that they have attained understanding of the connection between natural science, technology and social science, with a small minority expressing disagreement. The students' evaluation of attained practical skills, the results vary across the evaluation. In 2017-2019, a majority of the students agreed partially or fully, but in 2020 only a third of the respondents expressed agreement. 42% of the respondents in 2020 expressed partial of full disagreement. With the exception of the 2019 evaluation, approximately a fourth to a third of the respondents expressed disagreement with the statement.

Table 5 shows the students' evaluation of some of the program learning outcomes.[14] The respondents were overwhelmingly positive, rating their attainment of the goals as good or very good. The exception is the 2018 cohort's evaluation of the learning outcome tied to issues related to sustainable seafood industry. A large share (42%) rated their acquisition as good or better, but there was a higher degree of satisfactory and limited acquisition responses than in the other cohorts. When asked to evaluate their attainment of ability to reflect on their own academic performance, the majority also reported satisfactory or better, but the share of responses that reported degrees of limited acquisition varied from one fifth to a fourth.

Table 6 shows how the respondents rate games based on their perceived learning outcomes.[15] The questionnaire included questions on games in general, and the three specific games explored in this thesis. Half of the 2017 respondents reported N/A on games, while the corresponding number for 2018 is one fifth. These results are expected as GBL was introduced over time. Only a single respondent in the 2019 evaluation responded N/A. The evaluation for 2018 shows that the majority of the students that evaluated games considered games to have a satisfactory or better contribution to learning

---

[14] Broad knowledge about the exploitation of marine resources on the basis of biology, technology, economy and social science; Understanding of interaction in the value chain in the seafood industry; Insight in national and international issues related to sustainable seafood industry

[15] In paper two, the results for "Quiz, Kahoot and similar" were also reported. Some instructors in the BFA have used quiz applications in their courses, but these are outside the scope of this thesis, and not reported.

outcomes. A minority rated the games as having limited contribution. The evaluation for 2019 is more positive, with the large majority rating games as good or better. A small minority rated the games as satisfactory or worse. In 2020, there were no respondents that rated the contribution games had to learning as very good, but a large majority reported games as good or satisfactory. Approximately a fourth of the responses evaluated the contribution as limited.

This section of the evaluation included open questions. One asked about student active learning in general,[16] worded "What is your experience of student active learning contributing to your learning process?" The responses were generally positive, conditionally positive or neutral across the evaluations. In the first two evaluations, several students responded that they had few experiences with student active learning. In the 2018-2020 evaluations, there were one expressively negative response in each. None of these mention games. The neutral and conditionally positive comments bring up class- and group dynamics as a factor that impacts the usefulness of active learning. In general students bring up discussions and reflection through experiencing several points of view as positive. In both 2018 and 2019, one response explicitly referenced games as an example of active learning contributing to their learning.

Students were also asked to give examples of positive learning experiences (in general) from their time in the program. In 2018, two of the respondents mentioned the use of games in marine resource management as positive examples, one stating that "The Green Grouper Game was also very useful and made me understand what the course and the field of resource management is about". In 2019, one response was conditionally positive to *Go n' Fish*, and one response mentioned games as positive. In 2020, one response mentioned *Fish Banks Ltd.* and *Green Grouper Game* as positive experiences.

Table 6 also shows the result on the evaluation relating to the three games in the marine resource management instruction loop. 37% of the respondents in 2018 and 2019 rated *Fish Banks Ltd.* as N/A. Unexpectedly, a bit over a third of the 2019 and a fourth of the 2020 respondents answered N/A.[17] The majority of the 2018 cohort rated the game's learning contribution as satisfactory or better. A fairly large minority rated the impact on learning outcomes as limited. The 2019 evaluation was more positive, rating the game as good or better. No respondents rated it as satisfactory or having little impact, and only a single respondent rated the impact as very little. 2020 also shows mainly positive

---

[16] Worded as problem solving, discussions, experiments, presentations, and similar.

[17] This is probably caused by students having skipped some of the games, as they were not required to participate in all game sessions. Some respondents have probably participated in the other GBL-activities that were tested out once or twice, and not in the scope of this thesis.

results, with the majority of students rating the game as satisfactory or better. As with 2019, one respondent rated the contribution to learning as very little.

For the *Green Grouper Game*, the response rates are also interesting. 31% of the 2019 cohort rated the game as N/A, while the rest rated the game's contribution to learning as good or better. Half of the 2020 respondents rated the game as N/A, with the remaining answers being satisfactory or better.

Go n' Fish has the lowest rate of N/A across the evaluations, with 37% in 2018, 13% in 2019 and 8% in 2020. This game was the first game developed and tried out, and was used in several courses, so this is expected. In 2018, a majority rated it satisfactory or better, and a small minority rated the impact as limited. The cohort 2019 seems to have had a good experience with the game, rating it overwhelmingly positively, with no negative responses. The 2020 evaluation is a bit more varied but mainly satisfactory or good, but with a fourth of the responses as limited impact.

After rating the specific games, the respondents were asked about other experiences they had with games in the program. In 2017, one student mentioned *Go n' Fish* as a both fun and instructive. The other comments related to quiz or not having experienced GBL. In 2018, three responses mentioned *Go n' Fish*, as instructive and useful for exam preparation. In 2019, one responder commented "Fun and interactive way of learning. Very pleased to have participated in these, and how easy it is to see the effects of different actions on the environment/resources when it is in a game". In 2020, one student commented that *Fish Banks Ltd.* and *Green Grouper Game* are good at illustrating the difficulty of getting everyone to agree, which makes management hard. The same comment expressed that *Go n' Fish* is "basically a quiz, so the learning outcome is the same as asking each other questions".

The evaluation asked students to compare their learning outcomes from games to the other forms of teaching in the program. In the 2017 evaluation, the comments were mainly that they had not experienced use of games. Two responses were positive, one calling it a good and instructive supplement, the other calling it a fun approach. One respondent expressed a negative opinion, noting that they are not excited for this form of learning. In the 2018 evaluation, two respondents had negative comments. One respondent felt that the execution of the game session was ineffective and took too much time compared to the learning outcome, and that the time could have been more effectively spent on studying, as the game did not appear to be relevant for the exam. Several respondents were positive, calling attention to the *Green Grouper Game* as the most instructional one, and that the games were engaging, and games being a good variation from lectures. One of the positive responses stated that the game experiences should be applied more post-play, suggesting that

there could be an assignment tied to the games later in the course.[18] One respondent stated that the games should be used more, as one game session is not enough to understand the point of the game.

In the 2019 evaluation there was one negative comment about *Go n' Fish*, relating to the quality of the questions being important for the game's usefulness. Several respondents commented that usefulness of *Go n' Fish* was contingent on the level of knowledge and effort the players put into it. One respondent reflected on the lack of an answer-sheet being frustrating. Some of the positive comments highlighted that *Go n' Fish* gave an indication of what they need to study more. One respondent stated that games were welcoming and inclusive, and let them try and fail without major consequences. For 2020, one respondent expressed that they don't think games contributed to learning, and other activities were more fun. One expressed that the game was fun, but felt they were too simple for bachelor students, and the time could have been used on more exam-relevant activities. Three responses were conditionally positive, one calling attention to *Fish Banks Ltd.* and *Green Grouper Game* being instructive, one that they made it easier to remember the curriculum, and one that games let them understand the whole context.

Table 7 presents the results for the closed questions on whether or not games had been positive learning experiences, the importance of debriefing for learning outcomes, and GBL's relevance for understanding real-world issues in the seafood industry.

Across the 2018-2020 evaluations, the proportion of students that consider games as a positive learning experiences is high, with 2019 having the highest rate of agreement. Neutral responses vary, from 37% in 2018, to 19% in 2019 and 25% in 2020. The evaluations generally show little disagreement with the statement. In 2018, a small minority expressed disagreement, while the 2020 evaluation shows a third of the respondents expressing partially disagreement.

To a large extent, the responses indicate that debriefing was important for the learning outcomes. A majority of respondents in 2018 and 2019, with a larger majority of in 2020 expressed that they agree fully or partially. The rate of neutral responses is fairly similar across evaluations (21% in 2018, 25% in 2019 and 17% in 2020). Very few respondents disagree that debriefing was important, mainly in 2018 where a small minority expressed disagreement.

The last question was negatively worded, asking students to agree or disagree with the statement "Game-based learning gives a bad understanding of real issues in the seafood industry". The students seem to find games relevant. Almost half of the 2018 respondents neither agreed nor disagreed, while

---

[18] As mentioned earlier, the later use of the management games had written assignments connected to the games as part of the structured debriefing.

a fourth in the 2019 and 2020 evaluation gave neutral responses. Few respondents agreed with the statement. Only a single respondent each in 2018 and 2020 expressed partial agreement. A single respondent in 2019 agreed with the statement.

After this section of closed questions, the respondents could enter examples of good game experiences they had during the BFA. In the 2017 evaluation, one student mentioned *Go n' Fish* in the seafood production course. In 2018, two students mentioned *Green Grouper Game* (one expressing that it was "very instructive"), one mentioned *Fish Banks Ltd.*, and one mentioned *Go n' Fish* (adding that it was "very fun"). In 2019 there are several comments, some naming the games without qualifiers. One respondent explicitly mentioned the use of games in the marine resource course. Another reflected on how they enjoyed playing to win in *Fish Banks Ltd.*, even though it had adverse consequences for the fish stocks as the tension between the groups was good. One expressed that *Go n' Fish* was useful for exam preparation. In 2020, two students mentioned *Go n' Fish*, adding the usefulness for exam preparation.

5 Discussion and conclusion

This final chapter contains a discussion of the strengths and limitations of the theoretical and empirical parts of the thesis, and discussion of the results in light of the research questions: How can game-based learning impart the underlying concepts of sustainable fisheries governance (including the historical development of management)? How can core learning objectives in marine resource management be integrated in game-based learning activities, and what impacts have games as educational practice had on the Bachelor of Science in Fisheries and Aquaculture? Finally, I discuss how the results from this case study in light of the broader turn towards active learning.

5.1 Strengths and limitations

As a case study, this thesis focuses on reflections on the use of a specific combination of games in a single bachelor program in a limited period of time. The data is debriefing forms from game sessions supplemented by field notes and the end-of-program evaluation. The selection of respondents is limited to the students who filled in the debriefing forms, or answered the program evaluation (response rate reported in Table 2). I have attempted to present the data collection and analysis transparently and coherently in the search for what the results can tell about the impacts of the use of GBL in the BFA.

The efforts to implement GBL in the BFA were part of a larger drive on student active learning, and happened at the same time as other revisions of the program took effect. This makes it harder to link overall trends reported in the program evaluation to GBL alone. The evaluation included direct questions on GBL in general, and the games specifically. The combination of data collected at the end

of the program and from individual students after each game session might make it possible to comment on what the respondents think of the efforts over time. However, it has to be mentioned that the data is limited, and some of the respondents in the end of program evaluations have reported N/A on some the games this study focuses on. There are some errors in the program evaluations, where some respondents have been able to mark several options in the closed forms. For some of the questions, the total responses are over 100%. These anomalies are limited to a single extra answer in some questions. As I only have access to the aggregated results, I cannot remove these responses. Despite these small errors, the data is considered valid and reliable.

As my position in the project has been as an insider, I have also participated closely in the development, implementation and revisions of the GBL activities, making it harder to analyze the impacts of GBL on the teaching staff from a neutral position. The data collection from the SimFish-project has not looked into grade statistics, partly due to revisions in the program structure making comparisons difficult. Another factor is an increase in applicants to the BFA program, increasing the grade point average for admission to the program. In essence, this makes this thesis not a study of the effects of GBL in the full BFA-program, but a study of the impacts the GBL instruction loops have had in the marine resource management part of program where GBL was primarily used.

The research on GBL for fisheries learning has been a combination of theoretical reflection on adapting existing and designing new games that match the ILOs of the program, and provide learning activities and experiences that are conducive to reflection in structural debriefing. This means that we have built the boat as we rowed. The development and introduction of GBL can be likened to the abductive approaches in this study, existing between theory and empiricism as the measures have been modified and adapted over time, based on our experiences as instructors and feedback from students. This has made this study explorative, and served to ground the work more strongly in the context. As I will argue in the next sections, some of the findings can find application beyond the context of the BFA.

5.2 Discussion of results

With the limitations in mind, zooming in on the case of the use of GBL instruction loops in marine resource management, there are some trends that can be identified in the collected data. It is clear that the games have served to engage the students. To a large extent, students report positive feelings in the debriefing forms. The main feelings they identify are achievement, happiness, excitement, curiosity and joy of learning, and they report the attitudes of their teammates as positive (some commenting on competitive spirit). The end of program evaluation also indicates that the majority found the games to be a positive learning experience. In the BFA use of GBL, one of the goals of having the students express their feelings ties in with the concept of debriefing, and moving them from the game experience to the next steps in the process of learning. There have been several studies that examine

the role of enjoyment and engagement in GBL. In Shellman and Turan's (2006) assessment of their use of a simulation in an International Relations course, they address the issue of enjoyment influencing judgement of effectivity by having separate entries for enjoyment and evaluation of enhanced learning of knowledge of theories, concepts and skills. Jabbar and Felicia (2015) finds that the cognitive and emotional involvement players have in the gameplay is related to engagement. Iten and Petko (2016) interrogates whether experience of enjoyment can indicate learning, albeit in the context of primary school students. Their main finding is that willingness to play is mainly related to expectations of usefulness and ease, not expected enjoyment. The authors advise a focus on several aspects of engagement besides fun and enjoyment. Both the debriefing forms and the BFA program evaluation split ratings of feelings from evaluation of learning outcomes. Some students express negative feelings in relation to the games, such as disappointment of not winning or tiredness. The main negative feeling reported is frustration, but for the most part in connection with positive feelings. This might be attributed to the concepts of "optimal challenge" and "flow". Shernoff et al (2003: 171) define flow as referring to "a state of mind characterized by focused concentration and elevated enjoyment during intrinsically interesting activities", often resulting from using skills to overcome significant challenges. These characteristics are similar to those of deep learning approaches (Biggs and Tang, 2011). Hamari et al (2016) explores the impact of flow in GBL. Their study had respondents answer questions on learning, engagement, immersion, challenge and skill. They find that while engagement and flow had positive impact on learning outcomes, immersion did not have a significant impact. The authors conclude that their study demonstrates that games can effectively frame learning challenges in ways that promote engagement and immersion. This matches the picture painted by the student evaluations, and my experience from participatory observation as game master in the game sessions. While debriefing forms were not used systematically for *Go n' Fish*, paper three discusses the sociocultural dimension of the game as used in a different program. The few comments about *Go n' Fish* that were reported in the BFE program evaluation are similar to the ones reported by the students in the study presented in paper three.

The program evaluation shows that the majority of the respondents from 2018-2020 evaluate games as having a satisfactory or better contribution to their learning outcomes, both for GBL in general and for the specific games (although some of the respondents indicate that they have not played all the games). The debriefing forms also shed light on how the games have made the students interested in learning more about specific topics in fisheries management, such as specific management measures and the consequences and interactions in real-world fisheries regulations.

The 2020 program evaluation has the largest share of respondents (one third) expressing partial disagreement with the games having been a positive learning experience. This cohort has the lowest response rate (24%), and the highest degree of women responding (83%). In relation to this result,

Riemer and Schrader (2015) present an interesting study. They evaluate university students' attitudes, perceptions and intentions to learn with quizzes, simulations and adventures (understood as virtual worlds where students progress through a narrative in order to learn). The respondents evaluated attitudes, cognitive and affective perceptions and intentions to learn. The main finding was that women rated higher negative affective perceptions when asked about serious games in general, but more positive perceptions on affect and learning when asked about specific games. As the program evaluation for 2020 shows, when asked to rate the contribution to learning outcomes for the specific games, there is just one respondent rating *Fish Banks Ltd.* as "little", while a fourth rates *Go n' Fish* negatively (8% very little, 17% little). While the number of respondents is too low to make a bold claim, the results from the 2020 cohort matches the trend reported by Riemer and Schrader, with the negative affective reporting on the games in a group of respondents predominately made up of women being lower when queried about specific games, and not games in general.

A recurring theme in the debriefing forms from *Fish Banks Ltd.* and the *Green Grouper Game* are statements about unfairness when deals are broken by other players, problems of having no rules or enforcement of regulations, and problems with securing broad support from the different stakeholder groups when proposing management plans. The program evaluation shows that the majority of respondents rate their attainment of understanding of interactions in the value chain of the seafood industry as good or very good. These statements can be seen as the games giving the students opportunities to engage with the Foucalt's concept of governmentality in the context of fisheries management. Jentoft and Johnsen (2015) offers a concise definition:

> *"Foucault (1978) introduced the term "governmentality," which we understand as the practices resulting from governing interventions and the responses to the interventions within the system-to-be-governed. Governmentality thus has a dual meaning. On the one hand refers to the governing system's apparatus for governing and the belief in its ability to govern. On the other hand, it is about the willingness of citizens to let themselves be governed"* (ibid: 707).

Jentoft and Johnsen explore the structures of the Norwegian small-scale fisheries and how the partnership between the managing authorities and fishers have generated mutual trust to the institutions of management, and a willingness to adapt and respond to changes in the socio-ecological environment. For sustainable fisheries, the understanding of the institutional aspects of sustainability is key. The comments from the students that the games contributed to deep learning about the importance of governance, illustrating the tragedy of the commons, and lack of perfect solutions indicate that the games have been useful to illustrate some of the wicked problems involved in marine resource management. The results from the debriefing forms also indicate that students find the resource management games to be similar to the real world, in regards to interactions between

stakeholders, non-static situations requiring adaptability, and complexity of problems and solutions. Some express that the games are simplified. How the students react to what they perceive as unfairness when unsustainable overfishing has no consequences is relevant in relation to the ethical dimensions of governance. Schrier (2014) examines sustainability and ethics in games, and presents a study of sustainability-related decision-making in a popular commercial role-playing game. Her findings suggest that experiencing the context of decision-making in a game world may impact the ethical thinking processes of players. She asserts that educational interventions should facilitate reflection on long-term consequences, and provide opportunities for making decisions and exploring outcomes. The comments in the debriefing forms seem to indicate that the games have triggered ethical reflections in the students, and is an example of how the engagement in the game sessions has played a part in moving the students along the path in the learning process, and relating their own attitudes and values to the course content. The BFA program evaluation also indicates that the students find games to be relevant for learning about the seafood industry, with very few respondents agreeing that games give bad understanding. Paper one further discusses how the interaction between stakeholders involved in institutional politics can be shown in the format of games. Paper four examines how socio-ecological systems can be better presented in games.

The main activity students report as having happened during the game sessions are discussions, communication and cooperation, many noting the usefulness of these for their learning. The students' feedback indicates that use of GBL has provided them with opportunities for social learning and application of higher order thinking. The end of program survey asked students to report the attainment of practical skills. Generally, the majority expresses agreement, with the exception of 2020, where more respondents express disagreement. As the BFA is a program where the students participate in several forms of active learning, such as internships, labs and research cruises, it is hard to tie these results to the use of GBL. As the focus on 21st Century skills was increased after the start of the project, some of the skills have not been made explicit in the wording of the evaluation question or the program ILOs. Paper two presents the in-game activities and their link to 21st Century skills. However, the data collection has not been specific enough in regards to reporting on some of the skills. The qualitative feedback from the students indicate that many found the discussions, problem-solving and cooperation to be useful for their learning. More explicit inquiry tied to the attainment of 21st Century skills is needed in order to shed more light on the impact the games have had. Considering the importance of clearly defined and communicated ILOs have for successful instruction (Hattie, 2011), the partially implied nature of the skill training component of the GBL is a deficiency.

While the data shows that the students consider the contributions to learning outcomes from the games at satisfactory or better, there are some comments that shed light on the views of the respondents who are not positive. Some express instrumental views, thinking that the use of the time used on the games

could have been better spent on activities that were directly relevant to exam preparation. Some link the usefulness of *Go n' Fish* to the quality of the questions, or that the lack of an answer sheet is frustrating. These comments, as well as those highlighting the usefulness of the game in preparation for exams or structuring reading, mirror the responses analyzed in paper three.

The goal of using games to create learning experiences to debrief appears to have been successful. In the program evaluation, a large majority of the students express agreement that debriefing after games was important for the learning outcomes. There are no comments in the qualitative data from the program-evaluation that elaborates the students' views on this question. The debriefing forms for *Fish Banks Ltd.* and the *Green Grouper Game* shows the variety of reflections the student made at the end of the game sessions, to some extent showing the students' metacognitive perspectives on the games. Seen in relation to the program evaluations' mainly encouraging responses to attainment of ability to reflect on their own academic performance, games being a positive learning experience and their contribution to learning outcomes seem to indicate that debriefing has had a positive impact on the game-based instruction loop. In the evaluation for 2020, that had a large share of partial disagreement with games being a positive learning experience, only a single respondent (8%) expresses partial disagreement with debriefing being important, while the majority agree partially or fully. While the collected material does not offer more insight, the positive responses to debriefing could merit closer study, for instance in light of metacognition, and the sociocultural learning theory perspectives in paper three. The positive evaluation results for the games, learning outcomes and debriefing can also be seen in connection with the underlying basis of constructive alignment that informed the design of the instruction loop. As learning activities, the games and the debriefing of the experiences they have provided have been aligned with the ILOs and the way the students' attainment of these has been assessed.

5.3 Contributions to field

The theoretical reflections in this thesis can have broader applications outside of the BFA context. The in-depth look at the history of Norwegian fisheries in the format of games (paper one) can be relevant for GBL regarding other resource crises, and shows how historical perspectives are important for understanding resource management. The discussion of GBL in connection to 21st Century skills ILOs (paper two) can inform the design of games in other topics, mapping practice of skills and ILOs to game activities. How the use of GBL can contribute to sociocultural learning and structure student's use of effective learning strategies, and how to identify quality dimensions emerging from student evaluations (paper three) has broad application. The importance of reflection on the embedded values when including socio-ecological systems in game worlds (paper four) contribute to our understanding of how games can provide better mental models of human-nature interaction.

As a whole, this dissertation adds to the knowledge of game-based learning by contributing theoretical discussions on how the underlying concepts of sustainable fisheries management can be presented in games and game-based learning, and how core learning objectives tied to these can be operationalized through game activities. Furthermore, it presents empirical results from the case-study of the game-based instruction loop in marine resource management, showing the impacts on the student's learning processes in particular in relation to engagement with complex problem-solving, teamwork, importance of debriefing, and understanding of the facets of governmentality (including ethical considerations, problems with too much or too little regulation, and interaction between stakeholders).

5.4 Charting the waters - Implications for future fisheries GBL

In relation to the overall shift towards active learning, and change from the teaching paradigm to the learning paradigm, let us zoom out and place the findings from this particular case in a larger context.

The use of games in the BFA have been successful in making the learning in for marine resource management active by providing learning experiences that have been contextualized and integrated in the overall course instruction through debriefing. Furthermore, as learning activities, the GBL instruction loops have shown that they can be aligned with both the ILOs and the assessment. Even though the data is tied to this specific learning context, there are some implications that can be useful to explore further, both for other subjects in the BFA program or different educational programs. Less demanding GBL instruction loops, like *Go n' Fish* can also contribute to active learning and constructive alignment through course-wide integration. This form of playful learning offers both opportunities to work with course curriculum in a structured way by preparing questions, utilize effective learning strategies to attain the knowledge ILOs of the course, and take part in the construction of knowledge with other students. A topic that could be examined more closely is the opportunities games offer for aligning the learning process by involving the students in the creation of course assessment. The instruction loops in the BFA represent a big change by doing this, but this facet has not been sufficiently studied.

Games appear to be a good way of presenting issues and costs relating to sustainability, socio-ecological systems and the roles and action of stakeholders in the institutional politics of governance to students, and giving them agency in how to deal with them. The scenarios students experience in the games seem relevant (though not perfectly realistic) to them, granting simulated experience where they can move through the phases of Kolb's experiential learning cycle. Having game activities that build on each other can assist in illustrating historical developments. One of the main elements that emerges from the student feedback is that they clearly see the role of human beings in relation to the environmental, technological and economic components. There are several branches of studies besides those dealt with in games so far tried out in the BFA, where games could be used. Two immediately evident examples are the value chain of the seafood industry, and aquaculture development and

management. Likewise, other programs or courses that deal with socio-ecological systems might find relevance in instruction loops like the ones used for marine resource management.

The combination of a commercially available serious game and self-developed games worked well in the BFA, allowing the games to connect thematically with each other and the overall course content. Combining games developed by other academic communities with customized games should be considered for further developments of GBL in the BFA program.[19] When designing or adapting existing games to the context of fisheries learning, attention to the elements of the socio-ecological systems should be taken into account, as discussed in paper four.

The results show the importance of debriefing in relation to how students perceive their learning outcomes from games. The program evaluation implement has not been fine-meshed enough to catch the nuances of why, but the aggregated debriefing forms give insight in the topics the students were queried about. Future examinations of debriefing should seek to gather more meta-cognitive reflections from students on the role of debriefing.

As mentioned earlier, an ambition of the BFA program is to provide graduates with the 21st Century skills that are topical in current expectations of what higher learning institutions should prioritize; collaboration, communication, critical thinking and problem-solving. Unfortunately, the data collection has not been sufficiently detailed to add in-depth insight about training in some of the 21st Century skills. Partially, this can be explained by unspecific queries in the program evaluation implement, but also in the implied nature of these skills in the ILOs. Future evaluations and GBL-activities should make the specific learning outcomes tied to skill training more explicit. As shown by Qian and Clark (2016) and Ejsing-Duun and Hanghøj (2019), design-based games and activities show promise for promoting 21st Century skills. This could be a good starting point for future fisheries learning games.

While this dissertation focuses on GBL, it is worth noting that another major result from the SimFish project is the creation of the SimFish Lab, a large space for conducting learning activities that require

---

[19] Some recent published work that was not possible to try out in the span of this project are: Koenigstein et al (2020)'s hybrid board/roleplaying game for exploring sustainable ocean development on a global scale. They find that the strategies employed by players were surprisingly similar to real-world developments in marine governance, without reference to these being present in the game material or instructions. The authors suggest that the game can support development of key competencies for sustainable development. Raffn and Lassen (2021) presents a board game inspired by the works of Bruno Latour that challenges players to reflect on the established power structures and perspectives on interaction between humans and non-humans.

more room than traditional classrooms offer. Future work could also consider the possibilities beyond games this space offers for active learning.

Development work like the efforts carried out by the SimFish project are costly, both in time and money. The funding was provided by UiT's strategic program for innovative teaching. Introducing game-based learning in the BFA has required planning, development, implementation and revision. These processes would not have been possible without the significant effort expended by the SimFish project participants, who have been motivated for, and deeply invested in developing the quality of learning in the BFA program. Changing the paradigm is not done in two or four years, but I maintain that the work put in by my colleagues and myself has provided experience and results that have moved us some steps further along the path. In 2020, UiT published a report on time management and student active learning (UiT, 2020), pointing at the importance of comprehensive focus on educational quality development across all levels of the university, including the individual instructors, leadership and support infrastructure. Measures like these will be important for the sustainability of student active learning, both for specific measures in programs and courses, but also for building communities of practitioners.

Paper 1

Exploring fishery history in game form: "Never again April 18!"

This article explores how Norwegian fisheries history can be explored through games. Using the 1989 closure of the Norwegian coastal cod commons as a case, issues related to historical thinking and game studies are discussed. The main focus is on understanding history with serious games, but theoretical considerations for presenting the case in any game format are discussed. The case is a historical resource crisis, and the article argues how the three dimensions of sustainability (economic, environmental and social) can frame counterfactual imagination for questioning the social institution of resource management.

Keywords: game-based learning, Norwegian fisheries history, institutional politics, historical game studies, historical thinking, fisheries management, historical empathy, sustainability.

Exploring fishery history in game form: "Never again April 18!"

Introduction

Historical narratives are not limited to the format of text. Historical films have been the topic of scholarly attention for a while, and the field of historical game studies is evolving. The focus of this article is how a historical case can be presented in the form of a game, and the opportunities and challenges involved in doing so. Drawing on concepts of historical thinking and consciousness, the main lens for the analysis is teaching and learning history. The broader goal is to illustrate how games in any form can offer paths to understanding a historical resource crisis.

This article reviews the field of historical game studies and the use of games in teaching and learning, and presents how the historical case can be presented in the form of a game way that facilitates historical understanding. The proposed serious game is intended for post-secondary education.

The case is the surprising closure of the Norwegian coastal cod fisheries commons. On April 18, 1989, Norwegian fisheries changed forever. For the first time, the Norwegian Government announced that all cod fishing had to cease as the total quota had been filled. This broke with earlier praxis, where the coastal cod fishers had been allowed to continue fishing, even after the quota had been met. In the 30 years that have passed, 'April 18' has become an important event that represents a turning point for the entire Norwegian fisheries sector.

The primary research question of this article is how games can present the history of the 1989 closure of the Norwegian coastal cod commons. The secondary research questions are twofold: First, how can perspectives on historical thinking be implemented in a serious game about April 18? Second, what theoretical considerations are involved when presenting April 18 in the format of a game?

Historical thinking/ consciousness.

In order to understand history, it is necessary to have an idea of what historical thinking implies. *New Directions in Assessing Historical Thinking* (2015), edited by Seixas and Ercikan, gives a thorough examination of the various models of historical cognition that are employed, and how they are assessed. Duquette's (2015) chapter offers an operationalized model that addresses the relationship between the concepts historical thinking and historical consciousness. Her model illustrates the relationships between

the historical perspectives[1] and historical methods that facilitate interpretation and understanding of the past (ibid, 53).[2]

History in games and games as history.

Games have been present in human societies for thousands of years (Huizinga 1955), and videogames are currently a prevalent cultural medium for all age groups (ESA 2018). Tabletop gaming, such as board games, are currently experiencing a renaissance in terms of cultural impact (Pobuda 2018). History is a common inspiration and subject matter for games. The *Sid Meier's Civilization*-series of videogames (1991-2016) has been the focus of much research (Chapman 2013). Board games with historical settings are well represented in the rankings on the leading website for board games, Board Game Geek.[3] In current top ten games we find *Brass: Birmingham* (2018), *Through the Ages: A New Story of Civilization* (2015), *Twilight Struggle* (2005) and *Great Western Trail* (2016).[4]

---

[1] "Establish historical significance; Identify elements of continuity and change; Analyze causes and consequences; Develop historical empathy; and take into account the complexity of the past" (Duquette 2015, 53).

[2] "Question social phenomena of the past; Propose hypotheses; Check available sources; Analyze sources with respect to their reliability; Answer initial query" (ibid, 53).

[3] https://boardgamegeek.com/browse/boardgame, visited 13.10.2020

[4] These games deal with diverse historical topics; the industrial revolution in England, the development of human civilization from ancient times to the modern age, simulation of the cold war between USA and the Soviet Union, and the development of the U.S. cattle industry and railways in the 19th century.

Chapman, Foka and Westin (2017) state that the field of historic game studies has passed the establishment phase and increasingly delineated from the broader field of game studies. They define the field as:

> 'The study of games that in some way represent the past or relate to discourses about it, the potential applications of such games to different domains of activity and knowledge, and the practices, motivations and interpretations of players of these games and other stakeholders involved in their production or consumption' (ibid, 362).

In addition to sharing ancestry with other studies of history in popular media, Chapman, Foka and Westin state that the origin can be seen in connection with several of the diversifying processes that had an impact on the history discipline, such as memory studies, the linguistic turn and poststructuralist perspectives (ibid, 358–362). A core element is that it combines perspectives of how games in themselves engage with the past, as well as the engagement of the people involved in playing or making them. Games are not limited to being vessels for traditional historical narratives, but can be a distinct medium for history. Spring (2015) explores how popular videogames have made use of primary research in their world building, and argues that games can create historical arguments and engage players in historical questioning. Wright (2018) examines the role of paratexts for historical games, such as promotional material. McCall (2020) presents the Historical Problem Space Framework as a method for analyzing historical games as *games* rather than other media.

A common theme in the discourse on historical games is how mainstream games tend to perpetuate traditional, hegemonic representations of history, in particular centered on western European culture and white, European male actors (Fron et al 2007). Many topics are underrepresented, for example gender, geographical peripheries, ethnicities, or livelihoods. This is an important point, as historical serious games should

consider what type of historical perspectives or narratives they reinforce or challenge. Hammar (2017) argues that games can offer opportunities for counter-hegemonic understanding. Chapman, Foka and Westin (2017) note how there is an unfilled potential in understanding the historical expectations of players and game developers. This is of interest when considering how to operationalize insight from historical game studies for making serious games (ibid, 362 –367). How does the preconceptions of history learners shape the way they interact with a historical game, and to what extent should historical serious games try to utilize, or counteract, this on the design level?

Kapell and Elliott (2013a) provide a thorough discussion of the relationship between history and games, and links theoretical issues of historiography with understanding of games as a medium that can be analyzed and engaged with historically. Their aim is to answer an old question, i.e. historical representation in modern popular culture, from a new perspective. They maintain that unlike media that are understood through passively experiencing a narrative, games are different because they require engagement in the activity of *playing* in order for them to be understood. It is therefore possible to consider games to be *processes*, not *objects*. This distinction is important in light of the connection to historiography – the process in which historians construct history through a process of selecting facts, assembling them into a narrative, and present it in the form they choose (ibid, 5-9). In a game, the player is engaged through different types of agency: what actions to take (or not take), in what order, and interaction with other players. In other words, the player controls how the facts are assembled – not the historian. By allowing engagement with gameplay to complement (or replace) the assembly, games allow the player to have a greater control of the narrative, including the possibility of creating counterfactual outcomes.

Apperley (2013) asserts how counterfactual imagination can be useful for examining both the past and present. Counterfactuals can be a starting point for historical interrogation and reflection on multiple potential outcomes of past events. Chapman (2016, chapter 9) rigorously examines counterfactual history in relation to games. He argues how games are not limited to depicting history, but can promote reflection on why events unfolded the way they did. Chapman calls attention to the demands counterfactual history in games put on both designers and players, focusing in-depth on the interaction between the agency of the players and the structures of the game. A counterfactual pitfall is to put too much weight on individual historical actors, but Chapman argues that the structure and rules of a game can alleviate this concern. In the context of serious games, engagement with counterfactual imagination provides a strong potential for illustrating contingency and causality, and thus understanding of professional historical practices. By providing a process where the elements of history (historical facts and processes) are made explicit and interact, the player engages not only with what they know *has been*, but also with potential *what ifs* (Kapell and Elliott 2013a: 9 –17; Olwell and Stevens 2015).

