

# Design principles for an online app development course used globally. Experiences from the DHIS2 ecosystem

A Design Science Research study

Hanna Evensen



Thesis submitted for the degree of Master in Informatics:  
Programming and System Architecture  
60 Credits

Department of Informatics  
Faculty of Mathematics and Natural Science  
UNIVERSITY OF OSLO  
May 18, 2021



**Design principles for an online app  
development course used globally.  
Experiences from the DHIS2 ecosystem**

A Design Science Research study

**Hanna Evensen**

© 2021 Hanna Evensen

Design principles for an online app development course used globally. Experiences from the DHIS2 ecosystem

<https://www.duo.uio.no/>

# Abstract

Digital platforms are an emerging field in the Information Systems (IS) literature. Much of the research focuses on platforms in the Global North. However, recent research has highlighted a need for more research on platforms in the Global South, specifically focusing on innovation platforms and how to release innovation in the Global South. Facilitating innovation by developers in the Global South is also a theme in the Information and Communications Technologies for Development (ICT4D) literature. For more innovation to happen *in* developing countries, research has highlighted a need for tools to support innovation, known as boundary resources in the platform literature.

There has not been much research on developing such tools in an innovation platform used in the Global North and Global South, where developers have diverse backgrounds. I explore this gap by developing an online website consisting of courses to learn about the design system for the innovation platform DHIS2. The design system is used to standardize the apps developed for the platform and create better quality apps.

By using the design science research methodology, this research has used initial design principles from instructional design to develop the website. Through three design cycles of developing and evaluating the website, the initial design principles have been revised, and three new principles have emerged. The new design principles emphasize the diversity of the intended user group and include the principle of tailorability, the principle of offline mode, and the principle of feedback. Several people have participated in this research through interviews, participating in a focus group, and answering a questionnaire.

**Keywords:** Design Science Research, digital platforms, boundary resources, online courses, instructional design, ICT4D



# Acknowledgements

First of all, I would like to thank my supervisor Johan Ivar Sæbø for guiding me in the right direction, giving me feedback, and taking the time for regular meetings.

I would also like to thank everyone who participated in this research. I am very grateful to everyone who took time out of the day to partake in this research. This research would not have been possible without you.

I am also very grateful for having been a part of the DHIS2 design lab during the work with this thesis. Thank you to Anders Brustad and Hanna Kongsheim for facilitating activities within the DHIS2 design lab. Thank you to Magnus Li for his enthusiasm and advice to everyone in the Design Lab, even though not his students. I would also like to thank everyone who participated in the activities within the Design Lab.

Lastly, I want to thank dad and Nicholas for helping with the proofreading of this thesis. I would also like to thank the rest of my family for continual support and encouragement throughout my life.

Hanna Evensen  
University of Oslo  
May 2021





# Acronyms

**API** Application Programming Interface

**DHIS** District Health Information Software

**HIS** Health Information Systems

**HISP** Health Information System Program

**HMIS** Health Management Information System

**ICT** Information Communication Technology

**ICT4D** Information and Communications Technologies for Development

**IS** Information Systems

**IT** Information Technology

**JSON** JavaScript Object Notation

**MOH** Ministry of Health

**NSD** Norwegian Center for Research Data

**SDK** Software development kit

**UCT** University of Cape Town

**UI** User Interface

**UiO** University of Oslo

**UWC** University of Western Cape

**UX** User Experience



# List of Figures

3.1	Elements of a platform ecosystem (Tiwana, 2013, p. 6) . . . . .	12
3.2	Software ecosystem architecture, platform architecture, and actors (Dal Bianco et al., 2014, p. 12) . . . . .	15
3.3	The onion model of the platform boundary resource classes. (Dal Bianco et al., 2014, p. 16) . . . . .	16
4.1	Design science research cycles (Hevner, 2007, p. 2) . . . . .	25
4.2	Design science research knowledge contribution framework (Gregor and Hevner, 2013, p. 345) . . . . .	26
4.3	Design Science Research contribution types (Gregor and Hevner, 2013, p. 342) . . . . .	26
5.1	<b>Homepage when the user is not logged in</b> – (A) The navigation bar, (B) The headerbar, (C) Overview of the courses, (D) Course image, (E) Course description, (F) Links to resources . . . . .	41
5.2	Course overview for the course "DHIS2 components" with one of the sections in the accordion open. Note: the screenshot only shows parts of the accordion . . . . .	42
5.3	Overview of the topics covered in the "Action components" section in the course "DHIS2 components." . . . . .	43
5.4	Secondary navigation inside the course "DHIS2 Components". Known as breadcrumbs . . . . .	44
5.5	Presentation of the different button options in the course "DHIS2 components" . . . . .	45
5.6	Coding exercise with both a "show solution" button and a "show hint" button were the button for "show hint" is clicked . . . . .	47
5.7	Image quiz for the usage of the UI component Tag . . . . .	48
5.8	End of section multiple-choice quiz for the section "Data display components" in the course "DHIS2 components" . . . . .	49
5.9	Coding exercise from the course "DHIS2 components" . . . . .	50

5.10 Image quiz where the user has chosen the correct answer . . . . .	51
5.11 Multiple-choice questions after the action components section in the "DHIS2 components" course, where the user has chosen the two first multiple-choice question correctly and the third incorrectly . .	52
5.12 Congratulation page at the end of the course, where the user has received a badge for completing the first course . . . . .	53
5.13 Congratulation page at the end of the course, where the user has received two badges, one for completing the first course and one for getting all the questions correct . . . . .	54
5.14 Progression bar in the navbar . . . . .	54
5.15 Navigation bar when the user is not logged-in . . . . .	55
5.16 Navbar when the user is authenticated . . . . .	55
5.17 Log in page . . . . .	55
5.18 Settings page, when the user has completed one course and received one badge for completing the first course . . . . .	56
5.19 The homepage after the first design cycle . . . . .	59
5.20 The course image for the course "DHIS2 Components" with a checkmark for having completed the course . . . . .	63

# List of Tables

3.1	The classification of platform boundary resources . . . . .	17
4.1	Overview of the data collection methods used . . . . .	28
5.1	Overview of initial design principles . . . . .	39
5.2	Overview of instantiation of initial design principles . . . . .	58
6.1	Summary of the findings from the evaluation . . . . .	79
6.1	Summary of the findings from the evaluation . . . . .	80
6.1	Summary of the findings from the evaluation . . . . .	81
7.1	Final revised design principles . . . . .	91
7.2	Final revised design principles . . . . .	92



# Contents

<b>Abstract</b>	<b>i</b>
<b>Acknowledgements</b>	<b>ii</b>
<b>Acronyms</b>	<b>iii</b>
<b>List of figures</b>	<b>v</b>
<b>List of tables</b>	<b>vi</b>
<b>1 Introduction</b>	<b>1</b>
1.1 Motivation . . . . .	1
1.2 Research questions and objectives . . . . .	4
1.3 Structure of the thesis . . . . .	5
<b>2 Background</b>	<b>6</b>
2.1 Health Information System Program . . . . .	6
2.2 District Health Information System Software . . . . .	7
2.2.1 DHIS2 application platform . . . . .	7
2.2.2 DHIS2 design system . . . . .	8
2.2.3 DHIS2 design lab . . . . .	9
2.3 Summary . . . . .	9
<b>3 Literature review</b>	<b>10</b>
3.1 Definition of digital platforms . . . . .	10
3.2 Types of digital platforms . . . . .	11
3.3 Platform ecosystems . . . . .	12
3.4 Platform architecture . . . . .	13
3.5 Boundary resources . . . . .	13
3.6 Digital platforms for development . . . . .	17
3.7 Instructional design . . . . .	19
3.7.1 Gagne’s nine events of instruction . . . . .	20

3.8	Summary . . . . .	21
<b>4</b>	<b>Methodology</b>	<b>22</b>
4.1	Philosophical assumption . . . . .	22
4.2	Design science research . . . . .	23
4.2.1	A three cycle view of design science research . . . . .	24
4.2.2	Design science research contribution . . . . .	24
4.2.3	Design principles in design science research . . . . .	27
4.3	Data collection methods . . . . .	27
4.3.1	Relevance cycle . . . . .	29
4.3.2	Design cycle . . . . .	30
4.3.3	Rigor cycle . . . . .	32
4.4	Analysis . . . . .	33
4.5	Ethical considerations . . . . .	33
4.6	Limitations . . . . .	34
<b>5</b>	<b>Artifact Description</b>	<b>36</b>
5.1	Description of the technologies used . . . . .	37
5.1.1	React . . . . .	37
5.1.2	Firebase . . . . .	37
5.1.3	Codesandbox . . . . .	37
5.1.4	DHIS2 UI components . . . . .	38
5.1.5	Material-UI . . . . .	38
5.2	Initial design principles . . . . .	38
5.3	Instantiation of design principles . . . . .	40
5.4	The three design cycles . . . . .	59
5.4.1	Design cycle 1: Early sketches + development of the homepage . . . . .	59
5.4.2	Design cycle 2: Developing course content . . . . .	61
5.4.3	Design cycle 3: Adding more content to the courses and adding badges . . . . .	62
5.5	Summary . . . . .	63
<b>6</b>	<b>Evaluation</b>	<b>64</b>
6.1	Design principle 1 . . . . .	64
6.1.1	Questionnaire . . . . .	65
6.1.2	Focus group . . . . .	65
6.1.3	Developer in Mozambique . . . . .	66
6.2	Design principle 2 . . . . .	67
6.2.1	Questionnaire . . . . .	67



6.2.2	Focus group . . . . .	67
6.2.3	Developer in Mozambique . . . . .	67
6.3	Design principle 3 . . . . .	68
6.3.1	Questionnaire . . . . .	68
6.3.2	Focus group . . . . .	68
6.4	Design principle 4 . . . . .	68
6.4.1	Questionnaire . . . . .	69
6.4.2	Focus group . . . . .	70
6.4.3	Developer in Mozambique . . . . .	70
6.4.4	UX designer . . . . .	70
6.5	Design principle 5 . . . . .	70
6.5.1	Questionnaire . . . . .	71
6.5.2	Focus group . . . . .	71
6.6	Design principle 6 . . . . .	71
6.6.1	Questionnaire . . . . .	71
6.6.2	Focus group . . . . .	72
6.6.3	Developer in Mozambique . . . . .	73
6.6.4	UX designer . . . . .	73
6.7	Design principle 7 . . . . .	74
6.7.1	Questionnaire . . . . .	74
6.7.2	Focus group . . . . .	74
6.7.3	Developer in Mozambique . . . . .	74
6.8	Design principle 8 . . . . .	75
6.8.1	Questionnaire . . . . .	75
6.8.2	Focus group . . . . .	75
6.8.3	UX designer . . . . .	76
6.9	Further findings . . . . .	76
6.9.1	Questionnaire . . . . .	76
6.9.2	Focus group . . . . .	77
6.9.3	Developer in Mozambique . . . . .	77
6.9.4	UX designer . . . . .	77
6.10	Summary . . . . .	78
<b>7</b>	<b>Discussion</b>	<b>82</b>
7.1	Positioning the empirical work within the platform and ICT4D literature . . . . .	83
7.2	Revising the design principles . . . . .	85
7.2.1	Design principle 1 . . . . .	85
7.2.2	Design principle 2 . . . . .	86

---

7.2.3	Design principle 3 . . . . .	86
7.2.4	Design principle 4 . . . . .	87
7.2.5	Design principle 5 . . . . .	87
7.2.6	Design principle 6 . . . . .	87
7.2.7	Design principle 7 . . . . .	87
7.2.8	Design principle 8 . . . . .	88
7.2.9	Design principle 9 . . . . .	88
7.3	New design principles . . . . .	89
7.3.1	Tailorability . . . . .	89
7.3.2	Offline mode . . . . .	89
7.3.3	Feedback . . . . .	90
7.4	Final revised design principles . . . . .	90
7.5	Reflections and limitations . . . . .	93
<b>8</b>	<b>Conclusion</b>	<b>95</b>
8.1	Limitation . . . . .	96
8.2	Future work . . . . .	97
<b>A</b>	<b>Data collection</b>	<b>104</b>
A.1	Appendix: The Final Website . . . . .	104
A.1.1	DHIS2 components . . . . .	104
A.1.2	Course colours . . . . .	131
A.2	Appendix: Questionnaire . . . . .	139
A.3	Appendix: Focus group consent form . . . . .	150

# 1

## Introduction

In this thesis, I report from experiences developing a website to teach and promote a design system for the innovation platform District Health Information Software (DHIS)2. The design system contains various design principles and a library of User Interface (UI) components. It aims to enable developers to design and build usable and consistent apps, thereby standardizing apps within the platform.

Using the design science research methodology, I have created design principles for developing similar websites in the future. As with the nature of design science research, this research has followed a cyclic process, continually receiving feedback and developing new features. Several people have participated in this research through interviews, participating in a focus group, and answering a questionnaire.

### 1.1 Motivation

DHIS2 is one of the world's most comprehensive Health Management Information System (HMIS) platforms used by 73 low and middle-income countries (DHIS2, 2021b). The Health Information System Program (HISP) at the University of Oslo (UiO) manages the software development, often referred to as the core team. The core team has developed the DHIS2 design system and generic apps that use this design system. These generic apps can be customized through the UI and are utilized in various ways by the global DHIS2 community. However, sometimes the

functionalities offered by the core DHIS2 apps are not adequate, and in recent years there has been an increase in DHIS2 apps developed by the global DHIS2 community. An aim of the core team is that these custom apps should be generic and of high quality using common DHIS2 tools. The ambition is that these tools will increase the number of apps shared across the community.

The DHIS2 design system is one of the DHIS2 tools offered to create high-quality apps. It consists of a collection of principles and UI components. The principles describe how DHIS2 apps should look and work, whereas the UI components consist of building blocks used to create apps. Some UI components include buttons and input fields, and some are more specific components used in the DHIS2 world, like the Organisation Unit Tree. These UI components are supposed to be reused across all DHIS2 apps, and each of them has specific guidelines for use (Cooper, 2021). DHIS2 is not alone in having a design system. Many companies and organizations are starting to develop design systems for themselves. Some of the benefits of using a design system include improved scalability, keeping design and code overhead low, designing consistently, and improving usability and built-in accessibility. Using a design system also means tackling shared problems so teams can concentrate on solving specific user needs (Suarez et al., 2019).

The User Experience (UX) designer working in the core team at UiO is in the lead of the design system's specification for DHIS2. Developers in the core team are developing the UI components after his specification. However, the design system is not used that much by people outside the core team. Therefore, many of the custom apps developed in the HISP network do not adhere to the standards set by the core team. The core team's ambition is that more of the apps should use the DHIS2 design system and see it as a way for developers to build better quality apps with a standardized interface. Building apps with standardized interfaces will also make it more likely for HISP groups to reuse apps developed by other HISP groups.

However, initial findings raise concerns that there is a lack of good documentation surrounding the DHIS2 design system and a lack of UX design skills in the HISP network. People report that the documentation is too distributed and documentation targeting new developers is scarce. Good documentation is essential when the developers are spread worldwide, and there is a lack of face-to-face meetings. The lack of designers in the HISP networks causes the developers to have to make design decisions. Many of the developers in the DHIS2 community do not have any formal education in UX design, but

many seem to want to learn more. Therefore, having good documentation about the DHIS2 design system is important so developers who are not that experienced can learn how to use it and create better quality apps.

Motivated by the known advantages of using a design system, the lack of knowledge and documentation, and the increased likelihood of the apps being reused using the DHIS2 design system, I developed a website to teach and promote the DHIS2 design system. The website contains different courses for different parts of the DHIS2 design system. When it comes to developing learning resources, there exists a lot of previous research. Therefore, I have used initial design principles from instructional design when developing the website.

While research on learning resources is abundant, this research takes place in a new context that considers the development of online courses inside an innovation platform used in the Global North and Global South, where developers have diverse backgrounds. Heeks (2008) and Bonina et al. (2021) argue for more research on developing tools to support innovation in the Global South. In the platform literature, such tools could be considered as boundary resources. Ghazawneh and Henfridsson (2013) regard boundary resources as resources that support developers in developing apps for the platform. There is not much research on how to develop such tools. Much of the research on boundary resources focus on classifying different types of boundary resources. There is not much research considering the development of boundary resources, and especially developing boundary resources for use in the Global South.

Seeing that there is a need for more learning resources for the DHIS2 design system and the lack of research in developing such resources for use in the Global South and Global North, I have created a website with online courses to teach and promote the DHIS2 design system. The long-term aim is for the community to develop standardized apps that may be reused by people in other countries and improve the quality of the apps developed within the platform.

## 1.2 Research questions and objectives

The website developed as a part of this thesis contains courses to learn about app development, explicitly focusing on the DHIS2 design system. However, the aim is that the contributions of this thesis can be used as guidelines for developing other online app development courses that do not necessarily teach about using a design system. A theme is that the courses should be used globally. Here globally means users from multiple countries in the Global South and the Global North, with different backgrounds, skillsets, and needs for such courses.

The research question is as follows:

**RQ:** What are appropriate design principles for an online app development course used globally?

To answer this question I had a set of research objectives:

1. Identify initial design principles
2. Develop an instantiation of the design principles
3. Evaluate the instantiation
4. Develop new and revised design principles

To address this research question, I have conducted a design science research study to develop a set of design principles. Based on some initial design principles on developing instructional content from the literature on instructional design, specifically using Gagnes' nine events of instruction, I have developed a website. The website is an *instantiation* since it is developed based on a set of design principles. The initial design principles have been revised through three cycles consisting of development and evaluation.

## 1.3 Structure of the thesis

**Chapter 2 - Background** provides an overview of the HIS, HMIS, and DHIS2.

**Chapter 3 - Literature review** presents the related literature that will be used throughout the thesis. The related literature is focusing on platform literature and literature on ICT4D. At the end of this chapter, I will also present Gagnes' nine events of instruction, which were used to create the initial design principles.

**Chapter 4 - Methodology** presents the methodology design science research and the methods chosen for this thesis

**Chapter 5 - Artifact Description** describes the technology used, how I implemented the initial design principles and what I did in the three design cycles.

**Chapter 6 - Evaluation** presents the findings from the last evaluation of the website based on the initial design principles.

**Chapter 7 - Discussion** will position the empirical work within the literature presented in the literature review, revise the initial design principles, and develop new design principles. At the end of the chapter, I will also reflect on the research process and address some research limitations.

**Chapter 8 - Conclusion** summarizes the findings related to the research questions. In this chapter, I also provide some reflections on future work within the field.





# 2

## Background

In this chapter, I will give an overview of the research context. Consequently, I will introduce HISP, the platform DHIS2, and the DHIS2 design system.

