Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Information Technology and Electrical Engineering
Department of Computer Science

Anders Larsen

Exploring the Relevance of E-Portfolios for Recruitment and Artifact Retainment

Master's thesis in Informatics

Supervisor: Trond Aalberg

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Abstract

Electronic portfolios in higher education have been the subject of much research since the 90s, with academics especially touting the potential for enhanced learning. Such e-portfolios have received a mixed response, with recent reports showing both a growing rate of adoption at institutions, yet sinking popularity with students. Learning is not their only application, as coursework produced by students, known as ”artifacts”, could be shaped into e-portfolios marketing the student to potential employers. Simply retaining artifacts could also provide value to students that would otherwise lose access to them post-graduation.

E-portfolios for recruitment and artifact retainment are examined in this thesis, beginning with a look at e-portfolios through literature and state-of-the-art systems. The interest in e-portfolios is evaluated from the ground up by measuring the relevance of artifacts for both students and recruiters. A study of mandatory coursework establishes a set of artifact types, providing the framework for a survey measuring students' desire to retain and show the types of artifacts to recruiters. Meanwhile, interviews with a set of industry recruiters offer an in-depth examination of the recruitment process and how e-portfolios could assist them.

The students surveyed showed a clear interest in both retaining artifacts and showing them to recruiters, while the recruiters responded with cautious optimism. As the needs of various stakeholders would be key to the adoption of such an e-portfolio, a set of design considerations were formed based on the collected data. The design considerations provide an example of the functionality a modern e-portfolio for recruitment and artifact retainment would need, as well as challenges from previous literature. In the end, institutions tempted by the promise of e-portfolios are asked to thoroughly examine the needs of their stakeholders and to consider if the purported benefits of e-portfolios truly measure up to the alternatives.

Sammendrag

Elektroniske porteføljer i høyere utdanning har vært et tema det har blitt forsket mye på siden 90-tallet. Akademikere fremhever spesielt et forbedringspotensiale innenfor læring, men slike e-porteføljer har blitt møtt med blandede reaksjoner. Nyere rapporter viser at teknologien blir tatt i bruk ved stadig flere institusjoner, samtidig som studentene viser mindre og mindre interesse i å bruke den. Læring er ikke den eneste anvendelsen av teknologien, da studentenes fullførte arbeider, eller såkalte ”artefakter”, også kan settes sammen til e-porteføljer som markedsfører studenten til potensielle arbeidsgivere. Bare å ha tilgang til artefaktene kan vise seg å være verdifullt for studenter som ellers mister tilgangen til dem etter endt studie.

E-porteføljer for rekruttering og artefaktbevaring blir utforsket i denne oppgaven, først gjennom en undersøkelse av faglitteraturen og moderne e-porteføljesystemer. Interessen for e-porteføljer blir vurdert fra bunnen av ved å måle relevansen til artefakter for både studenter og rekrutteringsansvarlige. En undersøkelse av obligatoriske arbeider etablerer et sett med artefakttyper. Artefakttypene tilbyr et rammeverk for en spørreundersøkelse som måler studentenes interesse i å bevare og vise de forskjellige kategoriene av artefakter til arbeidsgivere. En rekke intervjuer med rekrutteringsansvarlige kartlegger ansettelsesprosessen og utforsker hvorvidt e-porteføljer kan hjelpe dem.

Spørreundersøkelsen viste at studentene har en tydelig interesse i å både bevare og vise frem artefakter til arbeidsgivere, mens de rekrutteringsansvarlige uttrykte en varsom interesse. De funksjonelle kravene til brukerne må møtes for at e-porteføljer skal bli tatt i bruk, som førte til at et sett med betraktninger for e-porteføljers utforming ble formulert basert på de innsamlede dataene. Settet med betraktninger tilbyr et eksempel på typen funksjonalitet et moderne e-porteføljesystem for rekruttering og artefaktbevaring behøver, samt en rekke utfordringer fra litteraturen. Til slutt bes institusjoner fristet av e-porteføljer om å utføre en grundig undersøkelse av hva deres interessenter egentlig ønsker, og å vurdere om de angivelige fordelene ved e-porteføljer sannelig måler opp mot alternativene.

Preface

This thesis was written by Anders Larsen as the conclusion of his Master of Science in Informatics degree, specialized in Interaction Design, Game and Learning Technology. The work was conducted in the 2019/2020 academic year, under the Department of Computer Science (IDI) at the Norwegian University of Science and Technology (NTNU).

The author would like to express his gratitude towards his supervisor, Trond Aalberg, for his invaluable guidance.

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Chapter 1

Introduction

As digitization efforts in higher education continue, students produce an ever-increasing amount of digital coursework material. This material is often managed with a Learning Management System (LMS), either owned or managed by the educational institution. The LMS provides communication between instructors and students, management of groups, and perhaps most importantly, the delivery and assessment of coursework. However, a key issue with the LMS is the ownership and control of the material. The institution manages the LMS, while instructors control course-specific functionality. As for ownership, a student would lose access to the platform and the material after their graduation.

Having access to one's material allows for more than just indulging in nostalgia. A collection of course material allows for holistic reflection, revealing previously hidden connections between courses. The student may think critically about their academic progress, and even prompt further advancement. The collection of material becomes more than just a body of work: it becomes an electronic portfolio. Like the LMS, e-portfolios emerged in the 1990s following the advent of the modern web. As the LMS functioned as a port of the traditional classroom experience, the e-portfolio stems from print-based portfolios used by writers in higher education. Writers would use portfolios to reflect on their work, critique that of others, and demonstrate their learning progression. While providing tangible proof of a writer's skills, the platform also allows for personal expression through deciding what material to highlight and how to organize it.

This thesis aims to explore the current state of e-portfolios. After describing previous research on the topic, a comparison is made between current state-of-the-art systems. A survey gives insight into students' habits for storing and using their coursework. Industry interviews describe the significance student coursework may or may not hold for recruitment processes. Finally, design considerations for developing a modern e-portfolio system are presented.

1.1 Background and Motivation

E-portfolios have a global presence and a plethora of different implementations. Depending on the features the institution desires, the implementation could require a degree of integration with the other platforms utilized by the institution. To provide a comprehensive overview of educational e-portfolios, the Norwegian University of Science and Technology (NTNU) was selected to be the focus of this thesis. Although the particular integrations could differ, this thesis should remain applicable to other institutions by serving as a case study.

As mentioned previously, a key issue of the LMS is the ownership and control of course material. Alumni of NTNU lose access to their user accounts after graduation, as is the case with many educational institutions around the world. As a result, coursework uploaded on several of the platforms NTNU use, such as Blackboard and Inspera, is no longer available to the students. E-portfolios could provide a common platform that automatically gathers delivered coursework, removing the need for students to archive their data prior to graduation.

NTNU aims at providing programmes that make their students sought-after in their respective industries. The majority of students from programmes like the MSc in Computer Science programme have acquired long-term jobs already a year before they have finished their studies. Oftentimes, this comes as a result of summer internships. However, students that haven't had a summer internship previously have less to show in terms of experience. While courses and programmes at NTNU have a set of learning outcomes, they are seldom specific enough for recruiters to gauge a candidate's skills. As a result, being able to easily share and reflect on one's coursework could prove valuable to recruiters, especially in terms of differentiating between seemingly equal candidates.

1.2 Research Questions

Much like the portfolios they originate from, e-portfolios have been used for a wide variety of applications. However, due to the multifaceted nature of the technology and its increasing level of adoption, e-portfolios remain loosely defined. To gain a better understanding of e-portfolios and their use cases, a literature review was conducted. Although the literature review did confirm that there are a great many use cases for e-portfolios, this thesis will primarily be focused on the retainment of educational artifacts post-graduation, and their potential role in recruitment. As a result, two research questions were formulated:

RQ1 What are the types of artifacts produced by students, and what relevance do they hold for alumni and recruiters?

RQ2 What design considerations should be taken into account for developing a modern e-portfolio system?

In order to answer the former part of RQ1, a case study was conducted with focus on two study programmes at NTNU. The case study would show the breadth of mandatory coursework produced by students, as well as the wide array of platforms coursework was delivered on. For the latter part of RQ1, a survey asked current students, as well as alumni,

if they would like to keep their old coursework, and if they would show their coursework to recruiters if prompted. Additionally, a set of interviews with industry recruiters served to show what they had to gain from looking at student coursework during a hiring process.

A comparison of state-of-the-art systems explored what current-day standards are, forming the basis for RQ2. The case study led to a set of categories of coursework, which would need to be supported by a modern system. The aforementioned survey and interviews also led to the discovery of what the users would need from an e-portfolio system. The data was combined into a set of design considerations for modern e-portfolio systems, effectively answering RQ2.

1.3 Thesis Outline

This thesis is organized into eight chapters, including the introduction.

Chapter 2 establishes concepts such as e-portfolios and virtual artifacts through earlier literature on the matter, followed by a comparison of state-of-the-art systems.

Chapter 3 introduces the methodology of the thesis through the methods that were selected to answer the research questions.

Chapter 4 details an exploration of coursework produced by a set of students, leading to a categorization of coursework.

Chapter 5 presents a survey conducted on students, gauging their current backup and usage habits for different categories of coursework.

Chapter 6 explores potential relevance of e-portfolios for recruitment by interviewing half a dozen industry recruiters.

Chapter 7 offers design considerations for developing a modern e-portfolio system, based on the data gathered from other chapters.

Chapter 8 summarizes how the thesis has answered the research questions, discusses the strengths and weaknesses of the thesis, and finally presents suggestions for further research.

Chapter 2

Literature Review

In the decades since its conception, numerous articles have been written on the subject of e-portfolios. The many applications of the technology have contributed to the field becoming as diffuse as it is wide. In order to understand what relevance e-portfolios could have for students and recruiters today, one must first understand what e-portfolios are and what they can be used for.

Section 2.1 introduces the concept of the e-portfolio and its many definitions. Section 2.2 goes on to explore the literary field and the main topics of research. Section 2.3 expands on the various use-cases for e-portfolios, two of which form the basis of this thesis, namely recruitment and artifact retainment. Finally, Section 2.4 presents and compares a number of modern e-portfolio systems.

2.1 E-Portfolios

While potentially summarized as simply as ”portfolios on a digital platform”, the exact nature of e-portfolios depends largely on the setting. A generally applicable description of e-portfolios can be found in Lorenzo and Ittelson (2005): ”An e-portfolio is a digitized collection of artifacts including demonstrations, resources, and accomplishments that represent an individual, group, or institution.” The report also describes three broad categories for e-portfolios, namely student e-portfolios, teaching e-portfolios, and institutional e-portfolios. Student e-portfolios may enhance reflection and learning, or serve as a showcase of the student’s accomplishments for career advancement. Teaching portfolios serve a similar purpose for teachers, while institutional e-portfolios operates on a larger scale. In the years since the report was written, the scientific community has primarily focused on student e-portfolios, which will be the subject of this thesis as well.

A description of the term ”artifact” will be dependent on the setting of the e-portfolio. In the broadest sense, a virtual artifact is described as any item existing in a digital environment. The artifact could be a representation of a real-world object, such as an image or a video, or a wholly original digital entity, such as software code or 3D models. In the case of student e-portfolios, artifacts typically refer to coursework a student may deliver over

the course of their study programme. For the domain of this thesis, more specific types of coursework are defined in Section 4.3.

Student e-portfolios have been in use in higher education to varying degrees since the 90s, and the adoption of e-portfolios is seemingly growing. In a report by Mayowski and Golden (2012) at Educause, a survey was sent out to 60 members of the Association of American Universities (AAU), where the ”response rate was a robust 50%”. Of those 50%, 77% of the AAU member institutions were implementing e-portfolios at the time. For reference, AAU is a non-profit organization of research universities in the USA, both public and private, and not necessarily representative of all American universities, nor the rest of the world.

Numerous studies of the same ilk have been used to indicate growth over the years, but the results can be highly misleading. A report by Dahlstrom et al. (2013) from Educause Center for Analysis and Research (ECAR) was published around the same time, and studied the *extent* of the e-portfolio usage. ”In 2013, the ECAR technology survey was sent to approximately 1.6 million students at 251 college/university sites, yielding 113,035 respondents across 13 countries.”. Comparing the last four years of surveys, e-portfolios have indeed experienced a sharp increase in usage, with as many as 54% indicating usage of the technology. However, 39% have only used e-portfolios in a single one of their courses. 9% have used them in a few courses, while a mere 5% estimate they’ve used e-portfolios in half or more of their courses.

In the following year, Dahlstrom and Bichsel (2014) found that only 25% of students had used e-portfolios over the course of that year. The survey also asked which of a list of 12 technologies students would like their instructors to use more, or to use less: ”Two technologies, social media as a learning tool and e-portfolios, had “use it less” rates that exceeded the “use it more” rates. Comparing these data with data from previous years, we see small but noticeable declines in nearly all “use it more” rates. E-portfolios and simulations/educational games were the only two technologies whose “use it more” rates increased (by 3 and 2 percentage points, respectively).” E-portfolios were not mentioned in the surveys for 2016, 2018, or 2019. They made a brief appearance in both 2015 and 2017, with Brooks and Pomerantz (2017) noting that e-portfolios remained one of the few technologies surveyed that a greater proportion of students wanted less use of, rather than more use of.

In the aptly named article ”Electronic portfolios for whom?”, Ayala (2006) reviewed 300 articles and found that fewer than 5% used students’ voices to illustrate their concerns and needs. In the cases where their perspective was included, e-portfolios ”were done unto them and not by them”, indicating that administrators were the driving force. Furthermore, while learning is often touted as the key benefit from e-portfolios, the author found that more than two-thirds of the articles were instead based on assessment and accountability issues. The author suggests that e-portfolio enthusiasts may have put the cart before the horse, and offers the following advice for future implementers: ”Start by conducting a true assessment of student needs and concerns and finish by critically reflecting on whether electronic portfolios benefit your institution.”. This thesis aims to do just that.

2.2 Research Topics

In order to provide a clear overview of what work has been done on e-portfolios in the past, the main topics of research need to be established. Thus began the work of gathering key papers in the field. The search terms utilized revolved around e-portfolio, eportfolio, electronic portfolios, digital portfolio, and online portfolio. The Google Scholar search engine was utilized, as it aggregates multiple scientific journals and allows for sorting and filtering by year, citations, and more.

Approximately 100 papers were selected from the search before they were filtered down to a number of 61. The papers were filtered based on a function of the year and the number of citations at the time of filtering. Older papers were required to have more citations than newer ones, as an indication of them standing the test of time. The articles were all published within a time period spanning from 1998 to 2020, and the distribution of papers by year can be found in Figure 2.1.

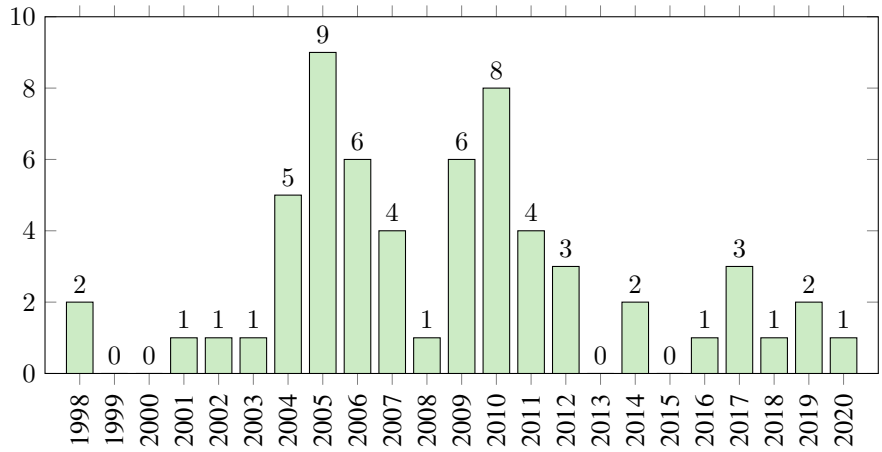

Figure 2.1: Histogram of selected papers by year

The papers were then categorized by examining their titles, abstracts, results, and conclusions. The examination was performed manually, looking for recurring keywords and terms describing the focus of the papers. The first type of categorization is by types, such as a case study or a set of guidelines. Those categories are overviews, case studies, guidelines, or commentaries. A paper of a given type may also be focused on a specific application of the e-portfolio, for example, a case study regarding e-portfolios used for recruitment. Three types of applications had enough papers to warrant their own categories, namely assessment, learning, and recruitment. All of these categories overlap to some degree, as a case study focused on e-portfolios for assessment can lead to a set of guidelines, for example. In that sense, the papers are categorized by their main application if one is prevalent, then by the type of paper if not. Figure 2.2 shows the distribution of papers by type or application, while a fully comprehensive list of papers by category is available in Appendix A.1.

Overviews introduce readers to the concept of the e-portfolio, often presenting the many applications and challenges of the technology. Earlier papers often focus on the potential advantages and use cases of e-portfolios, such as Lorenzo and Ittelson (2005) or Abrami and Barrett (2005). Later papers like Barrett (2010) may focus on more grounded approaches based on existing implementations of e-portfolios, while papers such as Clark and Eynon (2009) or Wilson et al. (2018) may examine the research field as a whole at the time of writing.

Case studies typically focus on a specific implementation of an e-portfolio system. The goal of the case study may be to prove the value of e-portfolios in a specific context, which is the case with Garrett and Jackson (2006). In other cases, the goal could be to demonstrate specific technology, or for example show how perceived ease of use affects student perception of the e-portfolio, which is the case with Shroff et al. (2011).

Guidelines are akin to overviews, in that they explore the various challenges that the e-portfolio field may be facing. Guidelines often focus on the importance of facing those challenges, offering constructive advice for others to consider. Examples include Tosh et al. (2005) and Gathercoal et al. (2002), both of which encourage adopters of the technology to first consider the student perspective.

Commentaries take a critical look at the field itself, like the aforementioned ”Electronic portfolios for whom?” by Ayala (2006). Papers like Rhodes et al. (2014) note that ”there is a need to move beyond case studies and anecdotal stories towards more rigorous methodologies”, while Challis (2005) points at the lack of meaningful research as a possible sign that e-portfolios could end up as an educational fad.

Assessment papers focus on the value of e-portfolios for formative or summative assessment. The term may involve both assessment for the sake of learning, or assessment of the learning itself. Many of the papers can be considered case studies, such as Hung (2012) or Baturay and Daloğlu (2010).

Learning is a wide term and quickly becomes a catch-all for any potential benefit of e-portfolios as a learning technology. Active reflection of artifacts may be considered a type of assessment, leading to the categories overlapping based on the phrasing the authors chose. Examples of learning papers include case studies like Wade et al. (2005) or Alexiou and Paraskeva (2010).

Recruitment papers are primarily focused on using e-portfolios to showcase artifacts and related reflections. Papers like Ciesielkiewicz et al. (2020) and Ward and Moser (2008) gauge whether or not employers in various industries are interested in the use of e-portfolios.

While a small subset of the hundreds, if not thousands of papers written on e-portfolios, this categorization does provide an indication of what the main topics of research are. This does not mean that e-portfolios have exclusively been used for assessment, learning, and recruitment, they are merely the most popular applications.