Serious games for teaching and learning.
In the context of games used to promote historical thinking, insights from the broader literature on game-based learning are relevant. Games take many forms, both analogue (trivia/board/card/roleplaying) or digital. Different formats have implications for how people experience, play or even define what games are (see Laas 2017). Several terms are used to differentiate games used for learning from entertainment games (Crookall 2010). This article will use the term serious game for the use of games in teaching and learning. In practice, a serious game has three phases. First, preparation (such as reading literature or attending lectures). Second, one or more sessions gameplay. Third,

structured post-game debriefing sessions, where the activity is connected to the overall context of the course. Ideally, the serious game is fully integrated in a course, and not a standalone experience.

The academic study of simulations and games in learning activities goes back as far as at least the late 1960s (Wilkinson 2016). A common focus is on the combination of game-play and intended learning outcomes (ILOs), and to a lesser extent on the entertainment of the players (Plass, Homer and Kinzer 2015). Reviews of empirical evidence show that games can be effective in promoting learning (Vlachopoulos and Makri 2017; Subhash and Cudney 2018). However, the effectiveness of game-based learning is debated. Tobias, Fletcher and Wind (2014) point out a need for refinement in the processes for designing games that reliably fulfill their ILOs. Linderoth (2012) challenges the assumption that games (as complex systems) inherently facilitate learning, arguing that the connection between games and learning must be examined empirically. Berg Marklund (2015) examines the complexities of educational games and logistical challenges in implementing game-based learning in formal education.

Using games to understand history.

The use of games in teaching history is well established in the literature, particularly in the context of using digital games made primarily for entertainment purposes (McCall 2011; Chapman 2016; Kapell and Elliott 2013a). The use of non-digital serious games, such as role-playing games and board games has also received some scholarly attention (Olwell and Stevens 2015; Hoy 2018). In the context of Norwegian history, *Priviligert* (2017) is a serious game for secondary education about the economic processes of the

18th century.[5]

McCall (2016) gives an overview of theory and best practices for teaching history with games, reviewing the literature stretching as far back as the late 1960s. By considering how games present history in different ways, it is possible for educators to find games that match what they aim to teach. The historical presentations in games can be placed on a spectrum, from focusing on the perspective of an individual experiencing a given set of historical circumstances, to more abstracted perspectives that focus on larger systems. Some broad categories for different approaches are *games* (characterized by dynamic, rule-based conflicts, and clearly defined goals and outcomes), *simulations* (focusing on rule-based models and abstracted, yet realistic presence of recorded history) or hybrid *simulation games* that combine the elements of both (McCall 2016, 517–523).

McCall goes further in detail than Chapman, Foka and Westin (2017) and Kapell and Elliott (2013a) in arguing why the characteristics that makes historical games distinct from other historical media are relevant for teaching and learning. In particular, he highlights two features: First, how games let their players experience a systemic context for the actions they take. Second, that players are able to make choices that have consequences for the context. Through allowing players to participate in, and repeat, this process, McCall proposes that games become 'lab-like, allowing players to explore historical contingency', and thus produce counterfactual narratives. Understanding the interplay of causality and narrative is an important skill for historical thinking (Førland

---

[5] Website, available only in Norwegian: http://www.privilegert-spill.no/. The game is a collaboration between Tidvis, a company working with interactive history dissemination and the Norwegian Institute of Local History.

2017). Serious games offer an arena for engaging with this by creating situations where the players are in position to compare the differences between the events of the game and the historical facts or accounts that they invoke. Furthermore, as representations and interpretations of history, games must be approached critically by both learners and educators in the same way as any other material used in the teaching (McCall 2016, 524–526, 536).

One of the main challenges for historical serious games is the interface between recorded history (in the sense of historical facts and accounts we can find in the sources) and the potential end results and outcomes of a game (which might be counterfactual or even ahistorical). Kapell and Elliott (2013b) argue that it is more important that games engage players in experiencing historical authenticity, than provide strict adherence to the facts in the historical record. Games can offer a different format for history to be presented, and engage players in experiencing historical processes from different perspectives.

Not all scholars agree on the merits of teaching history by focusing on what could have happened over historical facts. Central in this critique is that they do not teach students real people, real events or real processes (Robison 2013). O'Neill and Feenstra (2016) discuss how the expectations of players can make them inclined to consider games as potentially less trustworthy sources of historical information. Beavers (2020) explores player perceptions on informal learning of history using videogames. She finds that players often do not consider games as viable to learn from, but also that games can contribute to understanding of historical thinking. Beavis et al (2014) point at the pitfalls for teachers who might overemphasize the appeal and motivating effects of games for learning, and the need to focus on pedagogical strategies.

McCall brings up two core arguments for why, despite the criticism, games have merit in teaching history: the link between counterfactual thinking and understanding the reasons why historical events and processes got their outcomes, and that serious games are not intended to replace other teaching, curriculum and interaction with historical source material (McCall 2016, 526-528).

A central point for effective use of serious games is that the instruction does not end once a game is over. An important element is structured debriefing, where the connections between the game context and the ILOs are made explicit. Nicholson (2012) points at three essential characteristics of debriefing: 'what was done in the activity, how well the activity worked for the learner, and how the learning could be applied' (ibid). When considering historical serious games, debriefing is an interface between the counterfactual narratives produced and experienced in the game, and the historical ILOs, providing an additional arena for the players to engage with the complete game experience from historical perspectives and methods. Duquette's (2015) operationalized model of historical thinking perspectives is useful for structuring debriefing of historical games. When using games to understand history, the connection between playing and reflecting on the game, and the overall course instruction is a best practice for using the games to promote the skill of historical thinking in the learners (McCall 2016). Apperley's (2013) work on is also relevant, showing how after-action reports by players of historical games illustrate the tension between counterfactual imagination and aspiration for historical accuracy.

Another critical issue, that mirrors Chapman, Foka and Westin's (2017) point about games having a bias towards hegemonic representations of history, is that games tend to focus on systems. This contributes to how games are often bound by clearly defined rules and roles, and distinctly quantified game elements. This quantification has

several implications for the experience of the players: They will often have defined goals to fulfill, and they will have access to detailed information and control that surpass what historical actors had available (McCall 2016, 528-529). Hoy (2018) provides useful insight in using board games in history classes, in particular involving people found in historical sources. His findings on games and historical empathy are relevant for mitigating the problems of systemic focus in games. In Hoy's game, *Policing the Sound*, players engage with the historical smuggling between British Columbia and Washington state in the 19th Century. The game is based on archival research, and players take the roles of either smugglers or customs inspectors. In the game, players engage in simulations of illegal behavior. The players demonstrated increased understanding of the importance of social context in why people participated in smuggling. This differed from the more law-oriented perspective of smugglers as petty criminals that students demonstrated after reading course curriculum (ibid, 13–14).

April 18 and the reform of the North-Atlantic cod management system.

Fisheries are an important part of Norwegian history. Fishing has provided the material basis for the development of coastal settlements for thousands of years. The traditional springtime fishery of spawning cod in the Lofoten archipelago has been important for fishers from all parts of coastal Norway. This is the largest cod fishery in the world, and was Norway's first export industry. Fisheries were a driver in the development of long-lasting economic and social structures (Kolle 2017a, 2017b; Døssland 2017). The development of science-based management in Norway is also closely tied to the fisheries (Schwach 2013).

On April 18, 1989, the status quo in Norwegian fisheries changed. After several years of crisis in the cod fisheries, the coastal cod fishery was halted when the total quota was filled. Holm, Finstad and Christensen (2014) chapter 'Never Again April 18!'[6] and Holm and Finstad (2020) give a comprehensive review of the complex process leading up to the closure of the cod commons, and the lasting effects reform of the management system that followed had on Norwegian fisheries and society.

In the years leading up to 1989, the catch of cod had been poor. The scientific authorities tasked with stock assessments (the Institute of Marine Research) had warned about the declining cod stocks. The notion that coastal fishing with traditional gears did not impact the regeneration of the stock had been commonly accepted, but the small-scale fishing fleet accounted for as much as 20% of the total cod catch (Maurstad 2000). The effectiveness of the small-scale vessels had steadily increased with the introduction of modern equipment. The crisis in the northeast Arctic cod stock, and thus the environmental dimension of sustainability, was the rationale for closing the cod fishery.

In 1989, the health of the fish stock had become the main concern for management, but the economic and social dimensions of sustainability are also key in

---

[6] The quote is from the Norwegian Director of fisheries at the time, Viggo Jan Olsen. It states his expectation that management reform would avoid a similar situation in the future (Holm, Finstad and Christensen: 199). The statement is a play on 'Never Again April 9!', which refers to the 1940 invasion of Norway. Following the closure, stakeholders used 'Never Again' to state their understanding of the 1989 closure, such as coastal fishers expressing disapproval of the lasting effects on coastal communities and the fishing industry. The 2016 Norwegian Official Report on quota system also makes use of the term to describe the broad agreement that a shock like this should never occur again (NOU 2016: 26).

analyzing the historical significance of the closure as a turning point in Norwegian fisheries management. The new policy was formed on the basis of new developments in maritime law. It represented a shift in focus towards prioritizing the protection of the resource over other concerns, such as need for employment and settlement in the geographical periphery. The result was the swift introduction of a vessel quota system for the cod fisheries. Initially intended as a temporary measure, it became a permanent feature and the main management model for the other major fisheries. This represents a big change: From 1990 onwards, the historically open coastal commons became closed, and managed through quotas. As a break with continuity, this meant that the main objective of the management system was no longer to protect the coastal fishers, but the fish. The social dimension, and the clash between the perceptions of legitimacy by managers and local population, is also key. International dimensions played a role, as the North-Atlantic cod stock was jointly managed by Norway and the Soviet Union from 1975 and onwards. Norway's participation in the European Economic Area also had implications for the subsidy system that supported the coastal fleet.

Even though they were organized in the same union, the powerful Norwegian Fishermen's Association, the Norwegian fishers were not a single and harmonious group. There were tensions between coastal fishers and open sea trawlers, especially in discussions of who were responsible for the overfishing that had contributed to the stock collapse. The belief that traditional gears did not have an adverse effect on the stock size was still prevalent in the coastal population. The management reform resulted in the commons becoming closed, replaced with a vessel quota system with a clear distribution between the small-scale and sea-going fleets based on the total allowed catch, named the 'Trawl Ladder' (Armstrong 1999). On top of this, international agreements caused a dismantling of public subsidies to fisheries. With the closure of the

coastal fishing commons, and a switch in focus towards sustainable fish stocks as the main guiding principle, Norwegian fisheries policy was completely transformed, increasing the recognition of the sea-going trawler fleet. The fisheries industry had been characterized by a large degree of trust and collaboration between the state and the fishers, contributing to the high legitimacy of the system. The corporative system of fisheries management in Norway entered a new phase. The status of the industrial fisheries was strengthened, and the traditional position and identity of the small-scale fishers were challenged by a management system where they now shared the responsibility for sustainable fish stocks. Early in 1989, a new Coastal Fisher's Association was established, which over time grew and challenged the established position of the Norwegian Fishermen's Association (Grytås 2014).

The new vessel quota system also had large impacts on the fisheries in the traditional fishing areas of Sami, the region's indigenous people (Evjen 2014, Brattland et al. 2019). In other words, the event was very multifaceted, involving several institutions and layers of meaning. What started as a crisis in the cod stock set off a chain reaction that reshaped the management system, as well as the basis of existence for many coastal communities. The cod stocks eventually regenerated to a healthy size, but the deep societal changes lasted (Holm, Finstad and Christensen 2014; Holm and Finstad 2020). The break with the previous tradition went against the public understanding small-scale fisheries' effect on the fish stocks, and the resulting public and academic debates brought up issues relating to the tragedy of the commons and sustainability (Jentoft 1993).

Envisioning April 18 as a historical serious game.

The closure of the cod commons provides plenty of material from which an exciting

historical narrative can be constructed: Actors and stakeholders, resources and industry, national and international politics, tensions between the center and the periphery, and a break with continuity. Several approaches in the scholarship on historical games and serious games are useful for exploring April 18 in the format of a serious game intended for use in post-secondary education.

McCall (2020) presents the Historical Problem Space (HPS) framework as an analytical method for comprehensively exploring the dynamic relationships between components in historical games; looking at why games represent history in the way they do. While HPS focuses mainly on digital games, I find it to be useful for structuring the design of an analogue serious game. HPS's emphasis on dynamics highlights Kapell and Eliott's (2013b) point that the power of games lies in offering players historically authentic experiences, not records of facts. HPS defines the core components of a game's historic problem space as: Player agents (the historical actors controlled by the player); goals; the virtual gameworld (the historical setting) and elements that enable and constrain the players (agents, minions, resources, obstacles and tools); and the strategies, choices and behaviors available to the players in navigating the gameworld. The shape these components take are influenced by the conventions of the genre of the game (McCall 2020).

Peters and Westelaken's (2014) outlines a design model that concisely presents the process of making serious games:

> 1) The reference system is defined, which is understood as a complex real life situation that serves as the basis of the game, and thus defines the ILOs.
> 2) A schematic representation of the reference system is created, which identifies the relevant elements and connections to include.
> 3) Implementation of the schematic representation as a game (meaning the parts that make up the schematic are mapped onto game elements, such as the rules, mechanics and components).

This process is described using the terms: *reduction* (deciding what parts of the reference system will be present in the schematic), *abstraction* (defining the level of detail or simplification the parts that are present will have) and *symbolization* (parts of the reference system that are represented in a new way) (Peters and Westelaken 2014). By combining the HPS-framework and Peters and Westelaken's model it is possible to define and describe the various elements of April 18 as game components. The reference system in this case is the break in the continuity of the coastal cod common, and factors that exerted pressure on the resulting process of fisheries management reform. In order to abstract these factors, the three dimensions of sustainability (economic, environmental and social) are used. Sustainability is a useful framework for categorizing the different aspects of April 18 as a resource crisis, as the fishery represents a coupled human-biophysical systems (Kotchen and Young 2007).[7] A simple schematic presentation of April 18 outlining the broad factors that influenced the process is presented in figure 1. [Figure 1 here]

Before describing the implementation of the schematic representation using the HPS framework's components, the choice of genre must be considered. In essence, April 18 is a situation where actors are involved in institutional politics. Bridge (2014) points out that since institutional politics are structured by the 'rules of the game', they are well suited for being simulated in games. This is because a game's rules can be modified to mirror the rules that govern the simulated institutional processes. McCall's (2016) definition of *simulation games* is also useful, combining clear rules with a well-founded model of a past event. The key historical actors are the stakeholders involved,

---

[7] Purvis et al (2018) provides a thorough review of the origin of the concept of the three pillars of sustainability.

making their presence in the game important. Roleplaying is therefore a good choice of game genre. An established format for live-action historical roleplaying is *Reacting to the Past* (RttP). Olwell and Stevens (2015) describe RttP as a flipped-classroom approach where students embody roles in a historical setting, and attempt to gather support for their factions.[8] The instructor will serve as game master and facilitate the game, and provide feedback from the gameworld, and enforcing that the factions present historically authentic arguments. With these considerations in mind, April 18 can be envisioned as a roleplaying game, where the players take on the roles of different groups of actors engaged in institutional politics: stakeholders involved in negotiations about fisheries management reform in light of the ongoing cod crisis. Will the fishery continue with 'business as usual', or move towards a new order of management? This setting is ahistorical as such negotiations did not happen, but serves as a venue for players to explore the positions of the stakeholders that were affected by the closure of the cod commons. Table 1 shows the core game components of April 18 and their level of abstraction.

[Table 1 here]

The overall flow of the game is that the players are first assigned which stakeholder faction they will play, and prepare for their roles by researching their historical positions and arguments. The players in each faction discuss and agree on their objectives and strategy for the negotiations, and play out a series of negotiation sessions

---

[8] Clary summarizes the RttP game structure as: "Students are assigned distinctive roles and victory objectives that they pursue in alliance with some students and in competition with others. Students win through successfully persuading their classmates using historic arguments, ideas, research, and texts" (Clary 2019).

in plenary where they present their arguments. The gamemaster provides feedback from the gameworld (for example actors that are not embodied by players, and elements that constrain the negotiations). The status of the gameworld is abstracted by framing changes by how decisions are expected to impact the economic, environmental and social dimensions of sustainability. The players representing the Directorate of Fisheries will propose a course of action for how the cod crisis will be handled. All player factions vote if they are for or against the proposed action, but the decision is made by the Directorate of Fisheries. The gamemaster prepares a new scenario for how the proposed changes play out, including feedback from the non-player elements of the gameworld (such as constraints from demands made by foreign diplomats). The factions prepare for a new round of negotiations taking place after a year has passed in the gameworld, based on the feedback and new information on the state of the gameworld.

In addition to the in-game objectives the players attempt to complete, the serious game has defined intended learning outcomes. These shape how the players engage with the game's historical basis and engage in historical thinking. The table below shows the ILOs of the game, and links them to Duquette's (2015) operationalized model of historical perspectives and methods.

[Table 2 here]

Throughout the game and during debriefing, players engage with historical perspectives and methods. In preparing for their roles, the players must engage with historical source material pertaining to April 18 (for example scientific advice from the Institute of Marine Research, opinion pieces in the newspapers, or catch and sale statistics from the fisheries industry), and evaluate how they will inform their roles. The roleplaying game format can be beneficial for players' engagement with historical thinking. Hoy's (2018) findings on the potential of games to strengthen students' sense

of historical empathy are relevant. RttP has also shown increased understanding of historical contingency and empathy (Olwell and Stevens 2015). The debate on the impact of the closure on Norwegian coastal society was uncompromising when it took place in the 1990s, but current perspectives are mainly focused on the acceptance of sustainable fish stocks as the overall goal of management (Holm Finstad and Christensen 2014). The goal of studying the historical events surrounding April 18 is to learn understanding of the complex process, not moral judgements about sustainability. The status of the coastal fisher Norwegian fisheries was transformed, and the discussions at the time dealt with how the identity and role of the small-scale coastal fisheries was understood, both the fishers themselves and society.

With the players taking on the roles of stakeholders with conflicting interests, they can explore the internal motivations of groups that are undergoing far-reaching changes to their material basis, and the manifold social processes connected through the closing of the costal cod commons. In terms of historical theory, this plurality is a good way to facilitate multiperspectivity in how the players relate to the event (Stradling 2003). Through the simulated negotiations, players have agency in the narrative, allowing them to decide how the factions they embody attempt to safeguard and further their interests. If a faction is unable to agree on a consensus decision, some players might leave and make a new faction. Some examples are different stakeholders' willingness to accept a proposed division of quotas between the costal and sea-going fleets, or how they would relate to the indigenous dimension where a minority group is marginalized by the majority (which was not initially emphasized in the vessel quota system). In-game situations like these can be conducive to illustrate theoretical concepts such as Foucault's governmentality in the context of fisheries (Jentoft and Johnsen 2015).

These questions relate to historical empathy. Can a serious game about the April 18 help develop understanding of the social dimension – in contrast to the economic and environmental concerns – that had been strengthened by the shift in legal focus leading up to 1989? A key point here is that 'assessed by today's standards for sustainable resource management, the 1989 resolution does not appear problematic in any way. 'When the quota is filled, the catch must stop' (Holm, Finstad and Christensen 2014, 186, my translation). It is possible that contemporary players who more strongly emphasizes environmental sustainability will have trouble empathizing with the small-scale fishers and local communities that depended on the fishery for its material basis. In this way, does a historical game run the risk of acting as an arena where the past is colonized by current understanding of the subject matter? Central for this is Kapell and Elliott's (2013a) point that simulations allow players to experience contingency by seeing possible outcomes informed by contemporary perspectives, which were not necessarily available to the historic actors at the time. Debriefing represent an arena for counterfactual reasoning, exploring how the actions performed in the game relate to recorded history. This provides an opportunity to explore how pre-existing expectations influence interactions within the game. If a game session ends with the players favoring arguments and solutions that are skewed towards environmental sustainability, the debriefing and post-game instruction can focus more on topics that deal with the economic and social dimensions. Connecting the result of the game to historical hindsight also allows the game activity to facilitate understanding multiple perspectives. Not only the positions of involved stakeholders, but also geographical and temporal scaling, making links to both Norwegian fisheries management post-1989 and other resource crises. In order for debriefing and post-game activities to achieve this, they must attempt to go beyond the deliberations or consensus made by the players, and

connect with source material from the post-closure fishing industry. Relevant question to discuss could be if the decisions made by the players have accelerated or avoided a stock collapse and what would the economic and social effects have been? Debriefing and post-game discussions of what happened in the game offer opportunities for historical reflection on the real-world April 18: Why were the inshore cod fisheries not closed earlier, when the same problems with overfishing had been known and happened for years? Why did the Russians not demand that the inshore fisheries close at an earlier stage in the Joint Norwegian-Russian Fisheries Commission's negotiations?

The potential outcomes of the closure of the coastal common are also important. Will there be a new order in Norwegian fisheries management? If the game is to fulfill the ambition of letting the players experience a systemic context for their actions (McCall 2016) and make use of counterfactual outcomes to promote historical thinking, the players must also engage with the results of their actions. By abstracting the impacts of the decisions made by players through the concept of sustainability, the gamemaster can give the players feedback on how their actions have affected the gameworld. Through multiple sessions of negotiations, the players will re-evaluate their strategies and goals based on the evolving situation. This adds a sense of temporality and contingency to the experience, illustrating that management reforms are complex and take time.

Theoretical considerations in exploring the history of April 18 in game form.
The process of presenting April 18 in the form of a game makes several theoretical considerations visible. In the context of a serious game as outlined in the previous section, links to historical thinking are particularly important. Presenting April 18 in other game formats could open up other lines of historical reasoning. As Elliott & Kappel (2013a) point out, the agency of players in a game can replace or complement

the historian's act of assembly, meaning that close attention should be paid to the opportunities for agency a game offers to players in constructing a historical narrative. Chapman (2016) asserts the tension between agency and structure. In the case of April 18, the central theme is not the structures of commercial fishing in themselves, or the agency individual stakeholders involved. The core is the interplay of factors that resulted in a major change in the established management system – and how this transformed the entire understanding of Norwegian fisheries management; the goal was no longer protection of the coastal fishers, but the fish. For a game to engage with April 18, this is what must frame the agency of players.

When presenting a complex event through a game, the designer must prioritize which elements to include. In order to avoid a game that is too complex, some elements in the virtual gameworld must be simplified. Details are important for conveying nuance, as well as the presentation of facts. At the same time, there has to be a balance between fidelity and verisimilitude, and a level of detail that is sufficient for properly presenting the historical event as an authentic experience for players. The HPS-framework offers a vocabulary to describe and frame the different aspects of a historical setting, and how the game's genre and components shape the forms they take. April 18 could be envisioned in the form of a business simulation game. The player agent, operating a small fishing vessel, having to face that the rules they operate within change due to the commons becoming closed. The player would have to make choices in order to adapt to the new quota system, experiencing how a sudden change affects the strategies they have previously employed successfully. This would cast the other stakeholders in different roles, serving as agents or minions that enable or hinder the player.

For a historical serious game, elements that are not a part of the game can be included through preparation and post-game debriefing. Digital games often include in-game encyclopedias with complementary information about the different game elements. This way of inserting historical facts and narratives in a game can be useful, but is arguably not making use of the game format. Spring (2015) shows how the videogame *Red Dead Redemption* (2010) immerses the player in a well-researched historical argument about the transformation of the Old West frontier in the early 20th century. The player agent is a former outlaw roaming the Old West. Through conversations between characters, often not connected to the game's main narrative, different cultural, social and political elements of the ongoing transformation are brought to light. It is possible to imagine a game where the player is embedded in the events of April 18 in a similar way. The player agent would move around the Norwegian coast in the early 1990s. Throughout the game, the player would interact with characters and be presented with their thoughts on the ongoing situation in the fishery, and how society is changing.

In the serious game proposed earlier, the focus is on the stakeholders and their interactions, while most of the non-stakeholder elements are abstracted and symbolized. Stakeholders with conflicting interests are central to April 18, but the institutional politics are entangled with other issues. In the context of a resource crisis, concepts like sustainability, the tragedy of the commons, and human adaptation are relevant (Kotchen and Young 2007). These concepts provide opportunities for the counterfactual imagination described by Apperley (2013). Players are not limited to considering what will happen with the if a resource is depleted, but also engage with the possibility space of what happens if the resource is successfully conserved – not only for the environment, but also the economic and social spheres. Reflecting on all three

dimensions can offer opportunities for questioning the institution of fisheries management as a whole, exploring different scenarios.

Environmental history can be a useful approach for jointly analyzing the combination of issues related to policy, nature and science found in the crisis (Payne 2013; Schwach 2013). The part non-humans play in agency is an interesting discussion in historical theory (Asdal 2005; Mitchell 2002). The paradigm shift in Norwegian fisheries policy post-April 18 can be seen as an entanglement of several heterogeneous networks, material and immaterial, that shaped the development of Norwegian fisheries at a critical point in time.[9] These entangled elements are the facts that can be assembled to a narrative. By exploring them in a game, the role of the non-human elements and how they share the agency and shape situation can be highlighted through game rules and elements. Some game formats offer ways to include various elements of fisheries in less abstract forms. Digital games can simulate impacts of harvest pressure on fish stocks, for example as in *Fish Banks Ltd.* (1993). Simulator games such as *Fishing: Barents Sea* (2018) and *Fishing: North Atlantic* (2020) engage players in realistic operation of different commercial fishing vessels and gear types.

The premise for a resource crisis like April 18 has consequences for its solution, which in turn has implications for the type of gameplay that the players will engage in. The dramatic closure of the commons was contingent on a crisis in the cod stock in order to kick off the reform of the management system. Although there were other structural challenges, such as overcapacity and uncertain profitability, the sharp decline

---

[9] These elements include: International relations, management, science and technology, traditions, fishing gear and practices, center-periphery conflicts, indigenous dimensions, the North-Atlantic cod stock, and different vessel types.

in the cod stock was instrumental in triggering a break in the continuity of the management system. How the fish stocks are represented as a game element can be implemented in different ways that give players agency. The fish stock might be highly abstracted in the form of quotas, with players attempting to increase their division of the total quota. A less abstracted representation of the fish stocks, like in *Fish Banks Ltd.* (1993), lets the actions of the players decide whether the simulated population decreases or increases. Overfishing illustrates cause and effect, but player agency in unstainable fishing might not be required for exploring the historical problem space of April 18. The cod stock must be in a critical state for the process of reform to start, but it is not necessary for the players to have caused the collapse before they try to amend the situation.

April 18's emphasis on institutional politics between stakeholders with conflicting interests draws attention to two central questions in historical game studies: How games tend to focus on systems, and perpetuate traditional understandings of history (McCall 2016; Chapman, Foka and Westin 2017). In a game that models the relationship between different groups with stakes in a scarce resource, the game's perspectives on power are important. How the actors are framed is important for how the players develop historical empathy for their positions. Is there a bias towards defaulting to the hegemony of the governmental management systems, or ideals of environmental sustainability, as more important than the survival of traditional local communities in the coastal periphery? Alternatively, is there a bias towards romanticized representations of small-scale fisheries that paint an unflattering image of industrial trawlers? How power is present in the game can serve to reinforce loops of legitimization of the current status quo. In the context of April 18, these perspectives can illustrate on concepts like path dependency in the fisheries sector. When scarce

resources are re-distributed, the processes can often be experienced as creating winners and losers, such as the impacts the closure of the commons had for the indigenous Sami coastal fishers shows (Evjen 2014; Brattland et al 2018). The bias of the game or players affects how the game's narrative is assembled and understood.

Conclusions

The aim of this article has been to explore how a historical event, the closure of the Norwegian coastal cod commons in 1989, can be presented in the format of a game. The case resolves around a resource crisis involving different stakeholders that are entangled with material and non-material processes and factors. The field of historical game studies is rapidly evolving, increasing understanding of how games as media offer players ways of engaging with the past. In this article, the case has been explored through the lens of teaching and learning history, discussing how the transformation of Norwegian fisheries management can be told through a serious game. Furthermore, theoretical considerations of how April 18 can be presented in different game formats have been examined. Games are not texts, and one of the main elements of the format is that it offers players agency. Through rules and simplifications, a historical game frames the agency players have to assemble and explore a narrative. The concept of sustainability is a practical framework for highlighting the environmental, social and economic dimensions of a resource crisis. In terms of historical thinking, transporting the player to a complex process of management reform offers opportunities to engage with counterfactual outcomes and question the process of how and why history is created – how and why was the Norwegian fisheries management system transformed? By engaging with a historical break in continuity, and exploring the perspectives of multiple stakeholders with conflicting interests, it is possible to question the social

institutions that are embodied in resource management. Moreover, through authentic experiences, players can develop historical empathy for historical actors whose positions, when judged by current standards, might be considered unreasonable.

Literature

Apperley, Tom. 2013. "Modding the Historians' Code: Historical Verisimilitude and the Counterfactual Imagination" in *Playing with the Past: Digital Games and the Simulation of History*, edited by Kapell and Elliott, 185–198. Routledge. https://doi.org/10.5040/9781628928259.ch-012

Armstrong, Claire W. 1999. "Sharing a Fish Resource-Bioeconomic Analysis of an Applied Allocation Rule." In *Environmental and Resource Economics* 13(1): 75–94. https://doi.org/10.1023/A:1008255332482.

Asdal, Kristin. 2005. "Miljøhistorie som politikk- og vitenskapshistorie. Franske Forbindelseslinjer." *Nytt Norsk Tidsskrift* 22(3): 301–11.

Beavers, Sian M. 2020. "The Informal Learning of History with Digital Games". PhD diss., The Open University. https://doi.org/10.21954/ou.ro.0001111f

Beavis, Catherine, Leonie Rowan, Michael Dezuanni, Christie Mcgillivray, Joanne O'Mara, Sarah Prestridge, Colleen Stieler-Hunt, Roberta Thompson, and Jason Zagami. 2014. "Teachers' Beliefs about the Possibilities and Limitations of Digital Games in Classrooms." *E-Learning and Digital Media* 11(6): 569–81. https://doi.org/10.2304/elea.2014.11.6.569.

Berg Marklund, B. (2015). "Unpacking Digital Game-Based Learning : The complexities of developing and using educational games". PhD diss., University of Skövde, Skövde. http://urn.kb.se/resolve?urn=urn:nbn:se:his:diva-11805

Brattland, Camilla, Einar Eythórsson, Jørn Weines, and Knut Sunnanå. 2019. "Social–Ecological Timelines to Explore Human Adaptation to Coastal Change." *Ambio* 48: 1516–1529. https://doi.org/10.1007/s13280-018-1129-5.

Chapman, Adam. 2013. "Is Sid Meier's Civilization history?" in *Rethinking History* 17(3): 312–332. https://doi.org/10.1080/13642529.2013.774719

Chapman, Adam. 2016. *Digital Games as History*. Routledge. https://doi.org/10.4324/9781315732060.

Chapman, Adam, Anna Foka, and Jonathan Westin. 2017. "Introduction: What Is Historical Game Studies?" *Rethinking History* 21(3): 358–71. https://doi.org/10.1080/13642529.2016.1256638.

Christensen, Pål. 2017. "Under a New Management Regime, 1970–2015". In *Fish, Coast and Communities - A History of Norway*, edited by *Kolle, Nielssen, Christensen and Døssland, 291*–322. Fagbokforlaget. Bergen.

Clary, Katie Stringer. 2019. "Reacting to the (Public) PastTM: Innovations in Public History Pedagogy". *International Public History* 2(1): 8–14. https://doi.org/10.1515/iph-2019-0005

Crookall, David. 2010. "Serious Games, Debriefing, and Simulation/Gaming as a Discipline." *Simulation & Gaming* 41 (6): 898–920. https://doi.org/10.1177/1046878110390784.

Duquette, Catherine. 2015. "Relating Historical Consciousness to Historical Thinking through Assessment" in *New Directions in Assessing Historical Thinking*, edited by Erickan and Seixas, 51–63. Routledge.

Døssland, Atle. 2017. " Fisheries Vitalise the Coastal Communities, 1750-1880". In *Fish, Coast and Communities - A History of Norway*, edited by *Kolle, Nielssen, Christensen and Døssland,* 151–178. Fagbokforlaget. Bergen.

Entertainment Software Association. 2018. "Essential Facts About Video Games," 1–17. http://www.theesa.com/wp-content/uploads/2018/05/EF2018_FINAL.pdf.

Ercikan, Kadriye and Peter Seixas (Eds.). 2015. *New Directions in Assessing Historical Thinking*. Routledge. https://doi.org/10.4324/9781315779539

Evjen, Bjørg. 2014. "Åpning for sjøsamiske rettigheter?". In *Norges fiskeri- og kysthistorie, Bind IV: Havet, fisken og oljen, 1970-2014*, edited by Pål Christensen, 251–280 . Fagbokforlaget. Bergen.

Fron, Janine, Tracy Fullerton, Jacquelyn Ford Morie, and Celia Pearce. 2007. "The Hegemony of Play". *Situated Play, Proceedings of DiGRA 2007 Conference*: 309–18. http://www.digra.org/dl/db/07312.31224.pdf

Førland, Tor Egil. 2017. Problems of Causation in Historiography" in *Values, Objectivity, and Explanation in Historiography*. Routledge.

Grytås, Geir. 2014. "Maktkamp, nye reglar og fleire spelarar". In *Norges fiskeri- og kysthistorie, Bind IV: Havet, fisken og oljen, 1970-2014, edited by Pål Christensen,* 185–214. Fagbokforlaget. Bergen.

Hammar, Emil Lundedal. 2017. "Counter-hegemonic commemorative play: marginalized pasts and the politics of memory in the digital game Assassin's Creed: Freedom Cry". *Rethinking History*: 21(3), 372–395. https://doi.org/10.1080/13642529.2016.1256622

Holm, Petter, Bjørn-Petter Finstad and Pål Christensen. 2014. "Aldri mer 18. april!". In *Norges fiskeri- og kysthistorie, Bind IV: Havet, fisken og oljen, 1970-2014*, edited by Pål Christensen, 185–214. Fagbokforlaget. Bergen.