### 2.1 Health Information System Program

HISP is a research project to strengthen Health Information Systems (HIS) in developing countries (DHIS2, 2021*d*). The research project started in South Africa in 1995 as a collaborative research project between the University of Cape Town (UCT), the University of Western Cape (UWC), and a Norwegian Ph.D. candidate from UiO, with the initial aim to improve the health system in South Africa by addressing the information management challenges and the fragmented health system (Adu-Gyamfi et al., 2019). HISP was responsible for the efforts towards standardization and software development. The software development and prototyping efforts resulted in the making of the first version of the DHIS application (Braa and Sahay, 2012). Since the architecture of DHIS version one was not suited for distributed development, it triggered the development of DHIS version two under the leadership of UiO. The aim was to distribute the development activities to multiple countries in the HISP network, thereby bringing the software development closer to the context of use (Braa and Sahay, 2013). With the evolution of DHIS2, the HISP project has become a global movement with people, organizations, and groups spread worldwide. It consists of groups like HISP South Africa, HISP India, and HISP Uganda, as well as

multiple universities and Ministries of health, and more. UiO has had a core role in coordinating the community, providing capacity building around the software and its implementations, and developing the DHIS2 core (Adu-Gyamfi et al., 2019).

## **2.2 District Health Information System Software**

DHIS2 is a free and open-source web-based software platform used for data collection, management, and analysis. It is currently the world's largest HMIS platform used by 73 countries worldwide (DHIS2, 2021a). DHIS2 is a flexible platform, meaning that it is used in various ways around the world. It is also used in other contexts than health, like education, logistics, and agriculture projects (DHIS2, 2021c).

One of the key features of DHIS2 is that it can be customized and locally adapted through the user interface. DHIS2 contains a set of tools for data collection, validation, reporting, and analysis. However, what to collect, where the data comes from, and what format to use depend on the context of use. This will not require any programming, but it will require in-depth knowledge about the local HIS context and the conceptual design principles in DHIS2 (DHIS2, 2018).

However, sometimes the core applications developed by the core team might not provide all the functionality required for a specific context. In this case, due to DHIS2 being a platform, it allows developers outside the core team to create and install custom apps. On the DHIS App Hub, developers can share their apps with the rest of the DHIS2 community (DHIS2, 2021e)

### **2.2.1 DHIS2 application platform**

The DHIS2 application Platform is an application and build pipeline used to standardize application development within the DHIS2 ecosystem. Before the introduction of the DHIS2 application platform, a DHIS2 app was a standalone website where the developer needed to include common tools like the header bar, data fetching logic, and build scripts. Some of the application Platform's functionality includes a build system, development tools, runtime support, and standard functionality for DHIS2 apps. With the application platform, all the common things are provided for the developer to use. This means that the developer now only has to pay attention to implementing the business logic that is special for that app (McGee, 2019).

### 2.2.2 DHIS2 design system

The DHIS2 design system is developed by the core team at UiO. It contains a collection of design principles and a library of UI components to develop apps for the DHIS2 platform (Cooper, 2021).

#### Design principles

In DHIS2, the design principles are separated into 1) Content and Communication 2) Layout, spacing, stacking 3) Forms 4) Color 5) Typography and 6) Icons. The *Content and communication* section are concerned with principles regarding how to communicate across DHIS2 apps. Examples of principles include not using unnecessarily technical words and keeping the user informed about application status. The *layout, spacing, and stacking* section are concerned with choosing the right layout for different apps. The *forms* section is concerned with guidelines for how DHIS2 apps should use forms to collect user input. The guidelines for forms are set so that DHIS2 apps should follow a common format to make sure users are not unnecessarily challenged. The *color* section explains principles for the usage of colors in DHIS2 applications. Some examples of topics include the DHIS2 color scale and when to use specific colors. The *Typography* section explores guidelines for the selection of fonts, font size, and line height. The *icons* section gives guidelines for how to use icons across DHIS2 apps. It considers how to communicate with icons, being consistent, the different icon sizes, and color usage on icons (Cooper, 2021).

#### Components

The components consist of two parts: the reusable UI components and guidelines for use for each of the UI components. The reusable UI components contain functional components like buttons, tables and Organization Unit Tree that can be reused across DHIS2 apps. All the UI components have their own API which says something about how the component can be used. For example, a button component has the possibility to have an icon and specify whether the button should be small or large and whether it should be a primary, secondary or destructive button. The guidelines contain information about when and how to use the components and give examples of how the UI component is used in real DHIS2 apps. (Cooper, 2021).

### **2.2.3 DHIS2 design lab**

In late 2018, the DHIS2 design Lab was launched at UiO consisting of students and researchers. The DHIS2 Design Lab explores how to support innovation and promote design within DHIS2 (Design Lab, 2021). While writing this thesis, I was a part of the DHIS2 design Lab. The DHIS2 Design Lab facilitated several activities to support the thesis writing process. Some of the activities included seminars about the different parts of thesis, and co-reading sessions where I received and provided feedback to other students.

## **2.3 Summary**

To summarize, this thesis takes place within the software platform DHIS2, which is used worldwide. While the core team develops apps that the users' can customize through the user interface, developers in the community can also develop custom apps when there are no suitable apps available. To develop these apps, the core team provides resources such as the DHIS2 application platform and the DHIS2 design system. The focus of this thesis is to develop online courses to learn about the DHIS2 design system.

# 3

## Literature review

In this literature review, the focus will be to explore research in the platform literature in the IS field. The chapter will position the research and identify gaps in the literature. This literature review has been a narrative review (Baumeister and Leary, 1997).

Firstly, I will introduce digital platforms and different types of digital platforms. I will focus specifically on innovation platforms. Then I will discuss boundary resources and present research concerning digital platforms for development. Lastly, research on instructional design will be discussed, which forms the basis for the initial design principles used to develop the website.

### 3.1 Definition of digital platforms

There does not exist any overarching definition of what digital platforms are. Instead, the definition of digital platforms depends on the field of study. Some researchers have signaled that scholars need to come to terms with a clear description of digital platforms. Asadullah et al. (2018) argue that digital platforms are a challenging research object due to the lack of a conceptual definition and being spread across many regions and industries. Asadullah et al. (2018) distinguish between two different types of digital platforms: technical (e.g., software development and production) and non-technical (e.g., B2B and B2C transactions). The non-technical view sees digital platforms as being

concerned with the user interaction within the platform and how this market is different from other markets (Rossotto et al., 2018). The technical view of digital platforms focuses on the idea that digital platforms are technological developments that form as a foundation where complementary products and services can be developed (Tiwana et al., 2010; Ghazawneh and Henfridsson, 2013; Ceccagnoli et al., 2012). Viewing digital platforms as technical does not mean that they are only interested in technology, but more so that they are interested in the architecture of the platform and how the architecture can release innovation.

## 3.2 Types of digital platforms

Evans and Gawer (2016) mention three types of digital platforms: transaction platforms, innovation platforms, and integration platforms. Cusumano et al. (2020) define *transaction platforms* as intermediaries or online marketplaces, making it possible to exchange goods, services, or information. Transaction platforms will become more valuable the more people that use them. Some examples of transaction platforms given by Cusumano et al. (2020) include Amazon and Facebook. *Innovation platforms* are platforms that consist of technological building blocks where innovators can develop complementary services and products. They are often concerned with how technical architecture can enable innovation. The innovation platform focuses on how interfaces can facilitate the interaction between the platform and third-party developers (Yoo et al., 2012; Baldwin et al., 2009; Tiwana et al., 2010). DHIS2 is by many considered an innovation platform (Braa and Sahay, 2017; Roland et al., 2017) since it allows third-party developers to build apps on top of the platform. *Integration platforms* combine both elements from transaction platforms and innovation platforms. Evans and Gawer (2016) view companies like Apple as an integration platform since the platform contains matching platforms like the App Store and a third-party developer ecosystem supporting content creation.

The focus in this thesis moving forward will be on innovation platforms.

### 3.3 Platform ecosystems

Koskinen et al. (2019) argue that it is also necessary to show how digital platforms are connected to other socio-technical dimensions. Platforms are linked to other platforms, organizations, and various entities that together form an ecosystem. The authors elaborate on this by saying that researchers need to be aware that the platform's ecosystem is essential for success.

Tiwana (2013) defines *platform ecosystems* as consisting of the platform and complementary apps. The platform is, in this case, referring to software platforms. Software platforms consist of an extensible codebase that provides core functionalities shared by apps (Tiwana et al., 2010; Baldwin et al., 2009). Figure 3.1 shows a visual image of the platform ecosystem's elements. Tiwana (2013) defines an *app* as a software subsystem that extends the platform's core functionality. Tiwana (2013) argues that the platform will be more attractive when there are more apps available. The platform's *interfaces* allow the apps to communicate and interoperate with the platform core (Tiwana, 2013, p. 6). An example of an interface could be the Application Programming Interface (API). How thriving a platform is will depend on the diversity and vibrancy of the ecosystem (Tiwana, 2013, p. 6). Many of the platforms we know today did not start as platforms but rather as standalone products. After end-users started adopting the products and external developers started contributing, it turned into a platform (Evans and Gawer, 2016).

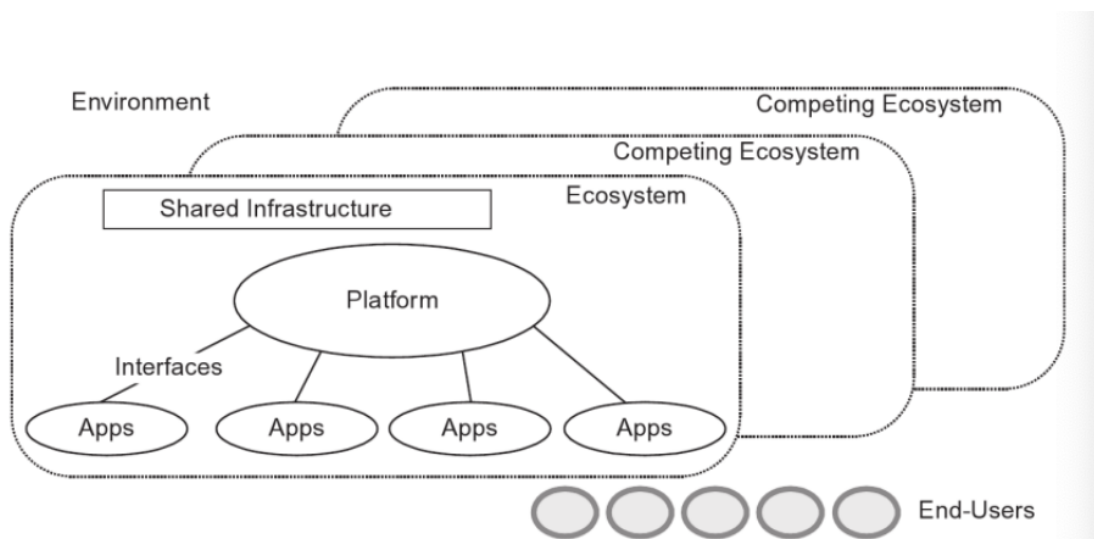


Figure 3.1: Elements of a platform ecosystem (Tiwana, 2013, p. 6)

### 3.4 Platform architecture

Baldwin et al. (2009) argue that a platform architecture should "partition a system into stable core components and variable peripheral components" (Baldwin et al., 2009, p. 8). By separating the platform like this, the developer do not have to build everything from scratch when developing a new product. Having a platform architecture will be beneficial when the system is complex, the requirements are heterogeneous, and the future developments on the platform is uncertain. The challenging part is knowing which components should remain stable and which should vary. The stable core will be the low-variety components, and the peripheral components will be the high-variety components. The two components can be combined into a working system with interfaces that must be stable and part of the platform. Having a platform architecture will make the system evolvable. The stable core components can also evolve, but the interfaces need to be stable (Baldwin et al., 2009). Separating into such a platform architecture allows for design flexibility at the outer layer and enabling local innovation without compromising the software core (Roland et al., 2017).

Roland et al. (2017) extend the platform architecture into a modular and loosely coupled software architecture consisting of custom apps, bundled apps, and a generic core. The *custom apps* are at the outer layer and have high design flexibility for further design improvements but low flexibility for use across tasks. The high design flexibility makes custom apps more appropriate when needing to meet specific user needs. The *bundled apps* are at the middle layer and allow the customization of pre-built apps to meet end-user needs, which has a high degree of use flexibility through customization, but low design flexibility due to software dependencies. Both custom apps and bundled apps interact with the platform core through what is known as boundary resources (Roland et al., 2017).

### 3.5 Boundary resources

Ghazawneh and Henfridsson (2013) define third-party development as systems development where one actor develops apps on behalf of the platform owner. The apps are developed to satisfy the end-users of the platform. Resources that support third-party developers are called *boundary resources*. The boundary resources act as the interface between the platform owner and the developer. Some examples of boundary resources include APIs, App Store, Software development kit (SDK), and regulations such as open-source licenses (Karhu et al., 2018). Through boundary resources, the platform owner can secure control over the platform and facilitate



so people can contribute to the ecosystem (Karhu et al., 2018; Ghazawneh and Henfridsson, 2013). Typically, boundary resources are developed by the platform owner as a response to seeing that the existing boundary resources are insufficient when it comes to contribution opportunities and control concerns (Ghazawneh and Henfridsson, 2013). Ghazawneh and Henfridsson (2013) propose a boundary resource model, which they argue is useful for understanding the balancing act between resourcing and securing the platform. *Resourcing* referring to the act of stimulating external contributors to develop, *securing* referring to maintaining platform control. The process of securing the platform is typically to prevent the development of apps that violate the platform.

Ghazawneh (2012) considers two types of boundary resources: social and technical boundary resources. Examples of technical boundary resources are API and SDK. The *social boundary resources* intend to transfer knowledge about developing software for the platform. Some examples of social boundary resources given include incentives, platform guidelines, and documentation (Ghazawneh, 2012). The technical boundary resources will expose or extend the platform architecture, whereas the social boundary resources will *explain* the platform architecture to third-party developers.

Dal Bianco et al. (2014) did not find the division between technical and social boundary resources sufficiently descriptive. Therefore they separate boundary resources into three levels: social boundary resources, application boundary resources, and development boundary resources. The technical boundary resources are here separated into application boundary resources and development boundary resources. The three levels of boundary resources can be seen in figure 3.3. *Application boundary resources* enable the application architecture to interface with the platform architecture. APIs fall under this category. *Development boundary resources* are defined as boundary resources that enable third-party developers to develop applications. Some examples include program resources that help the developers during programming, testing, debugging, deploying, and maintaining the applications, one example being SDKs. Thirdly, *social boundary resources* are defined as resources that "enable transferring knowledge about and coordinating the third-party application development" (Dal Bianco et al., 2014, p. 15). Dal Bianco et al. (2014) emphasize that boundary resources are not restrained to one of the boundary resources; they can be classified into several of the boundary resources simultaneously. Extending on the examples of social boundary resources given by Ghazawneh (2012), Dal Bianco et al. (2014) also include training material, promotion and training events, and online community forums as part of the

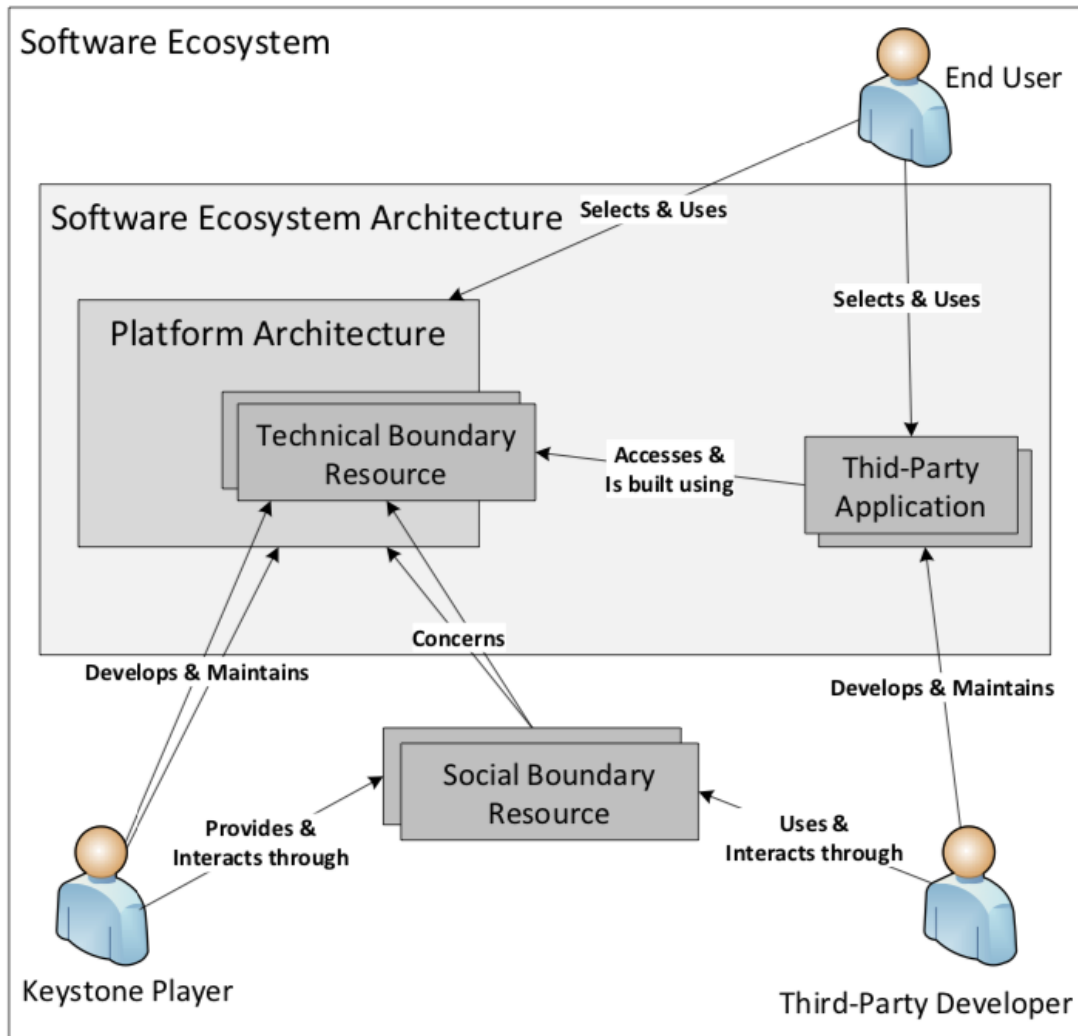


Figure 3.2: Software ecosystem architecture, platform architecture, and actors (Dal Bianco et al., 2014, p. 12)

social boundary resources. Figure 3.2 shows how third-party developers use social boundary resources to interact with the technical boundary resources. For a platform ecosystem to exist, Dal Bianco et al. (2014) emphasize that application boundary resources need to be present. Development boundary resources and social boundary resources are, on the other hand, not required. However, they make the ecosystem more attractive to third-party developers.