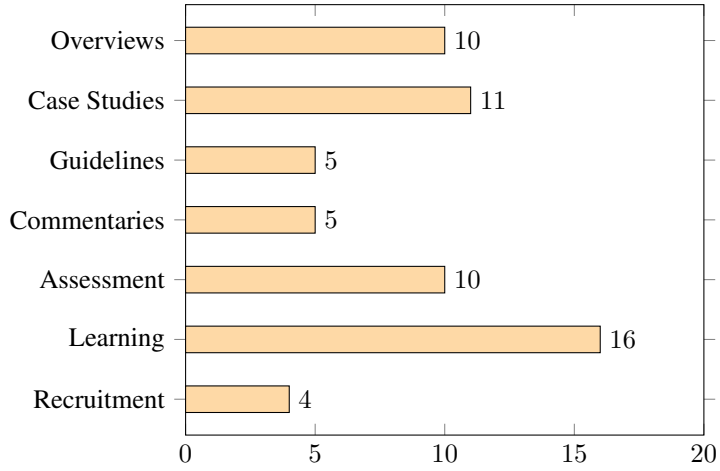

Figure 2.2: Selected papers by type or application

Of the three application categories, assessment and learning stand out as the most explored by far. However, this thesis will focus on two applications that have received less spotlight, namely e-portfolios for recruitment, and e-portfolios for artifact retainment. Although recruitment has already been mentioned, artifact retainment is at the core of every e-portfolio. At its most base level, an e-portfolio is a collection of artifacts, and having access to such a collection could provide value by itself.

2.3 Applications of E-Portfolios

Due to the breadth of the field, it is important to distinguish between the different types of e-portfolios. While Lorenzo and Ittelson (2005) does mention teaching e-portfolios and institutional e-portfolios, the field largely focuses on student e-portfolios. Within that category, one particular categorization stands out. In the words of Abrami and Barrett (2005): ”EPs have three broad purposes: process, showcase, and assessment.”. The literature may refer to these purposes by synonyms, but the meaning is largely the same. In other terms, they may be referred to as ”learning, recruitment, and assessment”, which matches the main topics of research.

Process portfolios refer to the learning process. Abrami and Barrett (2005) goes on to explain the five key stages of a tool-assisted learning process, paraphrased here:

1. Collection: all artifacts are collected and stored throughout the course or study programme the e-portfolio spans over.

2. Selection: artifacts that show a particular achievement in terms of learning goals are highlighted.

3. Reflection: students reflect on each selected artifact, comparing it to previous work.

4. Evaluation: the whole of their work is compared against the learning goals, and new goals may be determined.

5. Celebration: share e-portfolios with other students for collaborative learning.

Assessment portfolios may refer to formative assessment ("assessment *for* learning"), or summative assessment ("assessment *of* learning"). The former is centered on the students, where they maintain their portfolios and assess their progress themselves. The latter is centered on the institution, where students produce specific coursework artifacts and are evaluated as a result.

Showcase portfolios serve as evidence of a student's accomplishments and may be designed to be shown to others. These portfolios may be found as the result of a process or assessment portfolio. As may be apparent by now, assessment for learning and the learning process go hand-in-hand, and certain models may combine these purposes into a single "process" portfolio that eventually becomes a showcase portfolio. This forms the basis for the model presented in "Balancing the Two Faces of ePortfolios" by Barrett (2010). The author defines e-portfolios by their level of sophistication, of which there are three. The main points of each level are quoted here:

1. ePortfolio as Storage
    - Digital Conversion (Collection)
    - Artifacts represent integration of technology in one curriculum area (i.e. Language Arts)
2. ePortfolio as Workspace/Process
    - Organized chronologically (in a blog) – "Academic MySpace"
    - Captions focus on individual assignments (Background Information on assignment, Response)
    - Artifacts represent integration of technology in more than one curriculum area (i.e., Language Arts, Social Studies, Science, Math)
    - Reflections on Service Learning Activities
3. ePortfolio as Showcase/Product
    - Organized thematically (in web pages or wiki)
    - Selection of artifacts/reflection about...
        - Why did I choose these pieces? What am I most proud to highlight about my work?
        - What does this work show about my learning?
        - What more can I learn (Direction: Goals for the Future)?

In this model, the collection of artifacts is at the center. In a process where the e-portfolio system is well-integrated, this level would consist of making sure all artifacts are represented digitally in some way. This may be done manually, or automatically if the

e-portfolio is integrated with a digital delivery system. That collection may then evolve as users become accustomed to maintaining a basic portfolio. Despite being dubbed as level 2 and level 3, portfolios as a process and portfolios as a product don't build on each other directly. Both branch out from the collection of artifacts, and serve two different purposes. As a reminder, this thesis will focus on the collection of artifacts (level 1) for students, and the relevance of such a collection for alumni and recruiters (level 3). Artifact collections are rarely discussed in the literature, as authors often consider them to pale in comparison to the potential of fully-fledged e-portfolios. The few practical considerations related to artifact retainment are discussed in Chapter 7.

2.3.1 Recruitment

E-portfolios as a potential hiring tool shows promise, but is hindered by a lack of awareness. For example, Yu (2012) presents a semi-structured survey of ten HR managers at companies within several different industries. The survey found that despite few of the managers having heard of e-portfolios at the time (only 40%), the interviewees indicated a high level of interest in the technology. The paper also finds that the artifacts of the e-portfolios varied greatly depending on the industry, as noted previously. Another interesting point of the article is that the companies would want to use e-portfolios at different stages of the hiring process. Some recruiters might extract specific artifacts to screen candidates early, and others might want to use e-portfolios in the final stages for deeper insight.

Despite the academic interest in e-portfolios for recruitment, the industry has not necessarily caught on. In Ward and Moser (2008), 5310 employers were surveyed on their usage of e-portfolios for recruitment, of which 13% replied. "The reason companies gave for not using e-portfolios were:

- Not familiar with e-portfolios (75 percent)
- Not valuable (14 percent)
- Time constraints (13 percent)
- Cost (12 percent)

When asked if they planned to use e-portfolios in the future, however, 56 percent of all respondents said yes." The article goes on to encourage higher education institutions to promote e-portfolios as a recruitment tool. In a more recent paper, Ciesielkiewicz et al. (2020) surveys 52 HR directors, concluding that as many as "83% of the respondents would use an ePortfolio to select candidates for a job at some stage of the recruitment process." The paper does not however indicate how many of the HR directors were familiar with e-portfolios prior to the survey.

These findings are in line with the previous research on the topic, but the surveys seemingly only indicate an *interest* in using e-portfolios. To date, it remains unclear what percentage of employers actually request e-portfolios in their hiring process, or what percentage of student job-seekers attach their e-portfolios without being prompted to do so. With both higher education institutions and industry recruiters expressing an interest in

e-portfolios as a tool for recruitment, one may wonder what the lack of reported adoption stems from. Is there a mere lack of initiative, or are there underlying issues with the technology that have yet to be addressed by creators of e-portfolios?

2.4 State of the Art

As may be apparent from the case studies, e-portfolios can either be implemented specifically for an institution, or an existing tool may be utilized. Dr. Helen C. Barrett, now retired from the University of Alaska Anchorage, has been researching electronic portfolios since 1991. Having written 10 of the 61 papers in this literature review, she may be considered one of the most central researchers in the field. Barrett (2018) actively maintains a list of 42 tools through which an online portfolio may be developed. While the list may not be exhaustive, it shows the wide range of possibilities, where some tools are more specialized than others.

Artifact retainment can be handled manually using popular cloud storage tools. Dropbox and Google Drive offer a minimum of 25 and 15 Gigabytes of free storage respectively. Any file may be uploaded, with a range of file size limits according to the file type. The cloud storage service can sync with local files, making it trivial to back up a directory of coursework. Additionally, students of computer science programmes may upload their code to hosting platforms for version control systems, such as GitHub, GitLab, Bitbucket, or SourceForge.

Portfolios for recruitment can be made in any number of ways. Informal discussions with students of various design programmes in Norway and Sweden have provided a non-comprehensive list of possible tools one might use: Students with programming background may make their own portfolio from scratch with HyperText Markup Language (HTML), Cascading Style Sheets (CSS), and sometimes also JavaScript (JS). Students who are well-versed with design tools may use Adobe InDesign, or vector graphics editors such as Adobe XD, Figma, or Sketch. Many students who are less familiar with specific technologies may opt for What You See Is What You Get (WYSIWYG) website builders, such as Wix, WordPress, or Squarespace. Similarly, Adobe offers a specialized program for this very purpose, dubbed Adobe Portfolio. What tool the student chooses to use will be largely dependent on their skills or preferred price range.

Custom e-portfolio systems have the benefit of being able to fit the case perfectly. However, developing a system and integrating it with the other systems the institution is a resource sink. Institutions may not need to implement their own systems with so many options readily available. In order to gain an understanding of what modern e-portfolio systems provide, three state-of-the-art systems were examined more closely.

2.4.1 Digication

Digication (2020b) proclaims to be ”the leading provider of ePortfolio and assessment management systems”, with the platform serving over 5000 institutions, including Duke, Yale, Harvard, Stanford, and many more. Digication as a product can be acquired on an institution-wide basis, or for singular individuals. Pricing will depend on the size of the institution.

Digication (2020a) offers a publicly available help desk, where some sense of the functionality available can be acquired. Digication portfolios are effectively static web pages, where the student can add, remove, or edit existing pages. Templates with preset headings and page titles can be utilized, giving the student some indication of what type of information they should have. Administrators can create templates for the entire institution, while instructors may create templates for specific courses. Digication essentially offers a WYSIWYG content management system with drag-and-drop editing.

Depending on the template, students can completely customize the structure and aesthetic of the page. However, the main content of the portfolios is the text the student writes themselves. The potential applications for courses are endless, but students can make their personal portfolio for recruitment too. A student may make a page for certain artifacts they wish to highlight and write reflections around those artifacts, as well as providing needed context for the projects. Artifacts can be uploaded manually from a variety of sources, or Digication can retrieve them if the portfolio is connected to an LMS such as Canvas, Blackboard, Moodle, and more.

In terms of sharing portfolios, Digication offers a wide variety of options. Portfolios are initially private, but can be shared with specific individuals if desired. Individuals can also be added as editors, allowing for collaborative portfolios. They can also be made public to the institution, or viewable by anyone.

2.4.2 Mahara

Mahara is a free and open-source alternative to Digication. The developers and maintainers of the project aim to provide a Personal Learning Environment which is centered on the student, as opposed to an LMS that centers on the institution. At the same time, Mahara is particularly well integrated with the LMS Moodle, although other options can be used. While Digication offers hosting, backup, and unlimited storage, Mahara is hosted by the institution itself. As the product is available under the GNU General Public License, institutions are free to implement missing functionality they may need. The development team may also assist if the institution in question partners with Mahara, contributing to making the project sustainable.

The Mahara (2019) manual offers extensive documentation for the system. The manual compares the system to a museum, where there is a basement of artifacts that the curator can place in customizable exhibition spaces. This structure is essentially the same as what Digication offers. Blocks serve as pieces of content like artifacts or text, while skins offer limited visual customization. Some extra focus is placed on a social aspect, where viewers of the portfolio may directly interact with the creator. Mahara also offers specialized pages for journals/blogs and résumés, akin to Digication's templates. Like Digication, Mahara supports Learning Tools Interoperability (LTI) by IMS-Global (2019), which allows the system to easily connect with LMSs like Moodle, Canvas, OLAT, and Blackboard.

Access to the portfolio can be limited to users of the site, while secret URLs can be made for sharing with external individuals. Both types of sharing allow access periods to be specified, so that the user would gain and lose access at specific dates.

2.4.3 Blackboard Learn

Unlike the other two tools, Blackboard Learn is an LMS, facilitating communication between instructors and students, and offering course management tools. Despite integrating with many e-portfolio tools, Blackboard Learn also has a fully-integrated tool of its own. Blackboard (2018) offers a short manual compared to the other tools, but some functionality can still be gleaned.

Any graded coursework becomes available in a content collection, which can be made into artifacts. The artifacts themselves have a description allowing for reflection, while metadata from the graded delivery will supply context. Metadata can be filtered so that grades can be hidden from prospective employers. Due to the short length of the manual, it is left unclear to which extent sections can be placed and customized on a page. The portfolio as a whole can be used as an assignment that instructors can grade. Sharing portfolios functions in ways similar to both Digication and Mahara.

2.4.4 Summary

The three example systems sport similar functionality and interfaces, which may indicate a consensus being reached in terms of what works and what doesn't. While there is some functional variation between the three, a summarized overview of the systems can be formed here:

- Online portfolios structured into multiple web pages
- Artifacts either imported from an LMS or manually uploaded
- WYSIWYG drag-and-drop content management
- Templates providing preset structures
- Visual customization for colors, fonts, and layout
- Generating URLs with different access privileges

The listed functionality allows the systems to be used for learning, assessment, recruitment, and artifact retainment. Learning and assessment may be assisted by the ability to collaboratively work on the same e-portfolios, as well as sharing with others for review. Mahara in particular stands out with the built-in ability to comment on e-portfolios, as well as a journal template for continued iterative reflection. The availability of the e-portfolios also lets students share them with recruiters easily. Whether or not students retain access to the collection of artifacts after graduation will still be largely dependent on the business model of the institution.

These bullet points provide a baseline for answering RQ2, as they represent what users may have come to expect from modern e-portfolio systems. That is not to say that all e-portfolio applications do or need to adhere to this model, but it does act as a good framework that future design considerations can be centered around. Furthermore, this manifestation of the e-portfolio concept also provides a more tangible mental model that can be communicated to students and recruiters in later chapters.

Chapter 3

Methodology

The research questions provide the anchor which this thesis will be centered around. To answer RQ1, three methods were used. Firstly, a case study categorized the types of artifacts students produce. Secondly, a survey sent to students and alumni gathered information on expected artifact relevance. Thirdly, interviews with industry recruiters establish the relevance artifacts could have for recruiting students without prior work experience. In order to answer RQ2, research from the literature review provided some known challenges. Surveys and interviews also contributed to discovering the needs of the users, leading to the final design considerations.

The methods offer a mix of qualitative and quantitative research, where RQ1 is primarily covered by the quantitative sort. The research question calls for artifact types, which can be formed by categorizing a long list of artifacts. The relevance of the artifact types for students would be quantified by utilizing a survey with a Likert-type scale. A similar method could have been employed for recruiters, but RQ2 called for a more qualitative approach. The literature review offered both a wide categorization of papers, as well as the opportunity to look more in-depth at the ones more closely related to the aim of this thesis. Design considerations could be found in both the previous research and the comparison of state-of-the-art systems. The qualitative interviews with industry recruiters arguably offered the most important considerations, as they represent the end-users of the e-portfolios.

Section 3.1 describes the choice of method for the case study, leading to the use of a questionnaire. Section 3.2 details why a survey was used for collecting large amounts of data on artifact relevance. Finally, Section 3.3 explains the choice to use interviews to gather data from industry recruiters.

3.1 Case Study

In order to gauge the relevance of various types of artifacts for RQ1, the artifact types themselves needed to be defined first. Categorizing all artifacts produced across all courses at NTNU would be unfeasible, so the scope was limited to two study programmes, the

Master of Science programmes for Computer Science, and Industrial Design. The study programmes became the case to study, where the main goal was to gain an understanding of the breadth of artifacts produced. The better understanding of the coursework produced, the more comprehensive the final artifact types.

Each study programme at NTNU has a study plan that show which courses the students complete for the degree. Each course also has a course page with some information on the activities students are obligated to complete in order to take their exam. These two resources combined would form the main source of data collection, offering a contemporary study of the artifacts produced at the time. A list of courses and the coursework therein could be built, however, the information posted on the course pages was often too vague to accurately deduce what types of artifacts are produced in each course. As a result, a different method had to be utilized in order to map out what the students produce in terms of artifacts.

Several methods could have been employed to gather the information at hand, such as interviewing alumni or final year students on what they made throughout their degrees. This would be reliant on memory, given that they had not backed up their artifacts on their own, and it would be time consuming to both find students with the needed information, and then interview them. The artifact types needed to be based purely on an objective categorization of what students produce, while interviews excel at gathering qualitative data from a set of subjects.

Instead, the case study was boiled down to a questionnaire which could cover the breadth of courses in a short period of time. The questionnaire was based on the initial course page search, offering a set of informal artifact types. Professors and other related personnel who coordinate courses for the two study programmes were asked to fill in the questionnaire for their courses. Pivoting the case study towards a questionnaire allowed for the remaining data to be gathered in a timely manner, while the accuracy of the artifact types themselves were not a priority. Rather, the artifact types provided a framework for later work to based on. The design of the case study and the results of the questionnaire are detailed in Chapter 4.

3.2 Survey

Artifact types have different lifespans for different stakeholders. While recruiters might have no interest in old coursework, the students themselves might like to keep their artifacts for nostalgia. Similarly, recent coursework might not be relevant for a potential employer, but could help an active student in their later courses. In order to gauge the relevance of artifact types, a method of data collection was applied to students and recruiters separately.

An extensive survey was made to measure the relevance of artifacts for students. The artifact types resulting from the case study formed the core of the survey. The survey was designed to learn what habits students had for storing and reusing their old artifacts, as well as their interest in keeping post-graduation. Furthermore, the students were asked if they were willing to show their artifacts to recruiters, and to what degree they believed the artifacts to be an accurate reflection of their abilities.

The survey was sent out to active students, continuing with the case of Computer

Science and Industrial Design. In order to gather more responses, the survey was also sent out to other related study programmes that shared courses with the main programmes. The survey was also sent out to alumni so that the perceived relevance of artifacts to active students could be compared to the actual relevance to alumni.

Using a survey allowed for data gathering on a grand scale in a short amount of time. Surveys allow for countless responders, with little to no extra time being spent processing the results. Furthermore, a larger sample size make the results more statistically significant. However, keeping the responders limited to the focus group allows for more accurate data for the case in question. The quantitative approach allowed for the measurement of exactly *how* relevant certain artifact types were, while a qualitative data collection might only be able to say *if* artifact types are relevant or not. The design and results of the survey can be found in Chapter 5, along with interpretations of the results.

3.3 Interviews

While the survey to students and alumni gauged the willingness of students to share their artifacts with recruiters, another method was employed to see the industry side of things. Much like how answers from students and alumni could be compared to reveal the actual relevance of artifacts, the value students place in artifacts could be compared to the value recruiters see. At a bare minimum, asking recruiters relevant questions from the student survey could reveal if the interest in artifacts was one-sided.

A survey could have been utilized here too, where recruiters could be asked if they would look at student coursework, what types of artifacts would be most relevant, and so on. However, the recruiters were not just the subject of RQ1. E-portfolios for recruitment are made by students, and then delivered to recruiters who then act as the end user of the e-portfolios. For e-portfolios to have any value for recruitment, the needs and requirements of recruiters would need to be thoroughly examined. Surveys with open-ended questions could offer some insight, but a static form would be unable to ask follow-up questions and dig deeper into how the recruitment process works. As a result, quantitative research would be unsuitable for the type of data needed for the design considerations of RQ2.

Continuing with the case of Computer Science and Industrial Design, industry recruiters hiring from those study programmes were requested for an interview. The interviews asked the recruiters to describe the recruitment process at their companies, offering insight into what kind of material they gather from candidates, and how they evaluate it. Establishing the process allowed the recruiters to then reflect on potential advantages and disadvantages e-portfolios could introduce, providing meaningful answers to both RQ1 and RQ2. The design of the interviews is detailed in Chapter 6, along with an extensive concatenation of the responses.

Chapter 4

Case Study

In order to measure the relevance of artifact types, the types themselves need to be established first. Making a list of every artifact and categorizing them would provide the most comprehensive artifact types, but the work would also be highly infeasible. Basing the artifact types on a limited set of courses would provide a reasonable substitute, as long as the set of courses show a wide spread of artifacts.