Holm, Petter; Finstad, Bjørn-Petter. 2020. "April 18, 1989: The Acceptance of Overfishing in Norway". In *Too Valuable to be Lost: Overfishing in the North Atlantic since 1880*, edited by Garrido and Starkey, 109–128. De Gruyter.

Hoy, Benjamin. 2018. "Teaching History With Custom-Built Board Games." *Simulation & Gaming* 49(2). https://doi.org/10.1177/1046878118763624.

Huizinga, J. 1955. "Homo Ludens A Study of the Play-Element in Culture". Beacon Press. Boston, USA.

Jentoft, Svein. 1993. *Dangling Lines: The Fisheries Crisis and the Future of Coastal Communities: The Norwegian Experience*. St. John's: ISER Books

Jentoft, Svein, and Jahn Petter Johnsen. 2015. "The Dynamics of Small-Scale Fisheries in Norway: From Adaptamentality to Governability". In *Interactive Governance for Small-Scale Fisheries*, edited by Jentoft and Chuenpagdee, 705-723. Springer. https://doi.org/10.1007/978-3-319-17034-3.

Kapell, Matthew, and Andrew B. R. Elliott. 2013a. "Introduction: To Build a Past That Will "Stand the Test of Time"—Discovering Historical Facts, Assembling

Historical Narratives". In *Playing with the Past : Digital games and the simulation of history*, edited by Kapell and Elliott, 1–30. Bloomsbury Academic. https://doi.org/10.5040/9781628928259.ch-001

Kapell, Matthew, and Andrew B. R. Elliott. 2013b. "Conclusion(s): Playing at True Myths, Engaging with Authentic Histories Narratives". In *Playing with the Past : Digital games and the simulation of history*, edited by Kapell and Elliott, 357–369). Bloomsbury Academic. http://dx.doi.org/10.5040/9781628928259.ch-023

Kolle, Nils. 2017a. "The Norwegian Coast - Nature's Offerings". In in *Fish, Coast and Communities - A History of Norway*, edited by *Kolle, Nielssen, Christensen and Døssland,* 13–38. Fagbokforlaget. Bergen.

Kolle, Nils. 2017b. "Between Tradition and Modernity, 1880-1945". In *Fish, Coast and Communities - A History of Norway*, edited by *Kolle, Nielssen, Christensen and Døssland,* 179–206. Fagbokforlaget. Bergen.

Kotchen, Matthew J., and Oran R. Young. 2007. "Meeting the Challenges of the Anthropocene: Towards a Science of Coupled Human–Biophysical Systems." *Global Environmental Change* 17(2): 149–51. https://doi.org/10.1016/j.gloenvcha.2007.01.001.

Laas, Oliver. 2017. "On Game Definitions." J*ournal of the Philosophy of Sport* 44 (1): 81–94. https://doi.org/10.1080/00948705.2016.1255556.

Linderoth, Jonas. 2012. "Why gamers don't learn more: An ecological approach to games as learning environments". *Journal of Gaming and Virtual Worlds*, 4(1), 45–62. https://doi.org/10.1386/jgvw.4.1.45_1

Maurstad, Anita. 2000. "To Fish or Not to Fish: Small-Scale Fishing and Changing Regulations of the Cod Fishery in Northern Norway." *Human Organization* 59(1). https://doi.org/10.17730/humo.59.1.q0242m112x223862.

McCall, Jeremiah. 2011. *Gaming the Past: Using Video Games to Teach Secondary History*. New York: Routledge. https://doi.org/10.4324/9780203831830

McCall, Jeremiah. 2016. "Teaching History With Digital Historical Games: An Introduction to the Field and Best Practices." *Simulation & Gaming* 47(4): 517–542. https://doi.org/10.1177/1046878116646693.

McCall, Jeremiah. 2020. "The Historical Problem Space Framework: Games as a Historical Medium." *Game Studies* 20(3). http://gamestudies.org/2003/articles/mccall.

Meadows, Dennis L., Thomas Fiddaman and Diana Shannon. 1993: "Fish Banks, Ltd. A Micro-computer Assisted Group Simulation That Teaches Principles of Sustainable Management of Renewable Natural Resources", 3rd ed, Laboratory for Interactive Learning, University of New Hampshire, Durham.

Mitchell, Timothy. 2002. "Can the Mosquito Speak?". In *Rule of Experts: Egypt, Techno-Politics, Modernity*, 19-53. Berkeley, Calif.: University of California Press.

Nicholson, Scott. 2012. "Completing the Experience: Debriefing in Experiential Educational Games." *The 3rd International Conference on Society and Information Technologies* 11(6): 117–21. http://scottnicholson.com/pubs/completingexperience.pdf

NOU 2016: 26 Et fremtidsrettet kvotesystem

O'Neill, Kevin, and Bill Feenstra. 2016. "'Honestly, I Would Stick with the Books': Young Adults' Ideas about a Videogame as a Source of Historical Knowledge." *Game Studies* 16 (2). http://gamestudies.org/1602/articles/oneilfeenstra

Olwell, Russell, and Azibo Stevens. 2015. ""I Had to Double Check My Thoughts": How the Reacting to the Past Methodology Impacts First-Year College Student Engagement, Retention, and Historical Thinking." *The History Teacher* 48 (3): 561–72.

Payne, Brian. 2013. "Local Economic Stewards: The Historiography of the Fishermen's Role in Resource Conservation." *Environmental History* 18(1): 29–43. https://doi.org/10.1093/envhis/ems115

Peters, Vincent A.M., and Marleen van Westelaken. 2014. "Simulation Games - A Concise Introduction to the Design Process," no. August. https://doi.org/10.13140/2.1.4259.1367

Plass, J. L., Homer, B. D., & Kinzer, C. K. (2015). "Foundations of Game-Based Learning". *Educational Psychologist,* 50(4), 258–283. https://doi.org/10.1080/00461520.2015.1122533

Pobuda, Tanya. 2018. "Assessing Gender and Racial Representation in The Board Game Industry." *Analog Game Studies* V(IV).

http://analoggamestudies.org/2018/12/assessing-gender-and-racial-representation-in-top-rated-boardgamegeek-games/

Purvis, Ben, Yong Mao, and Darren Robinson. 2018. "Three Pillars of Sustainability: In Search of Conceptual Origins." *Sustainability Science* 14(3): 681–95. https://doi.org/10.1007/s11625-018-0627-5

Robison, William B. 2013. "Stimulation, Not Simulation: An Alternate Approach to History Teaching Games." *History Teacher* 46 (4): 577–88. https://doi.org/10.2307/43264159?ref=search-gateway:1f75191320a713c3d7a0ccdc911e632f

Schwach, Vera. 2013. "The Sea around Norway: Science, Resource Management, and Environmental Concerns, 1860-1970." *Environmental History* 18(1): 101–10. https://doi.org/10.1093/envhis/ems107

Spring, Dawn. 2015. "Gaming history: Computer and video games as historical scholarship". *Rethinking History* 19(2), 207–221. https://doi.org/10.1080/13642529.2014.973714

Stradling, Robert. 2003." Multiperspectivity in History Teaching : A Guide for Teachers". Strasbourg, France: Council of Europe.

Subhash, Sujit and Elizabeth A. Cudney. 2018. "Gamified learning in higher education: A systematic review of the literature." *Computers in Human Behavior* 87(February), 192–206. https://doi.org/10.1016/j.chb.2018.05.028

Tobias, Sigmund, J. Dexter Fletcher, and Alexander P. Wind. 2014. "Game-Based Learning." In *Handbook of Research on Educational Communications and Technology*, 485–503. New York, NY: Springer New York. https://doi.org/10.1007/978-1-4614-3185-5_38.

Vlachopoulos, Dimitrios and Agoritsa Makri. 2017. "The effect of games and simulations on higher education: a systematic literature review". *International Journal of Educational Technology in Higher Education* (Vol. 14). https://doi.org/10.1186/s41239-017-0062-1

Wilkinson, Phil. 2016. "A Brief History of Serious Games." In *Entertainment Computing and Serious Games*, edited by Dörner, Göbel, Kickmeier-Rust, Masuch and Zweig, 17–41. https://doi.org/10.1007/978-3-319-46152-6.

Wright, Esther. 2018. "On the promotional context of historical video games."
Rethinking History 22(4), 598–608.
https://doi.org/10.1080/13642529.2018.1507910

Table 1: Core game components of April 18 and abstraction level.

HPS core components	April 18	Abstraction level
Player agents (represented in a combination of *specific historical agents* and *historical collectives*)	Groups of players play as factions of stakeholders. Stakeholders in the cod fishery: • Small scale fishers • Open sea trawlers Stakeholders in fisheries management: • Directorate of Fisheries • Scientific authorities (Institute of Marine Research) Institutional stakeholders: • Norwegian Fishermen's Association • Representatives of interest groups (coastal communities, Sami fishers)	Low level of abstraction; the stakeholder factions will be based on players examining historical information to define their roles.
Goals	Gaining support for players' stakeholder group's interests in the reformed management system.	Abstracted, symbolized through the sustainability dimensions.
Virtual gameworld	The Directorate of Fisheries are arranging negotiations for reform of the fisheries management system in response to the ongoing cod stock crisis.	Symbolized through a counterfactual negotiation.
Agents	Stakeholder factions not played by groups of players	Symbolized through feedback by the game master.
Minions	Interest groups that are not party to the negotiations, but support different stakeholder groups.	Symbolized through feedback by the game master.
Obstacles	International relationships that constrain the negotiations: • Joint Norwegian–Russian Fisheries Commission • European Union	Symbolized through feedback by the game master.
Resources Tools	Arguments and positions presented in negotiations. Information used by the historical stakeholders. Information on the cod fishing industry (stock assessments, catch data, economic reports). Demographic data (population, employment).	Low level of abstraction from historical data, but also quantified in game effects through the sustainability dimensions.
Strategies Choices Behaviors	Define goals for stakeholder faction. Selecting and presenting arguments in negotiations. Negotiating with other stakeholder factions about acceptable compromises,	Level of abstraction is driven by players and their interaction with the game components.

Table 2: Intended learning outcomes and ties to historical thinking.

| Intended learning outcomes	Historical thinking perspectives and methods employed.
Explain the historical events that led up to the closing of the Norwegian inshore cod fishery common.	Establish historical significance, analyze causes and consequences,
Compare and contrast the different stakeholders involved in and affected by the closing of the inshore cod commons, especially in the context of "the tragedy of the commons" and the impact of management systems on different parts of the fishing fleet.	Analyze causes and consequences, develop historical empathy, question social phenomena of the past
Reflect on the closing of the inshore cod fishery in terms of break or continuity in Norwegian fishery and coastal history and fisheries management systems.	Identify elements of continuity and change, propose hypotheses
Appraise the importance opinions and scientific knowledge play in institutional politics.	Check available sources, analyze sources with respect to their reliability
Apply the dimensions of sustainability (economic, environmental and social) when analyzing social change in historical processes.	Question social phenomena, propose hypotheses
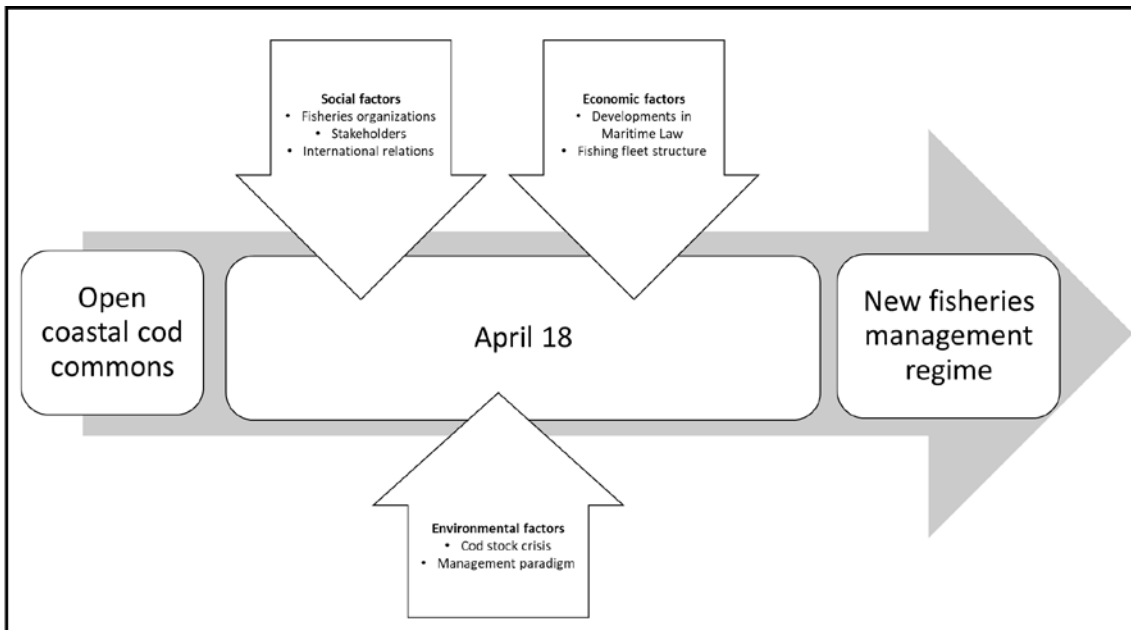
Figure 1: Schematic representation of April 18.

Paper 2

Promoting 21st Century Skills with Game-Based Learning in Interdisciplinary Fisheries Education

Jørn Weines,
UiT The Arctic University of Norway, Tromsø, Norway
jorn.weines@uit.no

Abstract: This conference paper presents the case of using a combination pre-made serious games and self-designed games at bachelor and master's programs at the Norwegian College of Fisheries Science to facilitate the integration of different disciplines and the development of practical skillsets that are necessary for success in the seafood industry after graduation. Furthermore, it explores the preliminary results of student surveys rating their experiences of game based learning in the bachelor in fisheries and aquaculture science program.

Keywords: Game-based learning, interdisciplinary programs, fisheries science, student-active learning, constructive alignment

Introduction

Aquaculture, small-scale and industrial fisheries are primary industries that are a source of food, employment and recreation for people all over the globe (FAO 1995). In 2018, the seafood export from Norway exceeded 10 billion euros (Seafood Norway 2019). The study of this important industry, Fisheries and Aquaculture Science, is an interdisciplinary field. It combines natural and social sciences in order to provide graduates with the necessary disciplinary knowledge, skills and competences for working in the seafood industry or management (Charles 1995). A graduate with a Bachelor's degree in Fisheries and Aquaculture Science (BFA) combines disciplines thar range from aquatic biology, via seafood production to the process of management planning. In addition to combining diverse academic fields, fisheries science and aquaculture science can also be considered to be transdisciplinary, due to the close connection between the academic community and both the seafood industry and governmental marine resource management (Tress, Tress & Fry 2006).

Although BFA graduates combine a variety of disciplines, their knowledge is still highly specialized. There is currently a focus on higher education institutions' obligations to not only offer a high quality academic education, but also provide their graduates with the skills needed to succeed in the workforce. As business, industry and management have become more complex, the role of the worker or manager has transformed. There is less use for routine skills, but the ability to communicate, share and use information efficiently has become more important. In addition to communication, key skills include collaboration, problem solving and critical thinking. A brief definition of these skills is provided in table 1 (P21 2019). The collective term for these skills are "21st century skills", not because they did not exist earlier, but due to the transformation our society has undergone, our reliance on them has increased (Binkley et al 2012). The use of internships at industry partners is one way to provide arenas for students to learn these skills during their education, but game-based learning is another method that is suitable for achieving these learning outcomes. Kivunja (2014) reviews the literature on effective teaching and the new learning paradigm that can provide students with the 21st century skills, and stresses the importance of educators providing students with effective training in the skills in order for them to be prepared to apply them when they start their professional careers. Moving from passive teacher-directed teaching to active student-centered learning is a central step towards promoting 21st Century skills.

Table 1: P21 Framework definitions of 21st Century Skills (P21 2019)

21st Century Skill	P21 Framework definition
Communication	Articulate thoughts and ideas effectively using oral, written, and nonverbal communication skills in a variety of forms and contexts; Listen effectively to decipher meaning, including knowledge, values, attitudes, and intentions; Use communication for a range of purposes (e.g. to inform, instruct, motivate, and persuade); Utilize multiple media and technologies, and know how to judge their effectiveness a priority as well as assess their impact; Communicate effectively in diverse environments (including multi-lingual).

Solve Problems	Solve different kinds of non-familiar problems in both conventional and innovative ways; Identify and ask significant questions that clarify various points of view and lead to better solutions.
Critical Thinking	Use various types of reasoning (inductive, deductive, etc.) as appropriate to the situation; Use systems thinking; Analyze how parts of a whole interact with each other to produce overall outcomes in complex systems; Make judgments and decisions; Effectively analyze and evaluate evidence, arguments, claims, and beliefs; Analyze and evaluate major alternative points of view; Synthesize and make connections between information and arguments; Interpret information and draw conclusions based on the best analysis; Reflect critically on learning experiences and processes.
Collaborate	Collaborate with others; Demonstrate ability to work effectively and respectfully with diverse teams; Exercise flexibility and willingness to be helpful in making necessary compromises to accomplish a common goal; Assume shared responsibility for collaborative work, and value the individual contributions made by each team member.

At the Norwegian College of Fishery Science (NCFS) at UiT The Arctic University of Norway, the bachelor and master programs in Fisheries and Aquaculture Science are being revised in order to better the students' acquisition of 21st century skills. Central in this is the big-tent concept of student-active learning. Michael (2004) provides a useful overview of different types of learning methods included in the big tent: Activity, collaboratively, cooperative and problem-based learning. BFA has a traditionally well-established use of research cruises and laboratory course, added have added new activities that includes student internships at relevant businesses and game-based learning. This paper presents the implementation of the game-based learning (GBL) at NCFS, which serve as a combination of the approaches from Michaels (2004), as well as preliminary results from the student evaluations of the GBL activities.

Through the use of GBL, students are provided with opportunities to both integrate the different components of the program, and apply them in a an authentic learning environment that promotes 21st century skills (Qian & Clark 2016). Moreover, game-based learning also provides opportunities for students to relate their theoretical skills and practical skillsets on complex and broad concepts, promoting deeper learning on issues such as sustainability (Blanchard & Buchs 2015). The GBL approach used at NFCS is mainly focused on hybrid board/roleplaying games with some computer support.

Sustainable resource use is highly topical, and this paper relates the current literature on game-based learning and 21st century skills to a practical example of a higher education program that is oriented towards a growing industry. The lessons are relevant for other fields, both in terms of transferability and comparison. This paper is based on preliminary results.

Models for Game-based Fisheries Science Education.

Before presenting the implementation of game-based learning on NCFS, I will present some models that explain the underlying concepts of the teaching scheme. The foundational idea behind the instruction in the interdisciplinary bachelor in fisheries and aquaculture science program is constructive alignment: The learner constructs understanding through what they do to learn, which can be promoted by aligning the learning activities, learning outcomes and assessment tasks. This means that the focus is on what and how the students are supposed to learn, instead of on the overall academic topic of the course (Biggs & Tang 2011). Constructive Alignment is illustrated in figure 1:
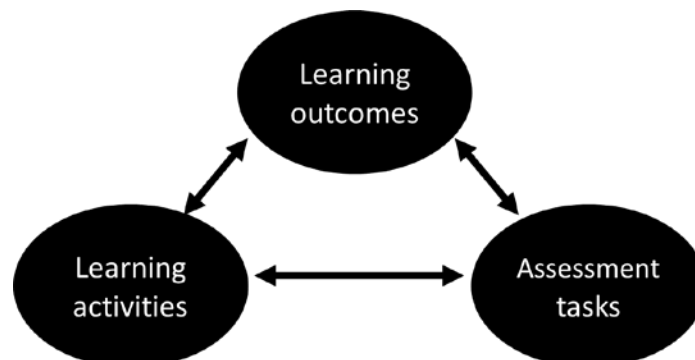

Figure 1: Constructive Alignment (Biggs&Tang 2011)

Fisheries and aquaculture science deals with complex, socio-ecological systems where different human and natural systems are interlinked (Fischer et al 2015). Environmental literacy is one of the interdisciplinary themes identified in the 21st Century Skills framework (P21 2019), and fisheries and aquaculture represents a good context for exploring this theme. In addition to understanding how different academic disciplines fit together, students of fisheries science must also link these skills to how complex issues affect each other across local, regional and global scales. Games offer opportunities for educators to operationalize and promote complex topics through simulation games. McCall (2016) puts forth the following definitions of games, simulations and simulation games:

- Games: "have players engaged in an artificial conflict governed by rules to achieve one or more predetermined goals with some form of quantifiable outcome, i.e. winners and losers, scores, etc."
- Simulations: "are dynamic—in the sense of their variables being manipulable—and simplified models of reality that have a degree of verisimilitude" and "pedagogically mediated (…) in that teachers intend them to be educational in some sense"
- Simulation Games: "occupy that middle ground as games—dynamic, rule-based and quantifiable conflicts—that provide playable models of a historical event, system, or process".

By these definitions, the games used at NCFS are closest to being simulation games. Peters & Westelaken (2014) provides a design model for translating a complex real-world situation to a simpler model in a simulation game, as shown in figure 2:
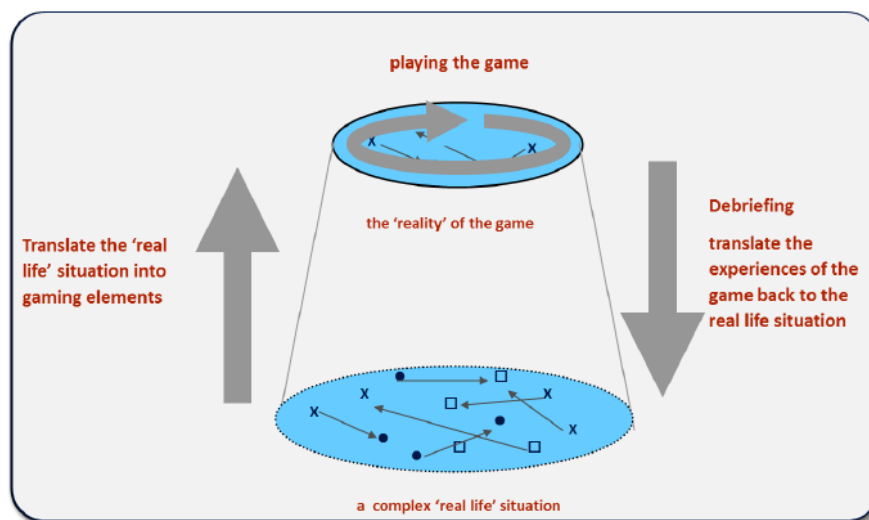
Figure 2: The Process of Designing and Applying Simulation Games for Complex Problems (from Peters & Westelaken 2014).

The elements that are necessary for illustrating the core situation are included, while the less important elements are abstracted or represented in other forms, creating a version of the reference system which is less complex. At NCFS this has in practice been done by the participation of subject matter experts in the design (or and adaption) of and running the games used, in order to align the content of the game with 'real life'. Through playing the game and structured debriefing, the players relate their experience of the simplified model to the real life situation.

Garris, Ahlers & Driskell (2002) offer a concise model of the input-process-outcome flow of an instructional game, which is useful for understanding the experience of participating in GBL, illustrated in figure 3:
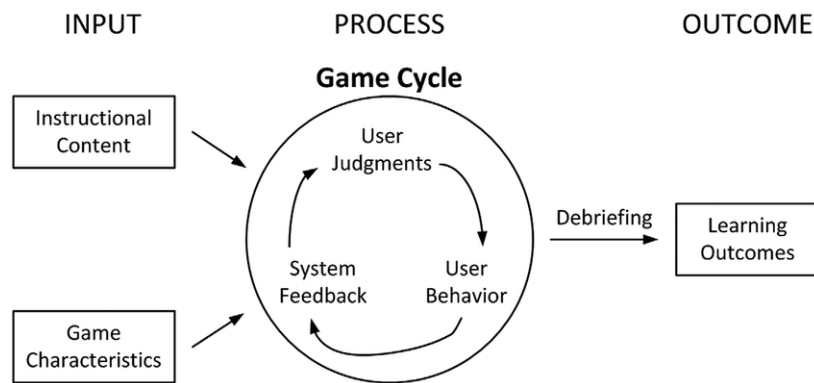
Figure 3: Input-Process-Outcome Game Model (from Garris et al 2002)

In a GBL activity, the instructional content is combined with the game elements and provides the learners with a cycle of gameplay, feedback and assessment. In the context of constructive alignment, this loop is an arena where the learners construct their understanding from performing the learning activities. By making decisions, evaluating the feedback from the actions taken, and making revised decisions, the learners get an experience, or simulated praxis, that can be related to the curriculum and overall topic. A key element for attaining the learning outcomes is structured debriefing, where the learners' experiences from the game cycle are reviewed and analyzed, and linked to the bigger picture. Where the simulation game simplifies reality in order to make it playable, debriefing allows the learner to decompress the simplified model and apply the experience to the real world (Garris et al 2002). The seminars and lectures that follow the GBL use the games as examples, and further relates to the concepts in the curriculum and practical application. An important element of this is to make sure that the learners get an opportunity to explore any potential issues connected to dealing with a complex situation translated into a simplified game. As with the design or adaptation of the games used at NCFS, an important element is that the educators involved in running the games are also the subject matter experts on the topics that are being explored through the GBL. The GBL is designed and carried out in order to provide a form of classroom praxis, from which the broader learning outcomes are engaged with as the course progresses.

Debriefing is not only important for the construction of understanding, but also for completing the experience for the participants. Nicholson (2012) points at the importance of also focusing on the particulars of the activity, and the learners' assessment of how the activity worked for them and how it contributes to their learning experience.

Game-based learning at the Norwegian College of Fishery Science

Games are one of the pieces in the student active learning environment at NCFS, in combination with internships, research cruises and laboratory courses. This means that games are not used in all the different classes. The GBL is intended to teach both core topics in the course curriculum, but also provide the learners with an arena to integrate their knowledge from the whole of the program, as well as practicing 21st century skills such as communication, problem-solving and critical thinking. GBL has been chosen as the method to achieve these goals since they provide both a form of simulated praxis that takes place in the classroom, and the common thread that helps learners "connect the dots" and understand interactions in complex systems. The combination of student-active approaches allows the learners to engage with and gain deeper knowledge on intricate topics through activities that are collaborative, cooperative and problem oriented and also gives effective training in 21st Century Skills (Blanchard & Buchs 2015, Michael 2004, Kivunja 2014). In the context of the BFA, GBL offers an approach that provides alignment between the activities and learning outcomes that goes beyond the traditional instruction methods of lectures and seminars.

This paper will cover the use of three games: The commercially available *Fish Banks Ltd.* (Meadows, Fiddaman & Shannon 1993), and two games developed at NCFS: *the Green Grouper Social Simulation Game* (Weines et al 2017), and *Go n' Fish – Fishing for Knowledge*. In addition, various forms of case-based roleplaying games are used in different courses, for instance in order to teach about the process of establishing marine protected areas. A game about differences in fisheries structure and quota systems, and one about sustainable value chains in seafood production are also in development.

Go n' Fish – Fishing for Knowledge is a knowledge game where the students prepare questions from the curriculum throughout the semester, and use the game in preparation for exams. This game has been used in a variety of courses, including scientific methods, seafood production, marine resource management and fish biology. The main concept of the game is that in addition to preparing the questions for the game, there is no answer sheet for the questions and the players have access to their textbooks and other study material when they play and also acts as jury. This facilitates a talk-and-play cycle that engages the learners, and goes beyond being a form of quiz or test in a different format. This model counters some of the criticism of trivia games in Game-Based Learning, as described by Nicholson (2011). In addition to being used in the teaching, the game has also been used as part of the oral exam in a marine resource management course. *Go n' Fish – Fishing for Knowledge* has also been implemented as part of the teacher's education program at UiT The Arctic University of Norway, and an article based on experiences from using it in the different programs is currently in progress (Strandbu, Weines and Esaiassen, forthcoming).

One of the main game-based learning activities is a combination of *Fish Banks Ltd*. and *the Green Grouper Social Simulation Game* (GGSSG). Students on the first semester of BFA play these games as part of an introductory course on marine industries, and they replay the games at a later stage in the program. The themes of these two games are connected. *Fish Banks Ltd.* (Meadows, Fiddaman & Shannon 1993) explores the tragedy of the commons (Hardin 1968). The learning outcomes for the game when used in BFA are shown in table 2:

Table 2: Learning outcomes for Fish Banks Ltd. in BFA.

Attain insight in central challenges in marine resource management, and the most important international developments in the field;
Be able to reflect over choice of management methods;
Be able to work with practical challenges in marine resource management;
Account, orally and in writing, for ecological, economic and social consequences of management measures;
Evaluate when and how management measures should be implemented.

Teams of players control fishing companies that invest in fishing vessels to exploit two fish stocks, one coastal and one deep sea. The goal is to gain the most profit, but as the fishing pressure increases the stocks will decline and be unable to recover. Through playing this game, the students experience how the lack of effective management makes it hard to exploit a renewable resource in a sustainable way when the main driver is profit. As part of the debriefing and in the lectures and seminars following the game, the students learn about the post-Hardin work on the tragedy of the commons (Ostrom 1990). When the students replay the game later in the program, they play a modified version where the game is run in a way where the students to a larger degree can find and agree on a solution to avoid a crisis in the fishery, and there are more arenas for negotiations between the teams. This version involves that the game-master to a larger extent is willing to provide some incentives for keeping fishing vessels in the harbor, without removing the tension of whether or not some of the companies will break the agreement in order to gain additional profit.

GGSSG (described in Weines et al 2017) is developed at the NCFS. In the game, the players take the role of independent fishery management professionals who are competing in an open call for a management plan that can end an ongoing fisheries crisis in a fictional country. The learning outcomes are outlined in table 3 below:

Table 3: Learning outcomes of GGSSG.

Experiment with the interdisciplinary complexities in making and implementing management plans, and explain the basics about marine resource management;
Appreciate the interdependence between the management actions and the three sustainability pillars (Economic, Environmental and Social sustainability);
Experiment and explain that no perfect management plan exists, but many possibly viable solutions do.

The game is a hybrid board/roleplaying game with some computer support. The game allows the players to explore the framework of social processes that constrain and influence how fisheries management plans are made, and how the different elements of sustainability (i.e. the economic, environmental and social dimensions) relate to resource management. It is played in groups, with the players spending limited resources to get access to new management tools (such as quota systems or government initiatives) and information about their effects,

and how they are received by the different stakeholders in the country where the game takes place. The game's scenario takes place in a fictional country, and an important tool for the players is the scenario description that gives them information about the world they are making decisions in. Over the course of the game, the players will combine up to nine management tools in their plan. As the game progresses, the complexity of the plan increases as more management tools and evaluation criteria are added. Finally, the groups present their management plans, arguing for why their suggested approach is the best solution. In the end, the game-master, in the role of the Minister of Fisheries, will decide if any of the plans will win the competition. In the debriefing and teaching that follows the game, the students learn more about the current scholarship and status of national and international management systems and implements.

When played sequentially, *Fish Banks Ltd.* and *the Green Grouper Social Simulation Game* build on each other and provide the students with a common context and experience for debriefing and reflection on the overall course curriculum. The players are exposed to a learning environment where they have classroom praxis of both an unmanaged profit-driven fishery without the possibility of sanctions, as well as the problems of designing a governance system that has both an effective combination of management instruments and is acceptable to sectorial stakeholders and the authorities themselves. With the repeated plays, both in the beginning of the program and later when the learners have acquired more knowledge on various dimensions of fisheries management allows them to apply their competence at different stages in their expertise. Through preparing questions for and playing *Go n' Fish*, the learners engage with the curriculum in a process of peer learning, and the questions are also a part of the final oral exam. The instruction loop is illustrated in figure 4 below.
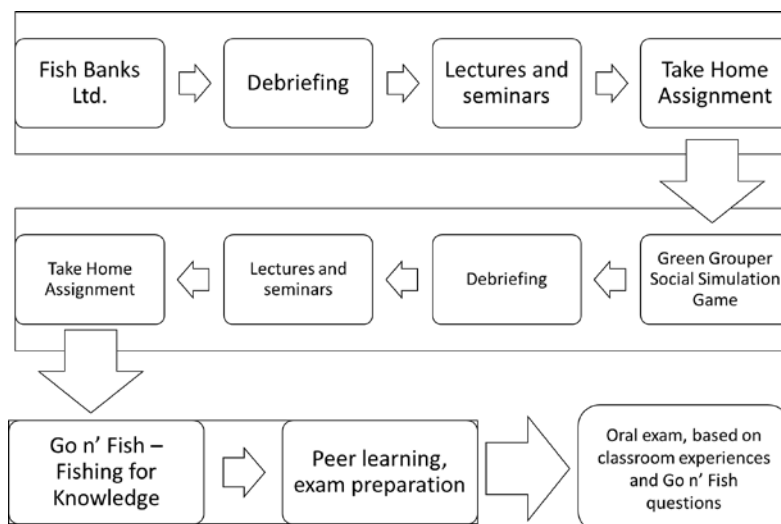
Figure 4: The instruction loop of Fish Banks Ltd., Green Grouper and Go n' Fish

Where the core of the learning outcomes from the games focus on topics related to fisheries, an important element is also the ability to practice 21st century skills. The applied learning, in groups, allows for the students to also practice a variety of skills, including communication, problem-solving, and critical thinking. Disciplinary knowledge and 21st century skills are not fenced off in different pastures, and practicing them in a context that makes sense for both is most effective (Rotherham & Willingham 2009). An overview of opportunities for skill trained in *Fish Banks Ltd.* and GGSSG is provided in table 4:

Table 4: Situations for practicing 21st Century Skills in Fish Banks Ltd. and GGSSG

Skills	Fish Banks Ltd.	GGSSG
Communication	Discussions within teams. Negotiations between teams.	Discussions within team. Presentation of the final management plan.
Collaboration, decision making	Deciding on strategy, whether or not to uphold non-binding agreements.	Prioritizing resource use, deciding on strategy.
Critical-thinking, problem solving	Evaluating the declining fish stock, allocating fishing vessels, deciding on when to stop expanding the fleet.	Evaluating combinations of management implements, figuring out why stakeholders does not react as expected, applying the information in the scenario to the game situation.

All of these skills are useful in workplace contexts, and are also important for the learning process. By providing the students with an active learning environment, the aim is that the games also contribute to metacognition, and facilitating that the students construct a bigger whole, learning to relate their academic learning to real-world situations.