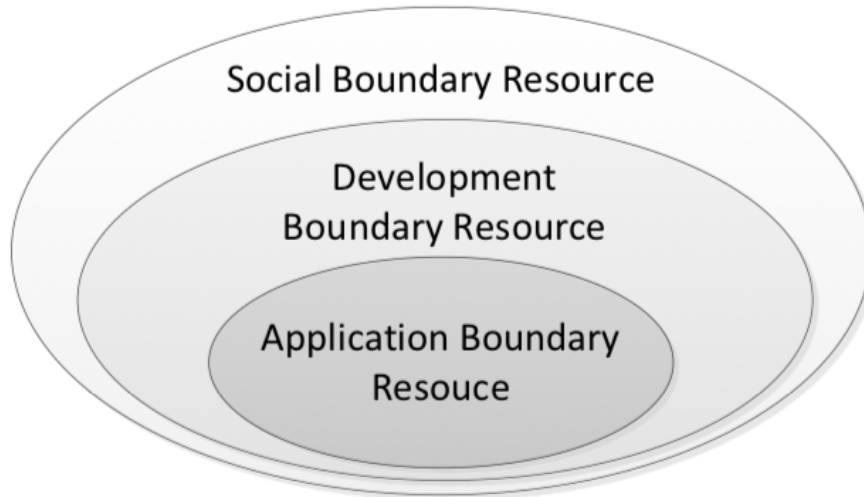


Figure 3.3: The onion model of the platform boundary resource classes. (Dal Bianco et al., 2014, p. 16)

Foerderer et al. (2019) define another type of boundary resource: knowledge boundary resources. In the study, the authors investigate how knowledge boundaries emerge between platform owners and complementors. *Knowledge boundaries* here referring to problems related to the spread of tacit knowledge. *Knowledge boundary resources* are resources to overcome knowledge boundaries. Some examples of knowledge boundary resources given by Foerderer et al. (2019) include information portals, interface documentation, massive open online courses, and communities of practice.

Foerderer et al. (2019) also propose separating knowledge boundary resources into three different types that differ in terms of scope and scale. Scope meaning the extent of the knowledge gap they need to overcome. Scale refers to how many complementors the resource can address. Depending on the scope and scale, Foerderer et al. (2019) introduce three types of knowledge boundary resources: broadcasting, brokering, and bridging. *Broadcasting* consists of boundary resources that complementors can access without interacting with the platform owner. Broadcasting includes resources such as guidelines and programming tutorials. *Brokering* is a semiformal and interaction-based resource. It includes resources such as help desks and phone resources. *Bridging* consists of ongoing and frequent interactions between experts of the platform owner and complementors (Foerderer et al., 2019).

Class	Definition
Application boundary resource	"Program resource that enable the third-party application to interact with the platform; they are also technical boundary resources" (Dal Bianco et al., 2014, p. 15)
Development boundary resource	"Program resources or tools that enable the third-party developer to develop and evolve applications; they are also technical boundary resource" (Dal Bianco et al., 2014, p. 15)
Social boundary resource	"Resources that enable transferring knowledge about and coordinating the third party application development" (Dal Bianco et al., 2014, p. 15)
Knowledge boundary resource	"Objects and activities employed by platform owners in order to overcome knowledge boundaries and enable effective product development outcomes." (Foerderer et al., 2019, p. 129)

Table 3.1: The classification of platform boundary resources

To summarize some of the different types of boundary resources and their definition, I have created table 3.1.

### 3.6 Digital platforms for development

Much of the previous research on digital platforms involves studies on commercial and for-profit platforms in the Global North. However, recently we have seen an increase in research concerning digital platforms in the Global South. Koskinen et al. (2019) argue that digital platforms show promise in the Global South regarding societal and developmental challenges. However, only in the last five years have digital platforms been discussed in conjunction with ICT4D (Bonina et al., 2021). ICT4D is a multidisciplinary field consisting of computer science, information systems, and development studies (Unwin and Unwin, 2009). In contrast to studies in Information Technology (IT) and Information Communication Technology (ICT), the main focus of ICT4D is not on the technologies themselves. Instead, it is concerned with empowering the poor and marginalized communities (Unwin and Unwin, 2009, p. 33). In the following paragraphs, I will explore the field of ICT4D in detail before discussing ICT4D together with digital platforms.

Heeks (2008) argues that ICT4D is moving to a next phase, which will mean new technologies, new ways for innovation, and another view of the world's poor. In ICT4D version 1.0, the people responsible for development had pressure to deliver, which meant that they often had to use off-the-shelf solutions. However, these efforts often failed (Heeks, 2008). ICT4D version 2.0 came as a result of the lessons from ICT4D version 1.0. Instead of viewing the poor as passive consumers, which was the case in the previous version, ICT4D version 2.0 views them as active producers and innovators. Heeks (2008) identifies three different types of innovation modes: pro-poor, para-poor, and per-poor. *Pro-poor* innovation is when innovation happens outside the poor communities but on their behalf. *Para-poor* innovation is when innovation is happening together with the poor communities. *Per-poor* is when innovation is happening within and by the poor communities. Heeks (2008) concludes by arguing for a focus on developing tools so that people in the Global South can produce digital content and services themselves, resulting in new jobs through ICT.

While pro-poor innovation still has a place in ICT4D 2.0, there is a danger of introducing a design-actuality gap (Heeks, 2008). Heeks (2002) define the *design-actuality gap* as the match or mismatch between local actuality and systems design. Heeks (2002) argues that the most extreme form of design-actuality gap occurs when industrialized country designers create an information system for an industrialized-country context that is later transferred to a developing country. In this case, the actuality of the local conditions in the developing country is not considered, making it more likely for a design-actuality gap to appear. Heeks (2002) argues that even when the information system is developed explicitly for a developing-country context by developers in the Global North, similar problems can be seen, since developers might have the wrong assumption about user actuality.

Since introducing ICT4D version 2.0, Heeks (2020) have also looked at whether we are now seeing a new version, ICT4D version 3.0. Heeks (2020) argues that some of the issues seen in ICT4D version 2.0 remain the same. For example, the topics discussed in the former paragraphs considering the view of the poor as innovators and the different models of innovation remain the same in ICT4D version 3.0. However, in ICT4D version 3.0, digital platforms are now seen as iconic technology.

Bonina et al. (2021) found that most of the digital platforms in the Global South were transaction platforms, and there was a lack of studies on *innovation platforms* concentrating on developmental outcomes. In total, Bonina et al. (2021) identified

34 transaction platforms and five innovation platforms in the Global South. Evans and Gawer (2016) also found in their survey that none of the platforms in Africa were innovation platforms; there were only transaction platforms. Nielsen (2017) also addresses the need for more research on digital innovation in developing countries, where software platforms in developing countries are mentioned as one area for future research.

In addition to classifying the different types of platforms in the Global South as either transaction platforms or innovation platforms, Bonina et al. (2021) also identify *eight* different development goals for the recognized platforms. Only two of the development goals are covered by innovation platforms: global health access and gender equality. The innovation platforms related to global health access were linked to the generation of local innovation. Other innovation platforms identified were related to inclusive innovation and inclusive co-creating targeting women.

Due to the lack of research on innovation platforms in developing countries and how they are linked to development outcomes, Bonina et al. (2021) propose research questions related to how to release the development potential of innovation platforms. Bonina et al. (2021) give a couple of examples for research questions, one being: “are boundary resources deployed in the Global North still effective to nurture and foster a local ecosystem of third-party innovators in Africa?”.

### **3.7 Instructional design**

This section will establish the basis for the initial design principles used to develop the website. An instructional-design theory is a theory that offers explicit guidance on how to better help people learn and develop (Reigeluth, 1999). Instructional-design theories are extensive and extend back to the 1970s (Gustafson, 2002). Reigeluth (1999) defines instructional design theory as:

"Instructional design theories are design-oriented, they describe methods of instruction and the situations in which those methods should be used, the methods can be broken into simpler component methods, and the methods are probabilistic"(Reigeluth, 1999, p. 7).

### 3.7.1 Gagne's nine events of instruction

A widely cited work on instructional design is the work by Rober Gagne. In Gagnes' book, *The conditions of Learning*, he created guidelines that guide the design of instructional events. He specifies nine instructional events that correspond to cognitive processes (Gagne and Briggs, 1974). Many web-based courses are designed according to Gagne's instructional events or similar instructional design models (Snyder, 2009; Ritchie and Hoffman, 1997; Anyatasia et al., 2020).

Below I will explain the nine events of instruction, and in chapter 5, I will describe how I implemented the principles in the website.

#### **Gaining attention (reception)**

Learning must first begin by gaining the learners' attention. According to Gagne, various events can be employed to gain the learner's attention. One way of gaining attention includes appealing to the learner's interests, for example, by asking a thought-provoking question.

#### **Inform the learner of the objective (expectancy)**

After gaining the user's attention, the next step is to inform the learners of the objectives. This could be accomplished by stating what learners will achieve during the course and how they can use the knowledge in the future.

#### **Stimulate recall of prior learning (retrieval)**

For learners to make sense of new information, you can relate it to something they already know or something they have already experienced, for example, by asking a recognition or recall question.

#### **Present the stimulus material (selective perception)**

This principle states that new information needs to be presented to the learner. An example given is if the learner must learn a sequence of facts, like events from history, then this must be communicated either orally or in printed format. The learning material must be presented using learning strategies that provide effective and efficient instruction.

**Provide learning guidance (semantic encoding)**

Providing learning guidance means offering guidance on how to solve a problem. Examples of how to provide guidance include using cues, hints, and prompts to help the learner understand.

**Elicit performance (responding)**

After being presented with new knowledge or skill, the next step is to practice to activate the learning process.

**Provide feedback (reinforcement)**

When the learner has attempted to demonstrate their knowledge, the next step is to provide immediate feedback on the learners' performance. There should at least be feedback concerning the degree of correctness about the learners' previous performance.

**Assess performance (retrieval)**

This principle states that there needs to be an assessment of the learning outcome, to test whether the learning outcomes have been achieved.

**Enhance retention and transfer (generalization)**

At this stage, skills have been learned and what remains is to enhance the retention and transfer of the learning. This principle is concerned with transferring the gained knowledge to situations that differ substantially from those used for learning itself

(Gagne and Briggs, 1974).

### **3.8 Summary**

This chapter introduced the reader to digital platforms, boundary resources, and digital platforms, specifically focusing on innovation platforms in the Global South. I have also introduced principles from Instructional design considering Gagne's Nine Events of Instruction. Chapter 5 will use these principles to develop a website, which will be a form of boundary resource. In chapter 7: discussion, I will position the practical work with the concepts of digital platforms presented in this chapter.



# 4

## Methodology

This chapter aims to describe the research approach used in this thesis. First, I will describe the philosophical assumption. Then, I will introduce the methodology design science research followed by an overview of the research process. After that, I will describe the data collection methods used in each of the three design science research cycles. Then, I will explain how the data was analyzed and reflect on some ethical considerations. Lastly, I will account for some of the limitations of the methodology and data collection methods used.

### 4.1 Philosophical assumption

All research contains some assumptions about what is 'valid' research and which research methods are appropriate (Myers, 1997). A well-known distinction made by Orlikowski and Baroudi (1991) following Chua (1986) describes the three "research epistemologies": positivism, interpretivism, and critical theory. Much of the research in IS focus on the competing paradigms positivism and interpretivism (Niehaves, 2007). However, inspired by Wicks and Freeman (1998), Goles and Hirschheim (2000) argue that *pragmatism* should also be recognized as a research paradigm in IS research. Goldkuhl (2012b) supports this view and names interpretivism and pragmatism as two possible and important research paradigms for qualitative research in IS. In this research, I position myself as a pragmatist. A theory for a pragmatist is true if it is useful. Then, in contrast to positivists, they are not looking for timeless truths, but accept that

there can be single and multiple realities (Marshall et al., 2005). Pragmatists are interested in whether or not the information is useful, "useful in the sense of helping people to better cope with the world or to create better organizations" (Wicks and Freeman, 1998, p. 129). Pragmatism, being concerned with action and change, has been stated to be appropriate as a basis for research that not merely observes but intervenes into the world (Goldkuhl, 2012b). Goldkuhl (2012b) argues that this would be the case if the intervention is organizational change, like in Action Research, or the building of artifacts, like in Design Research. Pragmatism is not restricted to explanation, which is the key form of positivism. Neither is it restricted to understanding, which is the key form of interpretivism (Goldkuhl, 2012b). This means that knowledge should not only try to explain or understand, but also be used in a constructive way for change and improvement. Pragmatists are therefore interested in constructive knowledge that is meant to be useful for action (Goldkuhl, 2012a). In pragmatism, knowledge forms such as prescriptive, normative, and prospective are essential (Goldkuhl, 2012b). I am interested in prescriptive knowledge in my research question since I want to create guidelines for how to develop a specific website.

## 4.2 Design science research

The methodology that I have used in this thesis is design science research. Over the last few years, more research within the IS field has looked at using design science research. Design science research is important in a discipline directed towards the creation of successful artifacts. Hevner et al. (2004) state that the purpose of using design science research is to achieve knowledge and understanding of a problem domain by building an application of a designed artifact. Since the goal of this thesis was to design and develop a new artifact in the form of a website, using design science research seemed like a good approach.

The plan was initially to use the methodology action design research and collaborate closely with the community. However, due to travel restrictions in the spring and autumn of 2020, this plan changed. As action design research requires the researcher to collaborate closely with the community, the plan to use this methodology was changed when the restrictions came into place.

Design science research has been happening for decades, but the research methodology has only recently been given a name (Iivari, 2007). The book, the *Sciences of the Artificial* by Herbert Simon helped realize the importance of this research methodology (Simon, 2019). Simon's (2019) ideas about the science of

design have encouraged the development of the scientific study of designing. However, the book does not provide much guidance on how to perform such research. Therefore, March and Smith (1995) proposed a framework for design science research driven by research activities and research outcomes. The research outcomes were classified as constructs, models, methods, and instantiations, whereas the research activities include: build, evaluate, theorize, and justify. The authors argue that IT research should build and evaluate constructs, models, methods, and instantiations. The research should also theorize about the artifact and justify the theories. Later, the framework proposed by March and Smith (1995) has been expanded to different process models and frameworks that intend to help people doing design science research. Some of the frameworks include Hevner et al. (2004) and Peffers et al. (2007). In Hevner (2007), he uses the IS research framework found in Hevner et al. (2004) but focuses on three different research cycles. This research framework guided my research and will be explained more in-depth in section 4.2.1.

### **4.2.1 A three cycle view of design science research**

The design science research framework by Hevner (2007) sees design science research as consisting of the three related cycles shown in figure 4.1: the Relevance Cycle, the Design Cycle, and the Rigor Cycle. *The Relevance Cycle* refers to the process of understanding the opportunity, problem, and criteria for a particular artifact in a specific context. *The Rigor Cycle* refers to thoroughly researching and referencing the knowledge base to ensure that the research contains research contributions and not simply design input. *The Design Cycle* refers to the artifact's construction, evaluation, and feedback to further refine the design. The artifact's requirements come from the relevance cycle, whereas design and evaluation theories come from the rigor cycle. The reader can read more about the data collection methods used in each of the three cycles under section 4.3.

### **4.2.2 Design science research contribution**

Gregor and Hevner (2013) present a design science research knowledge contribution framework arguing that the field has not understood what defines clear knowledge contribution from a design science research project, thereby limiting acceptance of design science research in the IS community. The authors argue that a design science research project can make research contributions at different levels depending on the research topic's problem maturity and solution maturity. Figure 4.2 shows the design science research contribution framework

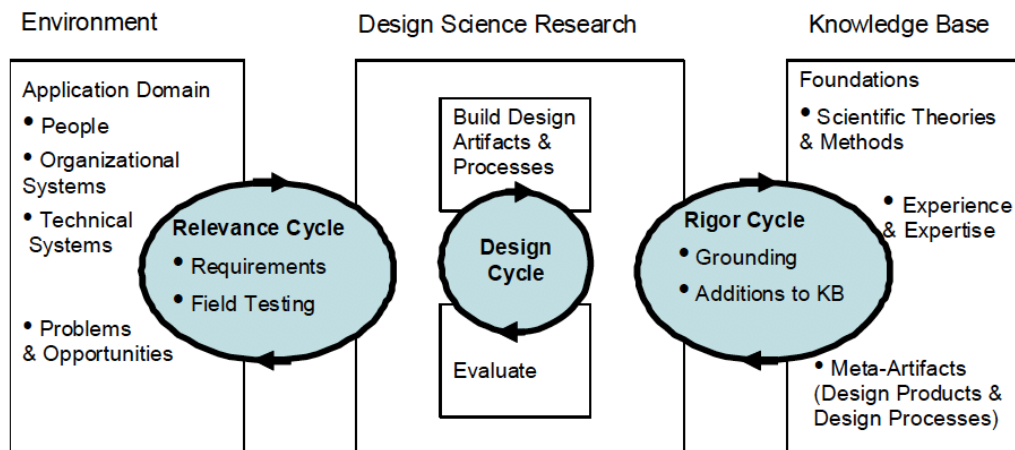


Figure 4.1: Design science research cycles (Hevner, 2007, p. 2)

discussed in Gregor and Hevner (2013). As seen in the figure, when the application domain maturity is low, and the solution maturity is high, the research falls under the category *exaptation*. The *exaptation* category attempts to extend known solutions to new problems. This research will fall under this category since there already exists design knowledge in one field, which is extended to another domain. In this research, the known solution would be how to develop instructional material, as discussed in section 3.7.1. The new domain would be how to develop such instructional material for a software platform used globally.

In the *exaptation* quadrant, design science research projects can contribute to the prescriptive knowledge base in the form of artifacts in one or more of the levels described in figure 4.3. The figure is from the research paper by Gregor and Hevner (2013), but it builds on the framework introduced by Puro (2002). It shows how to distinguish between different design science research outputs and uses three different maturity levels. This research will contribute to Level 1 and Level 2, as seen in figure 4.3. Level 1 contains the situated implementation of the artifact, and Level 2 contains knowledge as operational principles. In my case, Level 1 will be the instantiation of the initial design principles taking the form of a website. The instantiation is presented in chapter 5, Artifact Description. Level 2 will be the final design principles presented at the end of the discussion chapter in section 7.4.