In order to select a limited set of courses, work began to find suitable study programmes to examine. According to NTNU (2019b), NTNU has 41 971 registered students, half of which study technical or scientific study programmes. Furthermore, 35 638 students, or 84.9 percent of all the students at NTNU, are in Trondheim. In addition to providing a more representative sample, gathering data locally could be easier than reaching out to the campuses at Gjøvik and Ålesund. Of the 371 study programmes offered at NTNU, two were selected to be the focus of this case study.

Master of Science in Computer Science is a 5-year programme with a wide range of specializations (4 fields of study for year 3 and 8 specializations for years 4 and 5). Computer Science was selected for the wide set of courses in the programme, and the many variations of software artifacts one might produce there. Master of Science in Industrial Design is also a 5-year programme, with one specialization for product design, and another for interaction design. Industrial Design was selected based on their artifacts often tending towards the physical and the analogue, providing perspective to the highly digital Computer Science. Furthermore, design portfolios are commonly used by students at Industrial Design to show their work to potential employers. As design portfolios have become an industry standard, focusing on students that regularly maintain their own design portfolios could provide an interesting perspective to e-portfolios.

Section 4.1 describes the design of the initial data gathering through course pages, as well as the final questionnaire. Section 4.2 details the responses to the case study questionnaire, leading to Section 4.3 proposing a set of artifact types.

4.1 Case Study Design

With two study programmes selected, the corresponding study plans were consulted for a complete list of courses students undertake during their degrees. The study plans are updated on a year-to-year basis, so the list of courses was composed of year 1 from the class of 2019, year 2 from the class of 2018, et cetera. Courses are rarely moved between years, but that could have led to a missed course or two. Electable courses were not included in the final list, as the method for gathering data was time-consuming, and that would have doubled the number of courses to cover. The final list amounted to 77 courses, 28 of which were specific to Industrial Design, and the remaining 49 courses specific to Computer Science. This variance comes from the fact that Computer Science has far more specializations than Industrial Design, leading to more mandatory courses.

Each course page was subsequently scraped for mandatory coursework. However, the detail of information on most course pages was found to be lacking. The information was ultimately too vague to be able to accurately infer artifact types, leading to the creation of a questionnaire to fill in the gaps. The questionnaire would later be sent out to professors or other qualified course staff so that they could answer accurately for their courses. The data was anonymized, as the exact artifacts for each individual course hold less value than the overall artifact portfolio produced during a study programme. Table 4.1 details the final questionnaire, translated from Norwegian.

4.2 Case Study Responses

The questionnaire was sent out to the 52 professors that covered the 77 courses. The professors were requested to fill out the questionnaire once for each course they act as course staff for. A total of 30 responses was provided, from 25 individuals, covering 33 courses. The variation in amount comes from some individuals being responsible for multiple courses, and some individuals covering multiple courses in the same response. One of the responders did not include a course code, and another of the responders included a non-mandatory course (i.e. not on the original list of 77 courses).

4.2.1 Group Work

Question 1 aimed to indicate the degree to which group work is integrated into coursework across artifact types. The low sample size would not provide an accurate representation of just *how* integrated group work is, but it could show that group work definitely *is* an integral part of coursework. The distribution of responses was as follows:

- **”Yes”** received 16 responses
- **”No”** received 14 responses

With a minor majority, the responses indicate that group work is an important aspect of artifacts. As a result, a hypothetical e-portfolio system should prioritize functionality enabling the display of group work. For example, as any artifact could be a result of group work, one might need a way to see who did what. More on that in Chapter 7.

ID	Question	Type	Options
1	Does your course involve group work?	Multiple choice	• Yes • No
2	What types of coursework does your course involve?	Checkboxes	• Text documents (e.g. reports, pdf, docx) • Presentations • Computer code (e.g. single files or Git-based projects) • Exercises in math or physics • Images (e.g. diagrams) • Physical objects (e.g. sculptures, hardware) • Video files • Audio files • Other...
3	Please elaborate on what the coursework entails	Long answer text	(optional)
4	Where / how is coursework delivered?	Checkboxes	• Blackboard • Inspera • GitLab / GitHub • Showing work to teaching assistant • Physically (e.g. presentations, paper, and other tangible objects) • Custom course page hand-in system • Other...
5	What form does the exam take?	Multiple choice	• The course does not have an exam • Exam on paper • Digital exam (Inspera) • Other...

Table 4.1: Questions regarding courses sent out to course staff

4.2.2 Types of Coursework

Question 2 is the core of the questionnaire, asking the course staff to select which of the initial artifact types students produce in their courses. The initial artifact types were defined through the course page search, based on the artifacts that could be gleaned from the course pages. Due to there being several gaps in the information, the options would likely not cover all types of artifacts. The ”Other” option was included to allow the course staff to fill in the blanks. The other options could then later become artifact types of their own, or be merged into the existing ones. Figure 4.1 shows the distribution of answers.

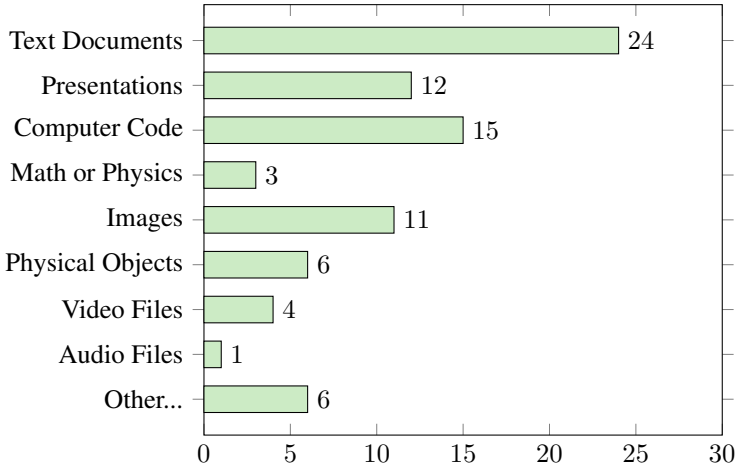

Figure 4.1: "What types of coursework does your course involve?"

The "Other" field received 6 responses, translated from Norwegian here:

1. Exhibition
2. Multiple choice test in Blackboard
3. Multiple choice exercises
4. Not exactly math, but theory exercises requiring calculation
5. 3D Models, Unity 3D prototypes, posters
6. Jupyter Notebooks

While open to interpretation, several of these artifacts could be merged into the other categories. Exhibitions (option 1) could be considered a form of presentation, and interactive exhibitions could be documented with a video. The multiple-choice tests in Blackboard (option 2 and 3) have a unique interface, but the answer sheet could be formatted as a PDF, making it part of the "Text Documents" category. Theory exercises requiring calculation (option 4) fit within the spirit of the Exercises in the Math or Physics category. Finally, posters (option 5) could be exported as PDFs or images. 3D models, however, could suffer from being grouped with the other categories. Several images or a video could be utilized, but being able to inspect the model could be critical to evaluating the work.

4.2.3 Coursework in Detail

Question 3 allowed course staff to optionally elaborate on what they meant by their selected coursework types, in case there were ambiguities in the options. 12 responses had a reply to question 3. Two responses were of particular note:

Firstly, one professor specified that their software project involved evaluating the setup of automated build systems, usage of version-control system Git, and the Git-repository manager GitLab. The professor went on to theorize that more and more code-based courses would move towards Git-based development flows, indicating a need to represent Git history in a potential e-portfolio system.
Secondly, a professor brought up peer evaluation as part of the coursework. Students write and deliver reports of a project, then go on to evaluate the reports fellow students have written. That evaluation is then itself evaluated by course staff as well. While a unique coursework activity, it does fit into the other types of deliverables, more specifically "Text Documents", in that the evaluation itself is ultimately delivered as a written PDF.

4.2.4 Delivery Platforms

Replies to question 4 could show the breadth of platforms a potential e-portfolio system might need to integrate with. Figure 4.2 shows the distribution of answers.

The first of the three "Other" simply said "Exhibitions", which fits into the category of physically delivering the coursework, as it includes presentations. The second reply explained that the Department of Mathematical Sciences as a whole has its own delivery system called "Ovsys". Finally, the third "Other" reply referred to "Möbius Assessment", a system designed for courses involving mathematics.

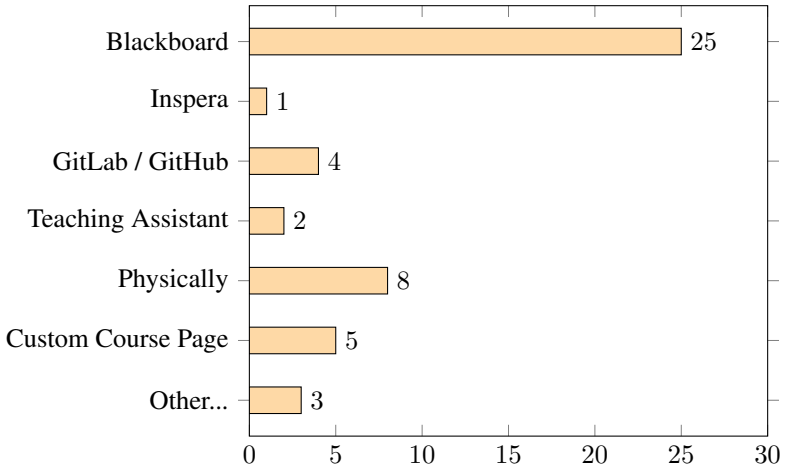

Figure 4.2: "Where / how is coursework delivered?"

On the intranet "innsida", NTNU (2019a) draws a distinction between Blackboard as an electronic learning system (eLS) and Inspera Assessment as a platform for graded submissions, noting that is is very important that the correct platform is used for the correct task. "The main rule for assessing student performance in the form of work and other activities that will ultimately result in a grade, must be done anonymously.", further elaborating that "Anonymity is only ensured in the examination system (Inspera), and for this reason it should be used when the identity of the candidates is supposed to be hidden."

During the initial course page search, 54 of the 77 courses, or 70.1%, supposedly included coursework that resulted in some percentage of the grade. Despite NTNU indicating that Inspera should be used in those cases, only 1 of the 30 responses to the questionnaire, or 3.3%, indicated that Inspera was used in their courses. In terms of usage, Blackboard is in the clear majority, with 83.4% of the replies listing it as a coursework delivery platform used in the course.

In terms of representing coursework on an e-portfolio system, the plethora of platforms poses quite the challenge. A system could interact with the named platforms in the questionnaire, such as Blackboard, Inspera, GitLab and GitHub. However, coursework that is merely shown to teaching assistants, delivered physically as paper, or presented as a presentation, would require some work to digitize. Furthermore, the replies to the ”Custom Course Page” and ”Other” options indicates that the true amount of platforms is an unknown quantity.

4.2.5 Exam Formats

The fifth and final question of the questionnaire asked course staff to describe which type of exam was utilized in the course, if any. Figure 4.3 shows the distribution of answers. While the responses are unsurprising, and not directly related to the research questions at hand, the numbers indicate that an e-portfolio system would need to accommodate for representations of both physical and digital exams.

None of the four ”Other” responses warranted the creation of a new category. The first noted that the course in question had a paper exam in 2019, but would move on to digital in 2020 or 2021. The second and third responses categorized the final exam as an exhibition or a presentation, both of which would mean ”No Exam”. The fourth response noted ”I hope this is what you have been asking for”, indicating that the field was misunderstood as a ”final notes or comments” field, which is common to include in questionnaires.

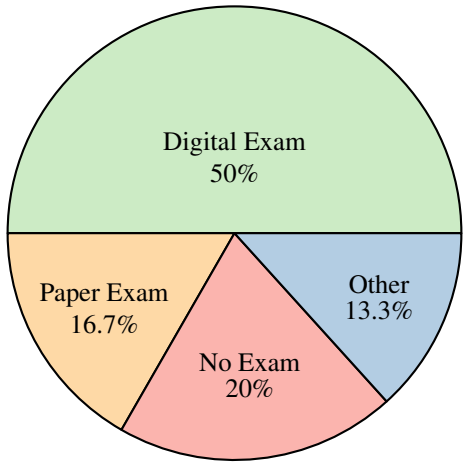

Figure 4.3: ”What form does the exam take?”

4.2.6 Tour of the Department of Design

After sending out the questionnaire, one professor in particular noted difficulties with using Blackboard and Inspera for the courses at Industrial Design, feeling that the platforms were not suitable for the needs of their courses. Instead of writing long paragraphs in the questionnaire, they offered to carry out a tour of the Department of Design. The tour covered most of the department building and involved meeting with a handful of professors responsible for courses at the institute. Frustration with Blackboard as a platform was a recurring theme throughout the tour, with some professors resorting to simply having students e-mail them their coursework.

For simple physical objects produced in courses where the primary goal is evaluating the aesthetics of the objects, images are considered sufficient. The objects are also on display in the building itself, but in some cases deteriorate over time, such as sculptures involving ice. Posters are also in display in the building, for example used to represent projects in a course on Game Design, where the game itself is accessible through a URL somewhere on the poster.

For several of the courses, 3D models are produced in SolidWorks and uploaded to Blackboard. Posters or images are sometimes also delivered to provide a summary, but the 3D models often have to be downloaded and opened in order to inspect individual components in detail. Furthermore, relying solely on images could lead to issues with plagiarism, possibly requiring the usage of image watermarks.

In some courses, work in progress also becomes part of the evaluation, showing some sort of progression and ability to adapt to feedback underway. Sketchbooks were often delivered to show different concepts and ideas, what was iterated on, and so on. Oftentimes the sketchbooks would contain material for other courses and be delivered back after evaluation, leading to archival challenges as they were seldom digitized. Digital sketchbooks were suggested as a viable alternative.

In the workshop, three larger machines were on display. All three machines required some form of interaction, which the examiner would interact with themselves during the evaluation. Video demonstrating the usage of the machine served as a backup, but that loses detail in texture and smell. A master student writing their thesis specifically on texture suggested macro photography in order to capture the coarse or fine nature of the material.

Size is another aspect that holds digitization back. For example, designing a user interface for a vending machine, how does one evaluate the legibility of the user interface? In this case, they would print out the images at a scale, stick it to a wall and see how close one would have to stand to feasibly read the instructions.

Finally, Virtual Reality was brought up as a type of artifact that poses unique challenges to e-portfolio systems. Items in VR could be shown through 360-degree video or as 3D models in embedded viewers like Sketchfab. E-portfolios in virtual reality were suggested as an alternative way to display a person's work.

The tour did not necessarily introduce new types of artifacts to the case study, but it did lead to a deeper understanding of what the semantics of the artifacts are. Such insight contributed to shaping the final artifact types.

4.3 Case Study Discussion

In retrospect, the case study could have covered more ground. The initial course page search was time-consuming, leading to non-mandatory courses being filtered out. However, when a questionnaire was made to fill in the needed information instead, covering more courses would require minimal work. Electable courses could have been included to double the number of courses, or more study programmes could have been included. The more courses, the more unique artifact types are discovered, and the final set of artifact types becomes more accurate. Comparing artifact types of different study programmes might also lead to some interesting results.

The responses indicate that the initial set of artifact types did represent the majority of the courses that were included in the survey, as most instances of ”other” responses could be merged with one of the existing categories. Merging categories make them wider and less distinct, but keeping a limited set of artifact types also makes them easier to work with. The final categories are as follows:

- Documents, including, but not limited to, reports, math and physics exercises, multiple choice quizzes, and peer evaluations. Applies to both digital and physical documents.
- Presentations, including, but not limited to, slides, exhibits, video and audio recordings of presentations.
- Code, including everything from smaller code snippets to larger software projects.
- Multimedia, including, but not limited to, images, graphs, posters, videos, movies, sound, music, and 3D objects.
- Physical objects, including, but not limited to, code-driven hardware, furniture, printed posters, fabrics, and any image or video representing physical objects.

The artifacts are primarily categorized based on semantics, as opposed to categorizing by the file types that would be used to represent the artifacts in e-portfolio systems. This makes the artifact types easier to comprehend for students and recruiters while gauging the relevance of file types would only be relevant for prioritizing technical implementation of an e-portfolio. Keeping a limited set of artifact types make the artifact types easier to work with, as students could very well find a survey with multiple questions for multiple artifact types daunting. The more statements or artifact types, the harder it could be to gather data in the survey.

Chapter 5

Survey

With the artifact types presented in Chapter 4, relevance for students and alumni could be gauged for each individual artifact type, which would contribute to answering RQ1. A survey was sent out to students through professors, student organizations, and NTNU Alumni. The survey was opened February 18 2020, and closed after 31 days on March 20. A total of 103 responses were gathered before the survey was closed, after a long period of no new responses coming in.

In order to reach out to active students, 34 professors and other course staff were asked for assistance. The professors contacted taught courses during the spring semester of 2020, with all the courses being mandatory for either Computer Science or Industrial Design. Due to students of many different study programmes taking some of the courses, the replies may not specifically represent Computer Science or Industrial Design. The courses ranged in size from anywhere between 20 and 500 students.

Finally, NTNU Alumni allowed the survey to be posted to their group on LinkedIn, which held a total of over 12000 members. Of those twelve thousand, a grand total of 3 alumni replied. Due to the lacking response, the responses were omitted from the survey results in order to avoid offsetting data gathered from active students. This places the final number of responses to the survey at an even 100.

Section 5.1 describes the design of the survey. Section 5.2 presents the responses, while Section 5.3 discusses the potential implications of the responses.

5.1 Survey Design

The survey was constructed in ”Nettskjema”, a tool hosted at the University of Oslo. Nettskjema is designed for creating and answering secure surveys, and this survey in particular was designed to be wholly anonymous. Anonymity was ensured by the Nettskjema platform, as it exposes no IP address, e-mail, or similar user information to the creator of the survey. The survey itself involved no text input and contained no questions asking for identifiable data.

The survey began with three introductory questions. First, the survey asks whether the user is a student or an alumnus so that the two sets of users could be separated and compared. Second, the survey asks if the user stored their own coursework manually. As alumni lose access to their coursework post-graduation, this could indicate whether or not backing their own data up is an issue. Finally, the user is asked if they keep their exam submissions. Exams are artifacts after all, but typically act as the final delivery of a course. As a result, students might not think to take a copy for future courses. The questions are presented as they were in the survey in Table 5.1.

Question	**Description**	**Options**
Are you currently a student, or have you already graduated?	(no description)	• I am currently a student • I have graduated, and am no longer a student
Do you store old coursework on a platform you have access to?	This does not refer to Blackboard or Inspera, but instead platforms you've uploaded your backups to, such as Google Drive, Dropbox, GitHub, or similar	• Always • Sometimes • Never
Do you keep your filled-in exam submissions?	This includes both the colored papers from physical exams, as well as copies of digital exams	• Always • Sometimes • Never

Table 5.1: Introductory questions to the survey

After the introductory section, each artifact type was presented with the same description listed in Section 4.3. For each artifact type, five statements were presented to be ranked on a Likert-type scale. The five statements were the same for all of the five artifact types. Each statement is described by a term in bold text for the sake of brevity, but those terms were not utilized in the survey itself. The five statements are found below in the non-bold text, with the word "coursework" substituted with the artifact type at hand:

- **Retainment**: I keep my old coursework
- **Reuse**: I have looked back at my old coursework to help me in other courses
- **Availability**: I want to have my old coursework available after my graduation
- **Recruitment**: I would show my old coursework to recruiters if requested
- **Accuracy**: I believe my old coursework is an accurate reflection of my abilities

5.2 Survey Responses

On the Likert-type scale, the options for each statement were as follows: Strongly disagree, disagree, neutral, agree, strongly agree. Each statement also allowed the option to select ”not applicable”, for example in cases where the student had not produced artifacts of the given type. For the following tables, the options are converted to a point scale from 1 to 5, where strongly disagree is a 1, strongly agree is a 5, and not applicable is N/A. Due to the number of replies coincidentally being 100, the number of replies will be listed by amount rather than a percentage, as they are the same value.