Results from debriefing forms and end-of-program surveys

The main data for evaluating the use of game-based learning in BFA is collected through an end-of-program survey. This survey evaluates the entire program, and the analysis of it will be published in an upcoming article (Weines, Lien and Finstad forthcoming), which will also thoroughly explore the effect of other changes made to the program. Surveys have been collected from one cohort from before the introduction of games, and two cohorts that attended the program during the process of implementation. Shellman & Turan (2006) shows that their use of simulation games strengthened substantive knowledge as well as critical and analytical thinking skills. While their survey was done in the context of a simulation game, it offers a good review of analyzing students' own reporting of their experience with game-based learning.

This section is preliminary as the first cohort that started post-implementation have not yet finished the program and answered the survey. As the implementation is one part of several changes that were made to the program at the same time, and therefore the survey deals with several topics. For this conference paper we have extracted the questions that dealt with game-based learning and 21st century skills. The 2017 survey was collected from cohorts that started in 2013 and 2014 (N=22, 44,8% return), and the 2018 survey from students that started in 2015 (N=19, 31,6% return). For the 2017 survey 50,1% of the respondents were male, while the 2018 survey had 26,3% male respondents. As the surveys is sent out at the time the students have completed the BFA program and are graduating, we consider their responses to be reliable. As the recipients to a large extent have not been exposed to games during their time in the program, much of the data collected so far serves mainly for comparison to the surveys collected from the current and future cohorts. The first survey from a cohort where all the students participated in game-based learning will be collected in 2019, and a deeper analysis and model testing of the survey data will be performed when these results have been collected. The presentation of this paper at the ECGBL conference will include this analysis.

Short open-format surveys have been collected as part of the post-game debriefing. The responses from these forms, as well as the open responses will also be analyzed and included in the updated version of this conference paper. There are also open responses from the program surveys that have not yet been analyzed and integrated in this paper.

Table 5: Students' views on the BFA program as a whole.

Students' views on the BFA-program as a whole:	Disagree		Partly Disagree		Neither agree or disagree		Partly Agree		Agree	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
The program has given me an integrated understanding of the connection between natural science, technology and social science	0%	5,3%	4,5%	10,5%	9,1%	21,1%	45,5%	31,6%	40,9%	31,6%
It was easy to see how the different courses were connected and built on each other.	4,5%	10,5%	13,6%	26,3%	13,6%	31,6%	45,5%	31,6%	22,7%	0%
Through the program I have attained relevant practical skills	4,5%	15,8%	27,3%	10,5%	27,3%	15,8%	36,4%	42,1%	4,5%	21,1%

Table 6 Students reporting on integrated understanding and insight.

Rate the extent of you acquisition of the following knowledge, skills and competence	Very little		Little		Satisfactory		Good		Very Good	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Broad knowledge about the exploitation of marine resources on the basis of biology, technology, economy and social science	0%	0%	0%	15,8%	27,3%	31,6%	59,1%	47,4%	13,6%	10,5%
Understanding of interaction in the value chain in the seafood industry	0%	0%	0%	5,3%	13,6%	21,1%	72,7%	52,6%	13,6%	21,1%
Insight in national and international issues related to sustainable seafood industry	4,5%	10,5%	4,5%	21,1%	9,1%	36,8%	63,6%	31,6%	18,2%	10,5%

Table 7: Students' evaluation of learning activities based on learning outcomes.

Students' own evaluation of learning activities based on learning outcomes	Very little		Little		Satisfactory		Good		Very Good		N/A	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Games (board games, computer games, roleplaying games, simulations)	9,1%	10,5%	9,1%	15,8%	4,5%	21,1%	13,6%	26,3%	9,1%	5,3%	54,5%	21,1%
Quiz, Kahoot and similar	4,5%	10,5%	13,6%	15,8%	13,6%	36,8%	18,2%	31,6%	22,7%	5,3%	27,3%	5,3%
To what extent has FishBanks contributed to your learning?	9,1%	5,3%	0%	15,8%	4,5%	21,1%	0%	15,8%	0%	0%	77,3%	36,8%
To what extent has GGSSG contributed to your learning?	9,1%	5,3%	0%	10,5%	0%	10,5%	0%	21,1%	0%	10,5%	86,4%	36,8%
To what extent has Go N' Fish contributed to your learning?	9,1%	5,3%	0%	10,5%	0%	26,3%	0%	5,3%	4,5%	5,3%	81,8%	36,8%

Table 8: Students' evaluation of game-based learning, debriefing and industry relevance.

Students' evaluation of the following statements:	Disagree		Partly Disagree		Neither agree or disagree		Partly Agree		Agree	
	2017	2018	2017	2018	2017	2018	2017	2018	2017	2018
Games have been a positive learning experience	9,1%	5,3%	0%	5,3%	36,4%	36,8%	18,2%	31,6%	4,5%	15,8%
Debriefing after the games was important for the learning outcome	4,5%	5,3%	0%	10,5%	50%	21,1%	13,6%	36,8%	0%	15,8%
Game-based learning gives a bad understanding of real issues in the seafood industry	9,1%	10,5%	13,6%	31,6%	45,5%	47,4%	0%	5,3%	0%	0%

As stated above, the current state of our data collection does not include many cohorts that have experienced the fully implemented game-based learning activities in the program. The response rate of the 2018 survey was also low (31,6%). We are therefore hesitant to make bold claims based on this data, and will revisit it when the 2019 survey has been gathered.

As shown in table 5, the students report a lesser degree of getting integrated interdisciplinary understanding, and experience of a common thread through the program. However, there is an increase in their reported acquisition of practical skills. Table 6 shows that the students report a general decrease in how they rate their acquisition of different skills, knowledge and competencies. The reasons for this will be further explored in Weines, Lien & Finstad (forthcoming).

From table 6 we see that most of the respondents in the data set have not had experience with games. The 2017 survey reports N/A from 54,5% of the respondents on the use of game-based learning (excluding quizzes such as Kahoot), with the corresponding 21,1% in the 2018 survey. The proportion that reports that they see little contribution to their learning outcomes from the games is low, and sees a small increase. The groups that reports that the contribution to learning outcomes has been satisfactory or better is also increasing.

Regarding table 5 and 6, the second survey also represents students having experiences GBL provided by instructors who have had more experience running the games. The effect of more experienced instructors can be a factor that contributes to the students' experiences, but at the same time, there have been games run by new instructors throughout the programs, particularly for GGSSGG.

Table 8 shows that as the student in BFA have been exposed to games as part of their learning activities, they have become less indifferent and more positive to them. While a small proportion report that they do not like the experience, 52,6% report that debriefing has been important for their learning outcomes. The share of students that are not skeptical to the relevance of games-based learning as a method for relating to current issues in the real-world seafood industry is also decreasing.

The main data we have available for analyzing the games are the student evaluation forms from post-game debriefing and course evaluation. In the 2019 course-evaluation from the cohort that completed the course using the instruction loop described in figure 4 we got anonymous responses from 14 of the 16 students. The students generally report that they are positive to the use of GBL, and that the games have contributed to their understanding of the concept of the tragedy of the commons and the process of fisheries management. In general, the students also report that the games provide practical examples that are useful for understanding the curriculum, as well as fostering discussions between the students. Several responses point out that GGSSG is well suited to illustrate the trouble with pleasing many different stakeholders. Only one response states they did not find the games to be relevant for learning or understanding the games. Further analysis of the qualitative data and depth interviews with students will be performed in the fall of 2019, and the results will be included in the updated paper.

Concluding remarks

This conference paper outlines the models and design for game-based learning in the bachelor of fisheries and aquaculture science at the Norwegian College of Fishery Science at UiT The Arctic University of Norway. Though the use of student active learning that applies constructive alignment, the aim is to provide graduates with the interdisciplinary skills, competences and knowledge that is in demand in the seafood industry, while also facilitating the development of important skills such as critical thinking, problem solving, communication and decision making.

While the data collection for evaluating these efforts are in the initial stage, the baseline for analyzing the outcome is in place. There is still unanalyzed qualitative data from the debriefing sessions of the games to include, which are directly relevant for the evaluation of the use of the games. First survey from student cohorts that have played the games at different stages in the program will be collected in spring 2019. These respondents will have completed the loop design described on page 5. The paper presentation at the conference will present a stronger analysis of the game-based learning efforts in the BFA program.

Literature

Biggs, J., & Tang, C. (2011). *Teaching for Quality Learning at University*. Maidenhead, UK: Open University Press.

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M. (2012). Defining Twenty-First Century Skills. *Assessment and Teaching of 21st Century Skills*. https://doi.org/10.1007/978-94-007-2324-5

Blanchard, O., & Buchs, A. (2015). Clarifying Sustainable Development Concepts Through Role-Play. *Simulation & Gaming* , 46(6), 697–712. https://doi.org/10.1177/1046878114564508

Charles, A. T. (2007). Fishery science: the study of fishery systems. *Aquatic Living Resources*, 8(3), 233–239. https://doi.org/10.1051/alr:1995023

FAO. (1995). *Code of Conduct for Responsible Fisheries_ 1995*. Food and Agriculture Organization of the United Nations.

Fischer, J., Gardner, T. A., Bennett, E. M., Balvanera, P., Biggs, R., Carpenter, S., … Tenhunen, J. (2015). Advancing sustainability through mainstreaming a social-ecological systems perspective. *Current Opinion in Environmental Sustainability*, 14, 144–149. https://doi.org/10.1016/j.cosust.2015.06.002

Garris, R., Ahlers, R., & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation and Gaming*, 33(4), 441–467. https://doi.org/10.1177/1046878102238607

Hardin, G. (2018). The tragedy of the commons. In Environmental Ethics for Engineers. https://doi.org/10.1201/9781351071765

Meadows, D.L., Fiddaman, T. and Shannon, D., (1993): *'Fish Banks, Ltd. A Micro-computer Assisted Group Simulation That Teaches Principles of Sustainable Management of Renewable Natural Resources'*, 3rd ed, Laboratory for Interactive Learning, University of New Hampshire, Durham.

Kivunja, C. (2014). Innovative Pedagogies in Higher Education to Become Effective Teachers of 21st Century Skills: Unpacking the Learning and Innovations Skills Domain of the New Learning Paradigm. International Journal of Higher Education, 3(4), 37–48. https://doi.org/10.5430/ijhe.v3n4p37

McCall, J. (2016). Teaching History With Digital Historical Games: An Introduction to the Field and Best Practices. Simulation and Gaming, 47(4), 517–542. https://doi.org/10.1177/1046878116646693

Prince, M. (2004). Does active learning work? A review of the research. Journal of Engineering Education, 93(July), 223–231. https://doi.org/10.1038/nature02568

Nicholson, S. (2011). Making the Gameplay Matter: Designing Modern Educational Tabletop Games. *Knowledge Quest* 40(1). 60-65.

Nicholson, S. (2012). Completing the Experience: Debriefing in Experiential Educational Games. *The 3rd International Conference on Society and Information Technologies*, 11(6), 117–121. Retrieved from http://scottnicholson.com/pubs/completingexperience.pdf

Ostrom, E. (1990). *Governing the Commons: The Evolution of Institutions for Collective Action*. New York: Cambridge University Press.

P21. (2019). Partnership for 21st Century Learning: Framework for 21st Century Learning Definitions. Retrieved from: http://www.battelleforkids.org/networks/p21/frameworks-resources

Peters, V. A. M., & Westelaken, M. van. (2014*). Simulation Games - A Concise Introduction to the Design process*, (August). https://doi.org/10.13140/2.1.4259.1367

Qian, M., & Clark, K. R. (2016). Game-based Learning and 21st century skills: A review of recent research. *Computers in Human Behavior*, 63, 50–58. https://doi.org/10.1016/j.chb.2016.05.023

Rotherham, A.J. and D. Willingham. (200). 21st century skills: The challenges ahead. *Educational Leadership*. 67(1).

Seafood Norway (2019). Inphographics Norwegian Seafood Export 2018. Retrieved from: https://en.seafood.no/news-and-media/news-archive/norwegian-seafood-exports-total-nok-99-billion-in-2018/

Shellman, S. M., & Turan, K. (2006). Do Simulations Enhance Student Learning? An Empirical Evaluation of an IR Simulation. *Journal of Political Science Education*, 2(1), 19–32. https://doi.org/10.1080/15512160500484168

Strandbu, A., Weines, J. & Esaiassen, M. (forthcoming). *Experiences on using Go n' Fish – Fishing for Knowledge in different programs*.

Tress, B., Tress, G., & Fry, G. (2006). Defining concepts and process of knowledge production in integrative research. *From Landscape Research to Landscape Planning*, (13), 13–26. https://doi.org/10.1007/978-1-4020-5363-4_2

Weines, J., Borit, M., Holm, P., & Hrynkiewicz, R. (2017). *Theoretical challenges in designing a social simulation game of balancing sustainability objectives in fisheries management*. https://doi.org/10.5281/ZENODO.1261071

Weines, J., Lien, I. H., Finstad, B. P. (forthcoming). *Evaluating the implementation of Game-Based Learning at the Norwegian College of Fishery Science*.

Paper 3

Spilt kunnskap på lektorutdanninga

Førsteårsstudentenes erfaringer med «Kunnskapsspillet»

Astrid Strandbu[1], Jørn Weines[2], Margrethe Esaiassen[2]

1: *Institutt for lærerutdanning og pedagogikk, UiT Norges arktiske universitet*, 9037 Tromsø

2: *Norges fiskerihøgskole, UiT Norges arktiske universitet*, 9037 Tromsø

SAMMENDRAG: Forskning viser at læringsmetoder som engasjerer studentene kan bidra til økt læringslyst og læringsutbytte. Et eksempel er bruk av spill som pedagogisk virkemiddel. Ved lektorutdanninga 8-13 ved UiT har Kunnskapsspillet stått sentralt i kvalitetsutviklingen av et førstesemesteremne i pedagogikk hvor formålet var å styrke profesjonsrelevans og økte studentenes trivsel og trygghet. I artikkelen undersøkes hvordan spillbasert læring bidrar til læringsutbytte, og hvilke kvaliteter studentene erfarer gjennom bruken av spillet. Artikkelen er teoretisk forankret i sosiokulturell læringsteori. Datamaterialet er evalueringer fra 274 studenter fra tre kull. Resultatene viser at studentene er positive til anvendelsen av spillet og erfarer at spillet bidrar til læringslyst, læringsutbytte og opplevelse av meningsfull sammenheng. I artikkelen diskuteres kvaliteter ved bruk av spillet og profesjonsrelevans. I videre styrking av læringslyst og læringsutbytte er det viktig å fokusere på frekvens ved anvendelse av spillet og underviserens rolle i læringsprosesser med spillbasert læring.[1]

Nøkkelord: Constructive alignment, læringslyst, læringsutbytte, meningsfull sammenheng, spillbasert læring

---

1   INTRODUKSJON

Ulike former for aktiv læring, som stimulerer studentenes engasjement, motivasjon og læringslyst, kan bidra positivt til læringsutbytte (Biggs & Tang, 2011; Prince, 2004; Jakobsen & Waldenstrøm, 2017). Et eksempel er bruk av spill i undervisningen. Spill og spilling er kjent for de fleste. Dette åpner for spill som et pedagogisk virkemiddel. Spill som læremiddel benevnes på ulike måter, blant annet som *spillbasert læring*. I spillbasert læring brukes spill som *en del av* læringssituasjonen for å strukturere arbeidet og forbedre og styrke studentenes læringsutbytte (Wiggins, 2016). Spill vil ikke erstatte annen undervisning, men spillelementer kan kombineres med fagstoff i en læringsprosess hvor både forarbeid og etterarbeid er sentralt (Garris et al., 2002). Gjennom forarbeid og etterarbeid settes spillet inn i den overordnede faglige konteksten for å bidra til refleksjon og læring (Nicholson, 2012; Garris et al., 2002; Crookall, 2010).

Mye av fokuset i forskningen på spillbasert læring har det siste tiåret vært rettet mot digitale spill. Det publiseres nå også mye om bruk av brettspill i undervisning (Boghian et al., 2019; Hoy, 2018). Bridge (2014) argumenterer for flere fordeler ved å lage læringsspill med utgangspunkt i velkjente brettspill. Spill som på overflaten ligner spill studentene kjenner fra før, gjør at det tar mindre tid å forklare regler og det kan produseres mange eksemplarer uten store økonomiske kostnader. I sum gir dette lave oppstartskostnader for både lærere og studenter. Læringsprosessen kan starte fra første terningkast. Ettersom mange grupper kan spille samtidig, uten at underviseren må involveres, er det også lett å anvende slike spill i store studentgrupper.

Denne artikkelen retter fokus mot bruk av brettspill som pedagogisk verktøy i læringsprosessen i et ti-studiepoengsemne i pedagogikk første semester ved lektorutdanninga 8-13, UiT Norges arktiske universitet (heretter lektorutdanninga).[2] En utfordring i studiedesignet ved lektorutdanninga er at studentene på et og samme kull er spredt over fire fakulteter og ni institutter, avhengig av om de har valgt fordypning i språkfag, samfunnsfag eller realfag. Det har vært stort frafall ved utdanninga, slik bildet også er ved mange andre lærerutdanninger (Skrøvset et al., 2017). På studiebarometeret har lektorutdanninga skåret lavt på områdene læringsmiljø og medvirkning, og i evalueringer har studentene uttrykket savn av kullfølelse og fellesskap med sine medstudenter. Lektorutdanninga ved UiT har hatt stor vekst de siste årene. Antall studenter ble nær doblet fra 2016 til 2017, fra 66 til 123 studenter. Med så stor økning kunne det forventes at eksisterende utfordringer ville bli enda mer fremtredende.

Pedagogikkemnet første semester i lektorutdanninga er det eneste emnet de to første studieårene hvor alle studentene på kullet har undervisning sammen. Siden høsten 2017 har det derfor vært satt spesielt fokus på dette emnet. Det er gjort omfattende endringer når det gjelder undervisningsmetoder med innføring av studentaktive læringsformer. Ulike trivselsfremmende tiltak er iverksatt, og fokus i undervisningen er rettet mot styrking av studentenes læringsstrategier og opplevelse av helhet, sammenheng og profesjonsrelevans. I denne artikkelen fokuserer vi på endringer i

---

[2] Emnekoden er PFF-1020, og tittelen på emnet er «Eleven, læring og danning i sentrum».

undervisningsmetoder med innføring av spillbasert læring. To spill er utviklet og tatt i bruk, Etikkspillet og Kunnskapsspillet. Vi avgrenser oss til å fokusere mot bruk av Kunnskapsspillet.

Et formål med artikkelen er å teoretisere spillbasert læring med Kunnskapsspillet som eksempel. Teoretisk plasserer vi oss innen et sosiokulturelt syn på læring (Vygotskij 1978, 2001). Et annet formål er å kaste lys over lektorstudentenes erfaringer med bruken av Kunnskapsspillet. Følgende forskningsspørsmål er stilt:

- Hvordan bidrar bruken av spillbasert læring til å oppnå læringsmålene i pedagogikkemnet første semester på lektorutdanninga?
- Hvilke kvaliteter erfarer studentene gjennom bruk av Kunnskapsspillet i dette emnet?

Det empiriske materialet består i hovedsak av individuelle studentevalueringer fra 274 studenter i kull 2017, 2018 og 2019. Datamaterialet består også av skriftlige referater fra gruppeevalueringer med studentene i de samme kullene og møtereferater fra evalueringsmøter med eksterne sensorer. Skrøvset et al. (2017) peker på lav arbeidsinnsats som en utfordring ved lærerutdanninger og relaterer dette til studentenes *læringslyst*. Kirk-Johnson et al. (2019) knytter lav arbeidsinnsats til utfordringer med å velge effektive *læringsstrategier*. Spill kan tenkes å være et verktøy som hjelper studentene å strukturere arbeidet med pensum. For å undersøke dette nærmere har vi spurt studentene om egen tilfredshet med å spille Kunnskapsspillet, nytte ved bruk av spillet frem mot eksamen og spillets relevans for egen undervisning som fremtidig lektor. Studentene er i tillegg stilt spørsmål om egeninnsats og trivsel og trygghet ved utdanninga. Sæthre (2014) løfter frem studentens egne drivkrefter og motivasjon, særlig første studieår, som avgjørende for å mestre studiet. For de fleste henger egeninnsats tett sammen med forhold som trivsel, trygghet og læringsmiljø. Spillbasert læring synes å ha et potensiale for å bidra til trivsel og trygghet, ved at studentene kan bli kjent under en lekende samarbeidsform (Plass et al., 2015). Dette diskuteres nærmere i artikkelen.

2   BAKGRUNN OG BESKRIVELSE AV KUNNSKAPSSPILLET

Spillrammen i Kunnskapsspillet, med regler og spillmateriell, er utviklet ved Norges fiskerihøgskole ved UiT som spillet «Go'n'fish – fishing for knowledge» i forbindelse med SimFish-prosjektet.[3] Go´n´fish ble i 2017 tilpasset lektorutdanninga som Kunnskapsspillet. I fortsettelsen beskrives først spillmateriellet og spillereglene i Go´n´fish. Deretter beskrives hvordan dette undervisningsverktøyet er tilpasset læringsmålene i førstesemesteremnet i pedagogikk ved lektorutdanninga.[4]

[3] SimFish er et prosjekt med støtte fra UiTs «Fyrtårnmidler» for nyskapende prosjekter for utvikling av utdanning. Nettside: https://uit.no/prosjekter/prosjektsub?p_document_id=448448&sub_id=573807

[4] Tredjeforfatter var sentral i utviklingen av spillet «Go´n´fish» ved Fiskerihøgskolen. Førsteforfatter har anvendt spillmateriellet i Go´n´fish i utviklingen av Kunnskapsspillet ved lektorutdanninga.

2.1 Et fleksibelt mulitverktøy for læring

Med sitt spillmateriell ligner Go'n'fish spørrespill som mange kjenner til fra før, som for eksempel Trivial Pursuit og Bezzerwisser. Spillmaterialet består av et spillebrett med felt med fire farger (gul, rød, blå og grønn) som lagene flytter rundt på, spørrekort i fire kategorier, en terning og brikker. Hver av de fire kategoriene relaterer seg til læringsmål med tilhørende pensum i emnet spillet anvendes i. Det er også en femte spillkortfarge (svart). Dette er en uhøytidelig kategori som forsterker lekelementet i spillet. Under spillet kaster studentene terning og flytter lagets spillebrikke i valgfri retning det antall øyne som terningen viser. Laget trekker så et spillkort tilsvarende fargen på spillbrettet som spillebrikken landet på og svarer på spørsmålet. For å kunne gå videre må laget gi et tilfredsstillende svar på spørsmålet. Spillebrettet er utformet slik at én rute av hver farge står i et «veikryss» og har et markert symbol (Se Figur 1). Lagene må svare riktig på spørsmålene i «veikryssene» i alle spillets kategorier for å kunne bevege seg inn mot spillebrettets sentrum. Det laget som er først ved sentrum vinner spillet.
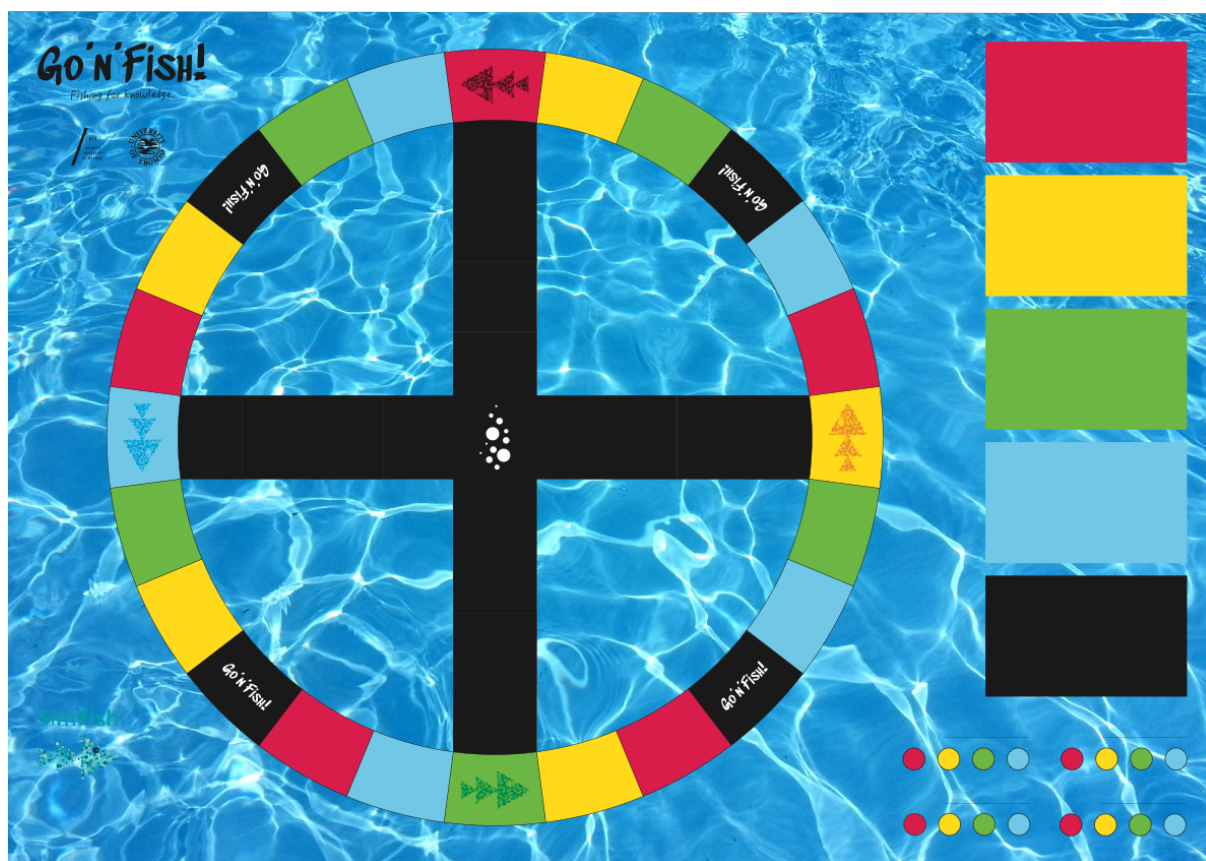
Figur 1: Go´n´Fish[5]

En vesentlig forskjell mellom Go'n'fish og spill som Trivial Pursuit og Bezzerwisser er at Go´n´fish ikke har faste spørsmål, men spørsmål som tilpasses emnet spillet anvendes i. Spillet kan således

---

[5]   Design by: Melania Borit, Margrethe Esaiassen, Petter Holm. Graphic design by: Ørjan Garfjell. Copyright @ 2017 SimFish. All rights reserved. simfish@uit.no

20

betraktes som et fleksibelt multiverktøy for læring. Som spillbasert læring, består Go´n´fish av tre faser som beskrives nærmere i fortsettelsen.

2.2 Første fase – studentene lager spørsmål

Den første fasen i den spillbaserte læringen er at studentene lager spørsmålene til spillet. Lagringskapasiteten i vårt korttidsminne er svært begrenset (Miller, 1956). Dersom fagstoffet og informasjonen som formidles ved forelesninger skal føre til varige læringsresultater, må informasjonen bearbeides. Eksempler på bearbeiding er «summegrupper» og «spørretid» (Pettersen, 2005). Å lage spørsmål til et spill er et tredje eksempel. Når studentene går sammen i mindre grupper, drøfter hva som var sentralt i dagens undervisningsøkt og lager spørsmål til spillet, aktiveres tankearbeidet rundt fagstoffet. Informasjon bearbeides til abstrakte skjemaer, visuelle forestillinger eller språklige uttrykk som lagres permanent i langtidsminnet (Bjørndal, 2015). Spørsmålene studentene har laget samles inn, og emneleder velger ut spørsmål som omsettes til spillkort. Emneleder kan føye til egne spørsmål, for å sikre at sentrale deler av pensum dekkes. Hvert tema/kategori får sin farge på spillkortene. Spillkortene lages fortløpende i semesteret parallelt med at det er undervisning i temaene for hver av de fire forhåndsbestemte kategoriene i spillet. Studentene lager spillkortene også i den sorte kategorien. Denne kategorien er ikke relatert til det faglige innholdet i emnet, men bidrar til en sosialiserende dimensjon i gjennomføringen av spillingene. I denne kategorien får studentene oppgaver som relaterer til fremføringen av neste spillekort, eller lekende aktiviteter. Dette gir studentene muligheten til å praktisere forskjellige verbale aktiviteter og rutiner som inngår i sosiale sammenhenger, «Playful talking» (Lytra, 2015). Med dette begrepet favner Lytra om de mange nyansene som inngår i sosial samhandling: erting, spøk, humor, ordspill, parodiering, og musikalitet i kommunikasjon.

2.3 Andre fase – spillseansen

Den neste fasen er selve spillseansen. Under spillet er studentene to og to på lag, og det er tre eller fire lag i hvert spill. Studentene spiller spillet slik det er beskrevet ovenfor. En innvending mot bruk av spørrespill i undervisning er at det er en vanlig quiz i annen drakt, og at studentene er passive når det ikke er deres tur (Nicholson, 2011). Denne kritikken unngår dette spillet da det ikke eksisterer noe fasit i spillet. Det er motspillerne som avgjør om svaret er tilfredsstillende. Dette krever kontinuerlig refleksjon, argumentasjon og diskusjon både innad i laget som skal svare på spørsmålet og mellom spillerne på de øvrige lagene som skal avgjøre om svaret er tilfredsstillende. På denne måten er spillerne involvert hele tiden; når de lager spørsmål til spillet og når de spiller spillet i en spille-og-snakke-syklus enten i rollen som spiller eller dommer. I spillet tar studentene i bruk en læringsstrategi som omtales som «retrieval practice», hvor de anstrenger seg for å hente frem kunnskap de har tilegnet seg tidligere i semesteret heller enn å lese pensum på nytt. Studier av retrieval practice fra de siste tiårene viser at denne læringsstrategien kan ha sterkere effekt på langtidslæring enn repetisjon av pensum (Agarwal et al., 2012; Karpicke & Grimaldi, 2012; Lun et al., 2018). Dette spillet er en læringsform som lar studentene praktisere denne studieteknikken, både når de svarer og når de er dommere overfor medstudentene.

2.4 Tredje fase – etterarbeid

Ved å observere studenter som spiller spillet, kan foreleser få innsyn i hvilke deler av pensum studentene erfarer som vanskelig. Dette kan gi retning til hva som bør prioriteres i repetering og videre bearbeiding av kunnskap. På samme måte kan også studentene bli klar over hva de ikke kan når de spiller spillet, noe som kan gi føringer for prioriteringer i studentenes videre arbeid med pensum (Richland et al., 2009). Strukturert etterarbeid gjennomføres på ulike måter i de emnene hvor Go´n´fish som fleksibelt multiverktøy for læring er tatt i bruk. Ved lektorutdanninga blir de 14 spørsmålene fra hver kategori lagt ut på den digitale læringsplattformen. På denne måten kan spillets innhold være en strukturerende ressurs i arbeid med pensum og læringsmålene i emnet frem mot eksamen. På lektorutdanninga har studentene også mulighet til å låne spillet, dersom de ønsker å organisere egne kollokvier. Spillet gir således studentene muligheten til å bruke retrieval practice som studieteknikk utover spilløktene som er organisert av emneleder.

2.5 Kunnskapsspillet og læringsmålene i pedagogikkemnet

På lektorutdanninga reflekterer de fire kategoriene i spillet sentrale tema i læringsutbyttebeskrivelsen i pedagogikkemnet første semester: *læring og læringsteorier* (kategori rød), *ungdom og identitet* (kategori gul), *danning* (kategori grønn) og *etiske teorier og profesjonsetikk* (kategori blå). Dette er tema som omtales i Nasjonale retningslinjer for lektorutdanning for trinn 8-13 (Nasjonalt råd for lærerutdanning, 2017).[6] Når det gjelder den siste kategorien står for eksempel følgende formulert: «Profesjonsfaget skal ivareta profesjonsetikk og bidra til å utdanne lektorer som har kunnskap om etikk og kan handle etisk forsvarlig.» (s. 12). Videre står det at utdanninga skal legge «...vekt på at studenten utvikler evne til etisk refleksjon, kreativitet, kritisk vurdering og problemløsning, kompetanser som skal bidra til å forberede dem for livslang læring.» (s. 4).

I hver kategori er det to typer spørsmål; teorispørsmål og refleksjonsspørsmål. Teorispørsmål krever at studentene definerer teoretiske begreper, mens refleksjonsspørsmål er spørsmål som skal stimulerer studentenes utvikling av evne til refleksjon, kritisk vurdering og problemløsning. Vi fortsetter med å bruke etikk-kategorien som eksempel. Et teorispørsmål i spillet er: «Redegjør for en etisk teori som har resultatet av en persons handling i fokus.» Eksempel på et refleksjonsspørsmål er: «Karl i 8. klasse synes synd på klassekompisen Arne som nesten aldri har med seg matpakke eller noe å drikke på skolen. Karl stjeler en yoghurt i kjøleskapet på skolen og gir denne til Arne. Hvordan synes du læreren skulle ha reagert dersom hun oppdaget dette? Ta i bruk ulike etiske teorier når du reflekterer over caset.» De to kategorier spørsmål i Kunnskapsspillet er ment å stimulere studentenes læringsutbytte både når det gjelder kunnskaper (teori) og ferdigheter (evne til refleksjoner).

---

[6] https://uit.no/utdanning/emner/emne/671159/pff-1020. De tre siste læringsutbyttene i emnet (å ta elevens perspektiv, klasseledelse og læringsmiljø og observasjon som metode) arbeider studentene med i en akademisk tekst som leveres inn etter praksis.

3 TEORETISK FORANKRING

I motsetning til Piaget, som i sin kognitive læringsteori var opptatt av læring på det mentale planet hos den enkelte, forfektet Vygotskij (1978, 2001) en forståelse av læring som grunnleggende sosialt. I følge Vygotskij konstrueres kunnskap i sosialt samspill *mellom* individer, hvor individet kan strekke seg og forstå mer i samspill med andre som er mer kyndig. Vygotskij relaterer læring til hvordan mennesker tilegner seg og bruker *materielle* og *kulturelle redskaper* i en bestemt kontekst, for eksempel pedagogikkundervisningen på lektorutdanninga. Disse redskapene er der fra før, før individets inntreden i verden (Säljö, 2013). Språk er et eksempel på et kulturelt redskap. Ulike artefakter fremstilt av mennesket til et spesielt formål, for eksempel en terning, et spillbrett og spørrekort i et brettspill, er eksempler på materielle verktøy. Som beskrevet innledningsvis, argumenterte Bridge (2014) for velkjente spill som har lave oppstartskostnader. Læringen i slike spill, som for eksempel Kunnskapsspillet, handler ikke om å lære og beherske de materielle redskapene i spillet, men om å lære gjennom språksetting av kunnskap i emnet hvor spillet tas i bruk.