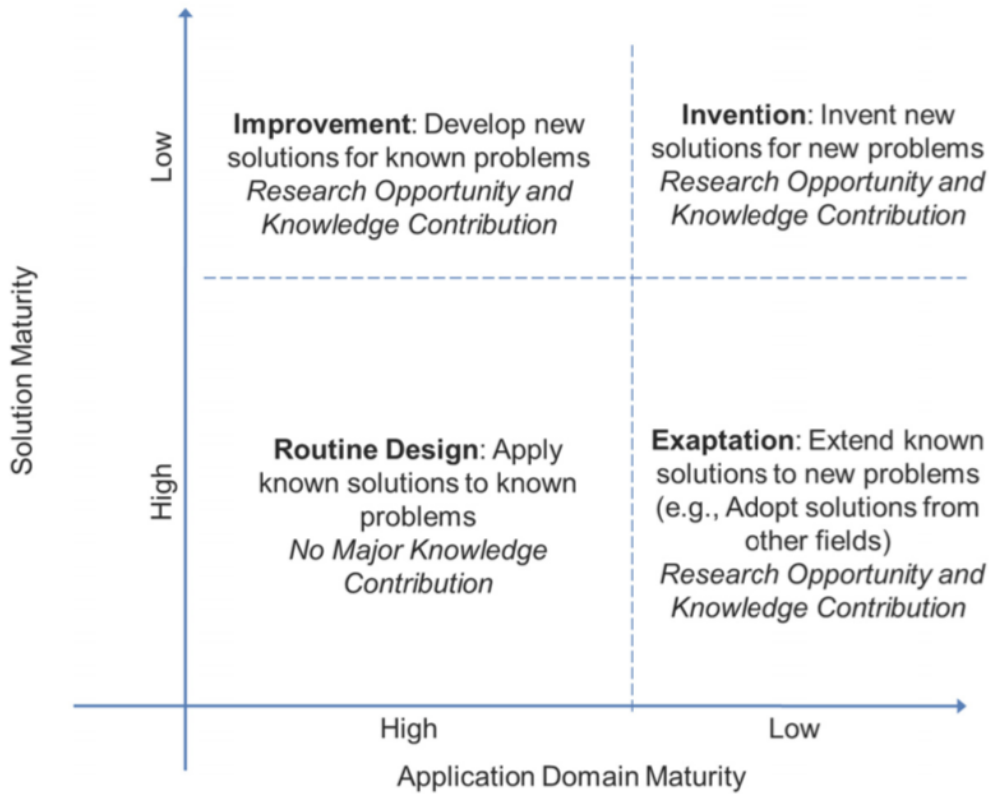


Figure 4.2: Design science research knowledge contribution framework (Gregor and Hevner, 2013, p. 345)

Table 1. Design Science Research Contribution Types		
	Contribution Types	Example Artifacts
More abstract, complete, and mature knowledge	Level 3. Well-developed design theory about embedded phenomena	Design theories (mid-range and grand theories)
$\updownarrow$ $\updownarrow$ $\updownarrow$ $\updownarrow$	Level 2. Nascent design theory—knowledge as operational principles/architecture	Constructs, methods, models, design principles, technological rules.
More specific, limited, and less mature knowledge	Level 1. Situated implementation of artifact	Instantiations (software products or implemented processes)

Figure 4.3: Design Science Research contribution types (Gregor and Hevner, 2013, p. 342)

### 4.2.3 Design principles in design science research

Formulating design principles is an important instrument to transfer design knowledge that contributes beyond the instantiation (Chandra Kruse et al., 2015). However, the formulation of these principles varies. Chandra Kruse et al. (2015) identifies three different orientations in formulating design principles for human use. The three orientations consist of action-oriented design principles, materiality-oriented design principles, and a combination of action and materiality design principles. The *action-oriented* design principles are defined as design principles that “give prescriptions about *what* actions the artifact allows for” (Chandra Kruse et al., 2015, p. 4042). The *materiality-oriented* design principles “prescribe *how* an artifact should be built and what it should compromise” (Chandra Kruse et al., 2015, p. 4042). The last category, action- and materiality-oriented design principles, combine the previous orientations. This category “prescribes *what* an artifact should enable users to do and *how* it should be built in order to do so” (Chandra Kruse et al., 2015, p. 4043). Chandra Kruse et al. (2015) propose a conceptualization of design principles considering both materiality and action. They suggest formulating design principles using the following structure:

Provide the system with **[material property—in terms of form and function]** in order for users to **[activity of user/group of users—in terms of action]**, given that **[boundary conditions—user group’s characteristics or implementation settings]**(Chandra Kruse et al., 2015, p. 4045).

Following this format, I specified several design principles. These will be presented in section 5.2.

## 4.3 Data collection methods

This section will describe the methods used in the three research cycles: the relevance cycle, the design cycle, and the rigor cycle, as seen in figure 4.1. All the data collection methods have been conducted digitally, except for the meetings in February of 2020 and one interview in the autumn of 2020.

Table 4.1 shows an overview of all the data collection methods, when they occurred, and who the interviewers were. This section will explain and give an overview of the many activities that this research has undergone.

Methods	When	Interviewers
Meeting with core developers	February, 2020	me and four other students
Meeting with UX designer	February, 2020	me and two others students
Semi-structured interview with UX-designer	September 3, 2020	me
Semi-structured interview with core developer	September 10, 2020	me
Semi-structured interview with core developer	September 15, 2020	me
Semi-structured interview with core developer	September 17, 2020	me
Semi-structured interview with core developer	September 22, 2020	me
Semi-structured interview with core developer	September 24, 2020	me
Semi-structured interview with developers in Tanzania	October 9, 2020	me and three other students
Demonstration of artifact to UX-designer	October 20, 2020	me
Demonstration of artifact to core developer	October 21, 2020	me
Semi-structured interview with developer in Mozambique *	December 18, 2020	me
Focus-group with five students	January 28, 2021	me
Seminar with product manager in DHIS2	March 2, 2021	DHIS2 design lab
Seminar with core developer	March 16, 2020	DHIS2 design lab
Seminar with UX designer	March 30, 2021	DHIS2 design lab

\* problems with the internet connection caused me to have to use the chat function on Zoom a little bit since we had difficulties with hearing what we said to each other

Table 4.1: Overview of the data collection methods used

### 4.3.1 Relevance cycle

This section will describe the data collection methods used in the relevance cycle.

#### Interviews

Interviews are often categorized into three different types: unstructured, semi-structured, and structured (DiCicco-Bloom and Crabtree, 2006). For the interviews conducted in this research, semi-structured interviews were used. Semi-structured interviews use elements from both unstructured and structured interviews. Before the interview, I prepared a set of predefined questions. However, I also asked follow-up questions and had the opportunity to diverge from the predefined questions. Adams (2015) expresses that semi-structured interviews are particularly suitable when some of the questions require follow-up questions or situations where you want to know more about the independent thought for each individual. A total of eight semi-structured interviews were conducted. Some of the semi-structured interviews were followed up by a demonstration of the website, as explained in section 4.3.2.

For the semi-structured interviews with the core developers, many of them developed the UI components for the DHIS2 design system. Consequently, some topics covered during the interview included the usage of the UI components, challenges with the UI components, what documentation exists, and what kind of documentation is lacking. Another theme included communication with HISP groups and their use of the UI components. In addition to giving an overview of the challenges, these interviews also gave me input on the website's functionality.

The semi-structured interview with developers in Tanzania was conducted together with other students from UiO. Consequently, not all the questions asked were directly relevant to my project. However, some themes covered included the existing documentation in DHIS2, their experience with UX design, and their choice of programming language.

In the semi-structured interview with the developer in Mozambique, I asked questions related to his background, role in the team, usage of existing DHIS2 documentation, and experience with the DHIS2 design system.



### **Meetings and seminars**

In the early stages of the research, I had two meetings with core developers in collaboration with other students. In the later stages of the research process, I also attended multiple seminars facilitated by the DHIS2 Design Lab. Both of these activities gave me insight into the current problems in the organization and their work practices.

### **Document investigation**

Documents can give hints about the practice and implicit knowledge (Crang and Cook, 2007). During the research, I looked at and evaluated guides, tutorials, and documentation that exist when it comes to developing apps for DHIS2. The document investigation was also helpful in the creation of the interview guides and identifying what already exists and what is missing, and it helped me identify potential content for the website. Some of the documents I investigated included the DHIS2 community website, the DHIS2 user guides, and documentation on Github.

### **4.3.2 Design cycle**

The design cycle contains the activity of building the website and evaluating the website, as seen in figure 4.1.

I have identified three design cycles. After each design cycle, I have evaluated the website using different methods. What was done in each of the three design cycles can be seen in section 5.4 under the chapter Artifact Description.

### **Build design artifacts**

The development of the website was a part of the design cycle's build activity. A major part of this thesis has been to develop a website to learn about the DHIS2 design system. The website is developed from scratch by me using the JavaScript library React and Firebase as backend to store information about the user. In chapter 5, I will present the website's main functionality.

### **Evaluate**

To evaluate the website, I have used the methods demonstration, focus-group, questionnaire, and expert evaluation.

#### Demonstration

Demonstrating the website was a method used in the earlier cycles to evaluate the website. After many of the interviews during the first design cycle, I demonstrated the website to the interviewees and got feedback on improvements and suggestions for future work. The demonstration was done by sharing the screen on the video conferencing software Zoom. The demonstration was also used as an evaluation method during the second design cycle. Here, I demonstrated the website to two people with no interview prior to the demonstration.

#### Focus groups

Another method I used to evaluate the website was to facilitate a focus group. The people who participated in the focus group were students who had some knowledge about DHIS2 and the design system. The participants were all given a link to the website before the focus group. They were encouraged to test the website beforehand. In total, five people participated in the focus group. All the participants participated in discussing the website, and some shared their screen when there was something specific they wanted to talk about regarding the website.

#### Questionnaire

A questionnaire was another method I used to evaluate the website. In appendix A.2, the reader can find the questionnaire used. The questionnaire was used as an additional method to the other evaluation methods to gain more feedback from the whole community. Since it is more time-consuming to participate in an interview, the hope was to get more people to assess the website by taking a less time-consuming questionnaire. In total, eight people answered the questionnaire. Of the people who answered, four were students at UiO, one worked as a developer in the HISP network, one worked for the Ministry of Health (MOH), another person was a core developer in DHIS2, and one was a contractor. The questionnaire was posted twice on the DHIS2 community website and on a Mattermost channel for students. This Mattermost channel was only for students that were a part of the DHIS2 design lab and therefore had some experience with DHIS2. The questionnaire was also sent by email to some core developers, and my supervisor posted the questionnaire in some private DHIS2 channels.

The questionnaire consisted of a combination of open-ended and close-ended questions. Due to being challenging to get many people to take the questionnaire, the open-ended questions were vital and provided interesting insight.

### Expert evaluation

After the third design cycle, I also had an expert evaluation by the UX designer to evaluate the website. Peffers et al. (2012) mention expert evaluation as one evaluation method in design science research. An expert evaluation is seen as an "assessment of the artifact by one or more experts" (Peffers et al., 2012, p. 402). The UX designer could be seen as an expert since he is the one who is responsible for the DHIS2 design system and has a lot of knowledge about it. The UX designer wrote a document as part of the expert evaluation after the final design cycle, which contained information about how the website could be improved.

### Interview

Before the interview with the developer in Mozambique, I sent a link to the website in order for him to test it before the interview. The first part of the interview consisted of general questions related to the relevance cycle seen in section 4.3.1. In the second part of the interview, I got feedback on the website. This feedback was a part of the evaluation after the final design cycle. During this feedback session, he shared his screen and talked about what he liked and things he thought could be improved. As mentioned in table 4.1, there was some trouble with the internet connection. During this part of the interview, I managed to hear what he said, so he could talk and share the screen at the same time. However, he had some trouble hearing me, and I had to send some of the questions in the chat on Zoom.

## **4.3.3 Rigor cycle**

### **Literature review**

The rigor cycle is concerned with grounding the research in the literature. The literature review could be seen as a part of the rigor cycle. The result of the literature review can be seen in chapter 3: Literature Review. The literature review has been a continuous process starting in the spring of 2020 and lasting until the end of spring 2021. Being a novice researcher has meant that this process has consisted of a lot of trial and error to find relevant literature. The literature review followed a narrative approach (Baumeister and Leary, 1997). I found some of the literature through the literature databases Google Scholar and Scopus, recommendations from other students and supervisors. Besides using boolean operators to search for literature, I also found literature through the

snowball effect by looking at the bibliography and related articles section in Google Scholar.

## 4.4 Analysis

Qualitative research has often been referred to as "wolly" and subjective. Since the data will be in multiple forms, Crang and Cook (2007) acknowledge that this informally constructed data is likely to get created through an informal process of piecing things together and gaining and changing focus as the research unfolds. To balance between the creative and structured processes, Crang and Cook (2007) advocate for a process in which both less and more systematic data construction and analysis are needed for proper research.

Before the actual beginning of the analysis phase, the data will already be partly analyzed. It is far from "raw," as Crang and Cook (2007) point out. Just refocusing the research aims and questions and updating the interview guides is a part of the analysis phase. This analysis will be considered a more loose form of analysis. The systematic analysis will be looking at the data more carefully and critically (Crang and Cook, 2007). I used thematic analysis as a method for analyzing the interviews. The first step of thematic analysis includes coding, where the text is highlighted in the transcripts, and codes are created to describe the content. From the codes, I then created themes, which are generally broader than codes. For the analysis related to the evaluation of the website, I also used thematic analysis. Here, I had some pre-defined themes associated with the initial design principles. Therefore, this analysis followed a deductive approach (Braun and Clarke, 2012).

For the coding of the interviews, I used the software NVivo 12. While being a student at UiO, I had access to the full version of the software. For all the interviews, I took extensive notes.

## 4.5 Ethical considerations

Several ethical issues were considered when doing this research. Some of the considerations are described below.

All the participants signed a consent form to show that they agreed to participate in the research, except for participants taking the questionnaire. In the questionnaire, it was stated that by completing the questionnaire, the participant agreed to partake in the research. This can be seen in the introduction page of

the questionnaire in appendix A.2.

The consent form changed during the study. When I had a clearer idea of what I was doing, the description got more precise. There were also some special considerations for the focus group that needed to be taken into consideration, which meant that the consent form diverged a little bit from the previous consent forms. This was related to group dynamics. The consent form used for the focus group can be seen in appendix A.3

The plan was to use an audio recorder during the data collection to better recall people's responses. However, I only used an audio recorder during the first two interviews after having received consent for that. I did not use an audio recorder for the consecutive interviews, since I realized that to use an audio recorder, the researcher should receive confirmation from the Norwegian Center for Research Data (NSD).

Confidentiality and anonymity were ensured by not using the participant's real name and not take any photos of the participants.

## **4.6 Limitations**

As mentioned in section 4.3.2 and table in 4.1, I had some issues with the internet connection during the interview with the interviewee from Mozambique. Due to the problems with the internet connection and having to send some questions using the chat, it took more time to send and receive a response to the questions than a typical interview would. Consequently, I could not ask as many questions as I would have liked without the interview taking much longer than planned.

Another limitation was the time restrictions to complete the project. The time restrictions meant that I did not have the time to thoroughly evaluate the artifact after each design cycle. While I did evaluate to some extent after each cycle, as seen in section 5.4, the most extensive evaluation happened after the final evaluation.

For the questionnaire I used both free-text and multiple-choice questions. While many people answered the free-text questions and it provided good insight. There is a possibility that I might have misunderstood something the participant wrote, since I did not have the option to ask follow-up questions.

Not getting more people outside Oslo and the core team to participate in the research was also a limitation. The website is aimed at a varied group of people spread all over the globe. However, this is not fully reflected with regards to who

evaluated the website.

Another limitation was that I did not use an audio recorder for all the interviews. This meant that I had to take notes while the interviewer was talking, in addition to coming up with follow-up questions. Having to take notes may have resulted in not asking as many follow-up questions. While I have written that the interviews were semi-structured, sometimes they might have leaned a little towards being structured. The aim was that they should be semi-structured. But, since I do not have that much experience with conducting interviews and the absence of an audio recorder, it was difficult to ask questions that diverged from the interview guide. However, this was easier after already having conducted some interviews.

# 5

## Artifact Description

This chapter will describe the tools I have used to develop the artifact, how I implemented the initial design principles, and explain the three design cycles I have followed.

The artifact I have developed is a learning website with different courses to learn about the DHIS2 design system. The website is developed from scratch by me as part of this thesis and is a fully functional website. Still, much of the courses' textual content is based on existing documentation about the DHIS2 design system. However, all the quizzes and coding exercises are created by me.

This chapter will not discuss the technical solution for how I developed the website, apart from mentioning the main technologies used in section 5.1. If you wish to look at the code I have written, details on how to access the code are available in appendix A.1.

## 5.1 Description of the technologies used

This section will describe the main technologies used to develop the website.

### 5.1.1 React

React is a JavaScript library for building user interfaces (React, 2021) and was chosen since it is the primary front-end language used by DHIS2. The DHIS2 UI components are also developed using React, so it was natural also to use this when developing the website.

#### JavaScript Object Notation

JavaScript Object Notation (JSON) is a way to structure data in a text-based format based on JavaScript object syntax. Often it is used to transmit data in a web application from the server to the client (MDN, 2021). I have used JSON to store information about the content of a course. I will describe how I used JSON in design cycle two in section 5.4.2.

### 5.1.2 Firebase

For the back-end of the application, I have used Firebase (Firebase, 2021). I chose Firebase as I had previous experience with the platform. Since I did not have much time to develop the website, it was important to be as efficient as possible and use systems I was familiar with.

By using Firebase as the back-end, it allowed me to store users and their login credentials. It also allowed me to store information about what courses the person had completed and what badges the person had received.

### 5.1.3 Codesandbox

Codesandbox is an online editor to create and share web applications without setting up a development environment. Codesandbox also allows you to create a sandbox on the Codesandbox website, and embed the sandbox on your website using a URL (Codesandbox, 2021). For all the coding exercises and coding examples discussed in this chapter, I used embedded sandboxes.



### **5.1.4 DHIS2 UI components**

For many of the UI components used on the website, such as buttons and radio buttons, I used the DHIS2 UI components. Since the website that I have developed attempts to teach using the DHIS2 UI components, it was also natural to use them when developing the website.

### **5.1.5 Material-UI**

In addition to the DHIS2 UI components, I also used Material-UI when there were no appropriate components in DHIS2. Material-UI components were used for icons and the Grid. The Grid allows you to create responsive layouts (Material-UI, 2021).

## **5.2 Initial design principles**

The initial design principles for the website were developed using Gagne's nine events of instruction, as seen in section 3.7.1. To format the initial design principles, I have followed the format specified in section 4.2.3. Table 5.1 shows the formulation of the initial design principles. In the next section, I will explain how I implemented the initial design principles.