5.2.1 Introductory Questions

While there were three introductory questions, the first question has been excluded from the results. As the submissions from alumni were too few, they were omitted from the data, leading to 100% of the remaining responses categorizing themselves as active students. The distribution of answers is shown in Table 5.2, with the options garnering the most replies highlighted in bold.

Question	Always	Sometimes	Never
Do you store old coursework on a platform you have access to?	30	**58**	12
Do you keep your filled-in exam submissions?	26	**51**	23

Table 5.2: Replies to introductory questions

The responses show a sizeable amount of students that store their own coursework at least sometimes. This shows that students already have some desire to retain artifacts, and would be willing to do some work to achieve that. That willingness may very well increase with a system better suited for the task.

A possible explanation for the significant majority answering ”Sometimes” for both questions could be the phrasing in the options. ”Always” and ”Never” are absolutes, leading to ”Sometimes” covering anywhere between ”once” to ”all but one time”. Instead, the options should have been something akin to ”Often, Sometimes, Never”, and possibly split ”Sometimes” into multiple options.

5.2.2 Documents

The document artifact type shows the lowest rate of ”N/A” answers compared to the other four artifact types. This could indicate that documents are the most widely produced form of coursework among those who replied to the survey. As a reminder, the document artifact type is defined as:
”Documents, including, but not limited to, reports, math and physics exercises, multiple choice quizzes, and peer evaluations. Applies to both digital and physical documents.”

Table 5.3 shows the distribution of answers, with the options garnering more than 20% of the replies highlighted in bold.

Statement	1	2	3	4	5	N/A
I keep my old documents	3	8	19	**35**	**35**	0
I have looked back at my old documents to help me in other courses	11	16	19	**45**	9	0
I want to have my old documents available after my graduation	5	6	18	**37**	**33**	1
I would show my old documents to recruiters if requested	4	7	18	**40**	**30**	1
I believe my old documents are an accurate reflection of my abilities	7	**33**	**22**	**29**	9	0

Table 5.3: Documents: Answers to statements on Likert-type scale

The replies indicate that many back up their documents, which fits well with the number of students who wish to have their documents available after graduation. Most students admit to using their documents as assistance for other courses, but a significant percentage disagrees with the statement to some degree. This disagreement could stem from documents being largely defined by their subject matter, leading to documents having little in common from those made in other courses.

When asked if they would show documents to recruiters, a significant majority agreed on some level. This contrasts with the final statement, which shows a far wider spread on whether students believe their documents are an accurate reflection of their abilities or not. This disparity is found in most of the artifact types and will be discussed in more depth in Section 5.3.

5.2.3 Presentations

Presentations are inherently challenging to describe due to their composite nature. As a reminder, the presentation artifact type is defined as follows:
”Presentations, including, but not limited to, slides, exhibits, video and audio recordings of presentations.”

An important note on representing presentations digitally is that seemingly few courses on NTNU would involve an audio or video recording of the presentations themselves. Even if such recordings are made, students don’t necessarily have access to them. If the students decided to use slides for their presentation, there is no guarantee that the slides would be representative of the presentation itself either. Text on slides can be descriptive or sparse, but speaker notes are not necessarily attached to the slides. In conclusion, if all a student has to represent a presentation is a set of non-descriptive slides, they might not be interested in keeping them. Table 5.4 shows the distribution of answers, with the options garnering more than 20% of the replies highlighted in bold.

Statement	1	2	3	4	5	N/A
I keep my old presentations	4	12	18	**32**	**23**	11
I have looked back at my old presentations to help me in other courses	18	**29**	20	18	3	12
I want to have my old presentations available after my graduation	7	16	**26**	**27**	16	8
I would show my old presentations to recruiters if requested	8	7	20	**42**	14	9
I believe my old presentations are an accurate reflection of my abilities	9	20	**34**	**22**	6	9

Table 5.4: Presentations: Answers to statements on Likert-type scale

The level of artifact retainment is similar to documents, although a bit shifted towards disagreement in comparison. The desire to keep the presentations post-graduation is even further shifted down, but students still generally agree to the statements. The largest difference between the two artifact types is apparent in the reuse of artifacts. With a whopping 47% leaning towards disagreement, a significant rise from the combined 11% from documents. Like documents, the presentations are largely defined by the subject matter, providing little overlap from course to course. And as previously mentioned, students might not have the most descriptive representation of their presentations, making it less useful as a tool for future presentations.

As with the previous artifact type, most students indicate a willingness to show their presentations to recruiters if requested, but that still does not necessarily line up with whether or not they think it is indicative of their abilities. The fact that students might not feel that the slides are an accurate reflection of the presentation itself could be a contributor to the disparity in this specific artifact type.

5.2.4 Code

While the survey reached out to a wider group than just Computer Science and Industrial Design, this artifact type shows the second-lowest number of ”N/A” replies. In other words, one may assume that most of the students who replied did have at least an introductory level of programming background. At the very least, the low amount of neutral replies could imply that students do have some opinions one way or the other on the artifact type. As a reminder, this is the definition of the code artifact type:
”Code, including everything from smaller code snippets to larger software projects.”

Table 5.5 shows the distribution of answers, with the options garnering more than 20% of the replies highlighted in bold.

When compared to the other artifact types, the replies for each statement indicate the highest level of agreement across the board. Beginning with artifact retainment, a vast majority of students indicate that they keep their old code somehow. While the level of retainment is comparable to documents, an explanation for the uptick could be found in the

Statement	1	2	3	4	5	N/A
I keep my old code	4	9	13	**32**	**41**	1
I have looked back at my old code to help me in other courses	2	9	6	**46**	**35**	2
I want to have my old code available after my graduation	1	3	13	**37**	**46**	0
I would show my old code to recruiters if requested	2	7	12	**40**	**38**	1
I believe my old code is an accurate reflection of my abilities	5	17	**26**	**32**	19	1

Table 5.5: Code: Answers to statements on Likert-type scale

very next statement: students use their old code to help them in other courses. The increase in reuse could be explained by needing to look up syntax, or specific techniques employed in earlier work. Even if the programming language of choice could vary between courses, old code from a different language could still help. When learning a structure like a for-loop or an if-statement, one might be assisted by reminding oneself of how the structures function in more familiar languages first.

Students also indicate an interest in having their old code available after their graduation. If the students start working as developers, then the code could assist them in the same way it could help them in other courses. One might expect the relevance of the old code to decrease with time. As the students write new code based on their old code, their experience moves forward one iteration at a time. The knowledge they might want to retain from their oldest code could then be a part of newer code, making the oldest artifacts irrelevant with time.

If requested, students would be very willing to show their old code to recruiters. Like with artifact retainment, the numbers are generally comparable to documents, although with a tad fewer neutral replies and more agreement. The minor increase could perhaps be best explained by the significant increase in agreement in regards to the final statement. While still more neutral than the other statements, students do seem to agree that the old code they wrote is representative of their abilities. The more neutral leaning could be a result of the demographics of the students who replied to the survey. A first-year student might believe all the code they've written so far is relevant. Meanwhile, a fifth-year student could feel that the code they wrote in the last two years is representative of their current abilities, but the three first years' worth of code is less representative, prompting a more neutral response.

5.2.5 Multimedia

The multimedia category features the highest level of neutral replies, as well as the second-highest level of "N/A" replies. This could be in part due to the broad nature of the category, which is defined as follows:

”Multimedia, including, but not limited to, images, graphs, posters, videos, movies, sound, music, and 3D objects.”

Table 5.6 shows the distribution of answers, with the options garnering more than 20% of the replies highlighted in bold.

Statement	1	2	3	4	5	N/A
I keep my old media files	4	8	20	**26**	20	**22**
I have looked back at my old media files to help me in other courses	8	**31**	17	14	6	**24**
I want to have my old media files available after my graduation	2	11	**27**	**24**	13	**23**
I would show my old media files to recruiters if requested	5	10	**27**	**26**	8	**24**
I believe my old media files are an accurate reflection of my abilities	7	15	**34**	15	6	**23**

Table 5.6: Multimedia: Answers to statements on Likert-type scale

In spite of the high level of ”N/A” replies across every statement, artifact retainment remains generally high. Even though the students keep their files, there seems to very little need for their reuse. There also seems to be less interest to keep the files available after graduation. This might indicate that students wish to keep their media files just in case they’re needed for another course, but experience indicates that they rarely are. Seeing as few ever had any use of the files, it makes sense that they feel less of a need to keep the files around post-graduation.

In terms of showing artifacts to recruiters, multimedia scores the lowest. Keep in mind that the majority of students don’t *disagree* with showing their media files, they’re just showing a lower level of agreement compared to other artifact types. Finally, there is a remarkable symmetry to the replies on the representative nature of media files. Most are neutral to the statement, which has been the trend across all artifact types. However, the amount of students who agree, strongly or otherwise, is almost exactly equal to those who disagree.

5.2.6 Physical Objects

This final artifact type has by far accumulated the most amount of ”N/A” replies, as many as 36-40%. To make it less damning, this could instead be angled as ”over 60% of students who replied have made physical objects during their studies”. In order to explain this, first consider the definition of the category:
”Physical objects, including, but not limited to, code-driven hardware, furniture, printed posters, fabrics, and any image or video representing physical objects.”

With the exception of ”code-driven hardware”, the other artifacts are examples of objects widely produced at Industrial Design. This could indicate that a significant portion of the students who replied to the survey do in fact come from Industrial Design, making

the results relevant for more than just Computer Science and similar study programmes. However, due to the inclusion of the hardware example, it is impossible to tell the exact distribution of study programmes.

Table 5.7 shows the distribution of answers, with the options garnering more than 20% of the replies highlighted in bold.

Statement	**1**	**2**	**3**	**4**	**5**	**N/A**
I keep my old physical objects	2	9	8	**26**	17	**38**
I have looked back at my old physical objects to help me in other courses	6	18	20	13	3	**40**
I want to have my old physical objects available after my graduation	1	7	17	**24**	14	**37**
I would show my old physical objects to recruiters if requested	4	4	19	**27**	10	**36**
I believe my old physical objects are an accurate reflection of my abilities	6	10	**23**	15	10	**36**

Table 5.7: Physical Objects: Answers to statements on Likert-type scale

Students have deemed the statements generally agreeable, but little sticks out in these numbers. Although technically the lowest of all artifact types, the level of artifact retainment for physical objects is still favorable. Similarly, the desire to keep the artifacts available after graduation is present, with fairly few noting disagreements. Meanwhile, the reuse of artifacts is quite mixed, leaning more towards neutral or disagreement. As with the other artifact types, students are still quite willing to show their artifacts to recruiters. Again, this does not match completely to the belief that it actually reflects their abilities well, which is fairly neutral for physical objects.

5.3 Survey Discussion

In order to compare the artifact types against each other, the Likert-type scale can be considered as a range from 1 to 5. An average score can be computed for each statement, normalized by removing the ”N/A” responses from the average. An overview of the scores can be found in Figure 5.1.

When compared to the other statements, the retainment of artifacts is overall high. The variance between artifact types is mostly negligible, as the lowest score is 3.64 (multimedia) and the highest is 3.98 (code). Having access to the artifacts allows for reuse and post-graduation availability, but students may discard their artifacts following their graduation.

The reuse of artifacts has by far the most variation and some of the lowest scores overall. Ranging from 2.53 (presentations) all the way up to 4.05 (code), there is a considerable difference in artifact types. As mentioned in the artifact type responses, the variance may come from the nature of the artifacts themselves. Presentations and multimedia are heavily

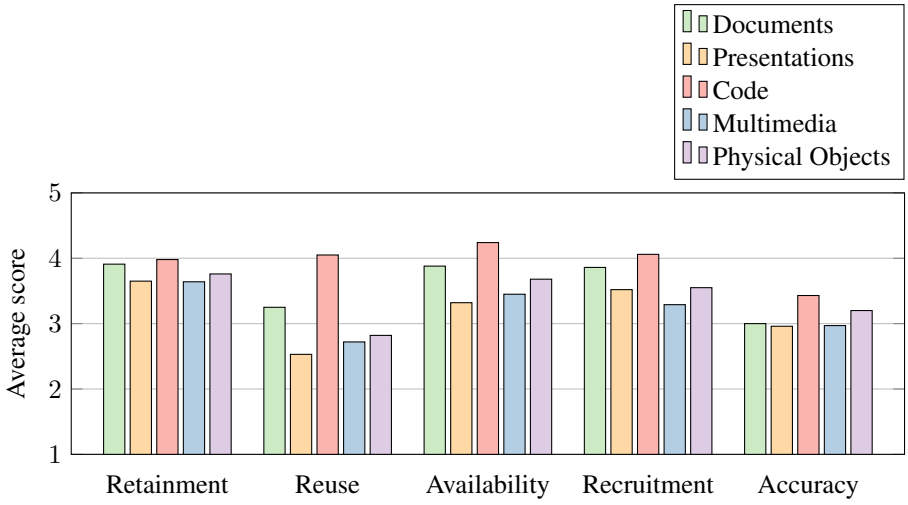

Figure 5.1: Average score of survey statements by artifact type

tied to the subject matter, while certain documents and physical objects may contain structures that can be reused. Code stands out as highly reusable in that sense, as a great deal of code can be ported directly from project to project. Structural aspects of documents and presentations may also be more ingrained in the students, as those artifact types are introduced earlier in school. Higher education may be the first time students are introduced to programming, leading to the most common structures not being memorized just yet. In other terms, the reuse of code may decrease as students are more familiar with the artifact type.

The desire to have artifacts available after graduation practically mirrors the students' retainment habits, albeit with some more variance. Presentations score lowest at 3.32, while code scores highest (across all statements) at 4.24. As indicated earlier, students may decide to hold on to artifacts "just in case", but then have less use of them after their graduation. Code showing a particularly high score may come from the high reuse value, especially if a significant portion of the students who replied to the survey will apply for jobs as developers following their graduation.

Students are generally willing to show their artifacts to recruiters, with code taking the lead at 4.06, and multimedia falling behind at 3.29. However, the statement itself may invalidate the intended purpose. As the statement specifies that the student would show their artifacts "if requested", disagreeing with a request could be seen as an illogical response. Declining to show material a prospective employer requests would simply lead to the candidate no longer being in consideration for the position, making the choice obvious. Some reluctance is shown, however, indicating that students may find some of their artifacts to negatively impact their chances of getting a job.

The accuracy of artifacts is the most neutral average overall, with few opting for strong opinions either way. Presentations show the lowest score at 2.96, while code remains ahead

at a modest 3.43. The use of the term ”old” in the statement may have shifted the results, as it asks the student to consider the accuracy of their entire set of artifacts. Newer artifacts may be highly accurate, while older artifacts may be increasingly irrelevant. The conflict could lead to a higher number of neutral responses than usual. This may also have affected the willingness to show artifacts to recruiters, as old artifacts may be less accurate and less likely to put the student in a favorable position.

The high level of ”N/A” responses in multimedia and physical objects may have led to less representative average scores. Students may have made artifacts that fit into the categories, but did not find suitable examples in the non-exhaustive list of artifacts in the descriptions. A longer description of the artifact types could have reduced the amount of ”N/A” responses.

Students' responses will be highly influenced by the way the options are phrased. In the introductory question of Subsection 5.2, a significant majority opted to respond to the all-encompassing middle option. As mentioned in the subsection, the phrasing of the options themselves may have led to the result. A simple yes or no option would force the student to take a clear stance, but it essentially translates to ”Sometimes or more” and ”Never”. In order to get a better indication to which degree students store their own artifacts, more options need to be included. Despite being absolutes, the outer options should still be included as viable answers. A clearer five-point scale such as ”Always, often, sometimes, rarely, never” may have balanced the results far better.

Similarly, the meaning of the mid-point of the five-point Likert-type scale may have influenced the results. ”Neutral” can act as a fallback when the student has mixed feelings or is generally unsure, as opposed to being exclusively for truly neutral responses. A phrasing like ”Neither agree nor disagree” may make the intended meaning of the option clearer. The impact on the results is likely negligible, as Armstrong (1987) found that a similar phrasing (”neutral” versus ”undecided”) hardly affected the scores. Averaging all the responses across statements and artifacts does not show an unreasonable central tendency either, as shown in the following distribution of responses:

- Strongly disagree: 5%
- Disagree: 13%
- Neutral: 20%
- Agree: 29%
- Strongly agree: 19%
- Not applicable: 14%

The lack of an alumni perspective reduces some of the statistical value of the results. Theories explaining the variance between artifact types and statements would hold more weight if they could be compared to alumni. The value of artifacts post-graduation is purely perceived, and students may feel more (or less) of a need to retain certain artifacts if it turns out that alumni never had any use of them. Similarly, one might assume that the accuracy of all artifacts would decrease with time, thus lowering the willingness to show them to recruiters. However, making such claims is best spared for a time when the alumni perspective can be properly determined.

Chapter 6

Interviews

The relevance of artifacts to recruiters was gauged by a set of interviews with industry recruiters, which would contribute to answering RQ1. In e-portfolio systems built for recruitment purposes, students create e-portfolios for recruiters to view. As recruiters effectively act as end-users for such systems, their perspective is highly valuable. Their needs for functionality should form the basis of later design considerations, which would then also contribute a great deal to answering RQ2.

As with previous data gathering, the focus was placed on Computer Science and Industrial Design once again. The student organizations for the study programmes, Abakus and Leonardo, function as a link between the students and the industry, and companies pay to market themselves to the students through events organized by the organizations. One such event is itDAGENE, a yearly public trade show. During itDAGENE, companies set up stands around campus, hold several talks and workshops, and gather for a banquet with the goal of mingling. While the event is primarily organized by students related to the Abakus organization, students from Industrial Design and several other study programmes are also welcome to participate in the event.

An assumption was made that companies that paid to have a stand at itDAGENE were also interested in hiring students for summer internships, or would hire fresh graduates for permanent positions. A total of 78 companies had a stand at itDAGENE in 2019, of which 11 companies were contacted for an interview. All but 2 of the filtered companies offered positions for both developers and designers, offering a great deal of perspective in each interview. 5 companies were consulting firms, while 6 developed in-house. Most of the companies at itDAGENE operate in the private sector, leading to only 2 of the contacted companies being part of the public sector. Of the 11 companies contacted for an interview, only 1 declined to meet, while 2 recruiters never responded. The remaining 8 responded with interest, of which 1 did not show up to the interview. While more companies could be contacted to fill in the gaps, patterns had clearly arisen from the 7 interviews conducted, and unique perspectives were few and far between after that saturation point.

Section 6.1 describes the design of the interviews. Section 6.2 presents the responses to the interview questions, while Section 6.3 goes on to interpret the data gathered.

6.1 Interview Design

The interviews were divided into two parts. The first part delved into the hiring process, aiming to gain an overview of how companies hire graduates. The comprehensive overview of the process would help deduce whether or not e-portfolios and the artifact types therein are relevant for recruiters, as per RQ1. The questions regarding the hiring process can be found in Table 6.1, along with the subsection the answers are covered in. The questions were ordered in such a way that one would mostly lead into the other organically. The more conversational the interview, the more data could be gathered, as opposed to interviews reminiscent of filling in a form. The final three questions stand more on their own, designed to prompt reflection in the recruiter. Reflecting on the hiring process transitions well into the second part of the interview, which revolves around e-portfolios.