Krysningspunktet mellom sosiokulturell læringsteori og spillbasert læring er godt etablert i litteraturen. Plass et al. (2015) går grundig gjennom litteraturen som er fundamentet for spillbasert læring fra et sosiokulturelt læringperspektiv. De er spesielt opptatte av hvordan spill kan tilrettelegge for *lekende læring*, hvor det ikke er spillet i seg selv som er det viktigste, men at deltakerne utvikler en mental modell for hvordan informasjon henger sammen. Et viktig poeng med spillet i spillbasert læring er ikke bare muligheten til å oppnå suksess, men også å feile uten at det har store konsekvenser. Perspektivet med lekende læring (Plass et al. 2015), underbygger læringslyst og et trygt læringsmiljø som sentralt ved bruken av Kunnskapsspillet i undervisningen ved lektorutdanninga. Uavhengig av læringsteori, anses gode relasjoner og et godt læringsmiljø som vesentlig for læring. Med henvisning til Vygotskij (1978, 2001), synliggjør imidlertid Dysthe (2013) en vesentlig distinksjon. Der sosial samhandling og relasjoner anses som *rammen rundt* læring i enkelte læringsteorier, er sosial samhandling *utgangspunktet for* læring i sosiokulturell læringsteori.

4 DATAMATERIALE OG METODE

Datamaterialet som ligger til grunn for denne studien er i all hovedsak individuelle skriftlige studentevalueringer gjennomført ved bruk av nettskjema i kull 2017, 2018 og 2019.[7] Datamaterialet består av kvantitative data innhentet gjennom spørsmål med lukkede svaralternativer og kvalitative tekstsvar innhentet gjennom åpne spørsmål i nettskjemaet. I tillegg inngår gruppeevalueringer fra studenter og data fra evalueringsmøter med eksterne sensorer.

For alle de tre kullene ble det stilt tre spørsmål som retter seg direkte mot studentenes erfaringer med Kunnskapsspillet. Det første spørsmålet omhandlet studentenes *tilfredshet* med å spille spillet: «Likte

---

[7] https://uit.no/om/orakelet/frag?p_document_id=516231

du å spille Kunnskapsspillet?» Det andre spørsmålet omhandlet studentens vurdering av *potensiell nytte frem mot eksamen*: «Tror du Kunnskapsspillet vil være til nytte i dine forberedelser til eksamen?» Svaralternativene på disse to spørsmålene var «Ja i stor grad», «Ja litt» og «Nei». Det tredje spørsmålet var et åpent spørsmål hvor studentene kunne utdype med kommentarer om Kunnskapsspillet. Til sammen var det 90 studenter som skrev kommentarer. For Kull 2019, ble det lagt til to nye åpne spørsmål knyttet til bruken av Kunnskapsspillet. Det første var en oppfordring om å *begrunne svaret knyttet til potensiell nytte frem mot eksamen*. Av de 75 studentene som svarte på dette spørsmålet var det 25 studenter som også begrunnet svaret. Det neste spørsmålet rettet seg mot studentenes *profesjonsutvikling*: "Tror du at du vil ta i bruk spill som Kunnskapsspillet i undervisningen når du blir lektor?" Spørsmålet ble stilt uten lukkede svaralternativer. Av de 67 studentene som svarte på spørsmålet, var det 12 studenter som også begrunnet sitt svar. Til sammen består det kvalitativt materiale av 234 tekstsvar med varierende lengde fra ett til 51 ord.

Andre spørsmål i evalueringen som har relevans i denne studien er spørsmål om *studentenes egeninnsats, samt trivsel og trygghet*. Følgende to spørsmål ble stilt om studentenes egeninnsats: «Hvor tilfreds er du med din egen innstas i emnet?» «Hvor tilfreds er du med din egen innsats når det gjelder arbeid med pensumlitteraturen i emnet?» Svaralternativene på disse to spørsmålene var «Svært tilfreds», «Tilfreds» og «Mindre tilfreds». Alle kullene ble stilt følgende to spørsmål om trivsel og trygghet: «Dersom du skulle ha behov for det, har du medstudenter på lektorutdanninga som du kan snakke fortrolig med?» «Dersom du skulle ha behov for det, opplever du at det er ansatte på lektorutdanninga som du kan snakke fortrolig med?» Svaralternativene på disse to spørsmålene var «Ja», «Nei» og «Usikker».

4.1 Utvalg

I de tre kullene var det til sammen 328 studenter som bestod eksamen i emnet. Av disse var det 278 som deltok i den individuelle evalueringen. Studien er godkjent av Norsk senter for forskningsdata. Studentene ble bedt om å krysse av på evalueringsskjemaet om de aksepterte at evalueringen ble brukt i forskning. Til sammen var det 274 studenter som også samtykket til deltakelse i forskning (Tabell 1).

Tabell 1. Oversikt studenter og antall deltakere i studien, kull 2017, 2018 og 2019[8]

	Semesterregistrert og møtt til undervisning	Oppmeldt til eksamen	Bestod eksamen	Fylte ut evalueringsskjema	N: Samtykket til deltakelse i forskning
Kull 2017	123	113	111	95	95
Kull 2018	135	124	124	107	105
Kull 2019	108	102	93	76	74
Sum	366	339	328	278	274

4.2 Analyseprosessen

Alle tre forfattere har deltatt i analyse av data. Det kvantitative materialet innsamlet gjennom spørsmål med lukkede svaralternativer, er analysert gjennom frekvensanalyser. Det kvalitative materialet er analysert både gjennom kategoriseringer og deretter kvantifisering av studentenes svar, og gjennom temasentrerte kvalitative analyser (Thagaard, 2013). For eksempel har vi i analyse av andre kommentarer om Kunnskapsspillet laget de tre kategoriene *positive ytringer*, *kritiske merknader* og *usikker,* og talt opp hvor mange ytringer det var i hver kategori (Tabell 4). I kvantifiseringen av studentenes vurdering av spillets relevans i egen undervisning som fremtidige lektorer har vi kategorisert studentenes svar i følgende tre kategorier: *ja*, *kanskje/sannsynlig* og *nei* (Tabell 5).

I de temasentrerte kvalitative analysene har vi sett nærmere på kvaliteter studentene erfarer gjennom bruk av kunnskapsspillet. Av de 234 tekstsvarene, er det 127 svar hvor ulike kvaliteter studentene erfarer lar seg analysere frem. De kvalitative analysene kan betegnes som en abduktiv analyseprosess, altså en veksling mellom fortolkning drevet av empirien og teoribasert begrepsfesting. Järvinen og Mik-Meyer (2017) beskriver dette som en form for *dialog* mellom teori og data.

5 MULIGE STYRKER OG SVAKHETER VED STUDIEN

Nytteverdien og bruk av studentevalueringer i kvalitetsforbedrende arbeid i høyere utdanning diskuteres (Esarey & Valdes, 2020; Wang, & Williamson, 2020). Dette er diskusjoner som er relevante også i vurdering av studentevalueringer som datamateriale i forskning. Blant annet problematiseres

---

[8] Kilde: Felles Studentsystem: Rapport 101.006 Søkerliste – ja/Svar/Møtt/Reservert og Rapport 580.001 Resultatfordeling vurderingsenhet

sammenhengen mellom gode studentevalueringer og studentenes læringsutbytte. Uttl et al. (2017) finner i sin metaanalyse ikke noen sammenheng mellom studenters tilfredshet med underviseren og undervisningen, og studentenes læring. Vi undersøker imidlertid ikke effekten underviseren eller undervisningen kan ha på studentenes læring. Det er studentenes tilfredshet med *spillet*, *opplevelse av nytte frem mot eksamen* og *opplevelse av profesjonsrelevans* som studeres. Forventninger om mestring er en innflytelsesrik faktor i studentenes læringsarbeid, noe Bandura (1997) begrepsfester som self-efficacy. Studentene har prestert godt på pedagogikkemnet første semester, dette kan ha påvirket studentevalueringene, men det kan også ha vært en forsterker i studentenes arbeid i studiet. En tredje innvending rettes mot bruk av standardiserte spørsmål i studentevalueringer (Spooren, et al., 2013). Sentralt i vårt evalueringsdesign er fritekstsvar hvor studentene kan gi mer utfyllende informasjon.

Første- og tredjeforfatter har hatt roller i utviklingen av spillet som denne studien retter fokus mot. Eksterne sensorer, som jobber både i ungdomsskole, videregående skole og ved andre lærerutdanningsinstitusjoner, har deltatt på evalueringsmøter og uttalt seg om sine vurderinger av studentenes læringsutbytte. Sensorer har hatt tilgang til de 56 spørsmålene fra de fire kategoriene i sine forberedelser til eksamen og har gitt god respons på hvordan dette har bidratt i struktureringen av både egen og studentenes forberedelse frem mot eksamen. Vi anser dette som viktig i kvalitetssikringen av artikkelens bidrag.

6   RESULTATER

Resultatene viser at studentene opplevde spillet som nyttig i forberedelsene til eksamen, de likte å spille Kunnskapsspillet, og de fleste ser for seg at de vil ta i bruk lignende spill i rollen som fremtidige lektorer. Når det gjelder studentenes vurdering av egen innsats i emnet viser resultatene at de fleste var tilfredse med egen innsats, mens under halvparten var tilfredse med eget arbeid med *pensum*. Angående trivsel og trygghet, viser resultatene at flertallet av studentene i de tre kullene har medstudenter og ansatte de kan snakke fortrolig med dersom de har behov for det. Disse resultatene utdypes nærmere.

6.1   Studentene opplever spillet som nyttig i eksamensforberedelsene

Studentene fylte ut evalueringsskjemaet før eksamen. I gjennomsnitt mente 74 % av studentene i de tre kullene at spillet «i stor grad» ville være til nytte i forberedelsene frem mot eksamen (Tabell 2). Bare 3 % av studenter svarte «nei» på dette spørsmålet. De eksterne sensorer mente at studentene jevnt over hadde kommet langt i sin profesjonsutvikling, til tross for at de bare har vært lektorstudenter i fire måneder ved eksamenstidspunktet. Det er liten forskjell mellom de tre kullene, men studentene i kull 2017 ser i noe større grad en potensiell nytte. Hele 81 % av studentene i dette kullet mente spillet i stor grad ville være til nytte frem mot eksamen, mot tilsvarende 66 % i kull 2018 og 77 % i kull 2019. Disse forskjellene kan knyttes til at kull 2017 ble bedre kjent med spillet, da de spilte det to ganger før eksamen.

Tabell 2: Nytte frem mot eksamen

Tror du Kunnskapsspillet vil være til nytte i dine forberedelser til eksamen?				
	Antall svar	Ja i stor grad	Ja litt	Nei
Kull 2017	88	71 (81 %)	16 (18 %)	1 (1 %)
Kull 2018	105	69 (66 %)	33 (31 %)	3 (3 %)
Kull 2019	75	58 (77 %)	14 (19 %)	3 (4 %)
Kullene samlet	268	198 (74 %)	63 (24 %)	7 (3 %)

6.2 Studentene likte å spille spillet

Studentene gir i evalueringen uttrykk for at de likte å spille Kunnskapsspillet (Tabell 3). I gjennomsnitt likte 65 % av studentene i de tre kullene det «i stor grad». Til sammen var det bare 4 studenter i de tre kullene som svarte «nei» på dette spørsmålet, mens 33 % likte det litt.

Tabell 3: Tilfredshet med å spille Kunnskapsspillet

Likte du å spille Kunnskapsspillet?				
	Antall svar	Ja i stor grad	Ja litt	Nei
Kull 2017	81	54 (67 %)	26 (32 %)	1 (1 %)
Kull 2018	105	67 (64 %)	36 (34 %)	2 (2 %)
Kull 2019	74	47 (64 %)	26 (35 %)	1 (1 %)
Kullene samlet	260	168 (65 %)	88 (33 %)	4 (2 %)

Studentenes kommentarer om Kunnskapsspillet underbygger resultatene om tilfredshet presentert i Tabell 3. Til sammen 90 studenter svarte på dette åpne spørsmålet, fordelt på i underkant av halvparten av kull 2017, rundt en femtedel av kull 2018 og en tredjedel av kull 2019. Det er stor overvekt av positive ytringer i studentenes fritekstsvar (80 %), hvor kull 2017 prosentvis har flest positive ytringer (Tabell 4). Kull 2019 er det kullet hvor flest studentene har kritiske merknader og flest forslag til hva som kunne forbedret bruken av Kunnskapsspillet: 33 % i kull 2019 sammenlignet med 10 % i kull 2018 og 12 % i kull 2017. En forklaring på dette kan være at emneleder for kull 2019 var nytilsatt. Å introdusere og gjennomføre spillet var sannsynligvis mer utfordrende for vedkommende, enn for emneleder for kull 2017 og 2018 som hadde utviklet Kunnskapsspillet.

Tabell 4: Kommentarer i fritekst om Kunnskapsspillet

	Antall kommentarer	Positive ytringer	Kritiske merknader/ forslag til endringer	Usikker
Kull 2017	43 (45 %)	38 (88 %)	5 (12 %)	
Kull 2018	20 (19 %)	16 (80 %)	2 (10 %)	2 (10 %)
Kull 2019	27 (36 %)	18 (67 %)	9 (33 %)	
Kullene samlet	90 (x %)	72 (80 %)	16 (18 %)	2 (2 %)

6.3   Spillet oppleves relevant som fremtidige lektorer

I evalueringen ble kull 2019 stilt spørsmålet om de tror de vil ta i bruk Kunnskapsspillet eller lignende spill i egen undervisning som fremtidig lektor. Av de 74 studentene som deltok i studien i dette kullet, var det 67 (90 %) som svarte også på dette spørsmålet. Resultatene viser at de fleste, 66 %, tenker at de selv vil ta det i bruk (Tabell 5). Formuleringer de bruker er; «ja», «absolutt», definitivt» og «helt klart». I tillegg er det 30 % som tenker at de kanskje eller sannsynligvis vil ta spillet i bruk. Disse studentene bruker formuleringer som; «vil tro det», «muligens», «kanskje», «sannsynligvis», «kan fort hende», «kan være en god idè» og «ikke umulig». De resterende (4 %) svarer «nei» på dette spørsmålet.

Tabell 5: Studentenes vurdering av spillets relevans i egen undervisning som fremtidig lektor

Tror du at du kan ta i bruk spill som Kunnskapsspillet i undervisning når du blir lektor?			
Antall svar	Ja	Kanskje/Sannsynligvis	Nei
67 (90 %)	44 (66 %)	20 (30 %)	3 (4 %)

6.4   Tilfredse med egen arbeidsinnsats og noe mindre tilfredse med arbeid med pensum

Som det fremgår av tabell 6 er tre fjerdedeler tilfredse med egen innsats i pedagogikkemnet første semester. I overkant av 10 % er svært tilfredse, og tilsvarende andel er mindre tilfredse. Resultatene viser videre at i underkant av halvparten er tilfredse og omtrent like mange er mindre tilfredse når det gjelder arbeid med pensum (tabell 7). Mindre enn 10 % er svært tilfredse med eget arbeid med pensum.

Tabell 6: Tilfredshet med egen arbeidsinnsats

Hvor tilfreds er du med din egen innsats i pedagogikk første semester?				
	Antall svar	Svært tilfreds	Tilfreds	Mindre tilfreds
Kull 2017	94	11 (12 %)	71 (75 %)	12 (13 %)
Kull 2018	104	16 (15 %)	75 (72 %)	13 (13 %)
Kull 2019	77	9 (12 %)	59 (77 %)	9 (11 %)
Kullene samlet	275	36 (13 %)	205 (75 %)	34 (12 %)

Tabell 7: Tilfredshet med eget arbeid med pensum

Hvor tilfreds er du med din egen innsats når det gjelder arbeid med pensum i emnet?				
	Antall svar	Svært tilfreds	Tilfreds	Mindre tilfreds
Kull 2017	94	9 (10 %)	47 (50 %)	38 (40 %)
Kull 2018	107	10 (9 %)	49 (46 %)	48 (45 %)
Kull 2019	74	3 (4 %)	33 (45 %)	38 (51 %)
Kullene samlet	275	322 (8 %)	205 (47 %)	124 (45 %)

6.5 Studentenes trivsel og trygghet er styrket etter endring av pedagogikkemnet høsten 2017

Evalueringer gjennomført et halvt år etter studiestart for kull 2016, viste at 41 % av studentene opplevde å ha en medstudent og 40 % opplevde å ha en faglig ansatt de kunne snakke fortrolig med ved behov.[9] Resultatene viser en markant styrking av studentenes trivsel og trygghet for kull 2017, 2018 og 2019, da dette økte til henholdsvis gjennomsnittlig 81 % (tabell 8) og 70 % (tabell 9). Som nevnt innledningsvis ble en rekke kvalitetsforbedrende tiltak satt inn fra og med kull 2017. Resultatene kan ikke tilskrives innføring av spillbasert læring alene. Jamfør Plass et al. (2015) bidrar imidlertid spillbasert læring til at studentene kan bli kjent under en lekende samarbeidsform, noe som kan bidra til nettopp trivsel, trygghet og styrket kullfølelse.

---

[99] Evalueringsdesignet ble endret i 2017 med nye spørsmål og fokus. Disse to spørsmålene om trivsel og trygghet ble imidlertid stilt både før og etter revideringen av pedagogikkement første semester.

Tabell 8: En medstudent på utdanninga å snakke fortrolig med

Dersom du har behov for det, har du medstudenter du kan snakke fortrolig med?				
	Antall svar	Ja	Usikker	Nei
Kull 2017	94	77 (82 %)	9 (10 %)	8 (8 %)
Kull 2018	107	81 (76 %)	13 (12 %)	13 (12 %)
Kull 2019	76	67 (88 %)	3 (4 %)	6 (8 %)
Kullene samlet	277	225 (81 %)	25 (9 %)	27 (10 %)

*Tabell 9: En ansatt på utdanninga å snakke fortrolig med*

Dersom du har behov for det, opplever du at det er ansatte på lektorutdanninga som du kan snakke fortrolig med?				
	Antall svar	Ja	Usikker	Nei
Kull 2017	93	71 (76 %)	19 (20 %)	3 (4 %)
Kull 2018	110	81 (74 %)	16 (14 %)	13 (12 %)
Kull 2019	76	44 (58 %)	26 (34 %)	6 (8 %)
Kullene samlet	279	196 (70 %)	61 (22 %)	22 (8 %)

7   DISKUSJON AV KVALITET VED BRUK AV KUNNSKAPSSPILLET

Gjennom analyse av 127 fritekstsvar, har vi fått et dypere innblikk i studentenes erfaringer og refleksjoner knyttet til bruk av Kunnskapsspillet. Fritekstsvarene er interessante fordi de viser nyanser og begrunnelser for hva studentene opplever som positivt og hvilke kritiske merknader og forslag de har til endringer. De fleste var svært fornøyde. Et lite mindretall var kritiske. Materialet viser ytterpunkter i studentenes tilfredshet. En student som var svært fornøyd skriver: «Veldig artig. Det var som ludo, monopol og alias i et spill med stoff som var pensum, 10 av 10 for fun.» Motsatsen er denne studenten: «Det finnes bedre måter å gjennomgå spørsmål på. For eksempel at man går gjennom spørsmål i plenum i fellesundervisningen.» Studentene hadde også ulike meninger om den svarte kategorien. En av dem skriver: «Det var bra før de svarte – så ble det bare enda bedre». En annen skriver: «Tullespørsmål var unødvendige. Burde vært erstattet med en vanlig kategori.»

De forskjellige temaene som trer frem i studentene fritekstsvar kan knyttes til det vi kaller *kvalitetsdimensjoner* ved Kunnskapsspillet. Gjennom den abduktive analyseprosessen har tre kvalitetsdimensjoner utkrystalisert seg: læringsutbytte, meningsfull sammenheng, og læringslyst, trivsel og trygghet (Figur 2). De tre kvalitetsdimensjonene henger sammen, kan være gjensidig avhengig av hverandre og også overlappende. Enkelte studenter trekker frem alle de tre kvalitetsdimensjonene. Dette

fremkommer blant annet i denne studentens kommentar: «En artig, sosial og smart måte å oppsummere pensum på hvor jeg fikk høre andres syn på spørsmålene.» Studenten legger både vekt på læringslyst (det var artig og sosialt), læringsutbytte (det var nyttig å høre medstudentenes svar) og meningsfull sammenheng (det var en smart måte å oppsummere pensum på). I fortsettelsen gir vi eksempler fra studentenes fritekstsvar innen hver av de tre kvalitetsdimensjonene og relaterer til sosiokulturell læringsteori og teori om spillbasert læring. Deretter synliggjør vi hvordan de tre kvalitetsdimensjonene henger sammen i en diskusjon av Kunnskapsspillets profesjonsrelevans.
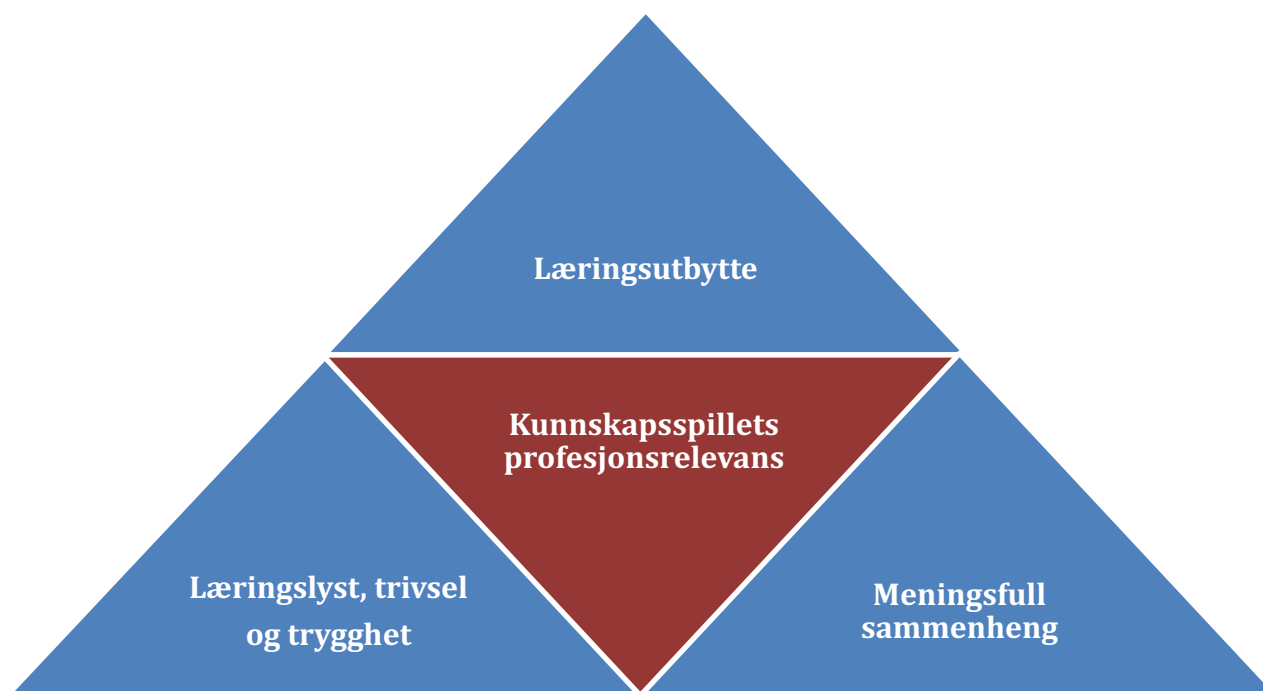
Figur 2: Kvalitetsdimensjoner i studentenes evaluering av Kunnskapsspillet

7.1 Læringsutbytte

Læringsutbytte forstås på ulike måter i nasjonal og internasjonal forskning. Begrepet retter seg for det første mot *intensjonen*, altså hva studentene forventes å kunne etter endt emne/utdanning. For det andre anvendes begrepet om *resultatet*, altså hva studenten faktisk sitter igjen med (Prøitz, 2016). I vår studie knyttes læringsutbytte til studentenes forventninger, noe som kan relateres til begrepet om self-efficacy (Bandura, 1997). Studentene opplever førstesemesteremnet i pedagogikk som et stort og omfattende emne hvor det er mye å lese. Flertallet mener at Kunnskapsspillet vil være til nytte frem mot eksamen og bidra til et godt læringsutbytte. Studentene begrunner dette på ulike måter. Enkelte er instrumentelle: «Kunnskapsspillet er jo eksamensspørsmålene. Så det vil åpenbart være nyttig.» Andre trekker frem at spillet er til hjelp fordi det avdekker kunnskapshull. En student skriver: «Noen spørsmål var vanskelige, men det er en fin måte å få en pekepinn på hva man må lese mer på.» En annen skriver: «Når man ser på spørsmålene leser man litt annerledes og vet hva som er viktig i et hav av informasjon.» En tredje student skriver: «Ikke bare lærer man ting og kan vise det man kan, men det blir svært åpenbart at det er områder man har svært lite kunnskap om.» Disse kommentarene synliggjør at studentene opplever at Kunnskapsspillet bidrar til *samstemt undervisning* (Constructive alignment), altså samsvar mellom

31

læringsmål, læringsaktiviteter og eksamensform (Biggs & Tang, 2011), og dette motiverer studentene. Kirk-Johnson et al. (2019) peker på at anstrengende læringsformer gir mer effektiv langtidslæring («*desirable difficulties*»), men viser i sine studier at studenter ofte velger bort effektive læringsstrategier fordi de feiltolker anstrengelse som et tegn på at de ikke får det til. Studentenes kommentarer peker på at Kunnskapsspillet hjelper studentene å strukturere arbeidet med pensum uten å demotivere dem. For enkelte bidro dette til å ta ned stressnivået frem mot eksamen. En student mener at Kunnskapsspillet var en «av de ryddigste måtene å presentere eksamensrelevant pensum på i et så omfattende fag.» En annen skriver: «Her har jeg faktisk mulighet til å få en titt inn i hva jeg burde lese på til eksamen, hva forberede meg på. Føles tryggere, mindre stressende.»

Flere studenter legger vekt på kvaliteten i det å samarbeide med andre og trekker frem at dette bidro til eget læringsutbytte. En student skriver: «Greit å få en idé om hvor jeg er faglig, og få hjelp av medstudenter.» En annen student trekker frem at Kunnskapsspillet bidro i språksetting av egen læring: «...det er en artig måte å sette ord på teori sammen med andre og utfordre seg på faglige områder man kanskje er litt usikker på.» Et tredje eksempel er studenten som skriver: «Trodde ikke det skulle fungere og at det ikke var noe gøy, men det var veldig interessant. Jeg klarte å hente opp mye kunnskap jeg trodde jeg ikke kom til å få frem.» Studentene lærer av å søke hjelp når de selv har behov for det, og erfarer at de selv lærer av å forklare fagstoff for sine medstudenter, noe som kan forstås i lys av Vygotskijs teori om *den proksimale utviklingssone*. Med den proksimale utviklingssone, sikter Vygotskij til sonen som eksisterer mellom hva studentene kan på egen hånd, og det studenten er i stand til å lære gjennom støtte fra andre. Den/de andre som forstår mer fungerer som stillas, noe Vygotskij (2001) begrepsfester som *scaffolding*. Clapper (2015) kobler dette til samarbeidsbasert læring (cooperative-based learning), og viser hvordan bruk av spill kan bidra til å skape en sone hvor studentene kan bistå hverandre i å konstruere forståelse av pensum sammen.

7.2 Læringslyst, trivsel og trygghet

Den neste kvalitetsdimensjonen er *læringslyst, trivsel og trygghet*. Begrepet læringslyst kan sies å stå i kontrast til begrepet læringstrykk som kom med PISA-undersøkelsene på begynnelsen av 2000-tallet. Der læringstrykk karakteriseres av ytre motivasjon, målstyring og mer kontroll (Ryan & Deci, 2000), er studentens indre motivasjon og lyst til å lære i sentrum i læringslyst (Skaalvik & Skaalvik, 2014). Motivasjon er et sentralt tema i forskning på spillbasert læring, og det er flere tilnærminger til hvordan motivasjonsfaktorer kan skreddersys i forskjellige læringsspill (Plass et al., 2015). Hovedinntrykket fra analyse av fritekstsvarene er at de aller fleste opplevde bruken av Kunnskapsspillet som engasjerende og motiverende i egen læring. En av studentene trekker frem at det var positivt å velge hvem de skulle spille sammen med og at spillet motiverte til å lese videre: «Jeg synes det er positivt at vi får mulighet til å låne spillet så man kan lese mer senere. Likte også at vi kunne velge gruppene slik at vi kunne være sammen med noen som vi trivdes og føler oss komfortable med.» Studentene trekker frem momenter som kan ses i lys av resultatene som viser at studentenes trivsel og trygghet er styrket etter endring av blant annet undervisningsmetoder med innføring av spillbasert læring.

Mange av studentene vektla de sosiale aspektene ved bruk av Kunnskapsspillet, og det å kombinere spill og eksamensforberedelser sammen med medstudenter. Biggs (2003) skriver om læring utenfor den tradisjonelle forelesningssituasjonen og fremhever interaksjon i grupper. Bruk av Kunnskapsspillet stimulerte arbeidet i studentdrevet kollokvieaktivitet. I Kull 2017 var halvparten av spillene utlånt før eksamen. Ei kollokviegruppe som lånte Kunnskapsspillet skulle tilbringe helga sammen og bake pepperkaker og spille spillet. Studentene lånte også spillet på egen hånd. En student skriver: «Tenker å låne det med meg og skrive ned spørsmålene så jeg kan øve på bussen.» En annen, sterkt konkurransedrevet student, lånte spillet for å forberede seg *før* hun skulle spille spillet i kollokviegruppa. Omkring halvparten av studentene i Kull 2017 møtte også på ikke-obligatorisk eksamensseminar tidlig på morgenen dagen etter studentenes julefest. Emneleder har også mottatt mange pensumrelaterte spørsmål på e-post relatert til de ulike kategoriene i Kunnskapsspillet. Studentenes bruk av Kunnskapsspillet i forberedelser til eksamen støtter på denne måten opp under den tidligere nevnte studieteknikken retrieval practice.

7.3 Meningsfull sammenheng

Meningsfull sammenheng, den tredje kvalitetsdimensjonen, er nært beslektet med koherens og samstemt undervisning. Koherens sikter mot hvordan integreringen av de ulike delene av lærerutdanninga (fordypning i fag, fagdidaktikk, pedagogikk og praksis) kan styrkes, og hvordan relevansen kan økes for å styrke studentenes profesjonskvalifisering (Hammerness, 2012; Heggen & Raaen, 2014). Biggs (2003) skriver om forholdet mellom læring som en aktiv prosess hos studenten og relevante læringsaktiviteter, og fremhever betydningen av at studenten opplever og skaper *mening* i sin læringsprosess: "…meaning is not something imported or transmitted from teacher to learner, but something learners have to create for themselves. Teaching is simply a catalyst for learning." I følge Biggs er det altså studenten selv som må skape meningsfulle sammenhenger. Undervisning kan kun fungere som en katalysator for dette.

Samstemt undervisning handler som nevnt over om samsvar mellom læringsmål, læringsaktiviteter og eksamensform (Biggs & Tang, 2011). Studentene uttrykker at de opplever meningsfull sammenheng mellom arbeidsform og eksamen. En student skriver: «Genialt spesielt med tanke på at svarene skal gis muntlig, som på eksamen, og at det ikke skal svares skriftlig.» Kunnskapsspillet bidrar videre til meningsfull sammenheng ved at de teoretiske spørsmålene og refleksjonsspørsmålene i de fire kunnskapskategoriene i Kunnskapsspillet samsvarer med læringsutbyttebeskrivelsesn i emnet når det gjelder både kunnskap (teori) og ferdigheter (evne til refleksjon). I relasjon til retrieval practice er kombinasjonen av teorispørsmål og refleksjonsspørsmål effektiv for å styrke langtidslæringen i begge kategorier (Agarwal, 2019).

8   DISKUSJON AV KUNNSKAPSSPILLETS PROFESJONSRELEVANS

De tre kvalitetsdimensjonene kan alle relateres til Kunnskapsspillets profesjonsrelevans. I fortsettelsen diskuteres utvikling av profesjonelt skjønn og identitet som fagperson, utvikling av endrings- og

samhandlingskompetanse og kunnskapsspillet som modellering av undervisning som sentrale elementer i studentenes profesjonsutvikling.

8.1 Utvikling av profesjonelt skjønn og identitet som lektor

Askling et al. (2015) diskuterer hvordan man kan arbeide med utvikling av profesjonelt skjønn i lærerutdanningen. Lærere står stadig overfor nye situasjoner som innebærer etiske utfordringer og dilemma hvor det ikke finnes fasitsvar, og der løsninger må baseres på skjønn. Å diskutere etiske dilemma som lektorstudent er en forberedelse til håndtering av profesjonsetiske dilemma som fremtidige lektorer. Første semester på lektorutdanninga løftes dette frem i forberedelse til praksis og i pedagogikkundervisningen blant annet i den spillbaserte læringa. Blanchard og Buchs (2015) presenterer resultater fra en spørreundersøkelse om bruk av rollespill for å tydeliggjøre hvordan komplekse tema knyttet til bærekraft henger sammen. Et sentralt poeng for Blanchard og Buchs (2015) er at gjennom å spille rollespill fikk studentene dybdekunnskap om flere deler av et sammensatt tema, noe som gjorde det lettere å forstå helheten. Dette resultatet er relevant i vår sammenheng. Flere av studentene trekker frem at Kunnskapsspillet bidro til det de begrepsfester som «dybdekunnskap» og at det ble lettere å se sammenheng mellom ulike temaer. En student skriver: «Veldig fin måte å øve på, får reflektert rundt alle temaene.» En annen student trekker frem følgende: «Diskusjoner og avgrense hva som er mest relevant, og øvelse på hvordan man kan knytte sammen temaer gjennom oppgaveskriving.»