#	Design principle	Design principle specification
DP1	Principle of reception	Provide the website with features that appeal to the user <b>[material property]</b> in order to capture the user's attention <b>[action potential]</b> , given that the user has started using the website <b>[boundary condition]</b>
DP2	Principle of expectancy	Provide the website with features that inform the user of the course objectives <b>[material property]</b> in order to anticipate what they will learn <b>[action potential]</b> , given that a course has gained the users' attention <b>[boundary condition]</b>
DP3	Principle of retrieval	Provide the website with features that stimulate the recall of prerequisite learned capabilities <b>[material property]</b> in order for users to make sense of the new material <b>[action potential]</b> , given that the user has some previous knowledge that could apply to the topic <b>[boundary condition]</b> .
DP4	Principle of selective perception	Provide the website with features that present the new material <b>[material property]</b> in order for users to get familiar with the material to be learned <b>[action potential]</b> , given that the user has started a new course <b>[boundary condition]</b>
DP5	Principle of semantic encoding	Provide the website with features that offer learning guidance <b>[material property]</b> , in order for users to receive assistance <b>[action potential]</b> , given that the user has a problem to solve <b>[boundary condition]</b>
DP6	Principle of responding	Provide the website with features that elicit performance <b>[material property]</b> in order for users to practice the new material <b>[action potential]</b> , given that the user has been presented with the material <b>[boundary condition]</b> .
DP7	Principle of reinforcement	Provide the website with features that give feedback on the users' performance <b>[material property]</b> , in order for the users to understand what they need to work on <b>[action potential]</b> , given that the user has tried to solve a practical problem <b>[boundary condition]</b> .
DP8	Principle of retrieval	Provide the website with features that assess performance <b>[material property]</b> , in order for users to test whether the expected learning outcome has been achieved <b>[activity of user]</b> , given that the user has completed a course <b>[boundary condition]</b>
DP9	Principle of generalization	Provide the website with features to enhance retention and transfer <b>[material property]</b> , in order for the user to generalize the knowledge taught to a new situation <b>[action potential]</b> , given that the user has completed the other courses <b>[boundary condition]</b>

Table 5.1: Overview of initial design principles

## 5.3 Instantiation of design principles

This section will explain how I implemented the design principles specified in table 5.1. The screenshots and explanations of the application in this section are considering the website after the final design cycle. I have not included screenshots covering all of the website's functionality in this section. Instead, the reader can find screenshots covering more of the application in appendix A.1. However, I have included screenshots of the main functionality. In table 5.2, I summarize how I implemented the initial design principles.

The first design principle was the following:

*DP1 Principle of reception:* Provide the website with features that appeal to the user [**material property**] in order to capture the user's attention [**action potential**], given that the user has started using the website [**boundary condition**]

To implement the first design principle, I developed two different features. The *first feature* was to present the courses with colorful images and course descriptions to capture the users' attention. The course descriptions argue the importance of the courses. The reader can view the courses on the homepage in figure 5.1. The *second feature* developed to try to appeal to the user was the possibility of receiving points and badges. The settings page in figure 5.18 shows all the possible badges the user can receive, and the course overview in figure 5.2 shows how many points a user can receive when completing the course.

While the homepage seen in figure 5.1 shows seven different courses, I have only created content for two courses: the course "DHIS2 Components" and the course "Color". This was due to time limitations.

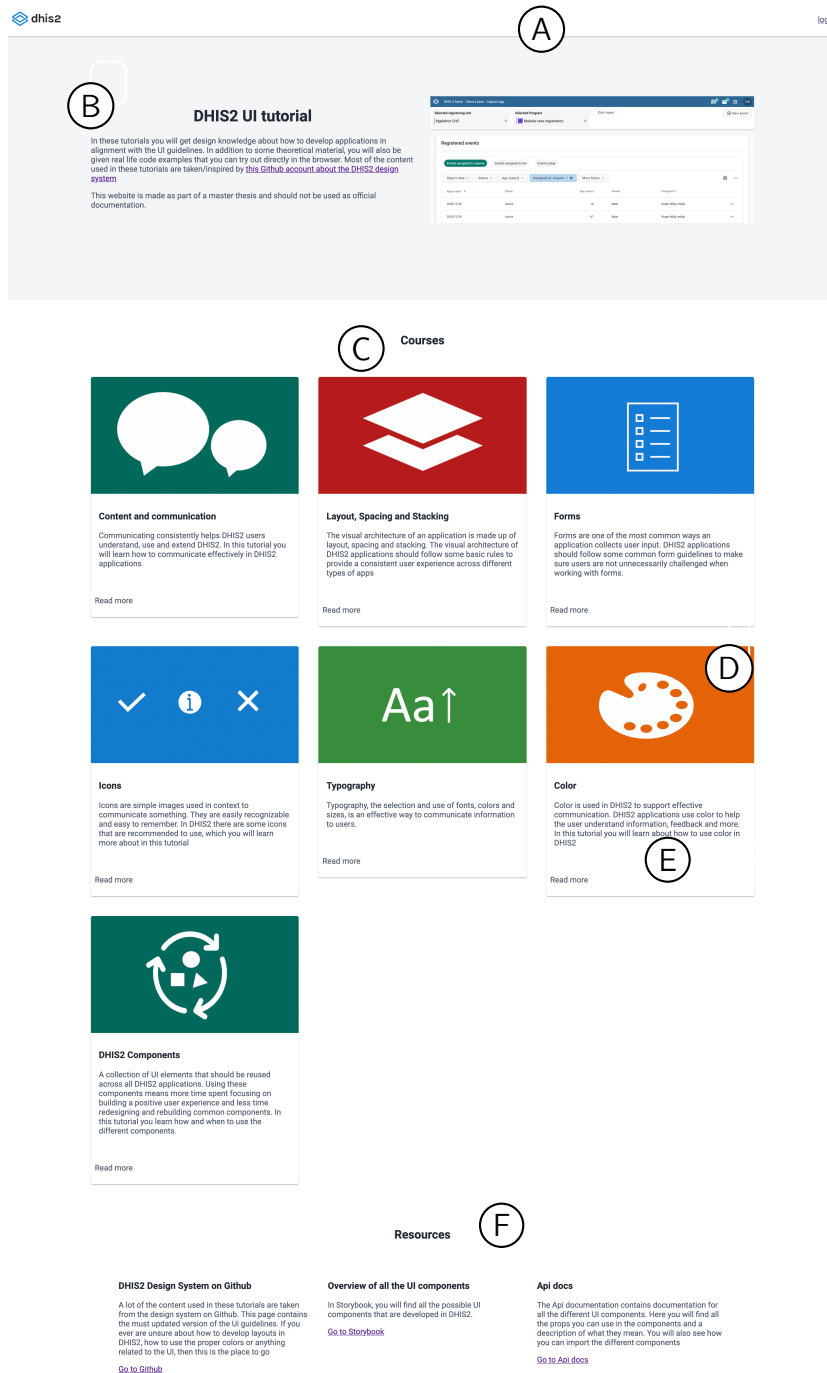


Figure 5.1: Homepage when the user is not logged in – (A) The navigation bar, (B) The headerbar, (C) Overview of the courses, (D) Course image, (E) Course description, (F) Links to resources

*DP2 Principle of expectancy:* Provide the website with features that inform the user of the course objectives [**material property**] in order to anticipate what they will learn [**action potential**], given that a course has gained the users' attention [**boundary condition**]

Design principle two is concerned with ensuring that the user knows what to expect from the courses. This design principle was implemented by having a course overview page, as seen in figure 5.2. There is an in-depth description on the course overview page, which explains the topics covered in the course. Next to the course description, there is a time estimate for how long it takes to complete the courses. Below the course description, there is an accordion that outlines each of the sections in the course. Figure 5.2 shows the course overview page where the accordion for section two is open.

Completion rate: 14%

[Home](#) / DHIS2 Components

## DHIS2 Components

DHIS2 has a collection of UI elements that should be reused across all DHIS2 applications. The components have been designed with DHIS2 use cases in mind. Using these components means more time spent focusing on building a positive user experience and less time redesigning and rebuilding common components. Each component has its guidelines for use. In this tutorial, you will learn how and when to use the different components.

**Expected duration:** 20 minutes  
**Possible points:** 12 points

The topics that will be covered in this module:

- Section 1: Introduction
- Section 2: Action components
  - Buttons
    - Lesson: The different types of buttons and their usage
    - Lesson: The Button API
    - Example: The different types of buttons in action
    - Lesson: Different button options
    - Coding exercise: Find the button mistakes and fix them

Figure 5.2: Course overview for the course "DHIS2 components" with one of the sections in the accordion open. Note: the screenshot only shows parts of the accordion

The course "DHIS2 components" has more content than the course "Colors." Therefore, in addition to the accordion, I have section overviews inside the course. Figure 5.3 shows a section overview for the "Action components" section in the course "DHIS2 Components"

The screenshot displays the DHIS2 course interface. At the top left is the 'dhis2' logo. In the center, there is a progress bar labeled 'Completion rate: 14%'. At the top right is a gear icon. Below the header, the breadcrumb path is 'Home / DHIS2 Components / Action components'. The main heading is 'Section 2: Action components'. The text explains that action components are user-interactable and lists topics for 'Buttons', 'Chip', and 'FlyoutMenu'. At the bottom, there are 'Back' and 'Next' buttons and a copyright notice for Hanna Evensen 2021.

**dhis2** Completion rate: 14%

[Home](#) / [DHIS2 Components](#) / [Action components](#)

## Section 2: Action components

Action components consist of components that the user will be able to interact with. When a user clicks on the component, an action will be performed.

Some of the topics that will be covered in this module includes:

**Buttons:**

- Lesson: The different types buttons and their usage
- Lesson: Button Api
- Example: The different types of buttons in action
- Lesson: Different button options
- Coding Exercise: Find the button mistakes and fix them

**Chip:**

- Lesson: Chip
- Lesson: Chip Api
- Coding Exercise: Chip in use

**FlyoutMenu:**

- Lesson: FlyoutMenu
- Lesson: FlyoutMenu Api
- Coding Exercise: Add more functionality to the flyoutMenu

**End of section quiz**

[Back](#) [Next](#)

Copyright © Hanna Evensen 2021.

Figure 5.3: Overview of the topics covered in the "Action components" section in the course "DHIS2 components."

*DP3 Principle of retrieval:* Provide the website with features that stimulate the recall of prerequisite learned capabilities [**material property**] in order for users to make sense of the new material [**action potential**], given that the user has some previous knowledge that could apply to the topic [**boundary condition**]

Design principle three was implemented by having a section on the homepage describing the prerequisites relevant to the courses. The homepage in figure 5.1 F) displays the prerequisites under a section called "Resources."

*DP4 Principle of selective perception:* Provide the website with features that present the new material [**material property**] in order for users to get familiar with the material to be learned [**action potential**], given that the user has started a new course [**boundary condition**]

Design principle four was implemented by presenting the new material in the course with the help of navigation buttons. I attempted to introduce the new material logically by following a given format. First, the course overview page will present the material to be learned. Then a new topic is presented with text-based lessons. After that, the website shows examples relevant to the text-based lessons. Lastly, the user will have to complete exercises to test the new knowledge. To assess that the new knowledge has been understood, I use quizzes and/or coding exercises. In figure 5.5, there is an example where the website presents information about the different button options.

I also implemented this design principle using "next" and "back" buttons and the usage of breadcrumbs. By having navigation inside the course with the help of "next" and "back" buttons, the website separated the learning content into smaller chunks. *Breadcrumbs* are a secondary form of navigation. Using breadcrumbs allows the user to see where they are in the course. The reader can see an example of the usage of breadcrumbs in figure 5.4.

[Home](#) / [DHIS2 Components](#) / [Action components](#) / [Buttons](#)

Figure 5.4: Secondary navigation inside the course "DHIS2 Components". Known as breadcrumbs

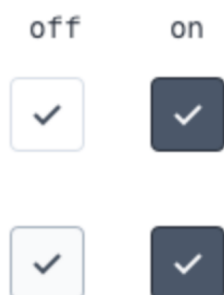
Completion rate: 14%

[Home](#) / [DHIS2 Components](#) / [Action component](#) / [Buttons](#)

## Lesson: Different button options

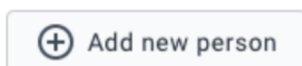
### Toggle

A button can represent an on/off state using the toggle option. Use a toggle button when the user can enable or disable an option and a checkbox or switch is not suitable. This will most often be in the case of a toolbar, such as bold or italic options in a text editing toolbar. A toggle button in this example uses an icon and does not need text. A text label should be provided in a tooltip on hover. The toggle option is available for basic and secondary type buttons.



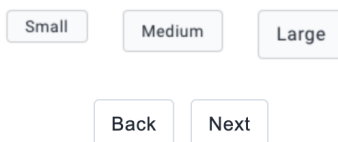
### Icons

Icons can be included in Basic, Primary, Secondary and Destructive buttons. Use an icon to supplement the text label. Remember that the user may not be fluent in the working language, so an accompanying icon on an important action can be a welcome addition. Buttons with icons only should be used for supplementary actions and should include a text tooltip on hover.



### Size

Buttons are available in three sizes: small, medium, large. Medium is usually the correct choice. Use small button in an information dense ui. Large buttons can be use on very simple, single action pages.



Copyright © Hanna Evensen 2021.

Figure 5.5: Presentation of the different button options in the course "DHIS2 components"



*DP5 Principle of semantic encoding:* Provide the website with features that offer learning guidance [**material property**], in order for users to receive assistance [**action potential**], given that the user has a problem to solve [**boundary condition**]

Design principle five assert that the website should offer learning guidance. This design principle is implemented by having a button below the coding exercises that will show the solution for the exercise. Below the Codesandbox in figure 5.6, there is a button that says "Show solution." Clicking this will show one answer for how the user could solve the coding exercise. Copying the code and pasting it into the embedded Codesandbox should change the browser window to reflect the image provided in the exercise.

For the coding exercise seen in figure 5.6, there is also a "Show hint" button in addition to the "Show solution" button. Clicking on this button would give hints for how the user could solve the coding exercise. In figure 5.6, the user has clicked the "Show hint" button. The button text will therefore say "Hide solution." Below the "Hide solution" button, there are some bullet points with hints for solving the exercise.

## Coding Exercise: Find the button mistakes and fix them

Use the information from the page about the different types of buttons and their usage to improve the code example below.

Tip: You will find some hints to the solution below the coding exercise and a possible solution

Hide hint

- Remember when you should use primary buttons. Does the interface follow the guidelines?
- Could you create better labels for the buttons?
- Do some of the button represent the same?

Show solution

Back

Next

Figure 5.6: Coding exercise with both a "show solution" button and a "show hint" button were the button for "show hint" is clicked

*DP6 Principle of responding:* Provide the website with features that elicit performance [**material property**], in order for users to practice the new material [**action potential**], given that the user been presented with the material [**boundary condition**]

Design principle six is concerned with allowing the user to practice the new material. The principle is implemented by having different coding exercises and quizzes where the user has to use the knowledge presented earlier in the text-based lessons.

There are two different types of quizzes: an image quiz and a multiple-choice quiz. The course "Color" uses the image quiz tasks the most. For this task, the user has to click on the image that uses color correctly according to the DHIS2 design principles. Figure 5.7 shows an example of an image quiz, while figure 5.8 shows an example of a multiple-choice quiz.

There are some coding examples and exercises in both the course "DHIS2 components" and the course "Colors." In the coding examples, the user gets familiarized with how to code something using the DHIS2 components or color schemes. In the coding exercises, the task is to change the code, for example by adding more functionality to an existing Codesandbox. Figure 5.9 shows an example of a coding exercise.

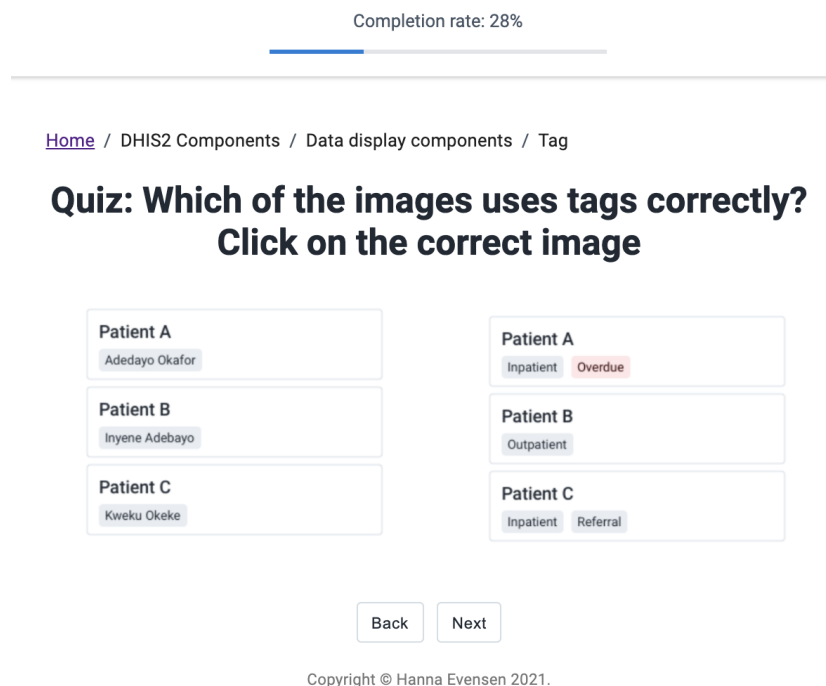


Figure 5.7: Image quiz for the usage of the UI component Tag

[Home](#) / [DHIS2 Components](#) / [Data display components](#) / End of section quiz

## End of section quiz: Data display components

### When should you use the data table?

- When you want to control the page layout instead of using Cascading Style Sheets (CSS)
- When you want to get an overview of your numerical data and show a pattern
- When the user needs to see all the available data

### When should you use standalone over inline filters in a table?

- When filtering is not one of the main actions on a page
- When filtering is one of the main actions available on the page.
- When filtering in data-heavy and compact tables

### When should you use the Tag component?

- When you know that the element will always be the same
- When you want a button with more subtle colors than the button component provides
- When you need a component for navigation
- Whenever an element in a collection needs to display its category or status
- When you want to display one-off, unique information

### When should you use the color blue for the tag component?

- The color blue tags should be used for content that displays an error
- The color blue for tags should be used for neutral information
- The color blue for tags should be used to indicate validity or success
- The color blue for tags should be used as the default color that should not imply meaning

Back

Next

Copyright © Hanna Evensen 2021.

Figure 5.8: End of section multiple-choice quiz for the section "Data display components" in the course "DHIS2 components"

[Home](#) / [DHIS2 Components](#) / [Action component](#) / [FlyoutMenu](#)

### Coding exercise: Add more functionality to the flyout menu

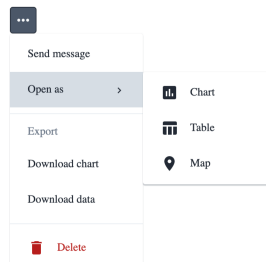
In this exercise, you are supposed to add more functionality to the flyoutMenu. Try to transform the code snippet to represent the image. You need to use the FlyoutMenu, MenuItem, MenuSectionHeader and MenuDivider as described on the previous page to reflect the image

For the the Chart, Table and Map icons I have used material-ui/icons

Tip: Below the code sandbox, you will find a possible solution if you are stuck

To import the icons I have used, you can use these import statements:

```
// Chart icon
import AssessmentIcon from "@material-ui/icons/Assessment";
// Table icon
import TableChartIcon from "@material-ui/icons/TableChart";
// Map icon
import RoomIcon from "@material-ui/icons/Room";
// Delete icon
import DeleteIcon from "@material-ui/icons/Delete";
```



```
1 import React, { useState } from "react";
2 import "./styles.css";
3 import { MenuItem, FlyoutMenu, Button } from "@dhis2/ui";
4 import MoreHorizIcon from "@material-ui/icons/MoreHoriz";
5
6 export default function App() {
7   const [showMenu, setShowMenu] = useState(false);
8
9   return (
10    <div>
11      <Button
12        dataTest="dhis2-ui-core-button"
13        name="Toggled button"
14        icon=<MoreHorizIcon />
15        onClick={() => setShowMenu(!showMenu)}
16        toggled={showMenu}
17        type="button"
18        value="default"
19      />
20    </div>
21    <showMenu 66 {
```

[Back](#) [Next](#)

Copyright © Hanna Evensen 2020.