Question	**Subsection**
What types of positions do employees have at your company?	6.2.1 Types of Positions
What is the process like for summer internships, what activities do applicants go through?	6.2.2 Process: Summer Internships
What is the process like for permanent positions, what activities do applicants go through?	6.2.3 Process: Permanent Positions
What material do applicants send in?	6.2.4 Application Material
Do you gather more information on the candidate than what they send in?	
What do you look for in the material? How do you separate candidates? (what do you look for in a candidate without prior work experience?)	6.2.5 Evaluating the Material
How do you look at design portfolios?	
What do you talk about during interviews?	6.2.6 Interview Content
What kind of projects do candidates bring up during interviews? (are school projects brought up?)	
Do you feel that coursework accurately reflect the abilities of the candidate?	
Assuming you're always iterating over the process, but are there any lacks or room for improvement in your current process?	6.2.7 Process Improvement

Table 6.1: Interview questions about hiring process

After the first part of the interview, the recruiters were introduced to the concept of e-portfolios. While the term had been used earlier in the invitation to the interview, the in-interview explanation provided the recruiters with a more elaborate description of what e-portfolios are and what kind of functionality the student and the recruiter might see. Following the introduction, three questions on e-portfolios and artifacts were posed. The

questions can be found in Table 6.2, along with the subsections the answers are covered in. The first two questions are deceptively simple in that they ask for pros and cons from the top of the recruiters' heads, but it also provides the most important feedback of the interview. The needs of recruiters contribute to shaping the design considerations of a modern e-portfolio system, as per RQ2. The final question could serve to indicate if artifact types outside of the given position are relevant to include, or if they can be safely omitted. It also contributes to answering RQ1, in that it revolves around the relevance of artifact types to recruiters.

Question	**Subsection**
Immediate thoughts to how e-portfolios could fit into your process?	6.2.8 E-Portfolio Integration
Immediate thoughts on challenges, problems or errors? (or errors with basing evaluation on coursework in general)	6.2.9 Challenges and Caveats
Is it interesting to look at school work outside of the specific position? For example looking at developer presentations, designer code etc.	6.2.10 Artifact Types

Table 6.2: Interview questions about e-portfolios relating to hiring process

6.2 Interview Responses

The companies that were interviewed ranged in terms of employee count from around 50 to 1000. The recruiters interviewed held varying positions at their respective companies, but did not necessarily represent recruitment for the entire company. While most of the companies had both designers and developers, fewer of the recruiters had experience evaluating designer portfolios.

The interview questions were gradually expanded as more interviews were conducted. When interesting perspectives were brought up, they could be included in later interviews in order to gain more reflections on them. As a result, the later responses were somewhat longer and more detailed than the early ones. However, the core interview design was present from the beginning and provided the bulk of the information needed.

The invitation to the interview noted that the specific names and details of companies would not be brought up in this thesis. This was done to allow the recruiters to speak freely about their processes, without fear of sharing sensitive information with other companies. Furthermore, the input of specific companies would be less interesting than a general overview. The raw interview data was scrubbed of identifiable information after the final interview and shuffled to further abstract the link between data and companies.

In the following subsections, the replies from the recruiters are combined and presented with minimal added commentary. Their perspective is offered first, while an interpretation is reserved for Section 6.3.

6.2.1 Types of Positions

To start, recruiters were asked to elaborate on the types of positions within their companies. While the positions themselves are not too important, it offers context to what kinds of companies are being interviewed. The primary focus of most of the companies interviewed is development and/or design, making up the bulk of the employee count. Employees are divided into categories in several different ways. For example, the developers could either be divided by experience (junior or senior developer), technology (Java developers, Go developers), by field (backend developers, frontend developers), or all rolled into the same profession (developers). Designers can be similarly grouped, as can business departments such as sales and marketing.

The granularity of the positions often depends on the number of employees within the department. While some companies decide to simply name the position based on the profession (developers, designers), the specific competence of a given employee is still kept track of internally. Even if their competence in their specialization won't be reflected in the job title, it would still be used for assigning employees to projects. In other terms, job titles don't necessarily reflect the full breadth of positions the companies offer.

6.2.2 Process: Summer Internships

Job listings for summer internships are typically posted in the fall prior to the summer in question. The deadlines vary from company to company, but companies in the private sector typically lock down their candidates earlier than those in the public sector. In any case, a candidate begins the process by sending in their application letter. The hiring process is less strict than it is for permanent positions, in part due to the summer internship itself often acting as a long job interview. This means the process can be as simple as looking through applications and having an informal meeting to get to know the candidate.

Looking through applications is no small task however. Even for the smaller companies ranging around 50-100 employees, there are upwards of around 300 applications every year. For the larger companies, that number is easily doubled. The screening phase is often quite thorough, filtering out as many as 80-90% of the candidates. This number varies mostly based on the number of available positions. The number of positions does not necessarily correlate with the size of the company, as one company might offer twice as many internships as another of similar size.

A candidate is typically interviewed for around 1-2 hours in total, with a significantly higher amount of time being spent on the part of the recruiter for each candidate. In other terms, being stricter in the screening phase could potentially save the recruiters a lot of time. In some cases, the recruiters could visit the school for a career fair and do speed interviews (around 10-15 minutes) as part of the screening.

For the candidates who pass through the screening, interviews are commonly offered. Companies might choose to divide the interviews into technical and social interviews, some even giving a case-based assignment to solve at home. The candidate is then brought back to present their solutions to the assignment. This contrasts to the technical interviews, which range from a casual conversation to math exercises and whiteboard algorithms. Going even further, candidates may be grouped together, or with employees at the company, to do case-based assignments or pair programming.

6.2.3 Process: Permanent Positions

The hiring process for permanent positions is largely the same as summer internships, but subject to greater scrutiny. After all, a summer internship lasts around 5-8 weeks, while a false positive for a permanent position would be more of an issue. On the other hand, candidates are often offered a permanent position at the end of their internship with no further process. This is due to the fact that the internship itself can be considered a hiring process, and an incredibly effective one at that. The company has the opportunity to gain an extensive and accurate view of the candidate, which would otherwise be impossible with the time constraints of filtering through so many candidates at the same time. For several of the companies, candidates carrying over from summer internships fill in the majority of permanent positions.

In the public sector, the process for permanent positions is quite strict. The companies are required to hire the most qualified candidate, and may only hire someone based on the criteria noted in the job listing. If a candidate is marked with functional impairments, then they are also obligated to consider that candidate. Despite this, many candidates with impaired functioning choose to omit that from their applications. When a company decides whether or not they want to hire a candidate, a separate council looks through and decides whether to approve or reject the company's decision. Apart from all that, the actual process is similar to summer internships. Two interviews are held in total, with a focus on testing tools (personality quizzes and such) and case-based assignments.

Meanwhile in the private sector, the process is quite similar to that of summer internships. Interviews are often longer, totalling at around 2-4 hours when all of them are combined. There is a greater focus on social interviews to make sure that the candidate is a good fit for the company culture. If a company is unsure of a candidate, they are also more likely to offer a case-based assignment to better inform their decision.

6.2.4 Application Material

The screening phase is largely formed by the same material across all of the companies. The job listings almost always request a CV, diplomas with grades (mostly from higher education), and a cover letter. Designers are required to attach their portfolios, while developers have the option to link to their profile on GitHub, where they may host their code repositories. Although developers aren't *required* to do so, not adding their de facto developer portfolio could almost count as a negative when others are placed higher for it. The general stance is that the more (relevant) information, the better a recruiter can form a representative profile of the person.

The material supplied is sufficient for the majority of the screening phase. In the later stages of screening, some of the recruiters might Google the person if they are so inclined. The recruiters intentionally avoid looking up the candidates on social media, as the profiles are rarely representative of the candidate as an employee. As a result, looking at social media would lead to false negatives more often than not. LinkedIn is used frequently for headhunting, where a recruiter might actively look for candidates to interview directly, instead of relying on job listings. In some cases, a candidate might neglect to mention they've appeared in an article out of modesty. If a candidate were to mention placing highly in a competition, then a recruiter would look it up to verify.

Finally, networking is an important aspect of the screening phase. Many of the companies that hire graduates actively recruit through career fairs and other events with student organizations. If members of the recruiting staff have met a candidate previously, it might have left a lasting impression that can prompt a thumbs up from the recruiter. Employees that were recently active in student organizations are often familiar with candidates that are currently active in the same organization. If a well-liked employee likes a candidate well, then odds are that the recruiters will too.

6.2.5 Evaluating the Material

A candidate's material is often the same as that of most other candidates. If a company largely markets itself towards a specific school, then they will mostly receive candidates from the same set of study programmes at that school. A recruiter noted that about 80% of their applications would be from students at similar programmes, typically studying in their third or fourth year. The bulk of their programming experience comes from three or four courses, one of which would be a software development project. This effectively forms the expected base level of experience that candidates need. The base-level candidates are considered qualified enough for the position, but if that is all the experience a candidate has then there is less to set them apart from other candidates.

Extracurricular experience primarily comes in three forms. The simplest to evaluate is prior work experience, where a candidate has already had an internship or a part-time position at another company. One recruiter referred to this effect as a "lucky loop", where candidates land positions early, making each new job easier to get. While the companies want the best candidates for the job, more unlucky candidates who may be just as qualified could be left out of consideration.

Secondly, volunteering for student organizations is a very big bonus. It can show that the candidate takes initiative, is motivated for their field, and has the drive to excel. Student organizations at NTNU rely entirely on volunteers, and engagement in the work shows an ability to work with others to push an organization forwards. As companies often hire former volunteers, the student organizations also become important networking opportunities. Volunteering in a given organization could get a foot in the door when other employees from the same organization can vouch for them.

Thirdly, hobby projects. Students who were unable to get direct work experience, or a position in a student organization, may want to consider making their own projects. For example a personal website, or a browser extension. The ability to start and complete a project indicates initiative, discipline, and an interest in the work. Furthermore, while the study programmes such as Computer Science are meant to be relevant for the industry, the courses mostly provide important theoretical background. In order to advance from the introductory-level experience provided, exercising practical skills with hobby projects is key. Practice makes perfect.

Grades

With hundreds of applications to go through for even the smallest companies, a simple metric one can use to sort the applications is the Grade Point Average (GPA). While the

recruiters seem mostly aligned on many of the questions brought up throughout the interviews, the usage of grades is a point of contention. If 80% of the hundreds of candidates have the same base level experience, the process can be simplified by sorting by their GPA.

Several of the recruiters expressed their grievances against the usage of grades, noting that certain courses base the entire grade on one exam lasting for a couple of hours. A semester of work could all be for nothing if the candidate becomes sick leading up to the exam, and the format might be better suited for certain students who can better memorize information. One recruiter in particular stated that recent research on the topic had found the connection between grades and job performance to be weak. For an example of the research the recruiter could have been referring to, see Armstrong (2010).

The total sum of grades could be irrelevant, but the recruiters might look at specific courses where the grade is based on project work over the semester. Oftentimes there are members of the recruitment staff who have more recently graduated from the relevant programmes, making them more up to speed on what courses to consider. Courses within the hard sciences such as math and physics might be more relevant for certain companies too, as the grades can be indicative of a candidate's ability to calculate and logically navigate the rules of the science.

A recruiter of a smaller firm theorized a correlation between the size of the company and the importance of grades. The bigger the company, the more candidates, and the less to separate the candidates by. A recruiter of an even smaller company refuted this claim, noting that time is a valuable resource for a start-up. Instead, it seems to be a matter of how many candidates the company has per available position.

On a more neutral stance, some recruiters noted that grades take the lowest priority. They are a contributing factor to the whole, but unless the GPA is particularly high or low, it usually does not factor in to the evaluation. One recruiter claimed that for 80-90% of the candidates, grades won't be a contributing factor. Other recruiters were quite fixated on grades, only wanting to hire the best of the best. Though middling grades can be excused for any number of reasons, consistently high or low grades are more indicative of the person's interest in their field.

Cover Letters

Regardless of grades and experience, cover letters provide the opportunity for a candidate to truly set themselves apart. Two students may have similar accomplishments, but their ability to express a unique motivation or interest in the company can make a world of difference. When hundreds of applications all look the same, cover letters that are custom made for the company stand out. If the letter could apply to any company, the candidate fails to show what makes them motivated for that particular firm.

Looking at how the candidate decides to structure and present themselves is as important here as it is in a CV. A very high GPA doesn't help if the candidate comes across as inarticulate or disinterested in the position. Similarly, lower GPAs and a lack of experience can be excused if the cover letter shines. At the very least, it can get a candidate called in for an interview they otherwise wouldn't have gotten.

Portfolios

Although GitHub-profiles are becoming increasingly prominent for the hiring of developers, they are not as ubiquitous as the usage of portfolios. Portfolios have become an industry standard for showcasing a candidate's work, and are required material for all the companies interviewed who hire designers. In some cases, they are even used when applying for study programmes relating to design in higher education.

The best portfolio, much like a CV, is made with the recruiter in mind. The structure of the document should be clear and easy to navigate. Take the recruiter's time constraints into account by being concise, while also managing to get the most relevant information across. Ironically, aspiring designers who claim to hold a passion for user experience may have portfolios that are cluttered and messy. The projects mentioned should also fit the company. If the position calls for web design, then having 4-5 projects only showcasing furniture would be a negative.

Within the constraints of making the portfolio legible, the candidates have a golden opportunity to personalize, showcase their style, and distinguish themselves from other candidates. Images can be indicative of the candidate's ability to communicate their message visually and contributes to showing off the candidate's sense of aesthetics.

6.2.6 Interview Content

The screening phase filters out the vast majority of candidates, allowing for deeper evaluation of those that remain. If anything was left unclear from the screening phase, the interviews can expand on that information. Gaps in the CV, quick switches between jobs, and lower grades can be brought up so that the candidate may defend their position. Recruiters note that the candidate's explanation of unfortunate circumstances or their ability to reflect on past mistakes will often nullify the disadvantage.

Good candidates are often involved in hiring processes for several companies at once, so the interviews are also an opportunity to talk about the company. Different recruiters have different structures for their interviews, but there is generally speaking a social interview and a technical interview.

Getting to know the candidate is essential for the social interview. What are their long-term goals, do they want to move into management in the future? Many of the companies interviewed are consulting firms, does the candidate want to interact with clients directly? The tech industry moves quickly, what habits do they have for keeping up with the evolving field?

Likeability is an important aspect of the interviews, but it can also be deceptive. Certain recruiters may ask questions relating to common red flags in order to get to know the candidate better. For example, how do they co-operate with others? How do they work with candidates they fundamentally disagree with? A recruiter for a smaller company noted that these kinds of questions are more important the smaller the company is. With a larger company, two employees that don't like each other can simply be placed on different projects.

Technical interviews are designed to make the candidate shine. The recruiter wants to find what the candidate is passionate about, so they can see if that passion lines up with the company. If the candidate has an interest in web security, the recruiters would often ask

about web security. Due to the project-based nature of the industry, technical interviews are intrinsically tied to the projects.

Projects

In terms of what types of projects are brought up, it largely depends on the experience the candidate has. The most recent is often the most relevant, with work experience and relevant volunteering placing highest. Candidates naturally bring up coursework if that's all they have to talk about.

The specific technology utilized in the projects is rarely in focus. With a base level of knowledge, candidates should be able to learn any technology the company uses. Exactly what the candidate has worked with isn't as important as *how* they've worked with it. In a technical interview, they might compare technologies and reflect on the choice of technology for the project. The interviewer might also ask them to write on the board, in order to describe the architecture of their last project.

The technology at hand will be relevant for a set of projects, but understanding the process is important to *all* projects. A lot can be learned about a candidate when asking them to describe a project that went wrong and what led to that point. Does the candidate respect an iterative process, or do they procrastinate and cram everything in at the end? Understanding the process is important so that the candidate may maintain such a process with less supervision in the future.

Similarly, while developers attach their Github profile, the project discussions aren't replaced. When a recruiter opens the profile, they see a wall of code, unsure of what is finished and what isn't. Candidates often attach too many projects, as they want to show that they are active and passionate. A recruiter won't have the time to look over every project on their own, so the candidate needs to "sell" their profile by reflecting on their projects.

Portfolios aren't necessarily the entirety of a candidate's work either, physical projects are sometimes brought into interviews too. Portfolios often show a result, but the process is more interesting. Many students can have affected the result, what part did the candidate play? Two candidates can have collaborated on making the same piece of furniture, but the difference in reflection can place one higher than the other.

Accuracy of Coursework

How representative coursework is depends on the context. If the coursework is recent and the tasks are relevant for the position, then it could be useful to look at. However, recruiters without a technical background might not be familiar with the particulars. In that case, the candidate can excel by exhibiting an ability to explain the coursework to the recruiter. It also makes it clear if the candidate knows the subject, or if other group members did all the work. Courses may also instruct students to work in a specific way, like utilizing Agile software development methodology. The work itself might not be useful, but the ability to reflect on the process and why they were meant to work that way can be useful.

If the candidates have nothing else to show for, then their coursework is as representative of a project as the recruiter will get. However, if a candidate has had an internship or other work experience, then the coursework is quickly irrelevant. Recruiters note that

the candidates typically know more than what the grades and projects may indicate, which contributes to them being more forgiving.

6.2.7 Process Improvement

Recruiters walk a thin line between subjectivity and objectivity. There are many people involved in the recruitment process, all of which have subjective biases. There is no such thing as a perfect interview, some level of gut-feel will play into the final decision. Members of the recruitment staff may match better with some candidates on a personal level. The recruiters rarely feel like they've hired the wrong person, but it can happen that they rejected a fantastic candidate. Wrongful hiring is very expensive, so if two of the interviewers vote yes and one voted no, the no wins. when recruiting students, it boils down to seeing them for their future potential, and predicting the future is hard.

The choice between two equally matched candidates can be swayed by any number of factors, many of them subjective. In the screening phase, many of the recruiters would often opt for a candidate that has received word-of-mouth from someone in the company. In the case of a department with a significant gender imbalance, one recruiter noted that they would swing towards the candidate of an under-represented gender. While not a direct result of the process itself, the recruiters themselves try to improve on their ability to choose fairly.

In some of the larger companies, recruitment is handled on a departmental basis. Candidates mark which fields they're interested in, or apply to specific departments. This can lead to cases where the candidate is ultimately marked as unfit for the department, but there might not be a process through which a candidate can be recommended to a different department. Recognizing these cases would require a good understanding of many departments and their needs, which is hard for one recruiter to handle.

Scheduling interviews can be a hassle, especially if the interviews are spread into several parts involving different interviewers. On the other hand, combining the interviews can be effective, but also exhausting for the interviewers and the candidates. One of the key upsides to separating the interviews is the ability to reject the candidate between each interview, saving time for the recruiters.

Finally, some of the recruiters find that there isn't more relevant material to request from candidates, and even if there was, then they likely wouldn't have time to go through it. The base-level candidates often don't have more relevant information to add, but going through the other material more efficiently may save some time. Saving time is not just for the recruiter's sake, but also for the candidate. The good candidates are in multiple processes at once, and they want to be able to offer them a position before their competitors.

6.2.8 E-Portfolio Integration

When asked if the recruiters believe e-portfolios could fit into their process, the reception was positive, if cautious. Several expressed interest, noting it could be very useful in the same way designer portfolios are. At the same time, time is a valuable resource. Unless the e-portfolio can be boiled down to a one-page resumé, it's unlikely that it would be used during the early screening phase. However, it could fit in later if the recruiters are unsure of a candidate.

The use cases largely depend on how big the e-portfolios would be, and how customizable they are. If the e-portfolios simply contain all the coursework a student has made over the past few years, it would be more irrelevant and overwhelming than a GitHub profile. The candidate must be able to highlight and order their artifacts to best fit the company they're applying for. The choice of what to highlight could be worth evaluating by itself.