Kvalifisering til læreryrket forutsetter ei utdanning som legger til rette for refleksjon, og hvor studentene kan «...lære av sine feil, tenkje kritisk, evne å spørje om råd og hjelp, være eksperimentell, evne å dele kunnskap med andre, være kollegaorientert og engasjert i utviklinga av lærerrolla.» (Heggen & Raaen, 2014) Kunnskapsspillet gir studentene en ramme for diskusjon av faglige problemstillinger med medstudenter. Dette inngår som en del av studentenes konstruksjon av identiteten som fagperson. Gjennom interaksjonen med andre får de reflektere over komplekse profesjonsrelevante problemstillinger i en trygg setting hvor det ikke er farlig å ikke vite, eller ta feil. At så godt som alle likte å spille spillet, at spillet oppleves som nyttig i eksamensforberedelse og profesjonsrelevant, viser at Kunnskapsspillet gir ei god ramme for utprøving av profesjonelt skjønn, noe som er sentralt i utvikling av identitet som lektor.

8.2 Utvikling av endrings- og samhandlingskompetanse

Dagens lærere skal fungere i en skole i endring. Endringskompetanse, og kompetanse i samhandling med andre er helt sentralt for fremtidens lærer. I Kunnskapsspillet trer studentene inn i lærerrollen og får trent seg på å samhandle og ta ansvar i alle spillets faser. Evalueringen viser at de aller fleste tar læringsprosessen på alvor, selv om spillet også gir rom for humor og latter. Kun en av studentkommentarene peker på den motsatte erfaringen: «Det er en grei tanke og et godt virkemiddel, men for å få utbytte er man avhengig av å spille med andre som er like interessert som en selv – ellers risikerer man mye tull.» Det kan tenkes at tullet som studenten her viser til, kommer som et resultat av den sorte uhøytidelige kategorien. I all hovedsak virker det imidlertid som at den sorte kategorien oppleves som positiv av studentene og for studentenes læring, jamfør perspektivet med lekende læring

(Plass et al., 2015). De sorte spillkortene kan også sies å ha profesjonsrelevans i studentenes utvikling av samhandlingskompetanse. I denne kategorien får studentene praktisere forskjellige former for verbale aktiviteter som inngår i sosial samhandling, i det Lytra (2015) omtaler som «Playful Talking». Dette er kommunikasjonsferdigheter lærere trenger i interaksjon med både elever og kollegaer. Det kan imidlertid være vanskelig å legge til rette for utvikling av slike ferdigheter i ei lektorutdanning.

Ved å spille Kunnskapsspillet har studentene erfart at de trenger hverandre og de kan nyttiggjør seg hverandres kompetanse i utvikling av egen kompetanse. Dette er en profesjonsrelevant erfaring. Forskning viser at undervisningen i norske klasserom er blitt mer individualisert etter Kunnskapsløftet (Haug, 2013). Sett i lys av NOU 2015: 8 Fremtidens skole (Kunnskapsdepartementet, 2015), er dette et paradoks. Ett av fire kompetanseområder som anbefales i fornyelse av skolens innhold er kompetanse i å kommunisere, samhandle og delta (s. 8). I følge Dysthe (2013) vil studenter stå bedre rustet i rollen som fremtidig lærer, dersom studenten er bevisst på selv å praktisere dialogiske og samspillsorienterte læreprosesser som student.

8.3 Kunnskapsspillet som modellering av undervisning

Ett av spørsmålene i evalueringen har direkte relevans for å undersøke Kunnskapsspillets profesjonsrelevans, nemlig spørsmålet om studentene vil ta Kunnskapsspillet eller lignende spill i bruk i egen undervisning som fremtidige lektorer. Så godt som alle mener at de absolutt eller muligens vil gjøre det. Studentene begrunner dette med at spillet oppleves som «relevant» og at det stimulerer læring ved å være «engasjerende», «morsomt», «motiverende» og at det «bringer inn variasjon i undervisninga». En av studenten skrev følgende: «...å ha noe konkret på jobbe med er ofte nyttig. I tillegg kan konkurranseinstinktet være til stor hjelp for å motivere elevene.» Å konkurrere kan engasjere. Det er mulig å vinne. Og som Plass et al. (2015) påpeker, det er også mulig å feile uten at det får store konsekvenser. En student skriver: «Slike måter er svært fine læringsmuligheter. Jeg selv er praktiker og lærer bedre av å diskutere enn å lese.» En av studentene som skal bli lektor i matematikk skriver: «Hadde ikke tenkt spesifikt på det (å ta spillet i bruk), men hvorfor ikke. Det er ikke nok muntlig aktivitet i matematikk så det kunne være et godt alternativ.»

Kunnskapsspillet har med andre ord fungert som noe mer enn at studentene har lært pedagogisk teori. For flere av studentene har det også modellert undervisning. Profesjonsrelevansen for studentene som vil ta Kunnskapsspillet i bruk i egen undervisning, knytter seg til erfaringer fra egen læringsprosess. Flere av studentene etterspør at emneleder kan lage flere spill. I oppsummeringen fra gruppeevalueringen fremgår følgende: «Vi vil ha lek og spill til flere temaer slik som i Kunnskapsspillet. Det er bra repetisjon på hva som er gjennomgått i fellesforelesningene i pedagogikk». Dette viser at studentene har erfart Kunnskapsspillet som et fleksibelt multiverktøy for læring, et artefakt for læring som er relevant både i eget studie og i et fremtidig virke som lektor i ulike fag.

9 KUNNSKAPSSPILLET PÅ LEKTORUTDANNINGA - VIDERE UTVIKLING

I følge Beavis et al. (2014) undervurderer gjerne undervisere den rollen de selv har i spillbasert læring, noe som kan svekke spillet som læringsmetode. Konklusjonen til Beavis et al. er at lærerens rolle i spillbasert læring er sentral. En av de viktigste oppgavene underviseren har ved bruk av spillbasert læring, er å sikre at spillet ikke er en frittstående aktivitet, men inngår som en integrert del av læringsprosessen (Beavis et al., 2014). Det er potensiale for videre utvikling i alle de tre fasene i læringsprosessen ved bruk av Kunnskapsspillet.

Forberedelsene til spillingen, når studentene lager spørsmål til spillet, kan for det første styrkes. En av studentene trakk frem at det kan være vanskelig å spille uten en fasit: «God læring. Eneste utfordring kan være at hvis ingen har et bra svar er det vanskelig å bedømme uten løsningsforslag eller stikkord.» I Kunnskapsspillet er det pensum som er fasiten i spillet, og studentene må anstrenge seg for å hente frem kunnskap, både når de svarer og bedømmer andres svar (jmf. Kirk-Johnsen et al., 2019). Et resultat det i så måte er verdt å se litt nærmere på er studentene tilfredshet med eget arbeid med pensum. Av de 275 studentene som svarte på dette spørsmålet er det 45 % som er «Mindre tilfreds» med eget arbeid med pensum, 47 % er «Tilfreds» og 8 % er «Svært tilfreds» (Tabell 7). I fortsettelsen vil vi stimulere til mer aktiv bruk av pensumlitteraturen når studentene lager spørsmål til Kunnskapsspillet. En måte å gjøre dette på, er at studentene setter referanse med sidehenvisning til pensum etter spørsmålet på spillkortet.

Også selve spillseansen kan videreutvikles. Vi vil legge til rette for at studentene spiller spillet flere ganger i løpet av semesteret, når to kategorier og når tre kategorier spillkort er produsert. Dette vil føre til at spillet blir tettere integrert i undervisningen og i studentenes læringsprosess gjennom semesteret. Vi ser også at det vil være en styrke å ha flere undervisere til stede under spillseansen. På lektorutdanninga har spillet vært brukt i studentkull på over 100 studenter, og enkelte ganger med bare en lærerressurs tilgjengelig. Med større lærertetthet, vil undervisere i større grad kunne være stillas for studentene i den proksimale utviklingssonen ved å delta i diskusjoner og svare på spørsmål.

Når det gjelder den tredje og siste fasen, etterarbeid, er det også et potensiale for å styrke studentenes læringsutbytte. Etter at studentene har spilt spillet kan det for eksempel være relevant å reflektere over egen læringsprosess i lys av ulike læringsteorier som sosiokulturell læringsteori, behaviorisme og kognitiv læringsteori. Det kan også være relevant å diskutere forholdet mellom læringsmiljø og læringsutbytte og variasjoner i studenters tilfredshet med å spille Kunnskapsspillet. Beavis et al. (2014) peker på farene ved å anta at spill er universelt engasjerende, uten å ta hensyn til mangfoldet i studentgruppen og andre forhold i det sosiale læringsmiljøet. For de kommende lektorene er dette diskusjoner med stor grad av profesjonsrelevans.

10 KONKLUSJON

I revideringen av pedagogikkemnet førstesemester ble det høsten 2017 gjort omfattende endringer. Ambisjonen var å styrke studentenes trivsel og trygghet, samt skyte fart og gi retning på studentenes profesjonsutvikling og utvikling av identitet som lektor gjennom et mer helhetlig sammenhengende og profesjonsrelevant emne. Undervisningsmetoder ble endret med innføring av spillbasert læring. Evalueringer fra kull 2017, 2018 og 2019 viser en styrking av det sosiokulturelle læringsmiljøet ved utdanninga. De fleste studentene har funnet sin plass på lektorutdanninga. De jobber sammen i grupper, og har lærere og medstudenter de kan snakke fortrolig med dersom de har behov for det. Vi vurderer at endring i undervisningsmetoder ved innføring av spillbasert læring har bidratt positivt. I artikkelen har vi diskutert studentenes evalueringer av Kunnskapsspillet i lys av kvalitetsdimensjoner som læringslyst, læringsutbytte og opplevelse av meningsfull sammenheng. Eksterne sensorer bekrefter at studentene presterer på et høyt nivå og at de er godt i gang med sin profesjonsutvikling etter bare fire måneder på utdanninga. Spillet har også fungert som noe mer enn at studentene har lært pedagogisk teori. Det har modellert undervisning og er profesjonsrelevant, og studentene oppgir at de også vil ta Kunnskapsspillet i bruk i egen undervisning.

Hovedinntrykket er at Kunnskapsspillet strukturerer arbeidet med pensum for både foreleser og student og også for sensor. Studentene er engasjerte og de gir uttrykk for læringslyst. Det er liten forskjell mellom de tre kullene. Kull 2017 er litt mer tilfredse med bruk av spillet, ser litt større potensiell nytte frem mot eksamen og har også flest positive ytringer i sine fritekstsvar sammenlignet med studentene i kull 2018 og kull 2019. Kull 2017 var også det kullet som tok spillet mest i bruk. Økt frekvens i bruk av spillet, og mer aktivt bruk av pensum i spillets ulike faser, vil være viktig for å bidra til en ytterligere styrking av studentenes læringsutbytte ved bruk av Kunnskapsspillet.

LITTERATUR

Agarwal, P., Bain, P. & Chamberlain, R. (2012). The Value of Applied Research: Retrieval Practice Improves Classroom Learning and Recommendations from a Teacher, a Principal, and a Scientist. *Educational Psychology Review*, 24(3), 437–448. doi:10.1007/s10648-012-9210-2

Agarwal, P. (2019). Retrieval Practice & Bloom's Taxonomy: Do Students Need Fact Knowledge Before Higher Order Learning? *Journal of Educational Psychology*, 111(2), 189–209. doi:https://psycnet.apa.org/doi/10.1037/edu0000282

Askling, B., Dahl, T., Heggen, K., Kuldbrandstad, L. I., Lauvdal, T., Maursethagen, S., Qvortrup, L., Salvanes, K., Skrøvset, s. og Thue, F. W. (2015). *Ekspertgruppe om lærerrollen. Et kunnskapsgrunnlag*. Fagbokforlaget

Bandura, A. (1997). Self-efficacy: The exercise of control. W H Freeman/Times Books/ Henry Holt & Co.

Beavis, C., Rowan, L., Dezuanni, M., Mcgillivray, C., O'Mara, J., Prestridge, S. & Zagami, J. (2014). Teachers' beliefs about the possibilities and limitations of digital games in classrooms. *E-Learning and Digital Media,* 11(6), 569–581. https://doi.org/10.2304/elea.2014.11.6.569

Biggs, J. B. (2003). Aligning Teaching for Constructing Learning. https://www.heacademy.ac.uk/sites/default/files/resources/id477_aligning_teaching_for_constructing_learning.pdf

Biggs, J. B. & Tang, C. (2011). *Teaching for Quality Learning at University*. Open University Press

Bjørndal, C. R. P. (2015). Det vurderende øyet. Observasjon, vurdering og utvikling i undervisning og veiledning. Gyldendal Akademisk.

Blanchard, O. & Buchs, A. (2015). Clarifying Sustainable Development Concepts Through Role-Play. *Simulation & Gaming,* 46(6), 697–712. https://doi.org/10.1177/1046878114564508

Boghian, I., Cojocariu, V.-M., Popescu, C. V. & Mata, L. (2019). Game-based learning. Using board games in adult education. *Journal of Educational Sciences & Psychology*, *9*(1), 51–57.

Bridge, D. (2014). You Sunk My Constitution: Using a Popular Off-the-Shelf Board Game to Simulate Political Concepts. *Journal of Political Science Education,* 10(2), 186–203. https://doi.org/10.1080/15512169.2014.894363

Clapper, T. C. (2015). Cooperative-Based Learning and the Zone of Proximal Development. *Simulation & Gaming*, 46(2), 148–158. https://doi.org/10.1177/1046878115569044

Crookall, D. (2010). Serious Games, Debriefing, and Simulation/Gaming as a Discipline. *Simulation & Gaming,* 41(6), 898–920. https://doi.org/10.1177/1046878110390784

Dysthe, O. (2013). Dialog, samspill og læring. Flerstemmige læringsfellesskap i teori og praksis. I R. J. Krumsvik & R. Säljö (red.) *Praktisk- pedagogisk utdanning. En antologi.* Fagbokforlaget.

Esarey, J. & Valdes, N. (2020) Unbiased, reliable, and valid student evaluations can still be unfair, Assessment & Evaluation in Higher Education, 45:8, 1106-1120, DOI: 10.1080/02602938.2020.1724875

Garris, R., Ahlers, R. & Driskell, J. E. (2002). Games, motivation, and learning: A research and practice model. *Simulation & Gaming*, 33(4), 441–467. https://doi.org/10.1177/1046878102238607

Hammerness, K. (2012). Examing Features of Teacher Education in Norway. *Scandinavian Journal of Educational Research*. Vol. 57 No. 4, 400–419. https://doi.org/10.1080/00313831.2012.656285

Haug, P. (2013). Tilpasset opplæring for den enkelte i fellesskapet. I R. J. Krumsvik & R. Säljö (red.) *Praktisk-pedagogisk utdanning. En antologi.* Fagbokforlaget.

Heggen, K. & Raaen, F. D. (2014). Koherens i lærarutdanninga. *Norsk Pedagogisk Tidsskrift*. Vol. 98 No. 1, 3–13.

Hoy, B. (2018). Teaching History With Custom-Built Board Games. *Simulation & Gaming*, 49 (2), 115–133. https://doi.org/10.1177/1046878118763624

Jakobsen, A. N & Waldenstrøm, L (2017). Fra lærerstyrt undervisning til varierte læringsformer. *Nordic Journal of STEM Education*, Vol. 1 No. 1, 319–327

Järvinen, M. & Mik-Meyer, N. (red.) (2017). *Kvalitativ analyse. Syv traditioner*. København: Hans Reitzels Forlag

Karpicke, J. & Grimaldi, P. (2012). Retrieval-Based Learning: A Perspective for Enhancing Meaningful Learning. *Educational Psychology Review*, 24(3), 401–418. doi:10.1007/s10648-012-9202-2

Kirk-Johnson, A., Galla, B. M., & Fraundorf, S. H. (2019). Perceiving effort as poor learning: The misinterpreted-effort hypothesis of how experienced effort and perceived learning relate to study strategy choice. *Cognitive Psychology*, 115, 101237. doi:https://doi.org/10.1016/j.cogpsych.2019.101237

Kunnskapsdepartementet (2015). *NOU 2015:8 Fremtidens skole — Fornyelse av fag og kompetanser*. https://www.regjeringen.no/contentassets/da148fec8c4a4ab88daa8b677a700292/no/pdfs/nou201520150008 000dddpdfs.pdf

Lun, K. A. W., Chi, L. S. & Hun, L. S. W. (2018). The learning benefits of teaching: A retrieval practice hypothesis. *Applied Cognitive Psychology*, 32(3), 401–410. doi:doi:10.1002/acp.3410

Lytra, V. (2015). Playful Talk, Learners' Play Frames and the Construction of Identities. *Discourse and Education*, 3, 1–12. https://doi.org/10.1007/978-3-319-02322-9_13-1

Miller, G. A. (1956). The magical number seven, plus or minus two: some limits on our capacity for processing information. *Psychological Review*, 63(2), 81–97. https://doi.org/10.1037/h0043158

Nasjonalt råd for lærerutdanning (2017). *Nasjonale retningslinjer for lektorutdanning for trinn 8-13*

Nicholson, S. (2011). Improving the Trivia Game Model Creating Original Games. Knowledge Quest, 65(1), 60–65.

Nicholson, S. (2012). Completing the Experience: Debriefing in Experiential Educational Games. The 3rd International Conference on Society and Information Technologies, 11(6), 117–121.

Pettersen, R. (2005). *Kvalitetslæring i høyere utdanning. Innføring i problem og praksisbasert didaktikk*. Universitetsforlaget

Pieter, S., Brockx, B., & Mortelmans, D. "On the Validity of Student Evaluation of Teaching: The State of the Art." Review of Educational Research 83, no. 4 (December 2013): 598–642. https://doi.org/10.3102/0034654313496870.

Plass, J. L., Homer, B. D. & Kinzer, C. K. (2015). Foundations of Game-Based Learning, 50(4), 258–283. https://doi.org/10.1080/00461520.2015.1122533

Prince, M. (2004). Does active learning work? A review of the research. *Journal of Engineering Education*, 93(July), 223–231. https://doi.org/10.1038/nature02568

Prøitz, T. S. (2016). Læringsutbytte slik lærere, forskere og politikere ser det. Utdanningsnytt.no https://www.utdanningsnytt.no/laereryrket-pedagogikk-skoleutvikling/laeringsutbytte-slik-laerere-forskere-og-politikere-ser-det/144679

Richland, L. E., Kornell, N., & Kao, L. S. (2009). The pretesting effect: Do unsuccessful retrieval attempts enhance learning? *Journal of Experimental Psychology: Applied*, 15(3), 243–257. https://doi.org/10.1037/a0016496

Ryan, R. & Deci, E. (2000). When rewards compete with nature: The undermining of intrinsic motivation and self-regulation. I C. Sansone & J. Harackiewich (ed): *Intrinsic and extrinsic motivation: The search for optimal motivation and performance*. San Diego, CA: Academic Press.

Skrøvset, S. Eriksen, A. Leming T. & Tobiassen, A. K. (2017). *Rapport – Oppstart med STIL. Læringslyst og læringsbehov. ProTed*, Institutt for lærerutdanning og pedagogikk, UiT. Refr. nr. 2018-72-1

Skaalvik, E. M. & Skaalvik, S. (2014). *Skolen som læringsarena. Selvoppfatning, motivasjon og læring.* 2. utgave. Universitetsforlaget.

Säljö, R. (2013). Støtte til læring – tradisjoner og perspektiver. I R. J. Krumsvik & R. Säljö (red.) *Praktisk-pedagogisk utdanning. En antologi.* Fagbokforlaget.

Spooren, P., Brockx, B., & Mortelmans, D. (2013). On the Validity of Student Evaluation of Teaching: The State of the Art. *Review of Educational Research* (Vol. 83). https://doi.org/10.3102/0034654313496870

Sæthre, H. Å. (2014) *Å tilrettelegge for at studentene skal lykkes.* Bergen: Haas1 – forlag

Thagaard, T. (2013). *Systematikk og innlevelse en innføring i kvalitativ metode.* Fagbokforlaget.

Uttl B, White CA, Gonzalez DW (2017). Meta-analysis of faculty's teaching effectiveness: student evaluation of teaching ratings and student learning are not related. *Studies in Educational Evaluation* (54), 22–42. doi: 10.1016/j.stueduc.2016.08.007.

Vygotskij, L. (1978). Mind in Society: The Development of Higher Psychological Processes. M. Cole, V. John-Steiner, S Schribner & E. Souberman (ed). Camebridge, Ma./London: Harvard University Press.

Vygotskij, L. (2001). Tenkning og Tale. A. Kozulin (red). Oslo: Gyldendal Akademiske.

Wang, G., & Williamson, A. (2020). Course evaluation scores: valid measures for teaching effectiveness or rewards for lenient grading? *Teaching in Higher Education*. https://doi.org/10.1080/13562517.2020.1722992

Wiggins, B. E. (2016). An Overview and Study on the Use of Games, Simulations, and Gamification in Higher Education. *International Journal of Game-Based Learning*, 6(1), 18–29. https://doi.org/10.4018/ijgbl.2016010102

Paper 4

Title: Better game worlds by design: The GAS framework for designing and analyzing games based on socio-ecological systems thinking, demonstrated on *Nusfjord* (2017)

Authors: Jørn Weines[1], Melania Borit[1]*

Affiliation:

[1] Norwegian College of Fisheries Science, UiT The Arctic University of Norway, Tromsø, Norway.

* Corresponding author: melania.borit@uit.no.

Abstract

The goal of this article is to propose GAS (**G**ame World Design and **A**nalysis for Socio-Ecological **S**ystems), a framework for the design and analysis of game worlds through socio-ecological systems lenses. GAS invites designers to a structured reflection of their choices regarding game world correspondence with a real or fictional reference system (assessed through accuracy, comprehensiveness, and balance) and game world consistency. The framework spells out the main elements to be included in the game world for that to be a credible socio-ecological system. The GAS framework is briefly demonstrated on *Nusfjord* (2017), as an exemplar of natural resource management themed analogue game. The framework is built using an interdisciplinary approach to game studies, history, media and literary studies, and natural resource management research. The application of the framework has the potential of making the

1

design and analysis of game worlds more relevant to the sustainability discourse of the 21st Century.

1. Introduction

Against the backdrop of the global development challenges of the 21st Century, systems thinking is increasingly important for people's daily lives. Games also exhibit this trend, with scholars pleading for incorporating more complex systems concepts into commercial games as a way to offer "a public outlet for exploring the complex interdependencies of a changing world" (Kelly and Nardi, 2014, no page). While this is a timely and sensible advice, it is not straightforward how to follow it, either from a design point of view or a game analysis one. This study aims to offer concrete guidance on how the concept of systems, and more specifically, socio-ecological systems (SES), can be included in games, be they digital or analogue, by proposing a framework for the design and analysis of game worlds: the GAS framework - **G**ame World Design and **A**nalysis for Socio-Ecological **S**ystems. The main research question of the study is to explore how SES thinking can be incorporated in the design and analysis of game worlds by building on knowledge and experience from the research domains of game studies, history, media and literary studies, and natural resource management.

After describing the GAS framework, we demonstrate its use on *Nusfjord* (2017) as an exemplar of natural resource management themed game. This is a recent, successful, and high profile board game, with a clear theme that is tied to economic development in a clear historical context, which provides rich opportunities to demonstrate our prosed framework. In this game, the players take the roles as the owners of a major fishing company in Nusfjord, a small fishing village in the Lofoten archipelago in Norway. Nusfjord is a real place and the Lofoten fishery is a significant part of Norwegian coastal and fisheries history. *Nusfjord* the game is designed by Uwe Rosenberg (Rosenberg, 2017), and is published for the commercial entertainment market.

Games are vehicles that transport their players between different realities (Peters & Westelaken, 2014). By doing this, they have the potential to provide many different benefits for their players, such as relaxation, excitement, social interaction, and learning. Games tell stories through the combination of content and mechanics that create a consistent world where players have agency (Arnaudo, 2018). Like other forms of media, games are lenses through which their users experience and gain awareness of different topics (Schell, 2019). Analogue games are currently experiencing a renaissance, with a massive growth, both in sales and participants (Pobuda, 2018). As the COVID-19 pandemic has forced billions of people around the world to spend more time at home, video games, which were already growing in popularity, have surged in demand (Epstein, 2020). This means that games, as a medium, represent an increasingly important cultural arena. Many of these games use natural resource management and environmental conservation as underling themes. In the real life, these themes are rather wicked ones, numerous examples showing how challenging it is to develop fisheries, forestry, agricultural exploitations, mining, or urban areas in a sustainable way. Looking at this development through SESs lenses it

3

is believed to provide a way forward out of the wicked problem (Defries & Nagendra, 2017), and it is this specific approach that we propose to use in this study. Considering the inherent complexity of the coupled biophysical and socioeconomic elements that make up the reality human society inhabits (Kotchen & Young, 2007), this study proposes a tool that can be used when designing or analyzing games where SESs are a major part of the theme, type, category, or mechanism. This tool focuses on the details of building game worlds. Based on the socio-ecological systems theory formulated by (Ostrom, 2007, 2009), our study expands how elements of such systems (real or fictional) are integrated in game worlds, by inviting game designers to a structured reflection over their design choices. This approach increases its importance in the case of games that draw inspiration from real world and history, as incorporating such inspiration in game worlds activates ethical considerations (e.g. how power hierarchies, gender, minorities or disputed events are portrayed (McCall, 2016; Pobuda, 2018)). As such, we build on the growing body of previous research on historical commercial off-the-shelf (COTS) video and analogue games (e.g. (Borit, Borit, & Olsen, 2018; Chapman, Foka, & Westin, 2017)) and on using COTS games to teach history (e.g. (Hoy, 2018; McCall, 2016)). When demonstrating the GAS framework, we employ the close reading methodology specific to media and literary studies to analyze the denotative and connotative meanings of game rules, game mechanics, artwork, and game components of *Nusfjord,* in an attempt to assess their potential for transporting players between the game world, the past reality of the Lofoten fisheries, and the current reality of discussions about overexploited fisheries and sustainable marine and coastal management. In doing this, we investigate how *Nusfjord* represents social, economic, and environmental interdependencies of the historical period it evokes. The scope of this analysis is not to point the finger at inaccuracies, but to demonstrate an example of analysis that could be done when

reflecting on the questions asked by the GAS framework, thus to analyze the game in relation to the discourse on sustainable SESs management.

Our research contributes to the debate on whether and how contemporary board games could become more progressive in their depiction of socio-ecological systems (e.g. (LaPensée, 2016)). Today's game designers have certain responsibilities, and transforming players for the better is one of them (Schell, 2019). Designers have the challenge, and opportunity, to design for innovation, to produce ground-breaking player experience by trying to solve difficult problems in game design such as addressing the relationships between games and learning or asking difficult questions about what games are, what they can be, and what their impact is on the players, both individually and culturally (Fullerton, 2018).

2. Conceptual lenses

2.1. Worldbuilding

There are three dimensions that characterize every game (Aarseth, 2003): gameplay (the players' actions, strategies, and motives), game structure (the rules of the game, including the simulation rules), and game world (fictional content, topology/level design, textures etc.). As such, there are many types of game design (Brathwaite & Schreiber, 2009): system design (the creation of rules and underlying mathematical patterns in a game), user interface (the design of how the players interact with the game and how the player receives information and feedback from the game through game components), world design (the creation of the overall backstory, setting, and

theme of the game; it often determines the scope of all the other design tasks related to the game).

The game world exists in the imagination of the player and the game is a doorway to this world (Schell, 2019). The world presented by the game cues the player into making assumptions about the rules of the game (Juul, 2005). For example, if an object looks like a fishing boat, it is supposed to catch fish. At the same time, the rules of the game cue the player into imagining the world (Juul 2005). For example, if one rule is that all the fish is sold at the end of a round, the player can imagine that there is a market for that fish, even though this market is not explicitly described. Thus, through the combination of rules, mechanics, and components, games create an imaginary world that the players experience. The actions made by players convey a sense of a connected whole: players create a story in the world of the game through the actions they make (Arnaudo, 2018). Worldbuilding is the design this imaginary world, often beginning with space and time representations, but "potentially including complete cultural studies of inhabitants, languages, mythologies, governments, politics, economies etc." (Fullerton, 2018). Designing game worlds bears similarities with the design of imaginary worlds for other media, for example movies, literature, or extended reality (Zaidi, 2017). As such, methods to build worlds or analyze them can be borrowed and used across media.

According to (Wolf, 2014), imaginary worlds have three properties that have to be taken into consideration during the worldbuilding process: invention, completeness, and consistency. Invention can be defined as the degree to which default assumptions based on the real world (or Primary World) have been changed in the game world (or Secondary World), "regarding such

things as geography, history, language, physics, biology, zoology, culture, custom, and so on"
(Wolf, 2014). Designers can decide if they want to invent a lot of the world (e.g. names, artifacts,
technologies, customs, landmasses, animals, creatures, laws of time and space), like in
Gloomhaven (2019), where the action takes place in a fantasy setting. Designers can also stay as
close as possible to the real world, like in *Agricola* (2007), where players are farmers working to
expand their farms in a 17th Century setting. The second property, completeness, refers to the
degree to which the world contains explanations and details covering all the various aspects of
the elements that could be expected to be part of that world. Besides the quantity of details
included in the world, a sense that the world has a background and a past history is also
necessary for it to seem complete. The third property, consistency, is the degree to which world
details are feasible and without contradiction (e.g. the world of *The Manhattan Project: Energy
Empire* (2016)). Lacking consistency may make a game world seem sloppily constructed, or
even random and disconnected. Inconsistencies may appear in the storyline, background details,
world infrastructure, or world mechanics. As each of these properties grow, worldbuilding
becomes more challenging, because increased completeness requires more complex consistency
checks, while consistency will limit what kind of invention is possible when the world grows.
Thus, all three properties should be considered simultaneously as the world takes shape. The
optimal combination of invention, completeness, and consistency would make a game world
more or less believable, possibly having consequences on gameplay and the feeling of immersion
(Wolf, 2014), though sometimes players may become less interested in the representational level
of the game and more focused on the rules of the game (Juul 2005).

When building a game world based on real places, people, or events, one also invokes history. Whether or not the game is designed as a historical game cannot be easily decoupled from the way in which it makes use of aesthetics that evoke a historical setting. A central part of why engagement with the past is seen as meaningful is because these connections speak to the cultural meaning, as articulated by Begy: "Since much of game studies is concerned with the cultural work games do, and their role in society, considering how they construct our understanding of our own past is critical to understanding the medium's capabilities. This in turn has particular implications for debates surrounding the legitimacy of games as historical representations" (Begy, 2017).

In the context of a game that invokes a historical setting, an important element is that games are processes, not artifacts, and through gameplay they provide players with agency in how the representation of history is constructed and experienced (Kapell & Elliott, 2013). Furthermore, games allow players to both experience a systemic context for the actions they make, as well as the consequences of these choices. The place of history in games is not only limited to illustrate actions and reactions, but to foster engagement with the past. Returning to the argument made by Begy (2017), this makes questions of legitimate use of history apparent. The representations of history that players encounter in games can form or shape their understanding of history. This means that game designers have the big responsibility to reflect over the degree of accuracy (or the degree of invention, to use Wolf's concept described above) they aim for when the game worlds they design incorporate or simulate the real world, and to make their decisions explicit, to avoid misunderstandings. For example, *Twilight Struggle* (2005), which simulates the Cold War between the US and Soviet Union, uses the discredited geopolitical "domino theory" as the basis

for its simulation, which makes an engaging game, but can promote misunderstanding of the complexity of the Cold War (Harrigan & Wardrip-fruin, 2011).

By using the worldbuilding lenses, one has a holistic view over the entirety of what is or could be imagined through the game. This perspective facilitates the design for a more immersive player experience, but also opens up for in-depth critical reflection over design choices.

2.2. Socio-ecological systems

Within a system, the component parts and the static relationships among them are the structure of the system, whereas the changes that occur in those components and the relationships among them over time are the processes characteristic of the system (Raser, 1972). Thus, in order to simulate any system, one has to be able to describe both the structure and the processes of the system. Since socio-ecological systems are a set of critical resources - natural, social (including cultural), and economic - whose flow and use are regulated by a combination of ecological and social systems (Redman, Grove, & Kuby, 2004), in the case of SESs, the structure includes component parts from both ecological and social systems. Examples of such systems are fisheries, forestry, agriculture, or urban areas. A socio-ecological system can be described in various way: a coherent system of biophysical and social factors that regularly interact in a resilient, sustained manner; a system that is defined at several spatial, temporal, and organizational scales, which may be hierarchically linked; a perpetually dynamic, complex system with continuous adaptation (Redman et al., 2004). For a detailed description of the characteristics of such systems, see (C. T. Weber, 2019).

As Ostrom (2009) explains, "SESs are composed of multiple subsystems and internal variables within these subsystems at multiple levels analogous to organisms composed of organs, organs of tissues, tissues of cells, cells of proteins, etc. In a complex SES, subsystems such as a resource system (e.g., a coastal fishery), resource units (lobsters), users (fishers), and governance systems (organizations and rules that govern fishing on that coast) are relatively separable but interact to produce outcomes at the SES level, which in turn feed back to affect these subsystems and their components, as well other larger or smaller SESs."

By using the SES lenses, one has to conceptualize the social and ecological elements of what can be represented in a game world and the relationship between these elements, with their interactions and outcomes. As SESs do not exist in a vacuum, one has also to conceptualize the background or context in which these SES elements can exist.

3. GAS framework

3.1. Description

While there are several influential publications for guiding game design (e.g. (Bjork & Holopainen, 2005; Duke, 2014; Elverdam & Aarseth, 2007; Engelstein & Shalev, 2019; Järvinen, 2008; Juul, 2005; McCall, 2020; Schell, 2019), none of these includes a detailed description of how to design the game world. However, since worldbuilding is an exercise undertaken in variety of other fields (e.g. movies, literature, or mixed reality experiences), though the terminology applied to the process may differ (Zaidi, 2017), advice on worldbuilding

from these related media can be adapted for game design and we have used this approach when building the GAS framework. As noted by Rapoport back in 1985, "[…] frameworks are neither models nor theories. Models describe how things work, whereas theories explain phenomena. Frameworks do neither; rather they help to think about phenomena, to order material, revealing patters …" (Rapoport 1985, page 256). As such, we have chosen to call our design and analysis tool a framework. We hope that this tool will help designers and analysis to reflect upon game worlds through the lenses of socio-ecological systems and to structure their design or analysis process.