Figure 5.9: Coding exercise from the course "DHIS2 components"

*DP7 Principle of reinforcement:* Provide the website with features that gives feedback on the users' performance [**material property**], in order for users to understand what they need to work on [**action potential**], given that the user has tried to solve a practical problem [**boundary condition**]

Design principle seven is implemented by giving feedback on the multiple-choice questions and the image quiz. Figure 5.10 shows an image quiz the user has clicked on the correct image. Since the user has clicked on the correct image, a green outline appears around the image. Below the image, there is a description that explains why it was correct. In contrast, when the user chooses the incorrect answer, a red outline appears around the image and a box underneath will explain why it was incorrect. The multiple-choice questions give feedback in the same way. Figure 5.11 shows a screenshot of multiple-choice questions where the user has answered three of the questions. The first two questions are answered correctly, and the third question is answered incorrectly. The user will receive feedback in the same way as the image quiz tasks.

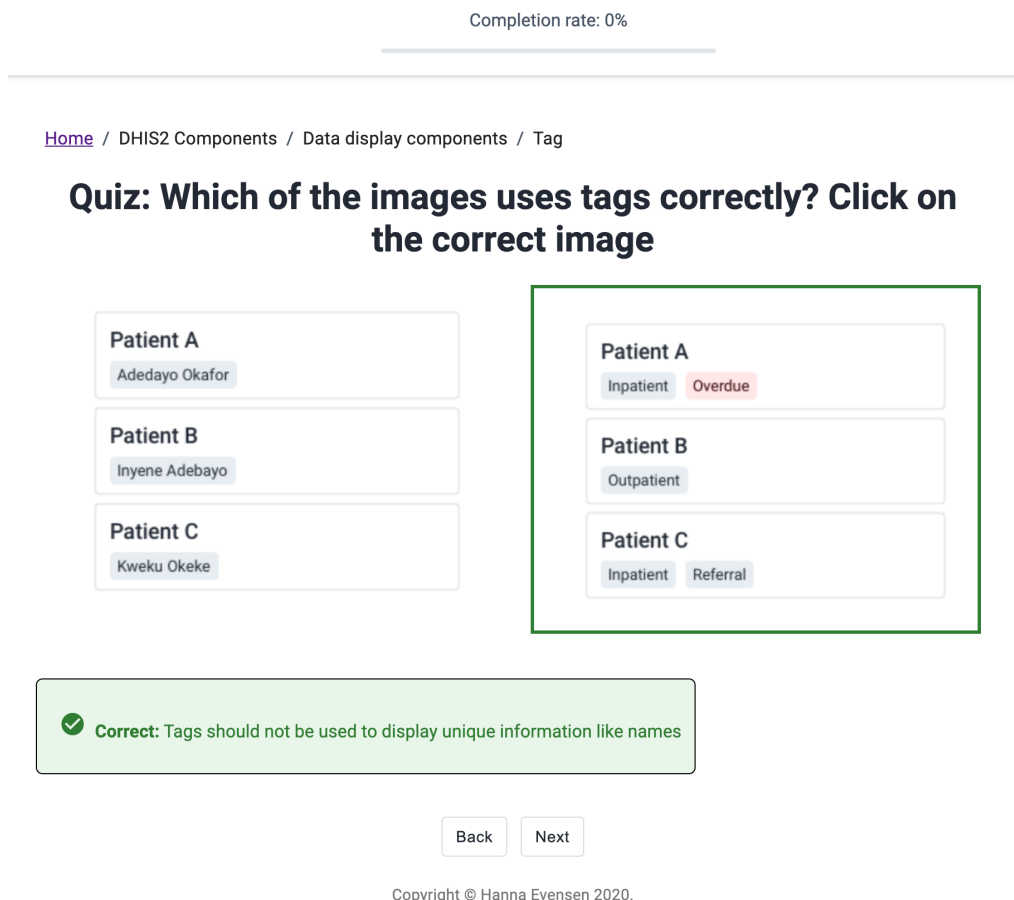


Figure 5.10: Image quiz where the user has chosen the correct answer

[Home](#) / [DHIS2 Components](#) / [Action components](#) / End of section quiz

### End of section quiz: Action components

When should you use the primary button?

- Primary buttons should be the default choice for the majority of actions. Several primary buttons can be used in the same area
- Primary buttons should be used to highlight the most important/main action on the page. Should rarely be more than one primary button

**✓ Correct:** Primary buttons should be used to highlight the most important/main action on the page, and there should rarely be more than one primary button. One example of when you would use a primary button would be a 'save' button on a form page.

- Primary buttons should be used when you want to highlight to the user the seriousness of the action
- Primary buttons should be used for passive actions, often as an alternative to the secondary action. If 'Save' is secondary, 'Cancel' could be primary. Do not use as the only action on a page

When should you use the destructive button?

- Destructive buttons should be the default choice for the majority of actions. Several destructive buttons can be used in the same area
- Destructive buttons should be used to highlight the most important/main action on the page. Should rarely be more than one destructive button
- Destructive buttons should be used when you want to highlight to the user the seriousness of the action

**✓ Correct:** Destructive buttons are used to highlight the seriousness of the action. Destructive buttons must only be used for destructive actions. One example for when you could use the destructive button could be a 'delete' action, like 'delete account'.

- Destructive buttons should be used for passive actions, often as an alternative to the primary action. If 'Save' is primary, 'Cancel' could be destructive. Do not use as the only action on a page

When should you use the secondary button?

- Secondary buttons should be the default choice for the majority of actions. Several secondary buttons can be used in the same area
- Secondary buttons should be used to highlight the most important/main action on the page. Should rarely be more than one secondary button

**✗ Incorrect:** Secondary buttons should be used for passive actions, often as an alternative to the primary action. If 'Save' is primary, 'Cancel' could be secondary. Do not use as the only action on a page

- Secondary buttons should be used when you want to highlight to the user the seriousness of the action
- Secondary buttons should be used for passive actions, often as an alternative to the primary action.

When should you use the toggle button?

- The toggle button should be used for auxiliary actions, for example clearing the content of an input.

Figure 5.11: Multiple-choice questions after the action components section in the "DHIS2 components" course, where the user has chosen the two first multiple-choice question correctly and the third incorrectly

*DP8 Principle of retrieval:* Provide the website with features that assess performance [**material property**], in order to test whether the expected learning outcome has been achieved [**action potential**], given that the user has completed a course [**boundary condition**]

For design principle eight, the website will assess performance inside the course through coding exercises, multiple-choice quizzes, and image quizzes. In addition to this, the website will also evaluate the users' performance for the whole course. After the user is finished with a course, the user will be presented with a congratulation page and the progression bar will increase. The reader can see the congratulation page in figure 5.12. On the congratulation page, the user will receive points and may also receive badges. The number of points is dependent on the performance in the quizzes. The performance means the number of correct answers the user got from completing the multiple-choice quizzes and the image quizzes. In addition to receiving points, it is also possible to receive badges when meeting specific criteria. In figure 5.13, there is an example where the person has received two badges: one for answering all the questions correctly and one for completing the first course.

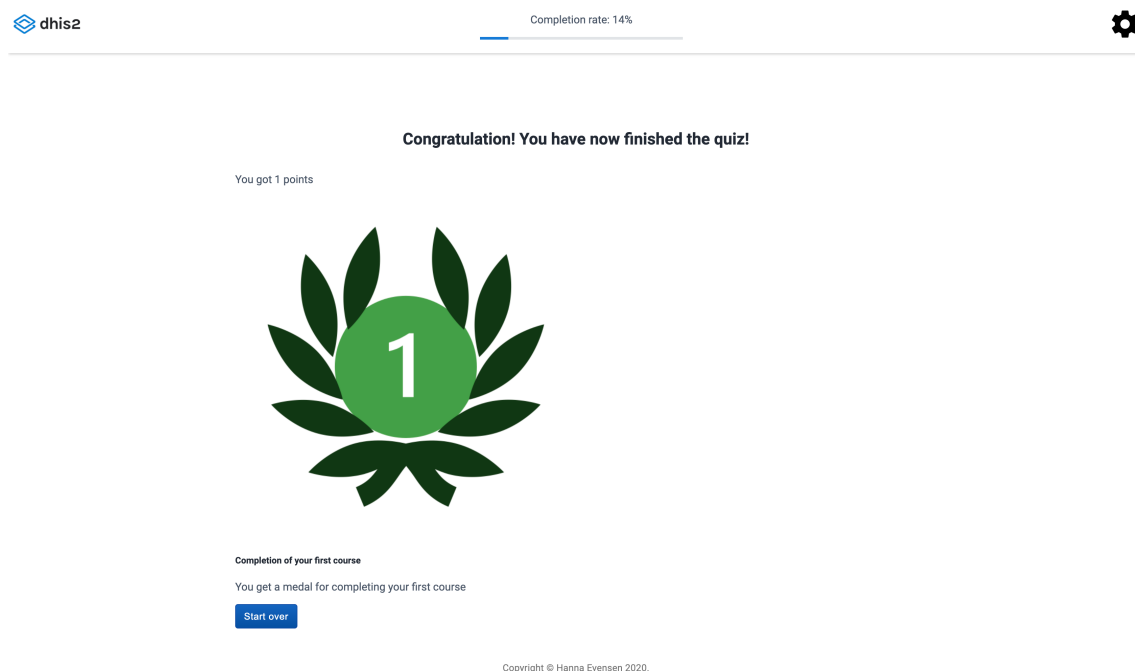


Figure 5.12: Congratulation page at the end of the course, where the user has received a badge for completing the first course



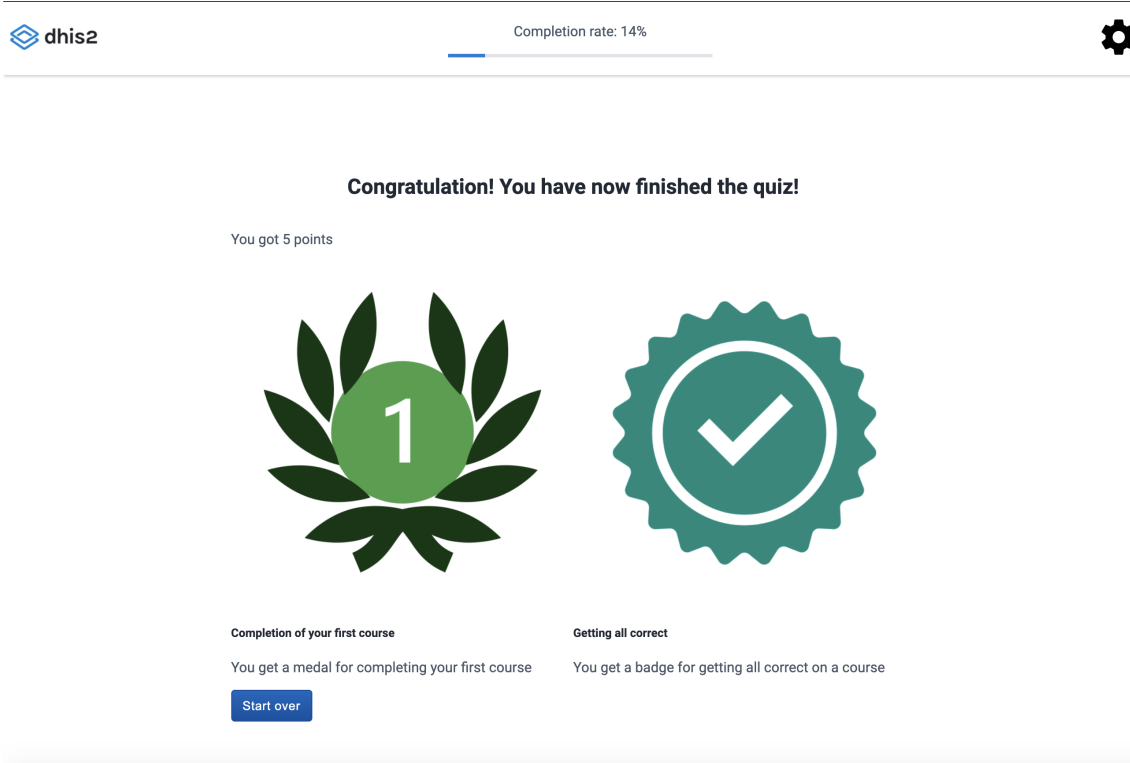


Figure 5.13: Congratulation page at the end of the course, where the user has received two badges, one for completing the first course and one for getting all the questions correct

The progression bar seen in figure 5.14 will assess the performance for all the courses. When the user completes a course, the progression bar will increase based on the number of points the user received during the course.

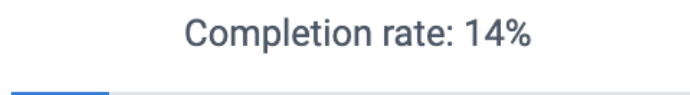


Figure 5.14: Progression bar in the navbar

The website will only save the results from completing the courses if the user is logged in to the website. To log in, the user first needs to have an account on the website. In the navigation bar seen in figure 5.15, there is a link to the right called "login." When clicking on this link, the login page seen in figure 5.17 will appear. To create a new account on the website, the user needs to click the link called "create an account here," as seen in figure 5.17. Clicking on this link will transfer the user to the signup page. Here, the user can create a new account. The signup page has a similar layout as the login page.



Figure 5.15: Navigation bar when the user is not logged-in



Figure 5.16: Navbar when the user is authenticated

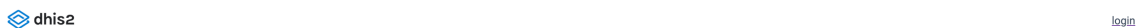


Figure 5.17: Log in page

The settings page displays all the available badges that a user can receive. Figure 5.18 shows the settings page. At the top of this page, the user's account that is logged in is displayed. There is also a button to log out of the website. Below this, the user will see the completed courses and all the badges the person has received. If the user has not received any badges, this section will not be shown. Below this section, there is a section that displays all the possible badges the user can receive. At the moment, I have only created four types of badges.

The screenshot displays the DHIS2 Settings page. At the top left is the DHIS2 logo, and at the top right is a gear icon for settings. A progress bar indicates a completion rate of 14%. The page is divided into several sections:

- Settings:** Shows the user's email as 'user1@gmail.com' and a 'Log out' button.
- Completed courses:** Features a card for 'DHIS2 Components' with a green background and a white circular icon containing a play button and a refresh symbol. Below the card, it states 'Points received: 1'.
- Received badges:** Shows a single badge with a green laurel wreath and a green circle containing the number '1'. The text below reads 'Your first course' and 'Badge for completing your first course'.
- Possible badges:** Shows three unearned badges in a light gray color:
  - 'Your fourth course': A laurel wreath with a circle containing the number '4'. Text: 'Badge for having completed more than four courses'.
  - 'All correct': A circular badge with a checkmark. Text: 'Badge for getting all correct on a course'.
  - 'Completing all courses': A trophy icon. Text: 'Badge for completing all the courses'.

Copyright © Hanna Evensen 2020.

Figure 5.18: Settings page, when the user has completed one course and received one badge for completing the first course

*DP9 Principle of generalization:* Provide the website with generalize the knowledge taught [**material property**], in order to ensure that the user can transfer the knowledge to a new situation [**action potential**], given that the user has completed a course [**boundary condition**]

Design principle nine is concerned with generalizing the knowledge taught in the course. Due to time restrictions, I did not have time to implement this feature. However, a possible suggestion for how to implement this design principle could be to have a task at the end of the course where the user has to utilize information taught in the course to develop a full application. The user will then have to set up a development environment themselves, and it will be closer to tasks that they are required to accomplish at work.

Table 5.2 summarize all of the design principles and how I implemented each of the design principles

### 5.3. INSTANTIATION OF DESIGN PRINCIPLES

#	Initial design principle	Instantiation of Material Properties
DP1	Provide the website with features that appeal to the user <b>[material property]</b> in order to capture the user's attention <b>[action potential]</b> , given that the user has started using the website <b>[boundary condition]</b>	<ul style="list-style-type: none"> <li>• Presentation of courses with colorful images and course descriptions</li> <li>• Possibility to receive points and badges</li> </ul>
DP2	Provide the website with features that inform the user of the course objectives <b>[material property]</b> in order to anticipate what they will learn <b>[action potential]</b> , given that a course has gained the users' attention <b>[boundary condition]</b>	<ul style="list-style-type: none"> <li>• In-depth description on the course overview page</li> <li>• Time estimation for how long it takes to complete the course</li> <li>• Accordion on the course overview outlining what you could expect in the course and a time estimate for how much time it will take to complete the course.</li> <li>• Overview for each of the sections inside the course "DHIS2 Components"</li> </ul>
DP3	Provide the website with features that stimulate the recall of prerequisite learned capabilities <b>[material property]</b> in order for users to make sense of the new material <b>[action potential]</b> , given that the user has some previous knowledge that could apply to the topic <b>[boundary condition]</b>	<ul style="list-style-type: none"> <li>• Prerequisite resources on the homepage</li> </ul>
DP4	Provide the website with features that present the new material <i>[material property]</i> in order for users to get familiar with the material to be learned <b>[action potential]</b> , given that the user has started a new course <b>[boundary condition]</b>	<ul style="list-style-type: none"> <li>• Courses presented logically with different learning material</li> <li>• Navigation in the course with back/next buttons + breadcrumbs, which allowed to separate the material into smaller chunks</li> </ul>
DP5	Provide the website with features that afford learning guidance <b>[material property]</b> , in order for users to receive assistance <b>[action potential]</b> , given that the user has been given a problem to solve <b>[boundary condition]</b>	<ul style="list-style-type: none"> <li>• Possible to see solution and hints in coding exercises</li> </ul>
DP6	Provide the system with features that elicit performance <b>[material property]</b> in order for users to practice the new material <b>[action potential]</b> , given that the user has been presented with new material <b>[boundary condition]</b>	<ul style="list-style-type: none"> <li>• Coding exercises, multiple-choice questions and image-quiz that demonstrate that they have learnt the material</li> </ul>
DP7	Provide the website with features that give feedback on the users' performance <b>[material property]</b> , in order for the users to understand what they need to work on <b>[action potential]</b> , given that the user has tried to solve a practical problem <b>[boundary condition]</b>	<ul style="list-style-type: none"> <li>• Feedback if you have answered correct/wrong on the multiple-choice question and the image quiz tasks</li> </ul>
DP8	Provide the website with features that assess performance <b>[material property]</b> , in order for users to test whether the expected learning outcome has been achieved <b>[activity of user]</b> , given that the user has completed a course <b>[boundary condition]</b>	<ul style="list-style-type: none"> <li>• End of course congratulation page with points and badges you have received for completing the course</li> <li>• Progress bar for all the courses</li> </ul>
DP9	Provide the website with features to enhance retention and transfer <b>[material property]</b> , in order for the user to generalize the knowledge taught to a new situation <b>[action potential]</b> , given that the user has completed the other courses <b>[boundary condition]</b>	Not implemented

Table 5.2: Overview of instantiation of initial design principles

## 5.4 The three design cycles

This section will describe the three design cycles used in this research. The design cycles consisted of a build activity and an evaluation, as seen in figure 4.1. When presenting the design cycles, I will follow this structure.