A couple of recruiters provided estimates for the types of artifacts they would want to see. It could be very beneficial to see 1 or 2 projects, but the projects would have to be fairly big. A duration of 1 to 3 months would be a minimum, depending on the time spent on that project compared to other courses. When interviewers are told which candidates they will interview, having access to their projects could let them have a more in-depth discussion about them during the interview. Referring to the specifics of the projects during interviews could also be easier.

The potential availability of e-portfolios proves useful to both recruiters and candidates. Students beginning their second or third year rarely have a lot to show for it, so recruiters may require candidates to present what artifacts they have made up to that point. Simply having the artifacts available allows the recruiters to get a feel for the candidate's coding style. Recruiters note that having access to more information can be helpful, even if they likely won't use it for most cases. It's a supplement to the material they already have, but would be no replacement for other tools. Candidates excel at different things, and coursework is but one of the many options.

Poption

Multiple recruiters mentioned their usage of a service called "Poption". The service allows candidates to fill out a form where they decide which information to share with which companies. The candidate may share their contact information, study programme, when they're graduating, and more. The service is also connected to "Vitnemålsportalen", the Norwegian diploma registry, allowing the candidate to automatically share their GPA. Poption may also show which career fairs both the candidate and the company have been at, essentially documenting their shared history. The recruiters who had been in touch with Poption recommended considering integrating a potential e-portfolio platform with the service.

6.2.9 Challenges and Caveats

Following the cautiously optimistic reflections of the recruiters, they were asked to mention possible challenges or problems with using such a system. To begin, it is worth noting that the recruiters would take the material with a pinch of salt. Students create the artifacts they are instructed to make to take their exam, and the coursework is rarely aligned with what the market wants. Some schools, study programmes, and courses are more outdated than others. They realize that the candidates are themselves a work in progress, and that the artifacts they produce will be of limited use.

A recurring issue is that of group work. If four or more students have made an artifact together, how would a recruiter be able to know what work the candidate in particular has done? Git history could be integrated into the view of a software project, and the ability to "tag" others might also help. After a certain point, a link to an open Git repository would

be just as effective. Recruiters did mention earlier that asking questions about the artifact would quickly detect if they simply tagged along for the ride, or if they too had an understanding of the system. There are also exceptions to the need for contribution statistics, such as candidates who want to move from a technical programme into a leadership role immediately.

A way for the candidate to add their description of the project would provide important context. A candidate could provide it directly during an interview, but inserting it in the e-portfolio would help during the screening phase. This is similar to the most requested feature, namely the ability for candidates to write their reflections. The artifact itself won't be as interesting as what the candidate has to say about it in retrospect. One recruiter noted that this could itself be an issue, as some candidates could be worse at conveying information through text than others. The ability to record a video or audio file could be more accessible, especially for people with functional impairments. Other recruiters countered by stating that multiple types of employees are needed. Both talkative and technical employees require some minimum of communication proficiency, as they are very unlikely to work entirely alone.

On the topic of structure, candidates would have to be able to personalize their e-portfolio to a great degree. While a unified standard structure would improve legibility, it would remove one of the key advantages with design portfolios. Designers need complete creative freedom, so they can express their understanding of the field and showcase their style and sense of aesthetics. The tool won't help distinguish between candidates if they all look the same. If e-portfolios are meant to replace portfolios, as the name implies, then it would also have to cover more than just coursework. Merging the designer portfolio into an e-portfolio would require some ability to add hobby projects, volunteering work and more.

Regardless of whether or not non-coursework would be included in the e-portfolios, many artifacts would be irrelevant for the recruiters. For the e-portfolios to be manageable, candidates would have to filter down their artifacts and have a way to order and highlight them. The choice of structure could be evaluated by itself, especially for designers. A recruiter mentioned that many candidates make catch-all website portfolios they send to all the companies they apply to. In order to fit every company, they often include too many projects. Like cover letters, custom-made e-portfolios would place the candidate higher.

Proposing e-portfolios as a new tool also comes with an interesting cultural challenge. If the tool becomes an industry standard, then candidates could be expected to filter their artifacts in such a way that only artifacts relevant for the company remains. That could then prove negative for the base-level candidates who weren't lucky enough to gain experience outside of their studies. In other terms, the tool could be more harmful than helpful to 80% of the candidates. The tool could help distinguish between the base-level candidates by providing deeper insight into their artifacts, and anyone could begin a hobby project. However, it might perpetuate the "lucky loop" where those fortunate enough to receive an internship early would place even higher in relation to base-level candidates with just as much potential.

6.2.10 Artifact Types

When presented with the five artifact types defined in Section 4.3 (documents, presentations, code, media files, and physical objects), the recruiters largely shared the same sentiments. The most relevant artifact types for recruiters depend on the position that is being filled. For developers, code would be more relevant than the rest. Research positions could have use of seeing published articles or theses (documents). Various business-oriented positions would require proven presentational skills. All the artifact types are important for someone, but none seem to be important for everyone.

The context of the artifact matters more than the artifact type itself, however. A great deal of the documents produced would be highly irrelevant for any position in the industry, but the process behind the artifacts could be worth mentioning. Odds are that a master's thesis would have little relation to the industry, but code written as proof-of-concept could utilize relevant technologies. More importantly, the process of writing the thesis can provide the recruiter with some insight into the candidate. For example how the candidate structured their work or coordinated with co-authors. If the process is the important part, then the artifact type may be wholly irrelevant. Like the project discussions in the technical interviews and otherwise, how the candidate works towards the end-goal often matters more than the goal itself.

Many of the companies in the industry foster strong habits for continued learning. Companies allot time for their employees to learn new and exciting technologies and research, which keeps them updated with the latest industry trends. Conferences are a big part of this continuous learning, and employees often hold talks to spread knowledge across companies and advance the field, with the added bonus of being good PR for the company. As such, several recruiters note that an interest in holding presentations can contribute to the evaluation of the candidate. If videos of presentations are available, then a recruiter could skim it over and get a better feel for the candidate. That being said, the contents of the presentations are rarely relevant, making slides less relevant.

For most of the companies, a variety of interests is central to their recruitment philosophy. While interacting with clients often benefits from a ”people person”, the companies also need people who prefer to hunker down and get some work done. This need seems to depend on the structure of the company. Where some companies are largely departmentalized, focus could be placed on the specific roles at hand. On the other hand, companies with fewer and larger departments may have more use of variety and jacks of all trades. Like design portfolios, CVs, and cover letters, tailoring the e-portfolio towards the employer will provide the best results.

6.3 Interviews Discussion

The interviews display a clear promise in e-portfolios for recruitment purposes, but the value will be highly dependent on the functionality of the tool. The artifacts themselves have questionable value, but little else in terms of relevant material exists for candidates with no prior experience. Simply having the artifacts readily available would be useful for both candidates and recruiters, but quality of life may be improved even further through the use of an e-portfolio.

Recruiters claim that screening candidates is incredibly time-consuming, and they may find it challenging to separate candidates with similar backgrounds. This seems to be less of an issue if the candidates have reached the interview phase, as two candidates on the same project can be separated by their reflections. E-portfolios may assist in this area, as candidates could describe the context and reflect on their artifacts directly. If the e-portfolio is concise enough, they could be used already in the screening phase, helping recruiters separate candidates early on. More detailed e-portfolios could be used in later stages to prepare for interviews, or to be reminded of the candidate's reflections in the final decision stage.

Based on the answers, it is natural to conclude that customization of the e-portfolios is essential. As mentioned multiple times, recruiters find that material tailored towards the specific company outshines the rest. As a result, specific versions for different companies would be key. A web-based tool could allow candidates to make a summarized single-page portfolio for the screening phase, while also having more detailed views of more artifacts available. The structuring of the e-portfolio itself could be evaluated by the recruiters, especially in the case of more creative fields. Designer candidates need to be able to showcase their own style, as well as demonstrate their understanding of the field.

In terms of the interview process itself, there remains room for improvement. The final three questions may be hampered by the fact that the recruiters had little time to reflect on how e-portfolios could fit into their process. Introducing the technology after their process reflection makes them relate the technology to their process all at once, potentially missing details from earlier in the interviews. Describing e-portfolios more in-depth at the beginning of the interview could have provided more time to consider ups and downs as they reflect on their process.

The interview questions were expanded as more insight was gathered, making the later interviews more detailed than the early ones. Even still, the interviews were reaching a saturation point by the last interview. The recruiters work with a lot of the same candidates, the same material, and similar positions. Thus, the first half of the interviews received mostly similar responses. However, each process was still unique in some fashion, leading to reflections on e-portfolios to still offer fresh perspectives. Furthermore, the reflections were more specific to the recruiters themselves, which combined with the "on the spot" nature of the questions suggests that there is still insight to gain. Moreover, these interviews were focused on companies that primarily hire newly-graduated developers and designers. The processes found in other industries may lead to other design considerations entirely.

Chapter 7

Design Considerations

Utilizing the information gathered in the previous chapters, a set of design considerations can be formed for a theoretical e-portfolio based around retaining and showcasing artifacts. Known challenges from previous research were discovered through Chapter 2, while Chapter 4 provided the lay of the land in terms of what artifacts and platforms apply to Computer Science and Industrial Design specifically. Chapter 5 showed a clear interest from students to retain artifacts and showcase them to recruiters, and this interest was also found with recruiters in Chapter 6.

Section 7.1 presents the users and stakeholders of the e-portfolio. Section 7.2 goes on to suggest functionality that the stakeholders would require from the tool. Section 7.3 explores data collection and third-party integrations. Finally, Section 7.4 poses practical and cultural challenges related to the case.

7.1 Stakeholders

E-portfolios can be made for any number of applications and users, but the considerations of this chapter will be focused specifically on the retainment of artifacts, and their use in recruitment. These applications are mostly separate, but some interface functionality may overlap for the sake of consistency. For the sake of grounding the design considerations, a specific case is utilized, continuing with the example of Computer Science and Industrial Design at NTNU.

The students are a type of end-user of the e-portfolio, interacting with both the retainment and the recruitment side of the application. A great deal of the work on the collection side could be automated, but students may contribute to the collection of artifacts by manually uploading them if need be, or adding in artifacts of their own. More on that in Section 7.3. On the recruitment side, the application will require more labor on the part of the candidate. As the finished e-portfolio would serve as a reflection of the candidate, they would need to spend time organizing and describing their artifacts.

When the e-portfolio is complete, it can be shared with a different type of end-user: the recruiter. The recruiter would primarily interact with the complete e-portfolio, as opposed

to sifting through an unfiltered collection of artifacts. The format of the e-portfolio determines the interaction the recruiters have with the application. A web-based solution could offer a summary of a candidate at first, showing their highlighted artifacts and reflections. Interacting with the application would then allow the recruiter to see more detailed views of particular artifacts, or even navigate the entire library of artifacts. If the recruiters prefer, they may avoid interacting with the system themselves by having the candidate export their e-portfolio as a PDF file instead.

The institution that decides to offer an e-portfolio is a stakeholder too, which in this case could be NTNU. The development of the application could be outsourced to consultants, but the institution itself serves as the bridge between the users and the application. As alumni lose access to other internal systems, NTNU would need to offer some form of a user profile for the former students. The institution hosting the application would be responsible for storage space on servers, as well as ensuring uptime of the service. NTNU may also contribute to the adoption of the service by providing documentation on how to utilize the application, or offering courses on what makes a good e-portfolio.

7.2 Functionality

In order to discuss the functionality stakeholders may require, the theoretical e-portfolio application is first described by the interface users would interact with. There are many approaches to such an interface, and this section provides an example based on existing systems. Recall from Subsection 2.4.4 the common characteristics of state-of-the-art e-portfolio applications:

- Online portfolios structured into multiple web pages
- Artifacts either imported from an LMS or manually uploaded
- WYSIWYG drag-and-drop content management
- Templates providing preset structures
- Visual customization for colors, fonts, and layout
- Generating URLs with different access privileges

Keep in mind that the state-of-the-art systems are designed for multiple use cases, including learning and assessment. As such, some of the characteristics above may be unneeded for artifact retainment or recruitment. Regardless, the characteristics will be expanded upon in the following sections, along with the needs of stakeholders.

The e-portfolio space is not necessarily exhausted for ideas yet, and there may still be room for other innovative approaches. For example, a professor noted in Subsection 4.2.6 the possibility of a virtual reality portfolio in the future. That being said, the characteristics from the state of the art exemplify the type of application stakeholders would come to expect.

7.2.1 Artifact Retainment

Artifact retainment does not require a great deal in terms of interface functionality. WYSIWYG content management, templates, and visual customization primarily allow the users to prepare the e-portfolio for public display. An application handling a collection of artifacts can be as simple as files in a directory on some server. As long as there is a way for artifacts to be uploaded to the directory, or downloaded from it, the minimum viable product for artifact retainment is achieved. Connecting the directory with an LMS would reduce manual labor, which is the subject of Section 7.3. For increased usability, one may take a clue from Dropbox (2020) or Google (2020), where users may sync the directory with the local file system, handling uploads and downloads for the user. In both cases, native file navigation on the computer can be used to explore the collection. However, if one does not wish to sync the files, or is on a mobile device, both a website and a mobile application is offered. The e-portfolio application could appear similarly, offering users a file navigation interface on a website.

Considering the artifact types from 4.3, artifacts may be text document files, sets of presentation slides, source code, images, videos, audio, or other complex files such as 3D objects. Most of the artifact types would be simply visualized with an embedded file viewer. Documents, presentation slides, and media files are trivial to show with modern web technology. For code, inspiration can be taken from code repository hosts such as GitHub or GitLab. The file navigator could be used to traverse the software package, with simple syntax highlighting making the source more legible. Embedded viewers also exist for 3D models, like Sketchfab. Regardless, artifacts that can't be viewed in the page itself could always be downloaded and viewed locally.

Having access to artifacts holds some value for recruiters too. Deciding which artifacts to show and generating a URL for the recruiter would be a quality of life improvement. However, the artifacts have limited use by themselves. A recruiter may gain some idea of what the candidate has produced recently, but the artifacts alone don't necessarily indicate if they were made in a group, who did what, and what the candidate actually gained from the artifact. Instead of seeing a raw collection of artifacts, an e-portfolio application would offer an editor through which the e-portfolio could be created and shared with recruiters.

7.2.2 Recruitment

Based on the state-of-the-art systems, e-portfolios on the web appear ubiquitous. For the student, an online WYSIWYG drag-and-drop editor would provide a great level of customization, as well as allowing users to intuitively influence their design. Such editors can be found in both Mahara (2019) and Digication (2020a), as well as several of the portfolio tools listed in Section 2.4. After creation, the recruiter could then access the e-portfolio with a web address. The e-portfolio would function as a website with pages, or it could potentially be exported as a PDF for use offline.

Recruiters noted throughout Chapter 6 that tailored material provides the best results. As it is the case for CVs, cover letters, and portfolios, it is natural to assume that the same applies to e-portfolios. As such, customization lies at the heart of making an e-portfolio for recruitment purposes. Customization can refer to three types of interaction, which will be expanded upon throughout this section:

1. Customization of content: editing blocks of text, like descriptions and reflections on artifacts

2. Customization of layout: structuring the e-portfolio by dividing the content into pages, as well as arranging the content on those pages

3. Customization of aesthetics: adapting the look and feel of the e-portfolio with fonts and colors

In order to adapt an e-portfolio to a company, one may need to change both the content and the layout. If a candidate applies to ten different companies, it would be tedious to make a new e-portfolio from scratch every time. Instead, one may duplicate the e-portfolio and make modifications to the copy. However, if changes are to be made to the content that one wants to reflect on several of the copies, one would have to manually update them all. Instead, one could consider structuring the e-portfolio into *blocks*, as Mahara (2019) does. A block could be a paragraph of text, a representation of an artifact, or a composite of multiple blocks. Any e-portfolio that uses that block could then be automatically updated if the block is changed.

Visual regression testing could help detect if the changes to font size, blocks, or artifacts lead to unforeseen visual errors on other pages or e-portfolios. Automated testing tools may take screenshots of the pages before and after changes are applied, then comparing the two pictures. For example, if the user is adding more text to a block, it may lead to the now longer block intersecting with another. A tool may detect such overlaps automatically, or the user may be asked to manually check usages of the given block to see if anything looks unseemly.

Finally, a note on access rights. All of the three examples brought up in Section 2.4 have the ability to share the e-portfolio through a URL, and one would expect the same from future systems. The examples also allow one to define access rights for users of the link, so that one may add other students as collaborators, or allow visitors to add comments to the e-portfolio. A similar system could be used to generate specific version links, where a candidate may want to highlight different artifacts in their summary, or they want to prevent access to the full artifact collection.

Artifacts

Artifacts are complex blocks that contain a great deal of information. Users of the e-portfolio may benefit from a simplified view of an artifact, deciding which information is most relevant to display. A simplified view should be able to represent the artifact as an image and act as a link to a more detailed view of the artifact. The image may be an automatic screenshot of the file as seen by the file viewer, or the user may upload their own image of the artifact.

The detailed view of an artifact could be an extension of the file viewer so that the recruiter could view it in the same way a student does. Having access to a file viewer also allows the recruiter to judge the artifact themselves. In addition to the artifact itself, more blocks of information can be added. These blocks could be written text, or one may record audio or video for accessibility, which for example Digication (2020a) allows for.

In order to fully understand an artifact, recruiters may wish for a contextual description. The description could include when the artifact was made, what course it was made for, the score the artifact achieved, if it was made with a group, and what the candidate contributed to the artifact if that is the case. Parts of the metadata could be automatically pulled from an LMS, like Blackboard (2018) does with its artifacts. If the artifact is a software project using Git, one may even interpret the Git history to generate contribution statistics. The statistics may provide rough insight into how much the members of the group contributed, but the metrics are hardly true to life. As contributions in code are packaged into ”commits”, the number of commits could vary greatly based on the size of the commits. Similarly, lines of code added, removed, or changed could be influenced by semantics such as whitespace.

As mentioned several times in the interviews of Chapter 6, personal reflection is considered by recruiters to be the main contribution of the e-portfolio. The user would be wise to write a reflection on the artifact, potentially including what went right or wrong with the artifact, what they learned from the creation of the artifact, if they're satisfied with their own contribution to the group, and more. A project may have gone terribly, but reflecting critically could show prospective employers that the candidate can learn from their mistakes. Reflecting on what one gained from a group project may even place the candidate higher than another that was on the same group. The reflections may not be a replacement for the in-depth conversation one might have in an interview, but it could provide enough of a taste for the candidate to land the interview.

Structure

Depending on which stage the e-portfolio is utilized, the e-portfolio could provide a varying level of detail. When used in the screening phase, time is of the essence, and a summarized view would be most appropriate. As suggested by one recruiter in particular, a single-page PDF highlighting 1-2 larger projects could be a helpful addition to their screening process. The limited size forces the candidates to be clear and concise in their text blocks. If successful, the recruiters may find that the reflections have piqued their interest, prompting them to invite the candidate to an interview. That being said, certain candidates may fill their single page to the brim with information, flying in the face of the time constraints set by recruiters. Like with CVs, cover letters, and designer portfolios, this would likely reflect poorly on the candidate.

How a candidate decides to structure their e-portfolio could by itself be under evaluation. Many of the companies interviewed in Chapter 6 are consulting firms, developing and designing websites for clients. The creation of an e-portfolio effectively becomes a demonstration of how the developer or designer would structure a website for the end-user, which in this case is the recruiter. Does the e-portfolio flow naturally from block to block? Are the most important blocks highlighted well? The legibility and usability of the e-portfolio would be under scrutiny, in addition to the visual interest it evokes.