The GAS framework is visualized in Table 1 (out of space considerations, the table also includes a brief demonstration of the framework). The framework is divided in three parts: decisions that are taken in the beginning of the world design phase (Part A), elements of the socio-ecological system (Part B), and considerations that have to be made in the end of the world design phase (Part C), though these considerations can be kept in mind throughout the design phase.

The elements listed under Part A of the GAS framework invite to reflection over the correspondence between what is intended to be represented through the game world (or the Secondary World) and a previously described system, either fictional or from the real-world (or the Primary World). We call this previously described system a reference system. Building on Wolf's concepts of invention and completeness presented in Section 2 and the work on mental models by (Smythe & Thompson, 2015), the GAS framework includes three reflection points: 1) The degree of accuracy, understood as the extent the game world correctly depicts the reference system. 2) The degree of comprehensiveness, understood as the extent to which the game world

encompasses all of the components of the reference system. 3) The degree of balance, understood as the extent to which the game world is focused equally across the reference system areas of focus.

The elements listed under Part B of the GAS framework build on a fusion of two of the most relevant socio-ecological systems frameworks: (Charles, 2000; Ostrom, 2007, 2009). Ostrom's multitier framework for analyzing a SES provided our GAS framework the conceptual tiers and linkages among the elements that constitute a SES. Because SESs are decomposable systems, each of the highest-tier conceptual element can be unpacked and related to other unpacked elements. Thus, Part B of the GAS framework is organized in levels. Charles' depiction of the fishery system provided some additional elements related to the natural, human, and management systems that interact in an SES where humans rely on the harvesting, processing, and distribution of goods. The framework can be used with any (game) world that is intended to be a representation of a socio-ecological system (e.g. fisheries, forestry, aquaculture, farming, mining, city development).

Part C of the GAS framework brings the attention to the extent in which game elements have a systematic or logical connection, they fit together well, and they do not contradict each other, i.e. degree of consistency of the world or consistency among game elements. Though the GAS framework includes this reflection point as a final check, the degree of consistency should be kept in mind throughout the design phase, especially when building complex worlds where various elements build on each other.

We envisage two types of users of the GAS framework: world designers and researchers/analysts. These can be cross-media world designers and researchers/analysts (e.g. board games, video games, comics, film, literature, extended reality etc.), though the wording of the framework focuses on game designers/analysts. The GAS framework can be used as a complementary tool to any other tools that are out there on game design (Raphael, Bachen, Lynn, Baldwin-Philippi, & McKee, 2010; Schell, 2019) or on world building (Wrede, 2009; Zaidi, 2017).

Worlds designers, be they worldbuilding practitioners across media, graphic designers, or designers of bits for games (e.g. character meeples, shaped resources), can use the framework as a checklist or a fill in matrix. However, the elements of the GAS framework are not exhaustive and items can be added as needed. The framework does not list items in an order of importance, because their importance varies in different contexts. However, it must be made clear that these items are not isolated silos and the SES is not the sum of the elements, but emerges from their integration within a game and through the meaning created by the player from the game manual, title, box, rules, and other elements before, during, or after playing the game. As also explained by (Wrede, 2009), while many of these elements may be helpful or crucial to certain game worlds, they will not all apply to every world. It is not necessary for a designer to include all, or even any, of the elements in order to start or finish designing. The idea is simply to provoke designers into thinking about the ways their settings and backgrounds hang together or not from a SESs perspective. The GAS framework should not be considered as an exhaustive and final list, but as a beginning point from which each individual designer can compile a personal list. The number of elements may lead to confusion about what is essential to the game world and

what is not, and render the process of building a coherent world challenging, especially if

designers are picking and choosing elements from different categories. If coherence is relevant

for the game, then we advise game designers to have this property in mind when reflecting over

the framework elements. Moreover, as (Flanagan, 2009, page 261) noted, "most players are not

attracted to overly didactic communication", thus designers have to reflect over what is the right

balance of elements for their game world in order to create a safe place where players feel

comfortable to play, even in a critical way.

As in the case of designers, the GAS framework can be used as a complementary tool to any

other tools that are out there on game analysis (González & Adelantado, 2016; Lindley, 2003).

By operationalizing elements of a SES, it is possible for researchers/analysts to assess the SES

representation in the game and reflect over what critical theories can be used for analyzing some

elements of the game or the game as SES (e.g. eco-criticism, indigenous criticism).

Table 1. The **G**ame World Design and **A**nalysis for Socio-Ecological **S**ystems (GAS)

framework. The framework can be filled in by the game designer(s) before, during, or after the

design process, or by the game analyst. The framework has three parts: A) Start decisions, B)

Socio-ecological system reference model, and C) Final check. Explanations of how to fill in the

framework are given in square parentheses. The questions of this framework focus on two main

aspects: description of the design choices and reflection of why these choices. The reflection

questions are suitable to be answered by the designer(s). The game analyst can also answer these

questions, based on assumptions or research, which should be made explicit. A brief

demonstration of the framework on *Nusfjord* (2017) is included in italics (see Section 3.2 for more details about this game). The demonstration is using the perspective of a game analyst

3.2. Demonstration

In order to help the reader follow the comments included in the demonstration of the game that is incorporated in Table 1, we provide here a description of the real world system based on which the *Nusfjord* game world is built on, followed by a general description of the game. For the purpose of this study, the Nusfjord coastal area in Norway is considered our focal socio-ecological system.

3.2.1. Nusfjord fishery

The abundance of valuable species such as cod, herring, and mackerel have made fisheries an integral part of Norway as a coastal society, both for sustenance and industry (Kolle, 2017c). The Lofoten seasonal fishery is an important part of the Norwegian past, with accounts dating back as far as there is recorded history. Taking place in February-April, this fishery harvests cod that is returning to the spawning grounds in Lofoten. Participation is not limited to local or regional fishers, but the entire coastal Norway. Historically, the fishery was important for many people with combined livelihoods, in particular those combining fishing and farming. As such, it contributed to both subsistence and commercial fisheries. To give a sense of scale, the fishery is still world's largest coastal cod fishery, with up to 30.000 fishers at its height. People of all ages participated in the fishery. Regional participation varied over time, depending on other

15

employment opportunities (such as construction, mining or industry). For coastal fisher-farmer households, the economic profit gained from fishing was significant. From the early 20th century and onwards, fishing became a more specialized occupation where the fisher spent more time at sea (Kolle, Nielssen, & Døssland, 2017).

To some extent, women participated in fisheries along the Norwegian coast, but participants in the Lofoten fishery were predominantly men. Women played an important part in the fisher-farmer combination, which hinged on a division of labor. As the seasonal fishery was modernized and became more intensive, women handled more of the farming. Preparation for the fishing season (e.g. equipment and provisions) was a shared responsibility, where women played a central role. In the context of commercial fisheries, processing of catch to product was a domain where women had a strong participation, e.g. the traditional production of dried codfish ("stockfish") (Johansen, 2014b).

The Sami are the indigenous people of the northern parts of Norway, Sweden, Finland and Russia. The Sami living in coastal communities in Norway participated in the Lofoten fishery. In 1971, there were few Sami participants from the Northern parts of Norway, but more from the coastal Sami communities closer to Lofoten. The coastal Sami fishers participated in both small-scale fisheries using small boats, as well as higher intensity fishery using larger vessels (Evjen, 2014).

The Lofoten fishery was closely tied to international trade. Fish has been a key Norwegian export since time immemorial. The catch from Lofoten was primarily sold outside the region, not

used for subsistence. Traditionally, fishing boats and equipment were owned by the fishers themselves (Kolle, 2017b, 2017a; Solhaug, 1983).

As a historical phenomenon, the Lofoten fishery has been a major focus for Norwegian discourse on "tradition vs modernization" in fisheries. A central conflict was regulations of fishing gear and vessels. A well-known event that illustrates the tension is the "Battle of Trollfjord" in 1890, where larger vessels attempted to shut out smaller boats from the fishery. Following this, new laws and regulations managing the fishery were introduced, , such as zones for different gear- and vessel types. Tensions were not only about gear, but also the relationship between small-scale fishers and capital and industry stakeholders (Jentoft & Kristoffersen, 1989; Johansen, 2014a). At its core, the Lofoten fishery is an institution, a SES with many stakeholders. The system had developed over time, with the goal of the regulations being safeguarding of small-scale fishers. A key element in understanding how the Norwegian fishery works is the Raw Fish Act of 1938. This law granted the (fisher owned) Norwegian Fishermen's Sales Organization the right to manage the primary sales of fish. During the economic downturn in the 1920s and 30s, fishers experienced poverty and marginalization, resulting in collective action and the introduction of the new law. The act empowered the fishers by allowing the sales organization set a fixed minimum price for fish, reducing the power the fish buyers had over the fishers and securing the financial interests of the fishers (Hersoug, Finstad, & Christensen, 2015; Jentoft & Finstad, 2018).

Due to its historic significance, the Lofoten fishery has become symbolic of coastal culture in Norway. While the size of the fishery has decreased over the past decades, it is still an important

part of the regional economy and food culture. Furthermore, Lofoten's importance, both as a spawning ground for the cod and the basis for small-scale fishers, makes it topical in ongoing discussions about tourism development (Henley, 2016), environmental conservation, and industry development, such as potential petroleum exploration in the area (Kaltenborn, Linnell, Thomassen, & Lindhjem, 2017).

3.2.2.   General description of the *Nusfjord* (2017) game

Uwe Rosenberg's *Nusfjord* (2017) is a competitive strategy Eurogame in the Worker Placement style. The theme is economic development, with the players acting as the owners of a major fishing company in Nusfjord, in the Lofoten archipelago in Norway, during its "heyday". Development is performed by exploiting natural resources and using basic market mechanisms, in addition to considering the advice from the local community (i.e. "the village elders"). To our knowledge, *Nusfjord* is one of the very few board games with commercial fisheries as its main topic. The game features illustrations and graphic design by Patrick Soeder. Following the format from (Borit et al., 2018), an overview of the game is presented in Table 2.

Here we use the terminology from Engelstein and Shalev's *Building Blocks of Tabletop Game Design* (2019) to reference the game mechanics. *Nusfjord* is a competitive game (STR-01). The goal of the players is to develop and expand their harbor and the surrounding area. Each player has their own harbor area board, with dedicated space for buildings, forest tiles, and ships. The game comes with the different decks of buildings that emphasize different elements of the game: "herring", "codfish" and "mackerel", though the connection between the deck names and their

buildings is weak. For example, the "codfish" deck includes three cards that refer to the cod fishery: *Codfish Farm*, *Fish Oil Cookery*, *Stockfishery*. There is a small element of Hidden Information (UNC-08), as each player is provided with a separate hand of buildings in the mid-stages, which they can build before these enter the common pool. The worker mechanic reinforces the economic development theme, as the actions in general do not involve fishing. Players can reserve special actions by recruiting Elders.

Table 2. Summary of the main aspects of the game *Nusfjord* (2017). Classifications with asterisk are reported from www.boardgamegeek.com, the 21th of January 2021.

4. Conclusions

Based on socio-ecological systems theory and world-building design principles, our study expands the pool of tools available to the critical game designer by introducing the Game World Design and Analysis for Socio-Ecological Systems (GAS) framework, a tool for design and analysis of game worlds through socio-ecological systems lenses. The framework shows how focus on the components of socio-ecological systems can inform decisions taken when designers engage in worldbuilding for games, or researchers analyze game worlds. Through focusing on the accuracy, comprehensiveness, and balance of the elements in a game world, it is possible to gauge the correspondence of the game world with a given SES. Not all games aim for historical accuracy or lifelike settings, but by analyzing these elements, designers or analysts can structure their critical reflection on the values and mental models that are embedded in games and how they shape the narratives players create when playing them.

We present a brief demonstration of the framework by analyzing the SES of *Nusfjord* (2017), showing how the game has moderate comprehensiveness and consistency, in addition to low balance and accuracy. Rosenberg has stated that the development of the game began as a stock-market game (M. Weber, 2017), something that is visible in the game's catch distribution mechanic. However, in *Nusfjord*, harvest of resources has no lasting consequences, and the function of the environment is to provide the necessary resources for the expansion of the players' companies. The underlying paradigm, which focuses on development and growth without posing any questions about scarcity and sustainability, is, unfortunately, common in games (Kelly & Nardi, 2014). The actions of players will not affect the sustainability of the fish stocks, and while it is possible to deforest the game world, players can reforest the island instantly.

The GAS framework is intended as a tool that can be combined with other approaches and frameworks, contributing insight on how fields pertaining to governance and natural resource management can be combined with game studies. In light of the current focus on human impact on the natural environment, reflection on how human beings understand our relationship with the resource systems our society depends on is too important for games not to treat seriously. In future research, the GAS approach can also be operationalized more specifically on other topics dealing with sustainability.

The GAS framework is a potentially powerful tool for designers (and game analysts alike) to move players from having a simplified concept of the world they are immersing themselves in

during play to reflecting on all dimensions of socio-ecological systems, as playing (simulation) games is considered a way to understand complex systems of relationships and to acquire a holistic sense of how everything is connected (Schell, 2019). We believe that this move can be achieved through better design of game worlds, a design that enhances reflection about the system to be depicted by the game. "Through participation in a game, the players experience environments and situations where they have meaningful interactions with the elements that are present in the game, creating a space for questioning the content of the game" (Flanagan, 2009). Such questioning, coined as "critical play", is characterized by a careful examination of social, cultural, political, or even personal themes that function as alternates to popular play spaces. Since the meaning players will extract from their play emerges from the choices made by the designers, it is important to be conscious about what implicit mental models are embedded in the game by these choices. As such, the GAS framework can support designers in their iterations, by adding reflection points on how the complexity of socio-ecological systems is considered in the values embedded in their design. This interdisciplinary study lies at the intersection of game studies, history, media and literary studies, and natural resource management research, and contributes to the ongoing discussions on meaningful play in the 21st Century.

References

Aarseth, E. (2003). Playing Research: Methodological approaches to game analysis. In
    Proceedings of the digital arts and culture conference (pp. 1–7). Retrieved from
    http://www.bendevane.com/VTA2012/herrstubbz/wp-
    content/uploads/2012/01/02.GameApproaches2.pdf

Abraham, B., & Jayemanne, D. (2017). Transformations. *Transformations*, *30*, 74–94. Retrieved from https://opus.lib.uts.edu.au/handle/10453/121664

Arnaudo, M. (2018). *Storytelling in the modern board game : narrative trends from the late 1960s to today*. McFarland & Co.

Begy, J. (2017). Board Games and the Construction of Cultural Memory. *Games and Culture*, *12*(7–8), 718–738. https://doi.org/10.1177/1555412015600066

Bjork, S., & Holopainen, J. (2005). *Patterns in game design*. Charles River Media.

Borit, C., Borit, M., & Olsen, P. (2018). Representations of Colonialism in Three Popular, Modern Board Games: Puerto Rico, Struggle of Empires, and Archipelago. *Open Library of Humanities*, *4*(1). https://doi.org/10.16995/olh.211

Brathwaite, B., & Schreiber, I. (2009). *Challenges for game designers*. Charles River Media, a part of Course Technology.

Chang, A. (2011). Games as environmental texts. *Qui Parle: Critical Humanities and Social Sciences*, *19*(2), 57–84. https://doi.org/10.1353/qui.2011.0009

Chapman, A., Foka, A., & Westin, J. (2017). Introduction: what is historical game studies? *Rethinking History*, *21*(3), 358–371. https://doi.org/10.1080/13642529.2016.1256638

Charles, A. (2000). *Sustainable Fishery Systems*. *Sustainable Fishery Systems*. Oxford, UK: Blackwell Science Ltd. https://doi.org/10.1002/9780470698785

Defries, R., & Nagendra, H. (2017). Ecosystem management as a wicked problem. *Science*, *356*(6335), 265–270. https://doi.org/10.1126/science.aal1950

Duke, R. D. (2014). Gaming: The Future's Language. Retrieved from http://cds.cern.ch/record/1748239

Elverdam, C., & Aarseth, E. (2007). Game Classification and Game Design. *Games and Culture*,

2(1), 3–22. https://doi.org/10.1177/1555412006286892

Engelstein, G., & Shalev, I. (2019). *Building Blocks of Tabletop Game Design. Building Blocks of Tabletop Game Design*. CRC Press. https://doi.org/10.1201/9780429430701

Epstein, A. (2020). Game on: How COVID-19 became the perfect match for gamers. Retrieved from https://www.weforum.org/agenda/2020/09/covid19-coronavirus-pandemic-video-games-entertainment-media/

Evjen, B. (2014). Åpning for sjøsamiske rettigheter? In P. Christensen (Ed.), *Norges fiskeri- og kysthistorie, bind IV*. Fagbokforlaget.

Flanagan, M. (2009). *Critical Play*. The MIT Press. https://doi.org/10.7551/mitpress/7678.001.0001

Fullerton, T. (2018). *Game Design Workshop*. A K Peters/CRC Press. https://doi.org/10.1201/b22309

González, C. S. G., & Adelantado, V. N. (2016). A Structural Theoretical Framework Based on Motor Play to Categorize and Analyze Active Video Games. *Games and Culture*, *11*(7–8), 690–719. https://doi.org/10.1177/1555412015576613

Harrigan, P., & Wardrip-fruin, N. (2011). Twilight Struggle and Card-Driven Historicity. In *Tabletop: Analog Game Design* (pp. 159–165).

Henley, J. (2016). Norway's Lofoten islands "risk being overrun by tourists." Retrieved from https://www.theguardian.com/world/2016/aug/03/norways-lofoten-islands-risk-being-overrun-by-tourists

Hersoug, B., Finstad, B. P., & Christensen, P. (2015). The system of Norwegian fish sales unions – An anachronism or a successful adaptation to modern fisheries? *Acta Borealia*, *32*(2), 190–204. https://doi.org/10.1080/08003831.2015.1089670

Holm, P., & Finstad, B. P. (2020). 6 April 18, 1989: The Acceptance of Overfishing in Norway. In Á. Garrido & D. J. Starkey (Eds.), *Too Valuable to be Lost. Overfishing in the North Atlantic since 1880* (pp. 109–128). De Gruyter Oldenbourg. https://doi.org/10.1515/9783110641738-007

Hoy, B. (2018). Teaching History With Custom-Built Board Games. *Simulation & Gaming*, *49*(2), 115–133. https://doi.org/10.1177/1046878118763624

Järvinen, A. (2008). Games without frontiers: Theories and methods for game studies and design. Tampere University Press. Retrieved from https://trepo.tuni.fi/bitstream/handle/10024/67820/978-951-44-7252-7.pdf?sequence=1

Jentoft, S., & Finstad, B. P. (2018). Building fisheries institutions through collective action in Norway. *Maritime Studies*, *17*(1), 13–25. https://doi.org/10.1007/s40152-018-0088-6

Jentoft, S., & Kristoffersen, T. (1989). Fishermen's Co-management: The Case of the Lofoten Fishery. *Human Organization*. https://doi.org/10.17730/humo.48.4.k045637kv290u886

Johansen, K. E. (2014a). Eit tidsskilje – motoriseringa. In *Norges fiskeri- og kysthistorie, bind III* (pp. 75–103). Fagbokforlaget.

Johansen, K. E. (2014b). Levestandard, likskap og livssyn. In *Norges fiskeri- og kysthistorie, bind III*. Fagbokforlaget.

Juul, J. (2005). Half-Real: A Dictionary of Video Game Theory. Retrieved February 23, 2020, from http://www.half-real.net/dictionary

Kaltenborn, B. P., Linnell, J. D. C., Thomassen, J., & Lindhjem, H. (2017). Complacency or resilience? Perceptions of environmental and social change in Lofoten and Vesterålen in northern Norway. *Ocean and Coastal Management*, *138*, 29–37. https://doi.org/10.1016/j.ocecoaman.2017.01.010

Kapell, M. W., & Elliott, A. B. R. (2013). *Playing with the Past : Digital games and the simulation of history*. Bloomsbury Academic. https://doi.org/10.5040/9781628928259

Kelly, S., & Nardi, B. (2014). Playing with sustainability: Using video games to simulate futures of scarcity. *First Monday*, *19*(5). https://doi.org/10.5210/fm.v19i5.5259

Kolle, N. (2017a). An Industry in Transition, 1945-1970. In *Fish, Coast and Communities: A History of Norway*. Fagbokforlaget.

Kolle, N. (2017b). Between Tradition and Modernity, 1880-1945. In *Fish, Coast and Communities: A History of Norway* (pp. 17–206). Fagbokforlaget.

Kolle, N. (2017c). The Norwegian Coast - Nature's Offerings. In *Fish, Coast and Communities: A History of Norway* (pp. 13–38). Fagbokforlaget.

Kolle, N., Nielssen, A. R., & Døssland, A. (2017). *Fish, Coast and Communities: A History of Norway*. (A. Kolle, Nils; Nielssen, Alf Ragnar; Døssland, Ed.). Fagbokforlaget.

Kotchen, M. J., & Young, O. R. (2007, May 1). Meeting the challenges of the anthropocene: Towards a science of coupled human-biophysical systems. *Global Environmental Change*. Pergamon. https://doi.org/10.1016/j.gloenvcha.2007.01.001

LaPensée, E. (2016). Indigenous Board Game Design in The Gift of Food. *Analog Game Studies*, *III*(II). Retrieved from http://analoggamestudies.org/?s=Indigenous+Board+Game+Design+and+the+Gift+of+Food

Lindley, C. (2003). Game Taxonomies: A High Level Framework for Game Analysis and Design. Retrieved from https://www.gamasutra.com/view/feature/131205/game_taxonomies_a_high_level_.php

McCall, J. (2016). Teaching History With Digital Historical Games. *Simulation & Gaming*,

47(4), 517–542. https://doi.org/10.1177/1046878116646693

McCall, J. (2020). The Historical Problem Space Framework: Games as a Historical Medium. *Game Studies*, *3*.

Ostrom, E. (2007, September 25). A diagnostic approach for going beyond panaceas. *Proceedings of the National Academy of Sciences of the United States of America*. National Academy of Sciences. https://doi.org/10.1073/pnas.0702288104

Ostrom, E. (2009). A General Framework for Analyzing Sustainability of Social-Ecological Systems. *Science*, *325*(5939).

Peters, V., & Westelaken, M. van de. (2014). Simulation games - A concise introduction to the design process. Nijmegen: Samenspraak Advies Nijmegen. Retrieved from http://www.samenspraakadvies.nl/publicaties/Simulation games -an introduction to the design process.pdf

Pobuda, T. (2018). Assessing Gender and Racial Representation in the Board Game Industry. *Analog Game Studies*, *V*(IV). Retrieved from http://analoggamestudies.org/2018/12/assessing-gender-and-racial-representation-in-top-rated-boardgamegeek-games/

Raphael, C., Bachen, C., Lynn, K.-M., Baldwin-Philippi, J., & McKee, K. A. (2010). Games for Civic Learning: A Conceptual Framework and Agenda for Research and Design. *Games and Culture*, *5*(2), 199–235. https://doi.org/10.1177/1555412009354728

Rapoport, A. (1985). Thinking about Home Environments. In *Home Environments* (pp. 255–286). Boston, MA: Springer US. https://doi.org/10.1007/978-1-4899-2266-3_11

Raser, J. R. (1972). *Simulation and Society* (4th ed.). Boston: Allyn and Bacon, Inc.

Redman, C. L., Grove, J. M., & Kuby, L. H. (2004). Integrating Social Science into the Long-

Term Ecological Research (LTER) Network: Social Dimensions of Ecological Change and Ecological Dimensions of Social Change. *Ecosystems*, *7*(2), 161–171. https://doi.org/10.1007/s10021-003-0215-z

Rosenberg, U. (2017). Nusfjord. Lookout Games.

Schell, J. (2019). *The art of game design: A book of lenses, 3rd edition*. *The Art of Game Design: A Book of Lenses, 3rd Edition*. A K Peters/CRC Press. https://doi.org/10.1201/b22101

Smythe, T. C., & Thompson, R. (2015). Conceptualizing Coastal Ecosystem-Based Management: A Mental Models Approach. *Society and Natural Resources*, *28*(1), 38–56. https://doi.org/10.1080/08941920.2014.933921

Solhaug, T. (1983). *De norske fiskeriers historie 1815-1880* (2nd ed.). Universitetsforlaget.

Weber, C. T. (2019). *Towards a Framework to Guide and Facilitate Interdisciplinary Social-Ecological System Research in Practice*. UIT - The Arctic University of Norway.

Weber, M. (2017). Uwe Rosenberg über Nusfjord und Worker-Placement. Retrieved from https://www.reich-der-spiele.de/speicals/Rosenberg-Nusfjord-0000297

Wolf, M. J. P. (2014). *Building Imaginary Worlds: The Theory and History of Subcreation*. Routledge.

Wrede, P. C. (2009). Fantasy Worldbuilding Questions. Retrieved from http://www.sfwa.org/2009/08/fantasy-worldbuilding-questions/

Zaidi, L. (2017). Building brave new worlds: Science fiction and transition design. Toronto: OCAD University. Retrieved from https://www.researchgate.net/publication/321886159_Building_Brave_New_Worlds_Science_Fiction_and_Transition_Design

Table 1.

Are you a game designer or a game analyst?	[If you are a game analyst, at all the reflection questions included in this framework explain what you consider the reasons of the game designer(s) were and if your answer is based on assumptions or on research.] [If you are a game analyst, answer the different parts of the framework in this order: A1, B, A2, C.] *Analyst.*
A. START DECISIONS	
A.1. Description of the system represented in the game	
A.1.1. What is the system represented in the game?	[Write a short description of this system.] *The fishing village Nusfjord, in Lofoten archipelago, Northern Norway, "50 years ago".*
A.1.2. Is the system represented in the game a socio-ecological system? If yes, what system?	[If the game includes biophysical (natural) and social (including economic and/or cultural) variables, the answer to this question is yes.] [If the answer to this question is no, there is no need to continue using this framework.] *Yes. Exploitation of fishery and forestry.*

A.1.3. Is the system represented in the game based on a previously described system, from real world or fictional? If yes, which one? If no, jump to question B.1.	[If the answer to this question is yes, write a short description of this previously described system, from the real world or fictional. Include a reference to a publicly available description of this system.] [If the answer to this question is no, jump to question B.1.] *Yes, the real world village Lofoten, in Norway. See Section 3.2.1 for a description.*	
A.2. Correspondence of the game with the reference model (reference model = the model of the real world or fictional system described at A.1.3)		
A.2.1. To what extent the game depicts correctly the reference model (i.e. the degree of accuracy)?	[If the reference model is based on a real word system, consider to what extent the game model depicts correctly historical events.] [Write a short description and/or choose a number between 1 and 5, where 1 means to a low extent and 5 to a large extent.]	[Explain why you chose this degree of accuracy.] *The mechanic of building boats does not match the ownership system where the vessels and equipment was owned by the fishers, or that the Lofoten fishery was mainly seasonal, with participation from visiting fishers from the entire Norwegian coast. The framing of distribution via stock ownership does not match the historical systems, as in the period Nusfjord is set, the cooperative system and the Norwegian Fishermen's Sales-organization's monopoly was in effect. With the exception of some cards (e.g. Shipping Line and Customs Area), there are few references*

	Score 2 (low). The game creates a suitable world for players to run a major private company that harvests local natural resources to develop the area. Seen only as such, this works well. However, the stories the players experience when playing the game do not either represent the past or give insight into the interactions between historical stakeholders and their interplay with their environment.	*to export of fish, which was the main market for the historical Lofoten fishery. The laws governing the Lofoten fishery can be seen as an example of institutional sustainability, where the concerns for the many people relying on the fishery (and the fish stocks) were given more weight than industrial efficiency (Holm & Finstad, 2020). As such, intensive catch methods such seine fishing have been forbidden since the end of the 19th Century. However, the game depicts intensive modernization of the fleet. The occupations of the Elders are anachronistic (e.g. aquaculture rose to prominence several decades after the time-period of the game).* *Forestry is a prominent part of the game, but commercial forestry is not possible in the archipelago due to the climatic conditions.* *Several artwork elements break with the historical accounts. The game boards show the archipelago and forests in sunny summer weather, which is not the season where the cod fishery takes place. The presence of various boat types (sloops, cutters, and schooners) are mostly variations of sailing ships that date from before the mid-1900s. The*

31

		Sami people are highly visible in the Elders artwork. However, this representation is not representative of the Sami participation in the Lofoten fishery, as many coastal Sami fishers participated as fishers.
A.2.2.To what extent the game model encompasses all of the components of the reference model (i.e. the degree of comprehensiveness)?	[Write a short description and/or choose a number between 1 and 5, where 1 means to a low extent and 5 to a large extent.] *Score 3 (moderate).*	[Explain why you chose this degree of comprehensiveness.] *The game world encompasses many of the components of the reference system (see GAS Part B). The ecological elements are present, but as relatively unchanging, affected only by player actions. The artwork presents a stylized representation of the nature of the Lofoten archipelago, but does not manage to go beyond the clichéd landscapes described by (Chang, 2011), being mainly represented as a backdrop and a resource (Abraham & Jayemanne, 2017). The economic models are highly present and well developed, but do not interact with the related ecosystems. Many of the social components are present, but some categories are missing (gender) or misrepresented (indigenous peoples). The elements of social-to-social interaction are well represented, but social-to-ecological interaction is weak. Social performance is highly visible as a result of the development done by*

		players, but ecological performance and effects on other SESs are not touched upon.
A.2.3. To what extent the game model is focused equally across the reference model areas of focus (i.e. the degree of balance)?	[Write a short description and/or choose a number between 1 and 5, where 1 means to a low extent and 5 to a large extent.] *Score 2 (low).*	[Explain why you chose this degree of balance.] *Out of the five areas of focus, only the ecological one is well represented (see GAS Part B). Social components and interactions are somewhat represented. External forces and outcomes have little focus.*

B. SOCIO-ECOLOGICAL SYSTEMS REFERENCE MODEL – Which of these elements are represented in the game and why?					
Level 1	**Level 2**	**Level 3**	**Level 4**	**Presence: Yes/No**	**Reflection: Why this choice?**
B.1. External forces	1.1 Settings	1.1.1 Economic development		*Yes*	*Main objective of the game.*
		1.1.2 Demographic trends		*No*	*Might be implied.*
		1.1.3 Political stability		*Yes*	*Players interact with leadership through recruiting elders.*

		1.1.4 Government resource policies		*No*	*Not explicit, but the game rules can be considered implied policies.*
		1.1.5 Market incentives		*Yes*	*Stock markets and supplies of game elements to acquire.*
		1.1.6 Media organization		*No*	
	1.2 Related ecosystems	1.2.1 Climate patterns		*No*	
		1.2.2 Pollution patterns (e.g. air, water, land)		*No*	
		1.2.3 Flows into and out of focal SES		*No*	
B.2. Ecological	2.1 Resource system	2.1.1 Sector (e.g. water, forests, pasture, fish)		*Yes*	*Forestry and fishery.*
		2.1.2 Clarity of system boundaries		*Yes*	*Sectors are separate.*

		2.1.3 Size of resource system		*Yes*	*Limited by game components.*
		2.1.4 Human-constructed facilities		*Yes*	*Both implied and explicit on game boards and cards.*
		2.1.5 Productivity of system		*Yes*	*Main focus of game.*
		2.1.6 Equilibrium properties		*Maybe*	*Might be implied.*
		2.1.7 Predictability of system dynamics		*Yes*	*Production of systems and costs are open information.*
		2.1.8 Storage characteristics		*No*	
		2.1.9 Location		*Yes*	*Regulated by game rules and components.*
	2.2 Resource units	2.2.1 Resource unit mobility		*Yes*	*Between game supply and player boards.*

		2.2.2 Growth or replacement rate		*Yes, but*	*No connection with real world. Controlled by player actions.*
		2.2.3 Interaction among resource units		*Yes*	*Conversion through game actions.*
		2.2.4 Economic value		*Yes*	*Abstracted, based on costs of cards.*
		2.2.5 Number of units		*Yes*	*Abstract tokens representing resources.*
		2.2.6 Distinctive markings		*Yes*	*Fish, branch, and coin shaped tokens.*
		2.2.7 Spatial and temporal distribution		*Yes and no*	*Forests placed on player boards, but temporality is weak as production is*

36

					controlled by player actions.
B.3. Social	3.1 Governance systems	3.1.1 Government organizations		*No*	*Not explicitly stated.*
		3.1.2 Nongovernment organizations		*Yes*	*Player companies.*
		3.1.3 Network structure		*Yes*	*Companies have their own networks, connected to Elders and community banquet table.*
		3.1.4 Property-rights systems		*Yes*	*Player owned game elements can only be manipulated willingly.*
		3.1.5 Operational rules		*Yes*	*Game rules structure.*
		3.1.6 Collective-choice rules		*No*	
		3.1.7 Constitutional rules		*No*	

37

		3.1.8 Monitoring and sanctioning processes		*No*	
		3.1.9 Markets	3.1.9.1 Harvest	*Yes*	*Central in mechanics.*
			3.1.9.2 Processing	*Yes*	*Central in mechanics.*
			3.1.9.3 Distribution	*Yes*	*Central in mechanics.*
			3.1.9.4 Wholesale / Retail	*Yes*	*Use of resources to build and use buildings.*
			3.1.9.5 Consumers	*Yes*	*Community banquet table.*
	3.2 Users	3.2.1 Individual attributes	3.2.1.1 Values, culture, beliefs, worldviews	*Yes*	*Building cards.*
			3.2.1.2 Knowledge	*Yes*	*Elders, building cards.*
			3.2.1.3 Ethics	*No*	

			3.2.1.4 Perception, preferences	*Yes*	*Elders have skills, building cards.*
			3.2.1.5 Importance of resource to user	*Yes*	*Building cards.*
		3.2.2 Socio-economic attributes	3.2.2.1 Number of users	*Yes*	*Player companies, workers.*
			3.2.2.2 Age	*No*	*Only elders.*
			3.2.2.3 Gender	*No*	*Only males. This makes the game an example of the lack of gender diversity in game art (Pobuda, 2018).*
			3.2.2.1 Indigenous peoples	*Yes, but*	*Elder cards show Sami people, but misrepresented.*
		3.2.3 Norms / social capital		*Yes*	*Elders have skills.*

		3.2.4 History of use		*Yes*	*Game art, building cards.*
		3.2.5 Technology used		*Yes*	*Game components.*
		3.2.6 Location		*Yes*	*Game art, game description.*
		3.2.7 Leadership / entrepreneurship		*Yes*	*Elder cards, player companies.*
		3.2.8 Welfare		*Yes*	*Building cards.*
B.4. Interactions	4.1 Social to ecological	4.1.1 Harvesting levels of diverse users		*Yes, but*	*The fish stock is a passive and reliably, but unrealistically provides the maximum possible yield. Several options for cutting down, thinning out or planting new forests.*

	4.2 Social to social	4.2.1 Information sharing among users		*Yes*	*Most information is open, small amount of private information.*
		4.2.2 Deliberation processes		*Maybe*	*Except "table talk", bribe elders with fish.*
		4.2.3 Conflicts among users		*Yes*	*Limited actions and buildings in supply.*
		4.2.4 Investment activities		*Yes*	*Core mechanic.*
		4.2.5 Lobbying activities		*Yes*	*Recruiting elders.*
		4.2.6 Self-organizing activities		*No*	*Not explicitly in rules.*
		4.2.7 Networking activities		*Yes*	*Player companies are networks of game assets.*
B.5. Outcomes	5.1 Ecological performance			*No*	*Player actions have no consequences on resource systems.*

	5.2 Social performance			*Yes*	*Developments show increase in industrial capacities and amenities.*
	5.3 Externalities to other SES			*No*	*No implicit effect on other SES.*

C. FINAL CHECK		
C.1. To what extend do the game elements have a systematic or logical connection, they fit together well, and they do not contradict each other (i.e. degree of consistency of the world or consistency among game elements)?	[Write a short description and/or choose a number between 1 and 5, where 1 means to a low extent and 5 to a large extent.] *Score 3 (moderate).*	[Explain why you chose this degree of consistency.] *Fishing and forestry exhibit an internal logic, but the buildings do not fit together well, as mixed in with buildings that match the expressed theme, there are castles and tourist attractions. The artwork contributes to lack of consistency by suggesting a confusing sense of what time-period the game takes place in, placing sailing ships and vehicles from different eras in the same environment.*

Table 2.