### 5.4.1 Design cycle 1: Early sketches + development of the homepage

The first design cycle started at the beginning of September and lasted until the end of September.

#### Build activity

In the first design cycle, I made some paper sketches of the website and developed the homepage's first version with login and sign-up functionality. The paper sketches contained some examples of the type of course content I was planning to develop. Besides some early paper sketches of the website, I also developed the application's main skeleton using the framework React and Firebase as back-end. In figure 5.19, there is a screenshot of the homepage after the first cycle.

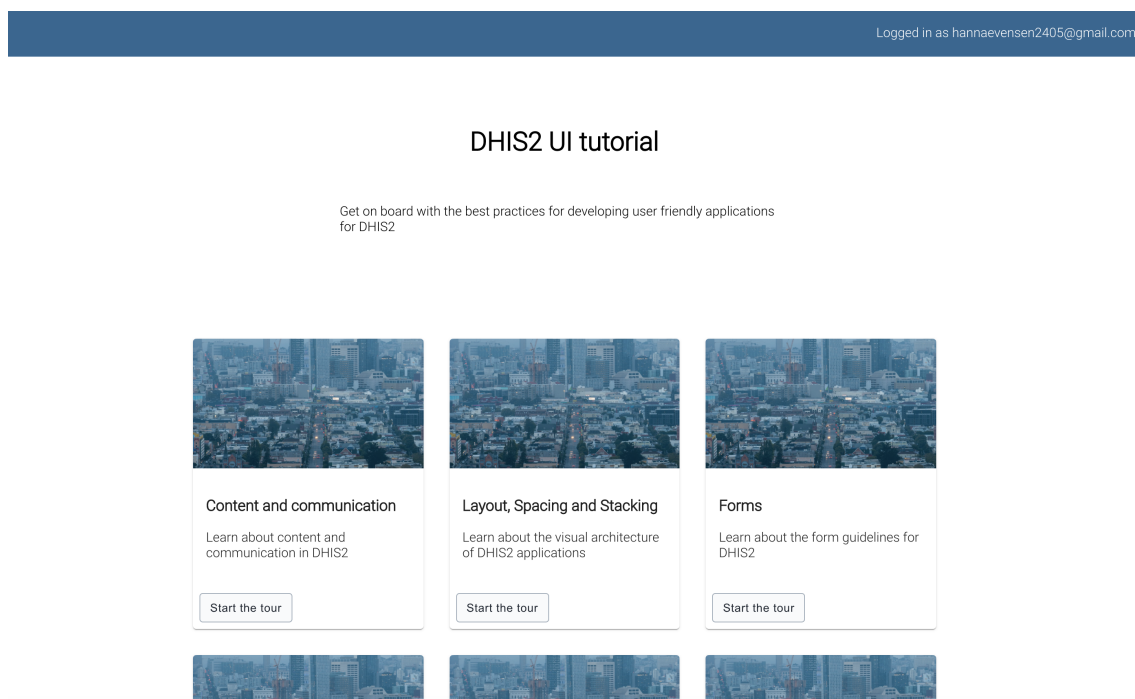


Figure 5.19: The homepage after the first design cycle

In figure 5.19 of the homepage, all the courses have a “start the tour” button. Clicking on this button would only show dummy data. By using the react-tour library, it was possible to click through the course. However, using the react-tour library proved to be too restrictive. Therefore, in the subsequent design cycle, the react-tour implementation was replaced by a custom implementation.

### **Evaluation**

To evaluate the website after the first design cycle, I had email correspondence with the UX designer. I used email since I wanted to get feedback quickly. I also demonstrated the website to many of the core developers after interviews. Through the evaluation, I received feedback based on the screenshots of the homepage and the paper prototypes. From the email correspondence, the UX designer was positive to the "teach, then quiz" flow. However, he also emphasized that the users need to see the benefits of completing the courses since the tricky part might be to get people to take them.

The interview with the core developers often started with questions about the existing documentation in DHIS2 and what was missing. The website Storybook displays all the UI components available. However, it did not provide information about when to use the component and what the component is used for. A theme in the interviews with the core developers was that it might be useful for developers to display the components and have text and explanations for every component. The documentation today did not showcase how the users could use all the components together. People also mentioned that my website could probably be more opinionated than Storybook when it comes to when the user should use the components. Some people wanted to see more significant tasks where the user gets an overview of how everything is connected. People were generally positive about having coding tasks that the user had to complete. However, it was mentioned that having automatic tests for the coding exercises would be a nice feature. Then the user could get specific feedback on what they had done correctly and what was incorrect. This was not practically doable in the short timeframe the website was developed.

The development of the website continued in-between the evaluation with the core developers and the UX designer. However, how the website looked at the different stages remained the same. The development mostly had to do with the back-end of the application and improving code quality.

## 5.4.2 Design cycle 2: Developing course content

The second design cycle started in the beginning of October and lasted until the end of October.

### **Build activity**

During the second design cycle, I developed course content for the course "DHIS2 components" and the course "Colors." During this cycle, the library react-tour was replaced by a custom implementation using JSON. I created a JSON array for all the courses. Each of the courses had an identifier, a name, and a description. Inside each of the courses, there was also an array that contained the course content.

I also developed the course overview page in this second design cycle, some coding exercises, and text-based lessons. The skeleton of the multiple-choice quiz and the image quiz was also developed.

### **Evaluation**

After the second design cycle, two people evaluated the website: the UX designer and a core developer. The website was evaluated with a demonstration where I shared the screen on Zoom. After I showed the website, I received feedback on possible improvements. Some suggestions for improvement included having a progress bar for the courses and receiving a checkmark when the user had finished the quiz. After demonstrating and listening to how I had developed the course content, the core developer also proposed using MDX instead of JSON. He thought it was good that I stored it locally instead of in Firebase. This makes it possible to use the website without connecting to a database, which can be resource-demanding. However, he said that using MDX might make it easier for a non-developer to change the course content in the future. Since this was too time-consuming to change, I decided not to prioritize this.



### 5.4.3 Design cycle 3: Adding more content to the courses and adding badges

The third design cycle lasted from November 2020 until February 2021.

#### **Build activity**

In the third design cycle, I created more content for the courses "DHIS2 components" and "Colors." I developed more coding exercises for the courses and made the multiple-choice questions fully functioning. I also added more text-based lessons and implemented the image quiz. After design cycle two, I had some image quiz tasks, but they were not functioning at this point. The images in the image quiz were present, but it was not possible to click on any of them and see if the answer was correct. During design cycle three, I developed this task type further. Now it was possible to see if the answer was correct or not. In this cycle, I also created the course images. To create the course images, I used PowerPoint. Figure 5.20 shows a closer look at the course image for the course "DHIS2 Components." In this screenshot, there is also a checkmark beneath the title that says "Completed." This checkmark means that the user who is signed has completed the course. The checkmark was suggested as a feature by the UX designer during the second cycle. Another suggestion from the second design cycle was to have a progress bar for the courses that would tell how many courses the user has completed. I also implemented this feature. Figure 5.16, shows the progress bar with the label "Completion rate."

#### **Evaluation**

To evaluate the artifact after the final design cycle, I interviewed a developer in Mozambique, posted a questionnaire, facilitated a focus group, and received feedback from the UX designer. Chapter 6 will go through the findings from each of the methods used to evaluate the website after the last design cycle.

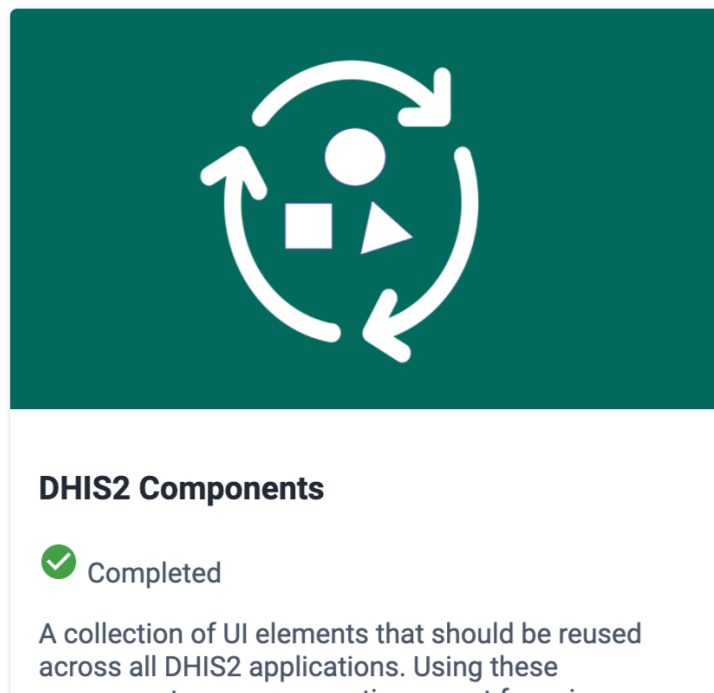


Figure 5.20: The course image for the course "DHIS2 Components" with a checkmark for having completed the course

## 5.5 Summary

This chapter has described the tools used to develop the website and explained how I implemented the initial design principles. It has also given an overview of the three design cycles this research has followed. For the next chapter, I will go through the evaluation of the website after the final design cycle and relate it to the initial design principles.

# 6

## Evaluation

This chapter will report the findings related to the summative evaluation of the website after the final design cycle and discuss it in relation to the initial design principles. The final evaluation of the website consisted of different data collection methods. It included a questionnaire, a focus group, an interview with a developer in Mozambique, and an expert review by the UX designer. At the end of this chapter, I will discuss some aspects of the evaluation that were not necessarily related to the instantiation of a design principle. Table 6.1 will summarize the findings from the evaluation.

### 6.1 Design principle 1

*DP1 Principle of reception:* Provide the website with features that appeal to the user [**material property**] in order to capture the user's attention [**action potential**], given that the user has started using the website [**boundary condition**]

The first design principle was implemented with two features. The first feature was to present the courses with colorful images and course descriptions. The second feature was the possibility of receiving points and badges. For the courses to appeal to the user, the features should be suitable for the user.

### 6.1.1 Questionnaire

One statement in the questionnaire was: "I think the website could be a good supplement to the other DHIS2 resources", which I argue says something about whether the website appeals to users. For this statement, 37.5% answered "Strongly Agree," and 62.5% "Agreed". To the question "Do you think the course would be suitable for beginners wanting to learn to use the DHIS2 design system" 62.5% answered "Yes" and 37.5% answered "Somewhat." None of the respondents answered "No." One said that whether the website would be suitable would depend on the audience and their background.

There were no specific thoughts about the homepage regarding the course images and course descriptions. People were more interested in the actual course content. However, one question that was asked that was more general was: "How was it to get familiar with the website?" 12.5% answered "Neutral," 50% answered "Easy," and 37.5% answered "Very easy." Another question that was asked was regarding the attractiveness of the website. This question was not specifically asking about the homepage but the whole website. The question was: "How visually attractive did you find the course?", 25% answered "Mediocre," 62.5% answered "Quite attractive," and 12.5% answered "Very attractive." When asked about what the best thing about the courses was, one person mentioned that the website being attractive was the best thing. However, another person in the survey noted that the website's visual design could be more appealing. Still, he also said that he thought it looked very much like a DHIS2 related content page.

There were not many people who said that they received points and badges for completing the courses, which suggests that the possibility of receiving points and badges might not have been that clear, or it might not have been that important for people to take the time to log in. One person mentioned that it was not that clear that the user had to click on the login button to sign up.

### 6.1.2 Focus group

The students in the focus group also thought the website was a good addition to the existing resources. All of the students had taken the platform course offered at UiO. The previous semester, a website was developed as a part of the course material. This website introduced the students to DHIS2. However, students in the focus group felt that information about the DHIS2 design system lacked in the platform course. Therefore, some of the students thought that the website I had developed would have been a good supplement to existing resources when

taking the platform course. Some students also mentioned that this resource could be helpful in the DHIS2 world. Even for developers in Norway, this could be a valuable website since many developers in Norway do not have that much design knowledge either.

In general, people seemed to think the homepage was good. However, one student suggested that the homepage should state the benefits of signing up. Some people felt that it was not clear that it was possible to receive points and badges. If the benefits of signing up were more apparent, people thought that the users would be more inclined to sign up. While one person said that it was easy to get to know the website, create a user and log in, another person in the focus group did not feel it was natural to log in. Someone also mentioned that they did not see the login button.

A couple of people in the focus group advocated for using the navbar more. One suggested having courses and resources besides the logo in the navbar. Another person suggested that it should be possible to click directly on a course from the navbar. Some argued that many people use the navbar to navigate, so there should be more up there. One person also suggested having trophies in the navbar.

The initial design principle is also concerned with having engaging descriptions of the courses. However, a topic that emerged in the focus group was whether people know what a design system is. Only having descriptions for each of the courses might not be enough. As some might not be familiar with what a design system is, a suggestion was to introduce the design system with a design systems fundamentals course. The user should complete this course before the other courses. In this course, a suggestion was to introduce why having a design system and having a similar identity across all DHIS2 applications is favorable. As a result, the benefits of completing the remaining courses might have been clearer

### **6.1.3 Developer in Mozambique**

The website did seem to appeal to the developer in Mozambique, and he said he liked it very much. He also mentioned that he felt that the website was a good resource for new developers. He noted that some of the documentation in DHIS2 is too advanced and not suited for new developers. While he said that the documentation is not necessarily missing, it is difficult to find the things you are looking for when you don't know the platform's structure. Therefore he thought the website that I had developed could be a good addition to the existing resources.

The developer in Mozambique seemed to like the homepage in general. However, he wanted more colors, especially since I had a course named "color." Another thing he mentioned was that there was too much text in the course descriptions on the homepage. He would have liked to get that information in the course overview instead when clicking on a specific course.

## 6.2 Design principle 2

*DP2 Principle of expectancy:* Provide the website with features that inform the user of the course objectives [**material property**] in order to anticipate what they will learn [**action potential**], given that a course has gained the users' attention [**boundary condition**]

This design principle was implemented by having a course overview page containing a course description, a time estimation, and an accordion showing the course content.

### 6.2.1 Questionnaire

Two people in the questionnaire mentioned that completing the courses took longer than what was written in the time estimate for that course and that a new time estimation should be made.

It was also mentioned that when opening up the course DHIS2 components, it might not be clear for users' what components are used for, suggesting that course description might not have been that clear.

### 6.2.2 Focus group

People in the focus group generally liked the accordion to see what the course would cover and how much time they should schedule. However, someone mentioned that it should be possible to go to a specific page from the accordion in the course overview. Then, if the user is uncertain about a particular topic, the user could go directly to that page. At the moment, the user would have to go through the whole course before finding the correct page.

### 6.2.3 Developer in Mozambique

The developer in Mozambique generally liked the course overview page. However, he would also like to have the option to jump to a specific page from the accordion.

## 6.3 Design principle 3

*DP3 Principle of retrieval:* Provide the website with features that stimulate the recall of prerequisite learned capabilities [**material property**] in order for users to make sense of the new material [**action potential**], given that the user has some previous knowledge that could apply to the topic [**boundary condition**]

Design principle three was implemented by describing prerequisites relevant to the course on the homepage under "Resources".

### 6.3.1 Questionnaire

People in the questionnaire found the placement of the "Resources" section on the homepage to be a bit off. One person mentioned not seeing the "Resources" until later. Someone also suggested stating more prerequisites for each course. One example that was given was when discussing the UI component "chips", the tutorial should highlight where in existing documentation the user should go to find information about the design system's chips.

### 6.3.2 Focus group

Multiple people participating in the focus group emphasized further links to external resources. Someone in the focus group mentioned that it is confusing to find information in DHIS2. Therefore, it was nice to have some links to other resources, as I had attempted in the website. However, this was not consistent, and someone in the focus group emphasized more links inside the courses. One example given was to directly link the color course to the documentation on Github about the DHIS2 color specification.

## 6.4 Design principle 4

*DP4 Principle of selective perception:* Provide the website with features that present the new material [**material property**] in order for users to get familiar with the material to be learned [**action potential**], given that the user has started a new course [**boundary condition**]

Design principle four was implemented by presenting the new material using various media and question types and having navigation inside the course with back and next buttons and breadcrumbs.

### 6.4.1 Questionnaire

In the questionnaire, some people emphasized that the courses were well-structured. One person wrote that the courses take you through the DHIS2 design system in a methodological way. However, some people mentioned that it was too much text on some of the pages. One person mentioned that having so much text was overwhelming, and the person suggested that I could improve the courses by having more steps with less information. Another person also mentioned that the text blocks could use better formatting for readability.

Some people said that the distribution between the different tasks was good. However, people had different opinions regarding the usefulness of the learning materials.

Results from the multiple-choice questions considering the usefulness of the different tasks:

- Text-based: Very useful 50% , Moderately useful 37.5% and Slightly useful 12.5%
- Multiple-choice: Very useful 87.5%, Slightly useful 12.5%.
- Coding tasks: Very useful 37.5%, Moderately useful 25%, Slightly useful 37.5%
- Image quiz: Extremely useful 25%, Very useful 50%, Moderately useful 25%

According to these results, the image quiz seems to be the most popular, and the coding tasks the least popular. In one free-text question, someone mentioned that the usefulness of the task would depend on the audience. The person assumed that the intended audience would-be developers of DHIS2 apps. In which case, the person argues that some of the material would be easier to get from the documentation. If the audience were designers who don't code the apps, e.g., just people making wireframes, then the coding exercises would not be as relevant.

One person also suggested new functionality in the courses. The suggestion was to display more example apps that apply the design principles properly.

The navigation inside the course was also a part of the implemented features for this design principle. One person noticed when using the back button in the browser and not on the webpage, he/she would go back to the main page and start all over again from the beginning. After noticing this behavior, the person said that he/she was more careful with using the "back" and "next" buttons available on the



page only.