Adding a template system may be helpful to give the students some indication of what they should have in terms of information, and how they should generally structure their pages. For example, the developers of the application could offer a tutorial with a template based on the key criteria recruiters look for, such as a front-page summary and more detailed views if desired. This could also lead to many of the e-portfolios looking the

same, so it is important that students are able to branch out from the preset templates and express their own sense of style and creativity. In cases where design is less of a factor for the position, e-portfolios looking the same could actually be helpful. A company could issue a template to applicants, essentially acting as a form to fill out. When going through the stack of applications, the recruiter might then have an easier time at quickly finding the information they want, as they know where to expect it. Templates may influence what the students initially believe to be a good structure, but students and recruiters would ultimately be the ones to form trends with time.

7.3 Data Collection

In an ideal system, users would be required to do as little manual labor as possible. State-of-the-art systems recognize this, as all three examples presented in Section 2.4 can retrieve delivered artifacts from supported LMSs. In the case of Blackboard Learn, the e-portfolio is fully integrated into the LMS, while the other two examples follow the LTI specification by IMS-Global (2019). Implementing with the LTI specification in mind would allow for the retrieval of artifacts from certain platforms at NTNU, such as Blackboard or Inspera (2020). The LTI specification is based on the OAuth authentication protocol. As the same protocol is used for accessing the GitHub and GitLab APIs, a similar technique may be employed to retrieve data from those platforms.

As a reminder, Figure 4.2 shows a non-exhaustive list of platforms. Integration with each platform from a list of unknown length falls outside the scope of this thesis, but any e-portfolio would need to be adapted for the institution in question. There is one entry of particular note from the list of platforms, namely the use of physical delivery. Manual uploads on the part of the student would be required at some stage, which might involve taking pictures of the artifact if it is a physical object. This would also be the case for platforms that have yet to be connected with the e-portfolio application, or for artifacts delivered by e-mail, as was the case with some courses at the Department of Design in Subsection 4.2.6. The manual labor may not be a barrier however, as Section 5.2 shows that plenty of students store their own coursework already.

Artifacts form the core of the e-portfolio, but there is still more relevant data that can be involved in the e-portfolio. The description of the artifact may be automatically filled with metadata from the LMS it was retrieved from. Such metadata could detail important context, such as if the artifact was part of group work, or what score the artifact received. From a recruitment perspective, one might take this integration a step further by integrating with Poption, as introduced in Subsection 6.2. Poption allows the candidates to share contact information and other relevant information, and is connected to the Norwegian diploma registry, allowing the candidate to share their GPA. If developing an e-portfolio application for recruitment purposes, one could consider the possibilities of Poption having a link to a candidate's e-portfolio, or vice versa. Regardless, having access to the scores of the artifacts or the grades of the courses may prompt even more reflection from the candidate.

7.4 Challenges

The concept of retaining artifacts that are already uploaded to some service on the internet may seem trivial, but there are some practical considerations one needs to take into account. As noted in Lorenzo and Ittelson (2005), e-portfolios accumulate year after year. As students graduate, they each have five years' worth of artifacts collected and may have made several iterations of e-portfolios, each with different versions for different companies. If students are given lifetime access, the amount of storage needed could grow out of proportion as years upon years of alumni retain their artifacts. Should alumni be charged a fee for their continued retainment? Should they only be allowed a limited amount of space? Will the access expire one day? As recruiters note that the relevance of artifacts drops significantly the moment a candidate has prior work experience, the latter may be the most viable solution.

As discovered in the case study, 53.3% of the courses from the selection contained group work. Although a somewhat small sample size in terms of NTNU as a whole, group work is central to developers and designers. As noted by recruiters, artifacts from larger collaborative projects are most relevant, as they are more indicative of how the candidates are expected to work in the industry. This is relevant because collaborative artifacts pose interesting challenges in terms of data ownership. Consider the following scenario: Student A and B worked on the same project together, and are applying to the same company. Student A, proud of their work, wants to show their work to the company. However, student B was unsatisfied with their own contribution and does not want the company to see that particular artifact. Can student B prevent student A from showing their work? Can a compromise be found by scrubbing the artifact for identifiable data? Removing a name from a report may be simple, but development projects involving Git will have extensive contribution history to go through.

Potentially having to edit artifacts lead to another issue, namely the proof of ownership. The application could provide a badge to indicate that the metadata is imported from an LMS, but such a badge could easily be faked with an image if users have complete creative control. Grades on a course as a whole can be verified by requesting signed prints from the Norwegian diploma registry, but who's to say the scores on a particular artifact are correct? The system would likely always need a way to upload an artifact manually, thereby circumventing the built-in plagiarism controls of the LMSs. What's to stop a candidate from gaining a competitive edge by taking someone else's work as their own?

7.4.1 Cultural Challenges

Finally, there are some cultural considerations to discuss, namely the development and adoption of an e-portfolio application. First of all, what does NTNU stand to gain from developing an e-portfolio application? A significant amount of money would be spent on salaries for both developers of the application, as well as maintainers. Expanding to include learning and assessment could enhance the educational value at the institution, but recall that surveys such as Dahlstrom and Bichsel (2014) and Brooks and Pomerantz (2017) show that students hardly use e-portfolios to begin with, and would rather use them less, if at all. If learning is not the objective, then the service mostly serves alumni who would have no use of the service the moment they gain a permanent job, sans nostalgia.

The artifact retainment aspect could easily be hand-waved with manual labor the students already do willingly, using services like Google Drive or Dropbox. For this case in particular, NTNU (2019c) already offers a terabyte of storage for students through Microsoft OneDrive.

Even if another system was to be developed, how would one encourage its adoption? Recall from Subsection 2.3.1 that e-portfolios for recruitment had yet to catch on. Academia theorizes the potential value for recruitment, and the recruiters that have heard of it seem interested enough. Based on the survey of Chapter 5 and the interviews of Chapter 6, a similar interest can be found in the particular case of this thesis. Recruiters could benefit from having access to the material, and it may actually help candidates that have less to show for. Students already do some manual work to retain their artifacts and are also willing to show them to recruiters if requested. This does however beg the question: will recruiters be the ones to request e-portfolios? Would companies be the ones to take initiative and prompt students to make e-portfolios? Or does it fall upon NTNU to encourage students to make and send e-portfolios that companies haven't asked for? Perhaps student organizations could have a pivotal role, as they are both connected to the school and the companies, potentially arranging workshops with companies to build e-portfolios.

Interest in e-portfolios may increase if a user-friendly application is made available, but that's a big "if" for the investment of time and money. What would the application do differently from the countless tools already out there? Recruiters note that GitHub profiles have had an increase in use as developer portfolios over the past few years. Some recruiters even go so far as to say that while it is optional to link to the profile, the candidate would effectively be worse suited competitively if they don't. If the main issue with the GitHub profiles is the lack of clear direction and overview, wouldn't the candidates be better served with finding ways to help candidates organize their profiles better? Designers already have full creative freedom in the portfolio tools they use today, be that at the cost of skill or money. If there is a desire for a similar recruitment tool for developers, then maybe they should take some inspiration. Perhaps NTNU, the students, and the recruiters would all be better served by simply using the tools that made the designer portfolio an industry standard.

7.5 Summary

Even with a limited set of applications, discussing e-portfolio functionality for two different sets of users at the same time may prove confusing. For the sake of clarity, and to answer RQ2 directly, the following guide summarizes the functionality and challenges that an institution may need to consider for student e-portfolios:

- **What is the main application of the system?** E-portfolios can potentially enhance learning and assessment, help students market themselves to recruiters, or act as a persistent collection of artifacts. Different applications will require somewhat different functionality
- **Who are the users of the e-portfolio?** In other terms: which stakeholders should be consulted for further requirements? Students are central to all applications of student e-portfolios, naturally. They may use the system to organize and retain their

artifacts, or use them to make an e-portfolio. Recruiters would be the viewers of completed e-portfolios, and may even have limited use of a raw artifact collection. Consulting users for their requirements is *critical* to the success of the system

- **What *is* the system?** Online web pages are the norm for most e-portfolios, but are optional for artifact collections that are mere files on a server. A WYSIWYG drag-and-drop editor would allow students to customize the web pages, which could then be viewed by the recruiters. Some recruiters may prefer a PDF exported from a summarized e-portfolio

- **Where does the data come from?** Systems following the LTI specification may import artifacts from an LMS, and similar protocols can be used for connecting with services like GitHub and GitLab. Manual uploads are always an alternative. Other data about the students, such as their GPA, could be retrieved from the Norwegian diploma service, or similar systems

- **How can students customize their e-portfolios?** Artifact collections may simply be organized into directories. The web editor may allow students to edit ”blocks” of text, as well as place them on various connected pages. The students may express themselves visually with various colors and fonts as well. The ability to create custom versions of the same e-portfolio is key to tailoring them to the recruiter in question

- **What are some challenges related to artifact retainment?** Storage costs may grow out of control, consider limiting the storage space, the duration of the artifact collection, or charging a fee for the system

- **What are some challenges related to e-portfolios for recruitment?** Depending on the policy of the institution or intellectual property rights, the ownership of the artifacts may be under dispute, potentially limiting their ability to be showcased. Manual uploads can complicate things further, as recruiters will be unable to verify if the artifact was actually made by the student

- **What are other challenges to consider?** The system would need users to be worthwhile, and planning how to encourage the adoption of the system may prove difficult. The cost of developing a system specifically for the institution may be higher than utilizing an existing system

- **What are other systems to consider as alternatives?** E-portfolios may be losing significant favor with students, considering alternatives could be prudent. Systems will vary greatly depending on the application of the e-portfolio, and some tools are more specialized than others

  - **Artifact Retainment:** Dropbox, Google Drive, Microsoft OneDrive
  - **Recruitment:** All-purpose e-portfolio systems include Digication and Mahara, amongst many others. Viable alternatives can be found in tools used to make designer portfolios, such as Figma, WordPress, Squarespace, or Adobe Portfolio.

These considerations were born out of a specific set of state-of-the-art systems, as well as interviews with a limited set of companies. Other cases than the one utilized in this thesis may require more considerations, so a thorough exploration of user requirements is recommended. Similarly, certain considerations may be waived if other systems the institution utilizes handle them, such as plagiarism control of manual uploads. That being said, the considerations are by no means exclusive to the case of Computer Science and Interaction Design at NTNU.

Chapter 8

Conclusion

In order to discuss the contributions and the research approach of this thesis, a reminder of the work done for the thesis is supplied here first. Chapter 1 introduced the purported promise of e-portfolios, as well as the lack of a system for artifact retainment or accurate judgement of student capabilities in the case of NTNU. This prompted the literature review of Chapter 2, where the various definitions and applications of e-portfolios were explored, followed by a comparison of three examples of modern e-portfolio systems. Chapter 3 elaborated on the methodological approach of the thesis, introducing the work that would be undertaken to answer the research questions.

Chapter 4 established a case study of the Computer Science and Industrial Design study programmes, showing a plethora of artifacts and platforms used for coursework in those two programmes alone. The case study concluded in the formation of a set of five artifact types, which would be compared and contrasted in the survey of Chapter 5. The survey measured the habits students had for manual retainment of artifacts, as well as the perceived relevance of artifacts for other courses and recruitment. A series of interviews were conducted with relevant recruiters in Chapter 6, establishing an understanding of their recruitment process and how e-portfolios could fit in. Finally, Chapter 7 combined the gathered data throughout the thesis to a set of design considerations and challenges for institutions looking into e-portfolios.

Section 8.1 relates the results of the work done in this thesis to the research questions. In a similar vein, Section 8.2 discusses the methodology of the thesis in retrospect, highlighting potential shortcomings. Finally, Section 8.3 points out room for wider and deeper research in both the case and the field.

8.1 Contributions

Prior to the research questions being established, some work went into determining the goal of the thesis. As this master's thesis was written at NTNU, the selection of e-portfolios as the research subject was motivated by the potential of such a system. A preliminary literature review indicated that e-portfolios for learning and assessment were largely sat-

urated, with highly mixed results. Artifact retainment on a technical level is mostly tied to the systems in use at the given institution, prompting the thesis to focus on a particular institution as a case study of sorts. Furthermore, focusing on a specific institution made the results from the survey and the interviews more reflective of potential future users.

Graduates at NTNU do lose access to most of their artifacts, and some sort of system for gathering and storing artifacts could assist alumni. The thesis was originally intended to lead to the implementation of a proof-of-concept system, which would serve as the results of the case study. Developing a system ended up falling outside of the scope of the thesis, and design considerations were formulated instead. As some of the literature may indicate, too many institutions have developed e-portfolios out of their own interest, when a rigorous study of what the users want should come first. Developing systems without catering to the needs of users, or without seeing if the users want the systems to begin with, could very well be one of the reasons students would rather use less of them.

8.1.1 Research Question 1

The research questions were not set in stone until around halfway through the thesis, after which only minor changes in phrasing were applied. Before the research questions were determined, an informal literature review was conducted. The preliminary literature review contributed to setting the research questions, as it indicated that the use of e-portfolios for learning and assessment had potentially stagnated. It also showed that there could still be interest in e-portfolios for recruitment and artifact retainment. As a reminder, here is Research Question 1:

RQ1 What are the types of artifacts produced by students, and what relevance do they hold for alumni and recruiters?

Three components contributed to answering RQ1. First, the case study of Chapter 4 established Computer Science and Industrial Design, the study programmes at NTNU that the thesis was centered around. By surveying professors and other course staff, the types of artifacts could be determined. Furthermore, an example of the breadth of platforms an institution like NTNU utilizes for coursework could be presented. Other information was also gathered, such as the exam form and the prevalence of group work, but the results were not significant enough to warrant further consideration. The artifact types themselves could vary based on the study programme or institution in question, but serve mostly to make surveying students easier. Artifact types are not needed on a technical level, where one would instead merely consider file types. However, establishing a set of artifact types allowed for a more extensive comparison of their relevance.

The second component of RQ1 was the survey of Chapter 5. The survey built on the artifact types established in the case study, aiming to answer what relevance the artifact types have for alumni. The idea was to survey Computer Science and Industrial Design specifically, then compare their responses to gauge perceived versus actual relevance of artifacts. The survey was ultimately opened up to more study programmes, and the alumni perspective was lost due to there not being enough responses. However, the survey still provided the *perceived* relevance of the artifact types. The results indicated an interest to retain artifacts across all artifact types, showing that the students are willing to back up

their files, even without an automated system. Furthermore, a clear interest was found in keeping artifacts despite their perceived lack of relevance for the most part. The results of the survey were positive overall, with some very minor variance between the artifact types. This goes to show that while there are differences between the artifact types, they are negligible and could very well be a by-product of the study programmes that were surveyed. For example, the survey may have had a majority of responses from the Informatics programme, inflating the relevance of code artifacts. Regardless, the results showed that students had a willingness to share artifacts with recruiters, despite limited belief in their accuracy.

The interviews with recruiters in Chapter 6 provided the final component of answering RQ1. In order to gauge the relevance of artifacts for recruiters, 7 interviews were conducted. The companies selected hired either students from Computer Science or Industrial Design, or both. The interviews first established the recruitment process of the companies, so that they could reflect later on whether or not e-portfolios could assist their processes. The typical recruitment process started with a screening phase, where even the smallest companies had to filter through hundreds of applications. As each candidate would often apply to multiple other companies too, filtering through the applications in a timely manner was key to getting the best candidates. Recruiters found that many of the candidates had largely the same background and experience, making it hard to differentiate between them. If a tool like e-portfolios could allow recruiters to efficiently examine more relevant material on the candidates, it could be easier to make a decision on which candidates to interview. Artifacts, and e-portfolios by extension, were irrelevant to recruiters for the most part, as it would easily be trumped by relevant work experience, volunteering work, or hobby projects. That being said, when the candidate does not have prior experience, which very often is the case, e-portfolios could be of assistance. The interest level of the recruiters could best be described as cautious optimism, as the interviews found a wide variety of design considerations that needed to be met as well.

8.1.2 Research Question 2

The components of the second research question overlap with those of RQ1, as the research questions are closely related. The first was designed to lead into the second, gathering data on the case and applying it to a hypothetical system. As a reminder, here is Research Question 2:

RQ2 What design considerations should be taken into account for developing a modern e-portfolio system?

Chapter 7 was designed to answer RQ2, effectively acting as an amalgamation of the chapters that came before it. In addition to introducing the concept of e-portfolios and their use over the years, Chapter 2 provided some known challenges with e-portfolios from previous literature. Not only technical challenges such as storage space and server maintenance, but also cultural considerations such as the adoption of e-portfolios and the measured interest in them. Furthermore, Section 2.4 compared three examples of state-of-the-art systems, establishing what functionality one could expect from existing applications.

While the state-of-the-art systems consider e-portfolios on a global scale, most of the functionality needed for the users of the specific case of NTNU came from Chapter 6. As mentioned earlier, the recruiters responded to e-portfolios with cautious optimism. An e-portfolio could potentially assist their process, but the system would have to meet their needs. If a company wishes to use e-portfolios in the screening phase, the e-portfolios would need to be shortened down to a single-page resumé covering 1-2 larger projects. E-portfolios used in the later stages of recruitment could be more extensive, allowing for interviewers to prepare to discuss them with the candidate, or to act as reminders of the candidate for the final decision of hiring them or not. The artifacts themselves are not the most important part, rather it is the reflections the candidates have around the artifacts that provide the most insight. This shows that customization is the most important requirement of e-portfolios for recruitment, both in terms of tailoring the content and the structure of it. E-portfolios would likely be judged in ways similar to CVs, cover letters, and design portfolios, as recruiters will take note of the relevance of the content, how it is structured in terms of legibility, as well as the artistic expression of the design.

The design considerations of Chapter 7 were based on the aforementioned data, effectively proposing answers to the questions raised by recruiters. The characteristics of state-of-the-art systems were elaborated on for the two ”sides” of the theoretical application, namely artifact retainment and recruitment. Potential third-party integrations were also brought up as a more technical consideration of data collection. Following the design considerations, there remained a number of questions without clear-cut answers, posed as challenges. These challenges ranged from practical issues such as storage space limitations, to the ownership and authenticity of artifacts. Furthermore, certain challenges related to the cultural aspects of e-portfolios were brought up, such as the adoption of such a system, and if an institution should develop such a system at all. Finally, for the sake of answering RQ2 as succinctly as possible, Section 7.5 offered a guide of points for institutions interested in e-portfolios to consider.

8.2 Discussion of Research Approach

Following the work done for the various chapters, reflections reveal potential shortcomings and limitations in the results in retrospect. The following subsections will explore what might have gone wrong, or what could have been done differently for each of the methods employed.

8.2.1 Literature Review

The literature review may have covered some of the most relevant papers in the field, but the selection seems quite centered on the U.S. While it is the largest English-speaking country by far, an effort could have been made to include a more global perspective. The interest in e-portfolios does seem to vary based on the specific case and implementation, and one might find that the interest in the U.K. or elsewhere would be different.

The categorization of papers may have proved more confusing than useful with the overlapping nature of the categories. One could have considered making the paper type categorization and the application categorization separate. That way, each paper would

have a type and an application, making the results clearer. As some papers don't focus on a specific application, an "N/A" option could be employed. At the same time, the overlap between categories may go to show just how diffuse the field of e-portfolios is.

Including even more recent papers could help get a better understanding of what the current-day situation is. However, the timeline of papers found in Figure 2.1 does provide an interesting impression that e-portfolios grew in popularity, but may have tapered off some years ago.