	Nusfjord (2017)
Release year	2017
Number of players	1-5
Playing time (minutes)	20-100
Age	12+
Score*	7.6 out 10
Rank overall*	378
Strategy rank*	220
Ratings*	4000
Game type*	Strategy
Game category*	Economic
Mechanisms*	Worker placement
Game focus	Development, Resource management and optimization
Historical time	Unclear. Gamebox states "50 years ago".
Geographical space	Lofoten Archipelago, Northern Norway
Player perspective	Owner of major fishing company
Player goal	Develop and expand the harbor and the surrounding landscape
Player gender	Not explicitly stated
Player main actions	Build buildings and ships Buy and issue shares Cut, thin out or replant forests Take and use "Village Elders" Serve fish and get gold

	Transfer resources from personal reserve
Main non-player characters (NPCs)	Village Elders (all men), affiliated to different domains: Constructions (Contractor, Builder, Carpenter, Architect), Forestry (Forest Manager, Silviculturist, Forester, Ranger), Shipyard (Constructor, Engineer), Governance / management (Sponsor, Steward, Harbor Master), Aquaculture (Pond Builder, Pisciculturist), Fishing (Shipowner, Sailor, Fish Deliverer).
Other NPCs	None
Resources	Workers Gold Wood Fish
Markets	Stock market Player built buildings Supply of elders
Constructions	Each game uses three decks of different building cards. Each building has various functions.

Biographical statements

Jørn Weines is a PhD Candidate in social science at the Norwegian College of Fishery Science, UiT The Arctic University of Norway, in Tromsø, Norway. Trained as a historian focusing on theory and methodology, he has previously worked on projects involving local-ecological knowledge, indigenous studies, and governance. His current research is on the use of game-based learning in fisheries education and historical game studies.

Melania Borit is an Associate professor in modelling and simulation of social processes at the Norwegian College of Fishery Science, UiT The Arctic University of Norway, in Tromsø, Norway. Being an interdisciplinary researcher, she has a wide range of interconnected research interests: social simulation, agent-based modelling, design of autonomous (social) agents; pedagogy and didactics in higher education, games and game-based learning; culture and fisheries management, seafood traceability; futures studies.

Works cited

Agarwal, P., Bain, P. & Chamberlain, R. 2012. "The Value of Applied Research: Retrieval Practice Improves Classroom Learning and Recommendations from a Teacher, a Principal, and a Scientist". Educational Psychology Review, 24(3), 437–448. doi:10.1007/s10648-012-9210-2

Ameerbakhsh, O., Maharaj, S., Hussain, A., & McAdam, B. 2019. "A comparison of two methods of using a serious game for teaching marine ecology in a university setting". International Journal of Human Computer Studies, 127(September 2017), 181–189. https://doi.org/10.1016/j.ijhcs.2018.07.004

Apperley, T. 2013. "Modding the Historians' Code: Historical Verisimilitude and the Counterfactual Imagination" in *Playing with the Past: Digital Games and the Simulation of History*, edited by Kapell and Elliott, 185–198. Routledge. https://doi.org/10.5040/9781628928259.ch-012

Ariffin, M. M., Oxley, A., & Sulaiman, S. 2014) "Evaluating Game-based Learning Effectiveness in Higher Education". Procedia - Social and Behavioral Sciences, 123, 20–27. https://doi.org/10.1016/j.sbspro.2014.01.1393

Barnabè, F. 2015. "Managerial Myopia in Mismanaging Renewable Resources The GONE FISHING Game". Simulation & Gaming, 46(6), 763–791. https://doi.org/10.1177/1046878115615991

Bell-Gawne, K., Stenerson, M., Shapiro, B., & Squire, K. 2013) "Meaningful Play: The Intersection of Video Games and Environmental Policy". World Futures Review, 5(3), 244–250. https://doi.org/10.1177/1946756713497472

Bellotti, F., Kapralos, B., Lee, K., Moreno-Ger, P., & Berta, R. 2013. "Assessment in and of Serious Games: An Overview". Advances in Human-Computer Interaction, 2013, 1–11. https://doi.org/10.1155/2013/136864

Berg Marklund, B. 2015. Unpacking Digital Game-Based Learning : The complexities of developing and using educational games. Dissertation Series NV - (2016) 8. Retrieved from http://his.diva-portal.org/smash/get/diva2:891745/FULLTEXT01.pdf%0Ahttp://urn.kb.se/resolve?urn=urn:nbn:se:his:diva-11805

Biggs, J., & Tang, C. 2011. *Teaching for Quality Learning at University*. 4th Edition. McGraw-Hill Education.

Binkley, M., Erstad, O., Herman, J., Raizen, S., Ripley, M., Miller-Ricci, M., & Rumble, M. 2012. "Defining Twenty-First Century Skills". Assessment and Teaching of 21st Century Skills. https://doi.org/10.1007/978-94-007-2324-5

Blanchard, O., & Buchs, A. 2015. "Clarifying Sustainable Development Concepts Through Role-Play". Simulation & Gaming, 46(6), 697–712. https://doi.org/10.1177/1046878114564508

Bonwell, C. C. & Eison, J. A. 1991. *Active Learning: Creating Excitement in the Classroom*. ASHE-ERIC Higher Education Report No. 1. Washington, D.C.: The George Washington University, School of Education and Human Development.

Booth, P. 2018. "Missing a Piece: (The Lack of) Board Game Scholarship in Media Studies". The Velvet Light Trap, 81(81), 57. https://doi.org/10.7560/VLT8106

Borit, M., Stangvaltait-Mouhat, L. 2020. "GoDental! Enhancing flipped classroom experience with game-based learning". European Journal of Dental Education, 24(4), 763–772. https://doi.org/10.1111/eje.12566

Boyle, E. A., Hainey, T., Connolly, T. M., Gray, G., Earp, J., Ott, M., Pereira, J. 2016. "An update to the systematic literature review of empirical evidence of the impacts and outcomes of computer games and serious games". Computers and Education, 94, 178–192. https://doi.org/10.1016/j.compedu.2015.11.003

Brattland, C., Eythórsson, E., Weines, J., & Sunnanå, K. 2018. "Social–ecological timelines to explore human adaptation to coastal change". Ambio 48, 1516–1529 https://doi.org/10.1007/s13280-018-1129-5

Broderstad, E. G., and E. Eythórsson. 2014. "Resilient communities? Collapse and recovery of a social-ecological system in Arctic Norway". Ecology and Society 19(3): 1. http://dx.doi.org/10.5751/ES-06533-190301

Chapman, A 2016. *Digital Games as History*. Routledge. https://doi.org/10.4324/9781315732060.

Chapman, A., Foka, A., and Westin, J.". 2017. "Introduction: What Is Historical Game Studies?" Rethinking History 21(3): 358–71.

Charles, A. T. 2001. *Sustainable Fishery Systems Fish and Aquatic Resources Series*. Wiley-Blackwell.

Chin, J., Dukes, R., & Gamson, W. 2009. "Assessment in Simulation and Gaming". Simulation & Gaming, vol 40(4), 553–568. https://doi.org/10.1177/1046878109332955

Christensen, P. 2014. "EF-strid og 200 mils økonomisk sone". In *Norges fiskeri- og kysthistorie, Bind IV: Havet, fisken og oljen, 1970-2014*, edited by Pål Christensen, 33–68. Fagbokforlaget. Bergen.

Clapper, T. C. 2018. "Capitalizing on the Most Important Part of a Learning Session: The Experience". Simulation and Gaming, 49(1), 3–7. https://doi.org/10.1177/1046878118755155

Connolly, T. M., Boyle, E. A., MacArthur, E., Hainey, T., & Boyle, J. M. 2012. "A systematic literature review of empirical evidence on computer games and serious games". Computers and Education, 59(2), 661–686. https://doi.org/10.1016/j.compedu.2012.03.004

Crookall, D. 2010. "Serious Games, Debriefing, and Simulation/Gaming as a Discipline". Simulation & Gaming, 41(6), 898–920. https://doi.org/10.1177/1046878110390784

Defries, R., & Nagendra, H. 2017. "Ecosystem management as a wicked problem", Science 270(April), 265–270. https://doi.org/10.1126/science.aal1950

Deterding, S. 2017. "The Pyrrhic Victory of Game Studies: Assessing the Past, Present, and Future of Interdisciplinary Game Research". Games and Culture, 12(6), 521–543. https://doi.org/10.1177/1555412016665067

Dichev, C., & Dicheva, D. (2017). "Gamifying education: what is known, what is believed and what remains uncertain: a critical review". International Journal of Educational Technology in Higher Education (Vol. 14). https://doi.org/10.1186/s41239-017-0042-5

Dicheva, D., Dichev, C., Agre, G., & Angelova, G. 2015. "Gamification in Education : A Systematic Mapping Study". Educational Technology & Society, 18(June), 75–88.

Dieleman, H., & Huisingh, D. 2006. "Games by which to learn and teach about sustainable development: exploring the relevance of games and experiential learning for sustainability". Journal of Cleaner Production, 14(9–11), 837–847. https://doi.org/10.1016/j.jclepro.2005.11.031

Ejsing-Duun, S., & Hanghøj, T. 2019. "Design Thinking, Game Design, and School Subjects: What is the Connection?" In: L. Elbaek, G. Majgaard, A. Valente, & S. Khalid (Eds.), Proceedings of the 13th International Conference on Game Based Learning, ECGBL 2019 (p. 201-209). Academic Conferences and Publishing International. https://doi.org/10.34190/GBL.19.143

Esarey, J. & Valdes, N. 2020. "Unbiased, reliable, and valid student evaluations can still be unfair". Assessment & Evaluation in Higher Education, 45:8, 1106-1120, DOI: 10.1080/02602938.2020.1724875

Finstad, B. P. 2014. "Markedstilpasning og globalisering". *In Norges fiskeri- og kysthistorie, Bind IV: Havet, fisken og oljen, 1970-2014*, edited by Pål Christensen, 185–214. Fagbokforlaget. Bergen.

Fron, J., Fullerton, T., Ford Morie, J., and Pearce, C. 2007. "The Hegemony of Play". Situated Play, Proceedings of DiGRA 2007 Conference: 309–18. http://www.digra.org/dl/db/07312.31224.pdf

Gibbs, P., Cartney, P., Wilkinson, K., Parkinson, J., Cunningham, S., James-Reynolds, C., Zoubir, T., Brown, V., Barter, P., Sumner, P., MacDonald, A., Dayananda, A. and Pitt, A. 2017. "Literature review on the use of action research in higher education". Educational Action Research, 25:1, 3-22, DOI: 10.1080/09650792.2015.1124046

Handegård, O. 2010. *NFH, FTFI og NFFR : 1945-1975 : lokaliseringsbeslutningene - en dokumentasjon : noen organisasjonsmessige endringsprosesser 1976-2009*. Vale forl.

Hamari, J., Shernoff, D. J., Rowe, E., Coller, B., Asbell-Clarke, J., & Edwards, T. 2016. "Challenging games help students learn: An empirical study on engagement, flow and immersion in game-based learning". Computers in Human Behavior, 54, 170–179. https://doi.org/10.1016/j.chb.2015.07.045

Hammar, E. L. 2017. "Counter-hegemonic commemorative play: marginalized pasts and the politics of memory in the digital game Assassin's Creed: Freedom Cry". Rethinking History: 21(3), 372–395. https://doi.org/10.1080/13642529.2016.1256622

Hanghøj, T., Krog Skott , C., Nielsen, B. L., & Ejsing-Duun, S. 2019. "Developing Design Principles for Game-Related Design Thinking Activities". In: L. Elbaek, G. Majgaard, A. Valente, & S. Khalid (red.), Proceedings of the 13th International Conference on Game Based Learning, ECGBL 2019 (s. 308-316). Academic Conferences and Publishing International. Proceedings of the European Conference on Games-based Learning https://doi.org/10.34190/GBL.19.120

Hardin, G. 1968. "The Tragedy of the Commons". Science 162: 1243-1248.

Hattie, J. 2011. "Which Strategies Best Enhance Teaching and Learning in Higher Education?" In Empirical Research in Teaching and Learning. https://doi.org/10.1002/9781444395341.ch8

Hawlitschek, A., & Joeckel, S. 2017. "Increasing the effectiveness of digital educational games: The effects of a learning instruction on students' learning, motivation and cognitive load". Computers in Human Behavior, 72, 79–86. https://doi.org/10.1016/j.chb.2017.01.040

Holm, P., Finstad, B. P. and Christensen, P. 2014. "Aldri mer 18. april!". In *Norges fiskeri- og kysthistorie, Bind IV: Havet, fisken og oljen, 1970-2014*, edited by Pål Christensen, 185–214. Fagbokforlaget. Bergen.

Holm P., Aglen A., Bjørkan M., Andersen J.I. 2020. "Trapped in the TAC Machine: Making a Fisheries-Based Indicator System for Coastal Cod in Steigen, Norway". In: Holm P., Hadjimichael M., Linke S., Mackinson S. (eds*) Collaborative Research in Fisheries*. MARE Publication Series, vol 22. Springer, Cham. https://doi-org.mime.uit.no/10.1007/978-3-030-26784-1_9

Holm, P., & Finstad, B. P. 2020. "6 April 18, 1989: The Acceptance of Overfishing in Norway". In Á. Garrido & D. J. Starkey (Eds.), *Too Valuable to be Lost. Overfishing in the North Atlantic since 1880*, 109–128. De Gruyter Oldenbourg. https://doi.org/10.1515/9783110641738-007

Hoy, B.. 2018. "Teaching History With Custom-Built Board Games". Simulation & Gaming 49(2). https://doi.org/10.1177/1046878118763624.

Iten, N., & Petko, D. 2016. "Learning with serious games: Is fun playing the game a predictor of learning success?" British Journal of Educational Technology, 47(1), 151–163. https://doi.org/10.1111/bjet.12226

Jabbar, A & Felicia, P. 2015. "Gameplay Engagement and Learning in Game-Based Learning: A Systematic Review". Review of Educational Research, 85(4), 1–40. https://doi.org/10.3102/0034654315577210

Jentoft, S., & Chuenpagdee, R. 2009. "Fisheries and coastal governance as a wicked problem". Marine Policy, 33, 553–560.

Jentoft, S., & Finstad, B. P. 2018. "Building fisheries institutions through collective action in Norway". Maritime Studies, 17(1), 13–25. https://doi.org/10.1007/s40152-018-0088-6

Jentoft, S., & Johnsen, J. P. 2015. "Exploring Challenges in Small-Scale Fisheries Governance". In: *Interactive Governance for Small-Scale Fisheries*, 13(February). https://doi.org/10.1007/978-3-319-17034-3

Johnsen, J. P, Finstad, B. P. 2020. "Er en annen verden mulig? Et institusjonelt perspektiv på kystopprør". In Almås, R. Fuglestad, E. M. (Eds) *Distriktsopprør – Periferien på nytt i sentrum*. Dreyer forlag.

Kapell, M., and Elliott, A. B. R. 2013. *Playing with the Past : Digital games and the simulation of history*. Bloomsbury Academic.

Kaplan, M. G. (2010). "Greening the Gamescape: How Virtual Game Worlds Can Reflect Real-World Environmental Values". A DISSERTATION SUBMITTED TO THE FACULTY OF THE GRADUATE SCHOOL OF THE UNIVERSITY OF MINNESOTA BY, (June), 1–170. Retrieved from https://search-proquest-com.fgul.idm.oclc.org/docview/619247080?pq-origsite=summon

Karpicke, J. & Grimaldi, P. 2012. "Retrieval-Based Learning: A Perspective for Enhancing Meaningful Learning". Educational Psychology Review, 24(3), 401–418. doi:10.1007/s10648-012-9202-2

Kelly, S., & Nardi, B. 2014. "Playing with sustainability: Using video games to simulate futures of scarcity". First Monday, 19(5), 1–14. https://doi.org/10.5210/fm.v19i5.5259

Kivunja, C. 2014. "Innovative Pedagogies in Higher Education to Become Effective Teachers of 21st Century Skills: Unpacking the Learning and Innovations Skills Domain of the New Learning Paradigm". International Journal of Higher Education, 3(4), 37–48. https://doi.org/10.5430/ijhe.v3n4p37

Koenigstein, S., Hentschel, L. H., Heel, L. C., & Drinkorn, C. 2020. "A game-based education approach for sustainable ocean development". ICES Journal of Marine Science, 77(5), 1629–1638. https://doi.org/10.1093/icesjms/fsaa035

Landers, R. N. 2014. "Developing a theory of gamified learning: Linking serious games and gamification of learning". Simulation & Gaming, 45(6), 752 –768. https://doi.org/10.1177/1046878114563660

Laudonia, I., Mamlok-Naaman, R., Abels, S. & Eilks, I. 2018. "Action research in science education – an analytical review of the literature". Educational Action Research, 26:3, 480-495, DOI: 10.1080/09650792.2017.1358198

Linderoth, J. 2012. "Why gamers don't learn more: An ecological approach to games as learning environments". Journal of Gaming and Virtual Worlds, 4(1), 45–62. https://doi.org/10.1386/jgvw.4.1.45_1

Linderoth, J., & Sjöblom, B. 2019. "Being an Educator and Game Developer: The Role of Pedagogical Content Knowledge in Non-Commercial Serious Games Production". Simulation & Gaming, 50(6), 771–788. https://doi.org/10.1177/1046878119873023

Lun, K. A. W., Chi, L. S. & Hun, L. S. W. 2018. «The learning benefits of teaching: A retrieval practice hypothesis". Applied Cognitive Psychology, 32(3), 401–410. doi:doi:10.1002/acp.3410

McCall, J. 2016. "Teaching History With Digital Historical Games: An Introduction to the Field and Best Practices." Simulation & Gaming 47(4): 517–542. https://doi.org/10.1177/1046878116646693.

McCay, B. Jentoft, S. 1998. "Market or Community Failure? Critical Perspectives on Common Property Research". *Human Organization* 57 (1): 21–29. https://doi.org/10.17730/humo.57.1.372712415k227u25

Meadows, D.L., Fiddaman, T. and Shannon, D. 1993. "Fish Banks, Ltd. A Micro-computer Assisted Group Simulation That Teaches Principles of Sustainable Management of Renewable Natural Resources", 3rd ed, Laboratory for Interactive Learning, University of New Hampshire, Durham.

Nicholson, S. 2012. "Completing the Experience: Debriefing in Experiential Educational Games!. The 3rd International Conference on Society and Information Technologies, 11(6), 117–121. Retrieved from http://scottnicholson.com/pubs/completingexperience.pdf

Nicholson S. 2015. "A RECIPE for Meaningful Gamification". In: Reiners T., Wood L. (eds) *Gamification in Education and Business*. Springer, Cham. https://doi.org/10.1007/978-3-319-10208-5_1

NOU 2014:16 2014. *Sjømatindustrien — Utredning av sjømatindustriens rammevilkår*. Nærings- og fiskeridepartementet. https://www.regjeringen.no/no/dokumenter/nou-2014-16/id2354149/

NOU 2016: 26. 2016. *Et fremtidsrettet kvotesystem*. Nærings- og fiskeridepartementet. https://www.regjeringen.no/no/dokumenter/nou-2016-26/id2523539/

NOU 2016-17:16. 2017. Kultur for kvalitet i høyere utdanning. Kunnskapsdepartementet. https://www.regjeringen.no/no/dokumenter/meld.-st.-16-20162017/id2536007/

Ostrom, E. 2009. "Design principles of robust poperty-rights institutions: What have we learned?" In K. G. Ingram and Y-H Hong (eds) *Property Rights and Land Policies*. Cambridge, MA: Lincoln Institute of Land Policy).

Pavlov, O. V., Saeed, K., & Robinson, L. W. 2015. "Improving Instructional Simulation With Structural Debriefing". Simulation & Gaming, 46(3–4), 383–403. https://doi.org/10.1177/1046878114567980

Plass, J. L., Homer, B. D., & Kinzer, C. K. 2015. «Foundations of Game-Based Learning". Educational Psychologist, 50(4), 258–283. https://doi.org/10.1080/00461520.2015.1122533

Prince, M. 2000. "Does active learning work? A review of the research". Journal of Engineering Education, 93(July), 223–231. https://doi.org/10.1038/nature02568

Proulx, J. N., Romero, M., & Arnab, S. 2017. "Learning Mechanics and Game Mechanics Under the Perspective of Self-Determination Theory to Foster Motivation in Digital Game Based Learning". Simulation & Gaming, 48(1), 81–97. https://doi.org/10.1177/1046878116674399

Purvis, B., Mao, Y., & Robinson, D. 2018. "Three pillars of sustainability: in search of conceptual origins". Sustainability Science, 14(3), 681–695. https://doi.org/10.1007/s11625-018-0627-5

Qian, M., & Clark, K. R. 2016. "Game-based Learning and 21st century skills: A review of recent research". Computers in Human Behavior, 63, 50–58. https://doi.org/10.1016/j.chb.2016.05.023

Qudrat-Ullah, H. 2007. "Debriefing can reduce misperceptions of feedback: The case of renewable resource management". Simulation & Gaming: An International Journal, 38, 382-397.

Raffn, J., & Lassen, F. 2021. "Politics of Nature: The board game". Social Studies of Science, 1–26. https://doi.org/10.1177/0306312720983907

Riemer, V., & Schrader, C. 2015. "Learning with quizzes, simulations, and adventures: Students' attitudes, perceptions and intentions to learn with different types of serious games". Computers and Education, 88, 160–168. https://doi.org/10.1016/j.compedu.2015.05.003

Schrape, N. 2014. "Gamification and Governmentality". In: Fuchs, M., Fizek, S., Ruffino, P., & Schrape, N. *Rethinking Gamification*. Meson press. https://doi.org/10.14619/001

Schrier, K. 2014. "Ethical Thinking and Sustainability in Role-Play Participants: A Preliminary Study". Simulation & Gaming, 46(6), 1046878114556145-. https://doi.org/10.1177/1046878114556145

Seale, Clive 1999. "Quality in Qualitative Research". Qualitative Inquiry vol. 5(5) pp 465-478 (13 sider) http://journals.sagepub.com/doi/abs/10.1177/107780049900500402

Schwach, V. 2013. "The sea around Norway: Science, resource management, and environmental concerns, 1860-1970". Environmental History, 18(1), 101–110. https://doi.org/10.1093/envhis/ems107

Shellman, S. M., & Turan, K. 2006. "Do Simulations Enhance Student Learning? An Empirical Evaluation of an IR Simulation". Journal of Political Science Education, 2(1), 19–32. https://doi.org/10.1080/15512160500484168

Shernoff, D. J., Csikszentmihalyi, M., Schneider, B., & Shernoff, E. S. 2003. "Student engagement in high school classrooms from the perspective of flow theory". School Psychology Quarterly, 18, 158e176.

Spring, D. 2015. "Gaming history: Computer and video games as historical scholarship". Rethinking History 19(2), 207–221. https://doi.org/10.1080/13642529.2014.973714

Sønvisen, S. A. 2014. "Contemporary fisher images : Ideologies , policies and diversity". Journal of Rural Studies, 34, 193–203. https://doi.org/10.1016/j.jrurstud.2014.01.011

Spooren, P., Brockx, B., & Mortelmans, D. 2013. "On the Validity of Student Evaluation of Teaching: The State of the Art". Review of Educational Research (Vol. 83). https://doi.org/10.3102/0034654313496870

Standal, D., & Hersoug, B. 2014. "Back to square one ? Fisheries allocation under pressure". Marine Policy, 43, 236–245. https://doi.org/10.1016/j.marpol.2013.06.004

Subhash, S., & Cudney, E. A. 2018. "Gamified learning in higher education: A systematic review of the literature". Computers in Human Behavior, 87(February), 192–206. https://doi.org/10.1016/j.chb.2018.05.028

Thagaard, T. 2013. *Systematikk og innlevelse*. 4. utgave. Bergen: Fagbokforlaget.

Thomas, G. 2010. «Doing case study: Abduction not induction, phronesis not theory". Qualitative Inquiry, 16, 575-82. http://journals.sagepub.com/doi/abs/10.1177/1077800410372601

Tobias, S., Fletcher, J. D., & Wind, A. P. 2014. "Game-Based Learning". In *Handbook of Research on Educational Communications and Technology*, 485–503. New York, NY: Springer New York. https://doi.org/10.1007/978-1-4614-3185-5_38

Tracy, S. J. 2010: "Qualitative Quality: Eight "Big-Tent" Criteria for Excellent Qualitative Research". Qualitative Inquiry vol. 16, 10: pp. 837-851

UiT The Arctic University of Norway, 2020. Report: *Timeregnskapet og studentaktive læringsformer -i spennet mellom forventning, ledelse ogsamarbeidskultur? Rapport fra arbeidsgruppe for gjennomgang av registrering og fordeling av undervisning med studentakive læringsformer, nedsatt av Strategisk utdanningsutvalg.*

Uttl B., White, C. A., Gonzalez, D. W. 2017. "Meta-analysis of faculty's teaching effectiveness: student evaluation of teaching ratings and student learning are not related". Studies in Educational Evaluation (54), 22–42. doi: 10.1016/j.stueduc.2016.08.007.

Vlachopoulos, D., & Makri, A. 2017. "The effect of games and simulations on higher education: a systematic literature review". International Journal of Educational Technology in Higher Education (Vol. 14). International Journal of Educational Technology in Higher Education. https://doi.org/10.1186/s41239-017-0062-1

Wang, G., & Williamson, A. 202). "Course evaluation scores: valid measures for teaching effectiveness or rewards for lenient grading?" Teaching in Higher Education. https://doi.org/10.1080/13562517.2020.1722992

Weines, J. 2016. *Local ecological knowledge as source material for historical research*. Masters Thesis, HSL Faculty, The Arctic University of Norway. https://munin.uit.no/handle/10037/9319/

Weines J, Borit M, Holm P, Hrynkiewicz R. 2017. "Theoretical challenges in designing a social simulation game of balancing sustainability objectives in fisheries management". https://zenodo.org/record/1261071#.Wy1bDIp9jDc

Wiggins, B. E. 2016. "An Overview and Study on the Use of Games, Simulations, and Gamification in Higher Education". International Journal of Game-Based Learning, 6(1), 18–29. https://doi.org/10.4018/ijgbl.2016010102

Wouters, P., van Nimwegen, C., van Oostendorp, H., & van Der Spek, E. D. 2013. «A meta-analysis of the cognitive and motivational effects of serious games". Journal of Educational Psychology, 105(2), 249–265. https://doi.org/10.1037/a0031311

Appendix 1 – End of program evaluation data[20]

Table 3 Respondents

Cohort	Invitations	Respondents	Return rate	Gender	From earlier cohorts
2017	49	22	44,8%	Women: 9 / 40,9% Men: 13 / 59,1%	2013: 54,5% 2014: 45,5%
2018	60	19	31,2%	Women: 14 / 73,7% Men: 5 / 26,3%	Other: 3/ 15,8%
2019	42	16	38,1%	Women: 6 / 37,5% Men: 10 / 62,5%	Other: 1 / 6,2%
2020	51	12	23,5%	Women: 10/ 83,3% Men: 2 / 16,7%	None

---

[20] As reported in chapter three, there are some errors in the aggregated program evaluations, where some respondents have not entered answers or chose multiple answers on closed questions. These errors are not possible to correct, meaning some answers have below or above 100% total.

Table 4 Students' evaluation of the BFA program as a whole

Students' views on the BFA-program as a whole:		Disagree	Partly Disagree	Neither agree or disagree	Partly Agree	Agree
The program has given me an integrated understanding of the connection between natural science, technology and social science.	2017	0%	4,5%	9,1%	45,5%	40,9%
	2018	5,3%	10,5%	21,1%	31,6%	31,6%
	2019	0%	0%	0%	50%	50%
	2020	8,3%	0%	0%	75%	16,7%
It was easy to see how the different courses were connected and built on each other.	2017	4,5%	13,6%	13,6%	45,5%	22,7%
	2018	10,5%	26,3%	31,6%	31,6%	0%
	2019	0%	18,8%	25%	50%	12,5%
	2020	0%	25%	16,7%	50%	8,3%
Through the program I have attained relevant practical skills.	2017	4,5%	27,3%	27,3%	36,4%	4,5%
	2018	15,8%	10,5%	15,8%	42,1%	21,1%
	2019	6,2%	12,5%	6,2%	50%	31,2%
	2020	25%	16,7%	25%	25%	8,3%

Table 5 Students' reporting on integrated understanding and insight.

Rate the extent of you acquisition of the following knowledge, skills and competence		Very little	Little	Satisfactory	Good	Very Good
Broad knowledge about the exploitation of marine resources on the basis of biology, technology, economy and social science	2017	0%	0%	27,3%	59,1%	13,6%
	2018	0%	15,8%	31,6%	47,4%	10,5%
	2019	0%	0%	12,5%	56,2%	31,2%
	2020	0%	0%	25%	58,3%	16,7%
Understanding of interaction in the value chain in the seafood industry	2017	0%	0%	13,6%	72,7%	13,6%
	2018	0%	5,3%	21,1%	52,6%	21,1%
	2019	0%	6,2%	6,2%	62,5%	31,2%
	2020	0%	8,3%	25%	41,7%	33,3%
Insight in national and international issues related to sustainable seafood industry	2017	4,5%	4,5%	9,1%	63,6%	18,2%
	2018	10,5%	21,1%	36,8%	31,6%	10,1%
	2019	0%	6,2%	6,2%	50%	43,8%
	2020	0%	0%	25%	58,3%	16,8%
Reflect on my own academic performance	2017	0%	18%	32%	41%	9%
	2018	0%	11%	58%	26%	11%
	2019	13%	13%	25%	38%	13%
	2020	0%	25%	17%	58%	0%

Table 6 Students' evaluation of learning activities based on learning outcomes.

Students' own evaluation of learning activities based on learning outcomes		Very little	Little	Satisfactory	Good	Very Good	N/A
Games (board games, computer games, roleplaying games, simulations)	2017	9,1%	9,1%	4,5%	13,6%	9,1%	54,5%
	2018	10,5%	15,8%	21,1%	26,6%	5,3%	21,1%
	2019	6,2%	12,5%	6,2%	37,5%	31,2%	6,2%
	2020	8,3%	16,7%	33,3%	41,7%	0%	0%
To what extent has FishBanks contributed to your learning?	2017	9,1%	0%	4,5%	0%	0%	77,3%
	2018	5,3%	15,8%	21,1%	18,8%	0%	36,8%
	2019	6,2%	0%	0%	18,8%	25%	37,5%
	2020	0%	8,3%	25%	8,3%	25%	25%
To what extent has GGSSG contributed to your learning?	2017	9,1%	0%	0%	0%	0%	86,4%
	2018	5,3%	10,5%	10,5%	21,1%	10,5%	36,8%
	2019	0%	0%	0%	37,5%	18,8%	31,2%
	2020	0%	0%	16,7%	16,7%	8,3%	50%
To what extent has Go N' Fish contributed to your learning?	2017	9,1%	0%	0%	0%	4,5%	81,8%
	2018	5,3%	10,5%	26,3%	5,3%	5,3%	36,8%
	2019	0%	0%	18,8%	25%	37,5%	12,5%
	2020	8,3%	16,7%	33,3%	25%	0%	8,3%

Table 7 Students' evaluation of game-based learning, debriefing and industry relevance.

Students' evaluation of the following statements:		Disagree	Partly Disagree	Neither agree or disagree	Partly Agree	Agree
Games have been a positive learning experience	2017	9,1%	0%	36,4%	18,2%	4,5%
	2018	5,3%	5,3%	36,8%	31,6%	15,8%
	2019	0%	0%	18,8%	25%	43,8%
	2020	0%	33,3%	25%	16,7%	25%
Debriefing after the games was important for the learning outcome	2017	4,5%	0%	50%	13,6%	0%
	2018	5,3%	10,5%	21,1%	36,8%	15,8%
	2019	0%	6,2%	25%	25%	31,2%
	2020	0%	8,3%	16,7%	41,7%	25%
Game-based learning gives a bad understanding of real issues in the seafood industry	2017	9,1%	13,6%	45,5%	0%	0%
	2018	10,5%	31,6%	47,4%	5,3%	0%
	2019	18,8%	37,5%	25%	0%	6,2%
	2020	8,3%	50%	25%	8,3%	0%