8.2.2 Case Study

When it was decided to turn the data gathering into a questionnaire, the case study could have covered more courses. Scaling up the course page search would be time-consuming, but the time spent on gathering data for the questionnaire was mostly spent by course staff. Including non-mandatory courses would offer more data while still limiting the responders to mostly Computer Science and Industrial Design. The more data, the more unique artifact types may be discovered, and the categorization may hold more statistical weight.

The questionnaire that was sent out to course staff had a list of options for artifact types. This list may have influenced the results. For example, the definition of "physical objects" including everything from hardware to sculptures and the likes makes it hard to tell what exactly the students make. Doing a more extensive search could have offered a more inclusive list of options. As an alternative, the survey could have asked the responders to specify the type of coursework for themselves without any premade options. That way, the artifact types could have been made from scratch, directly from the source. At the same time, text field responses might not be as detailed as the descriptions on the course pages.

The final artifact types are not too important on their own, but they may have influenced the distribution of answers on the survey of Chapter 5. The artifact types were grouped by a sort of semantics, where everything remotely physical would slide into the "Physical objects" type. As an alternative, grouping artifacts by their file type (documents, slides, code, images, videos) could have been utilized, but that ignores the *meaning* of the artifacts. Instead, the artifacts could have been grouped by their meaning in terms of coursework. For example, code-driven hardware and videos showing sculpture exhibitions come from wildly different courses.

The artifact types could be split to be made more specific. For example, multimedia could be divided into "graphs and models" and "posters", or code could be split into "software development in teams" and "code exercises". This would make the meaning of the artifact types clearer, and the different components of the categories could get significantly different results. However, as each artifact type had five statements to be placed on a Likert-type scale, the survey would be quite a bit longer and may have received fewer responses. In the end, the artifact types and the variance between them would differ from case to case, while their primary purpose in this thesis is to provide a framework for gauging whether or not students and recruiters would have use of e-portfolios.

8.2.3 Survey

A way to distinguish between Computer Science and Industrial Design could have offered interesting results, as certain artifact types seem more relevant to certain positions or study programmes. For example, developers may have more use of code, and multimedia or physical objects could be more relevant to designers. This might also reduce the amount of ”N/A” responses in various categories. Simply adding an introductory question asking which study programme the responder belongs to would allow the data sets to be separated. However, the issues with gathering responses to the survey would get in the way here. Splitting the already low amount of responses into even smaller sets would offer the results with less statistical power.

Despite there being over 12000 members in the NTNU Alumni group on LinkedIn, only three responded. Being unable to answer the alumni part of RQ1 was unfortunate, but it did not harm the core outcome of the survey for students. The main goal of including the alumni perspective was to be able to see if there were any significant discrepancies with the perspective of students, but no particular differences were expected either.

Unfortunately, NTNU does not have a system for sending out surveys to students. Asking professors to post the survey on Blackboard led to a few responses, but a great deal of the professors either declined or never replied. In an attempt to keep the responses mostly focused on Computer Science and Industrial Design, the corresponding student organizations (Abakus and Leonardo, respectively) were contacted. Both organizations declined to forward the survey to their students. A third student organization, Online, was contacted. Online is the student organization for Bachelor of Science in Informatics and Master of Science in Informatics, a matching bachelor + master degree programme akin to Computer Science, with less focus on mathematics and physics. Online accepted the request, leading to the number of responses effectively doubling.

The inability to get in touch with students of the two study programmes had a direct impact on the accuracy of the results. The inclusion of Online is unlikely to have affected the accuracy, as the represented programmes are quite similar to Computer Science. The importance of continuing with the original study programmes may have been overrated, as opening the survey up to more programmes could have led to far more responses. At the same time, the study programmes were also used to select companies to be interviewed, so that the results from students and recruiters could be more directly related. The inclusion of unrelated study programmes would make the results less relevant to compare.

8.2.4 Interviews

The interviews were fairly comprehensive overall, covering a great deal of ground with a limited set of recruiters. 7 interviews were conducted in total, and a great deal of the answers had started repeating from interview to interview. Still, more interviews could have been conducted with a modified set of questions. The questions that had begun to stagnate could be excluded from future interviews, and instead focusing on the questions that still gained fresh perspective with each interview. While every recruitment process is unique in some way, gathering more data on the subject would take quite some time. Meanwhile, gaining more perspective on e-portfolios would be helpful, and shortening the interviews would allow for more companies to be interviewed without as big of a loss of

time. The data-gathering could be taken a step further, and move over to a survey instead.

With the design considerations in mind, companies could be surveyed on their interest in the presented functionality, and remaining challenges could be discovered. Presenting the recruiters with a state-of-the-art system as an example could also help communicate what an e-portfolio could be like. Making the concept more tangible could make it easier for the recruiters to come up with ideas. Surveys also allow for more time to consider the responses, as opposed to answering on the spot. Such a survey could be sent out to the list of 78 companies that had stands at itDAGENE, as introduced in Chapter 6, potentially gaining quite a bit more information. Furthermore, more companies that specifically specialize in either design or development would be included, forming a clearer distinction between the requirements of the two. Including more companies in the public sector may have revealed larger differences between the public and the private sector too.

8.3 Future Work

While it is easy to consider alternative methods for gathering data in retrospect, every thesis has a limited time frame. More work remains to be done in the future, either to cover potential gaps in this thesis or to expand on the data already gathered. The vast majority of work this thesis set out to do was accomplished, but there is still valuable insight to gain. The interviews were reaching a saturation point in terms of learning about the recruitment process, but there may still be interesting considerations in terms of what functionality recruiters may want. Furthermore, recruiters from other industries may provide entirely different considerations.

Although the loss of the alumni perspective did not negatively impact the rest of the results, their perspective could still provide interesting results. Data may confirm the theory that artifacts lose relevance over time, which would impact what path an institution would take when deciding on a business model. For example, if alumni find that they lose interest in artifacts within five years, storage issues might be handled by removing access for alumni after five years.

For the case of NTNU, further study would be required prior to the consideration of actual system implementation. Much of the work in this thesis focused primarily on two study programmes for their broad set of artifact types. Looking into the artifacts made on a broader scale could show that certain artifact types could be far more important to consider. More obscure study programmes could also provide more obscure artifact types to consider.

This thesis has explored the relevance artifacts have to students, but that relevance may not be directly correlated with their willingness to use an e-portfolio application. Directly surveying students to gauge interest and test functionality would be key to avoid wasting resources on a system that users might not want. Those interested in promoting artifact retainment might be better off considering systems tailored for that very purpose. Similarly, recruitment processes could instead be enhanced by considering some of the tools that made design portfolios an industry standard.

This thesis has focused exclusively on e-portfolios for recruitment and artifact retainment, but the potential of e-portfolios for enhancing learning specifically at NTNU remains unexplored. While some of the literature in Chapter 2 may indicate that the technology has

been received poorly, a great deal of the papers also hint to untapped potential. The faults of e-portfolios might not be inherent to the concept itself, but could instead be a result of institutions forcing an implementation without consulting their users. The continued relevance of the e-portfolio field will ultimately come down to the adoption of e-portfolio systems. Research touting the potential of e-portfolios has been steadily produced for decades now, but users will be interacting with actual systems, not theoretical ones. Institutions would be wise to either develop systems with the user at the center, or be prepared to see the popularity of e-portfolios continue to sink. Even then, as some researchers have theorized, e-portfolios might not be long for this world, and could very well go down in history as another educational fad.

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Appendix A

Appendix

A.1 Literature by Research Topic

These are all the 61 articles that were selected for categorization in Chapter 2. The articles are divided by category, each of which also contains the descriptions from Section 2.2. Each article was categorized based on their title, abstracts, results, and conclusion, and belongs to only one category. In cases where the categories overlap, the most apparent category was selected. The articles are cited below and listed in the bibliography as well.

A.1.1 Overview

Overviews introduce readers to the concept of the e-portfolio, often presenting the many applications and challenges of the technology. Earlier papers often focus on the potential of e-portfolios, such as Lorenzo and Ittelson (2005) or Abrami and Barrett (2005). Later papers like Barrett (2010) may focus on more grounded approaches based on existing implementations, while papers such as Clark and Eynon (2009) or Wilson et al. (2018) may examine the field itself at the time.

- *An overview of e-portfolios* by Lorenzo and Ittelson (2005)
- *Directions for research and development on electronic portfolios* by Abrami and Barrett (2005)
- *Balancing the two faces of ePortfolios* by Barrett (2010)
- *Differentiating electronic portfolios and online assessment management systems.* by Barrett (2004)
- *Electronic portfolios 2.0: Emergent research on implementation and impact* by Cambridge et al. (2009)
- *E-portfolios at 2.0-Surveying the Field* by Clark and Eynon (2009)

- *E-portfolio: the DNa of the Personal Learning Environment?* by Attwell (2007)
- *Electronic portfolios: Blending technology, accountability & assessment* by Ahn (2004)
- *Assessing the future: E-portfolio trends, uses, and options in higher education* by Reese and Levy (2009)
- *Digital Ethics and the Use of ePortfolio: A Scoping Review of the Literature.* by Wilson et al. (2018)

A.1.2 Case Study

Case studies focus on a specific implementation of an e-portfolio system. The goal of the case study may be to prove the value of e-portfolios in a specific context, such as with Garrett and Jackson (2006). In other cases, the goal could be to demonstrate specific technology or for example show how perceived ease of use affects student perception of the e-portfolio, as is the case with Shroff et al. (2011).

- *Analysis of the technology acceptance model in examining students' behavioural intention to use an e-portfolio system* by Shroff et al. (2011)
- *Implementing project-based learning and e-portfolio assessment in an undergraduate course* by Gülbahar and Tinmaz (2006)
- *The diffusion of electronic portfolios in teacher education: Issues of initiation and implementation* by Strudler and Wetzel (2005)
- *A mobile clinical e-portfolio for nursing and medical students, using wireless personal digital assistants (PDAs)* by Garrett and Jackson (2006)
- *Preservice teachers' electronic portfolios: Integrating technology, self-assessment, and reflection* by McKinney (1998)
- *Costs and benefits of electronic portfolios in teacher education: Student voices* by Wetzel and Strudler (2006)
- *What Difference Can ePortfolio Make? A Field Report from the Connect to Learning Project.* by Eynon et al. (2014)
- *Enhancing project-based learning in software engineering lab teaching through an e-portfolio approach* by Macias (2012)
- *When cloud computing meets with Semantic Web: A new design for e-portfolio systems in the social media era* by Kim et al. (2010)
- *Development and roll out of the JETS e-portfolio: a web based electronic portfolio for endoscopists* by Mehta et al. (2011)
- *Identifying vocational student teachers' competence using an ePortfolio* by Korhonen et al. (2019)

A.1.3 Guidelines

Guidelines are akin to overviews in that they often show various challenges the technology faces. Guidelines often focus on the importance of facing those challenges. Examples include Tosh et al. (2005) and Gathercoal et al. (2002), both of which encourage adopters of the technology to first consider the student perspective.

- *Engagement with electronic portfolios: Challenges from the student perspective* by Tosh et al. (2005)
- *On implementing Web-based electronic portfolios.* by Gathercoal et al. (2002)
- *Strategic questions: What to consider when planning for electronic portfolios.* by Barrett (1998)
- *Directions in electronic portfolio development* by Gibson and Barrett (2003)
- *Database e-portfolio systems: A critical appraisal* by Kimball (2005)

A.1.4 Commentary

Commentaries take a critical look at the field itself, like the aforementioned "Electronic portfolios for whom?" by Ayala (2006). Papers like Rhodes et al. (2014) note that "there is a need to move beyond case studies and anecdotal stories towards more rigorous methodologies", while Challis (2005) points at the lack of meaningful research as a possible sign that e-portfolios could end up as an educational fad.

- *Towards the mature ePortfolio: Some implications for higher education* by Challis (2005)
- *Beyond the electronic portfolio: A lifetime personal web space* by Cohn and Hibbitts (2004)
- *Electronic portfolios for whom?* by Ayala (2006)
- *A call for more rigorous eportfolio research* by Rhodes et al. (2014)
- *Student Secondary Use of ePortfolio Data: A Need for Digital Ethics Guidelines* by Kirby et al. (2019)

A.1.5 Assessment

Assessment papers focus on the value of e-portfolios for assessing students. The term may involve both assessment for the sake of learning, or assessment of the learning itself. Many of the papers can be considered case studies, such as Hung (2012) or Baturay and Daloğlu (2010).

- *E-portfolios: an assessment tool for online courses* by Mason et al. (2004)

- *Using electronic portfolios for formative/classroom-based assessment* by Barrett (2006)
- *Validity of portfolio assessment: which qualities determine ratings?* by Driessen et al. (2006)
- *E-portfolio assessment in an online English language course* by Baturay and Daloğlu (2010)
- *Assessing the efficacy and effectiveness of an e-portfolio used for summative assessment* by Buzzetto-More (2010)
- *E-portfolio assessment system for an outcome-based information technology curriculum* by Tubaishat et al. (2009)
- *A washback study on e-portfolio assessment in an English as a Foreign Language teacher preparation program* by Hung (2012)
- *Using Facebook-based e-portfolio in ESL writing classrooms: impact and challenges* by Barrot (2016)
- *Improving workplace-based assessment and feedback by an E-portfolio enhanced with learning analytics* by van der Schaaf et al. (2017)
- *Mutual feedback in e-portfolio assessment: an approach to the netfolio system* by Barbera (2009)

A.1.6 Learning

Learning is a wide term and quickly becomes a catch-all for any potential benefit of e-portfolios as a learning technology. Active reflection of artifacts may be considered a type of assessment, leading to the categories overlapping based on semantics. Examples include case studies like Wade et al. (2005) or Alexiou and Paraskeva (2010).

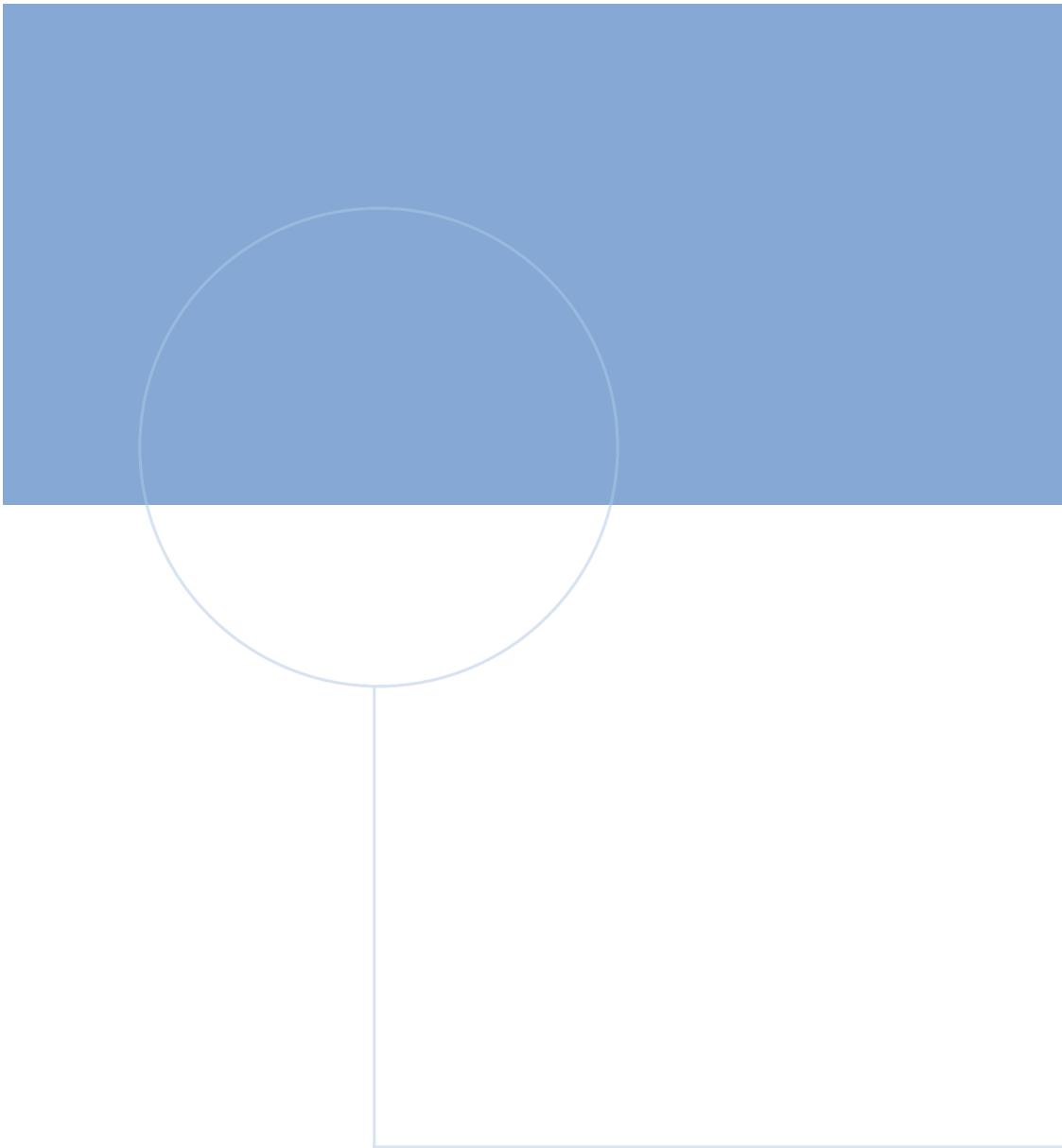
- *Researching electronic portfolios and learner engagement: The REFLECT initiative* by Barrett (2007)
- *White paper: Researching electronic portfolios and learner engagement* by Barrett (2005)
- *Student-directed assessment of knowledge building using electronic portfolios* by Van Aalst and Chan (2007)
- *Improving literacy and metacognition with electronic portfolios: Teaching and learning with ePEARL* by Meyer et al. (2010)
- *An electronic portfolio to support learning* by Wade et al. (2005)
- *ePortfolios: Digital stories of deep learning* by Barrett (2001)

- *Performance assessment and electronic portfolios: Their effect on teacher learning and education* by Pecheone et al. (2005)
- *Student perceptions of ePortfolio integration in online courses* by Bolliger and Shepherd (2010)
- *Enhancing self-regulated learning skills through the implementation of an e-portfolio tool* by Alexiou and Paraskeva (2010)
- *Encouraging self-regulated learning through electronic portfolios* by Abrami et al. (2007)
- *Promoting Self-Regulation and Critical Reflection through Writing Students' Use of Electronic Portfolio.* by Jenson (2011)
- *Online personal learning environments: structuring electronic portfolios for lifelong and life-wide learning* by Richter et al. (2009)
- *Creation of a learning landscape: weblogging and social networking in the context of e-portfolios* by Tosh and Werdmuller (2004)
- *An e-portfolio design supporting ownership, social learning, and ease of use* by Garrett (2011)
- *High-impact ePortfolio practice: A catalyst for student, faculty, and institutional learning* by Eynon and Gambino (2017)
- *Factors That Contribute to ePortfolio Persistence.* by Thibodeaux et al. (2017)

A.1.7 Recruitment

Recruitment papers are primarily focused on using e-portfolios to showcase artifacts and related reflections. Papers like Ciesielkiewicz et al. (2020) and Ward and Moser (2008) gauge whether or not employers in various industries are interested in the use of e-portfolios.

- *E-portfolios as a hiring tool: Do employers really care* by Ward and Moser (2008)
- *E-portfolio, a valuable job search tool for college students* by Yu (2012)
- *Electronic portfolios in recruiting? A conceptual analysis of usage* by Strohmeier (2010)
- *The Potential of the ePortfolio as a Recruitment Tool: From the Perspective of HR Directors* by Ciesielkiewicz et al. (2020)



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