### 6.4.2 Focus group

In the focus group, someone also mentioned that there was too much information on some of the pages. Therefore, a suggestion was to use multiple pages.

Someone also said they liked the usage of breadcrumbs, but then they became aware that not all were clickable, which they should be. Some of the people in the focus group also advocated for improved navigation inside the courses. To improve the navigation inside the courses, someone suggested that there should be some navigation inside each page. The student suggested that there could be a table of contents for each page. The table of contents would take the user to the different parts of the page.

Another thing that was mentioned was to have a small introduction before the coding examples and exercises. One person mentioned that he would like a heads up before the coding exercises.

### 6.4.3 Developer in Mozambique

The developer in Mozambique also said that he sometimes felt it was too much text on some of the pages. He would also like to have the option to click on the breadcrumbs.

### 6.4.4 UX designer

The UX designer reported using the back and next buttons in the browser and not the dedicated "next" and "back" buttons provided on the webpage. Using the browser's back button would take the user out of the quiz. The UX designer felt that this could be confusing for the user who wanted to go back to the previous section to reread some information. The UX designer reported that this happened multiple times, which was an issue when one had gone deep into the "DHIS2 Components" course since he had to go through 20+ pages again.

## 6.5 Design principle 5

*DP5 Principle of semantic encoding:* Provide the website with features that afford learning guidance [**material property**] in order for users to receive assistance [**action potential**], given that the user has been given a problem to solve [**boundary condition**]

Design principle five was implemented by seeing the solution and hints in some of the coding exercises.

### 6.5.1 Questionnaire

People who participate in the questionnaire seemed to want to have more learning guidance. Some people said that they would like to receive more help when doing the courses.

### 6.5.2 Focus group

Some people mentioned that they would like to have the option to see solutions/get hints, not being aware that this was possible in some of the coding exercises. This may suggest that the placement of the hints could be better.

For the coding exercises someone also said that they would like to receive more guidance. The student compared it to Codeacademy, where the user will receive more guidance.

## 6.6 Design principle 6

*DP6 Principle of responding:* Provide the system with features that elicit performance [**material property**] in order for users to practice the new material [**action potential**], given that the user has been presented with new material [**boundary condition**]

Design principle six was implemented by having tasks that would elicit performance. These tasks included multiple-choice quizzes, image quizzes, and coding exercises.

### 6.6.1 Questionnaire

A developer who took the questionnaire mentioned not being interested in editing code in a tutorial. Instead, the developer said that he would like to learn more about the DHIS2 design principles. However, he also noted that this approach could help people who do not have a lot of React experience and want to learn how to develop apps for DHIS2. In contrast, another person preferred more coding exercises in general and thought having coding exercises was better than the image quiz and the multiple-choice quiz. The person emphasizes that this may be personal taste, mentioning liking more practical learning methods, f.ex by playing with code. However, the person also sees it as essential to have

some theory and learn why the components exist and how to use them correctly. Another person said that sometimes it felt that it was more a lesson in React than a lesson in using the DHIS2 design system. The person elaborated further, saying that it could be helpful depending on the user's background. Therefore he mentioned that he would like to have the option to skip over specific exercises. Another person said that he would like to have even more quizzes in general, arguing that new knowledge can be more quickly tested and retained.

Having bigger tasks was also something that was mentioned. One person said that he would like a step-by-step real project development. For example, do a small project from A-Z where the participants can use React knowledge in building real DHIS2 applications. When asked about whether there is anything else that he would like to add about the website, the same person said that he would like the website to have a complete playground where the developer can play around and develop basic apps for DHIS2.

One issue that was reported by a couple of people was that they had trouble with the embedded code sandbox. The people who mentioned this issue said that the cursor was misplaced a couple of symbols towards the left. One person got used to the error and consequently remembered needing to place the cursor incorrectly when typing something. However, although being able to do coding tasks, the respondent did not look forward to the coding assignments due to this error. Another person had to resort to using the keyboard instead due to the errors the misplaced cursor caused. Some people mentioned that having a non-embedded version might have been better. One person who said that he also had this issue with the embedded version reported that it helped open the dedicated coding sandbox page.

### **6.6.2 Focus group**

The majority of the people in the focus group leaned more towards being designers than developers. Consequently, many were more interested in the course "Color," which did not contain many coding exercises but emphasized design. The "Color" course used image quizzes a lot, and many of the people in the focus group seemed to enjoy this task. Some of the students thought the examples were good and that comparing images was an excellent way to visualize things. The people in the focus group felt that correct color usage was very important. Especially being consistent with the color usage, so the user will be able to have correct focus. The focus group also mentioned that the development of DHIS2 in some countries often had colorful apps and that they did not want the apps to look alike. People

in the focus group felt that this was a battle to take, especially regarding the difference between danger and confirm colors.

One person in the focus group who examined the course "DHIS2 components" a little bit more said that he generally liked having coding exercises seeing that he had tried out other types of courses (like code academy). Still, he found it challenging to navigate the embedded code sandbox examples and felt it was difficult to scroll with the embedded version. The cursor was also misplaced with a couple of symbols.

In order to practice the new material, even more, a suggestion by one of the students was to have a task with a drag-and-drop interface. In the drag-and-drop interface, the person could drag different components and see if they used them correctly. Then, they could check to see if they used the correct colors.

### **6.6.3 Developer in Mozambique**

The developer in Mozambique also said that he liked the code sandbox exercises but that it would have been helpful to have some more extensive tasks. When asked about what type of tasks he liked the most, he said the coding exercises, the multiple-choice questions, and the image quiz.

### **6.6.4 UX designer**

In the earlier stages of the development, the UX designer suggested having a prototyping site where you could drag components to the page and check that you used them correctly. This is similar to the suggestion by the student about the drag-and-drop interface. He would like to have something like this, where the site would warn if the user has used more than one primary button on the same page. However, this was abolished due to being very time-consuming to accomplish well.

The UX designer also suggested that the different answers in the "quiz" section should be emphasized, perhaps with a border around each answer. The UX designer argues that it can be difficult at a glance to see that there are two different answers. He also suggests providing hover states for the clickable answers since it is not clear that they are clickable. The hover state should be visibly different, and the cursor should reflect that the answer is clickable.

## 6.7 Design principle 7

*DP7 Principle of reinforcement:* Provide the website with features that give feedback on the users' performance [**material property**] in order for the users to understand what they need to work on [**action potential**], given that the user has tried to solve a practical problem [**boundary condition**]

Design principle seven was implemented by receiving feedback on the multiple-choice question and the image quiz.

### 6.7.1 Questionnaire

It was not asked explicitly in the questionnaire how they felt about receiving feedback on the quizzes. But one person mentioned that while the coding exercises were better than the image quiz or the quiz, the person mentioned liking receiving correct/wrong answers in the quiz.

### 6.7.2 Focus group

Some of the people in the focus group said that it was very good to receive feedback on the quizzes. However, someone suggested that the user should get links in the feedback to learn more about the topic.

### 6.7.3 Developer in Mozambique

The developer in Mozambique also liked the multiple-choice quizzes and the image quiz and receiving feedback for the quizzes.

## 6.8 Design principle 8

*DP8 Principle of retrieval:* Provide the website with features that assess performance [**material property**] in order for users to test whether the expected learning outcome has been achieved [**action potential**], given that the user has completed a course [**boundary condition**]

Design principle eight was implemented by having an assessment at the end of the course. The user would get an end-of-course congratulation page with points, and badges received. A progress bar will also assess how many courses have been completed.

### 6.8.1 Questionnaire

There were not that many people who answered that they had received badges in the survey. When asked about how they found receiving badges, 37.5% said that they had not received any badges. This suggests that they either did not sign up to the website, they did not fully complete a course, or it may be an unidentified error since the user should receive a badge when completing your first course if you have signed up. This does suggest that it might not have been that obvious that you could sign up, and the benefits of signing up might not have been that clear. However, I asked no question about whether they signed up, so it is impossible to be sure. For the people who did receive badges, 25% said it was "Very exciting" to receive badges, 25% said it was "Exciting," and 12.5% were Neutral.

A couple of people mentioned that they found the progress bar to be a bit confusing, and they would instead like to have one for each course. There is only one progress bar named "completion rate" for all the courses. Someone said they felt it was unclear what the completion rate was for, and some thought it was a little bit out of place. Some people found this progress bar confusing since they believed that this should change when clicking next inside the courses. However, they later realized that this progress was related to all the courses and not the current active course.

### 6.8.2 Focus group

Multiple people said that they thought it was cool to receive points and badges for completion in the focus group. One said that he loved the concept of gamification. In the focus group, one person said that he would like to receive "Spicy titles," saying that it would be cool to be a "UI guru." Since courses can become a little boring, adding more spicy titles and animations and making it more "childish."

This sparked a discussion in the focus group. While people in the focus-group, generally liked the idea of receiving badges, someone said that we should think about cultural differences, saying that badges with silly titles and using fun emojis might not be perceived that well by serious health authorities. This person still thought that the idea of using some badges could be accomplished well, but that it should not be that silly. Still, someone said that since the tutorials are aimed more towards developers and not necessarily towards health professionals, it might still work. Whether they would like such silly titles is not possible to know, and this discussion was more about the students imagining how the rest of the community would perceive the badges.

Having a progress bar for each of the courses was also suggested in the focus group. Another suggestion was to show the score the user had received when completing the course on the homepage for that respective course.

### **6.8.3 UX designer**

The UX designer mentioned that he would also like a progress bar for each course, seeing it as an encouraging element that would nudge the user to keep going.

## **6.9 Further findings**

Some of the suggestions that I received regarding improvements do not fit under any design principles, and I will discuss them here.

### **6.9.1 Questionnaire**

In the questionnaire, it was mentioned that adding a rating system might be a good idea. Then people would be able to review the courses, which could generate a feedback loop and possibilities to improve the courses' content even more.

One issue that was mentioned was when signing up. The user was asked for a username, but the website only accepted email. Some people also mentioned receiving a 404 page when duplicating the page.

Everyone in the questionnaire said that the response time they were pleased with the response time of the questionnaire. Some describes it as "pretty good", "fast" or "very good". However, one person mentioned that while the website was very performant, some of the images took a bit of time to load. Therefore, the person suggested to use code instead of images to make it load faster.

### 6.9.2 Focus group

A suggestion for improvement mentioned in the focus group was to save the courses' progression. Right now, the course will only be saved when the user has completed the whole course. The user will not be able to save the progress if the user is halfway through the course. Therefore the person said that it would have been nice to have the option to save progression. Then you would be able to pick up where you left off.

Some students also mentioned issues with the signup page requesting a username and the 404 error page. Another issue mentioned in the focus groups was the hover effect on the image quiz tasks. The grey hover effect should appear when the user hovers over the image. However, students mentioned that this hover effect only occurred when the user arrived at that image quiz the first time. If the user went to another page of the course and then returned to the same image quiz, the hover effect did not appear.

The need for internet connection to use the coding exercises was also mentioned as an issue. Some had travelled to countries in the HISP network and experienced the lack of internet connection first hand. Someone said that it was not really good internet connection at the university and people used a memory stick to store YouTube videos. Therefore, it was suggested that the courses should have an offline mode.

### 6.9.3 Developer in Mozambique

The developer in Mozambique also mentioned that when he is finished with a course, he would like to have the option to go back home. In addition to the "start over" button that starts the courses, he would like to have a button that would take the user back to the home page.

### 6.9.4 UX designer

The UX designer mentioned that it would have been clearer if the action buttons were placed consistently. The "Start course" button is left-aligned, but the "Back" and "Next" buttons are center-aligned.

There was also an issue with the page layout "showcase of DHIS2 components", which did not work well on smaller screen widths. The UX designer suggested stacking the sections vertically below a certain screen width.

In addition, the UX designer also mentioned that the Table and the Data table



components are being mixed up, and the font family used in the code examples is incorrect. According to the design system, the font family should be Roboto.

## **6.10 Summary**

Table 6.1 summarizes the findings from the last evaluation of the website. The table separates results for each of the design principles and the evaluation method used. In chapter 7, the initial design principles evaluated in this chapter will be revised based on the evaluation, and some new design principles will be discussed.

Table 6.1: Summary of the findings from the evaluation

Design principle	Questionnaire	Focus group	Mozambique	Expert review
Design principle 1	<ul style="list-style-type: none"> <li>• Good supplement to existing resource</li> <li>• Generally thought that it was suitable for new developer</li> <li>• Not many thoughts on the homepage</li> <li>• Majority thought it was "Quite attractive", but the views varied</li> <li>• Not clear that it was possible to receive points and badges</li> </ul>	<ul style="list-style-type: none"> <li>• Good supplement to existing resources</li> <li>• Not clear that it was possible to receive points and badges</li> <li>• Use the navbar more as a form of navigation</li> <li>• Would like a design systems fundamentals course</li> </ul>	<ul style="list-style-type: none"> <li>• Very good website</li> <li>• Good resource for new developers</li> <li>• Would like to have more colours</li> <li>• Too much text introducing the courses on the homepage</li> </ul>	-
Design principle 2	<ul style="list-style-type: none"> <li>• Wrong time estimates for the courses</li> </ul>	<ul style="list-style-type: none"> <li>• Liked seeing the course overview with time estimates</li> <li>• Would like to have the option to go directly to a page from the course overview</li> </ul>	<ul style="list-style-type: none"> <li>• Liked seeing the course overview</li> <li>• Would like to have the option to go directly to a page from the course overview</li> </ul>	-
Design principle 3	<ul style="list-style-type: none"> <li>• More links to external resources and state prerequisite</li> </ul>	<ul style="list-style-type: none"> <li>• More helpful links, also inside the courses</li> </ul>	-	-

*continued on the next page*

Table 6.1: Summary of the findings from the evaluation

Design principle	Questionnaire	Focus group	Mozambique	Expert review
Design principle 4	<ul style="list-style-type: none"> <li>Well-structured</li> <li>Too much information on some pages</li> <li>Good distribution between different learning material</li> <li>Navigation inside the course not working properly</li> </ul>	<ul style="list-style-type: none"> <li>Too much information on some pages</li> <li>Liked breadcrumbs, but all should be clickable</li> <li>Would like better navigation inside one specific page in the course</li> <li>Add small introduction before coding exercises</li> </ul>	<ul style="list-style-type: none"> <li>Too much information on some pages</li> <li>Liked breadcrumbs, but all should be clickable</li> </ul>	<ul style="list-style-type: none"> <li>Navigation with back and next buttons inside course not working properly</li> </ul>
Design principle 5	<ul style="list-style-type: none"> <li>Would like to receive more guidance</li> </ul>	<ul style="list-style-type: none"> <li>See solution and hints</li> </ul>	-	-
Design principle 6	<ul style="list-style-type: none"> <li>Difference in what type of task they like</li> <li>Bigger tasks</li> <li>Issues with embedded code sandbox</li> </ul>	<ul style="list-style-type: none"> <li>Liked the image quiz</li> <li>Coding exercises could be valuable, but difficult to use embedded codesandbox</li> <li>Would like a drag-and-drop interface to see if the person used components/colors correctly</li> </ul>	<ul style="list-style-type: none"> <li>Liked the coding exercises</li> <li>Bigger tasks</li> </ul>	<ul style="list-style-type: none"> <li>Drag-and-drop components</li> <li>Emphasize the answers in the "quiz"</li> </ul>
Design principle 7	<ul style="list-style-type: none"> <li>Liked receiving feedback on quizzes</li> </ul>	<ul style="list-style-type: none"> <li>Liked receiving feedback on quizzes</li> <li>More links in the feedback to learn more about the topic</li> </ul>	<ul style="list-style-type: none"> <li>Liked receiving feedback on quizzes</li> </ul>	-

*continued on the next page*

Table 6.1: Summary of the findings from the evaluation

Design principle	Questionnaire	Focus group	Mozambique	Expert review
Design principle 8	<ul style="list-style-type: none"> <li>• Not that many who signed up, but of the people who did 25% said it was "Very exciting" to receive badge, 25% Exciting and 12.5% Neutral</li> <li>• Progress bar confusing. Would like a progress bar for each course</li> </ul>	<ul style="list-style-type: none"> <li>• Cool to receive points and badges</li> <li>• Would like to receive more "silly" titles and badges</li> <li>• Progress bar confusing. Would like a progress bar for each course</li> </ul>	-	<ul style="list-style-type: none"> <li>• Progress bar confusing. Would like a progress bar for each course</li> </ul>
Further findings	<ul style="list-style-type: none"> <li>• Feedback system to improve courses</li> <li>• Issues with signup page</li> <li>• Receiving 404 page</li> <li>• Good response time</li> </ul>	<ul style="list-style-type: none"> <li>• Should be possible to save course progression</li> <li>• Issues with signup page</li> <li>• Receiving 404 page</li> <li>• Courses should have an offline mode</li> </ul>	<ul style="list-style-type: none"> <li>• Misses a button that would take the user to the homepage after completion</li> </ul>	<ul style="list-style-type: none"> <li>• Should be consistent with button alignment</li> <li>• The page "showcase of DHIS2" components not working well on smaller</li> <li>• Table and Data table components are being mixed</li> <li>• Wrong font in the coding exercises</li> </ul>

# 7

## Discussion

This study aims to develop a set of design principles for an online app development course used globally. Within this chapter, I will address the research questions in light of the evaluation of the website and literature presented in the literature review. The research question for this thesis is the following:

**RQ:** What are appropriate design principles for an online app development course used globally?

To answer this research question, I had a set of research objectives which consisted of 1) identify initial design principles, 2) develop an instantiation of the design principles, 3) Evaluate the instantiation, and 4) Develop new and expanded design principles. The first two objectives were explored in chapter 5. The second objective was explored in chapter 6. This chapter will explore the last research objective considering the development of new design principles for a new context. Firstly, I will place the practical work with this thesis in relation to the literature. Secondly, I will discuss the findings from the evaluation of the website with the initial design principles and revise the design principles. Thirdly, I will develop new design principles based on the evaluation and the literature. Finally, I will discuss the limitations of this research.

## 7.1 Positioning the empirical work within the platform and ICT4D literature

This section will position the empirical work within the platform and ICT4D literature.

This thesis has developed a website with online courses to learn about the DHIS2 design system. The website could be seen as a part of the DHIS2 software ecosystem. It is a resource to learn about another part of the ecosystem: the DHIS2 design system.

The DHIS2 design system is a boundary resource since it supports third-party developers in developing applications (Ghazawneh and Henfridsson, 2013). Using the division of boundary resources created by Dal Bianco et al. (2014), the DHIS2 design system could be seen as a development boundary resource. As development boundary resources are tools that can help third-party developers develop apps, I consider the design system to fall under this category.

The website that I have developed to learn about the DHIS2 design system can also be viewed as a boundary resource. It is a boundary resource to utilize the DHIS2 design system. However, I consider it to be a social boundary or a knowledge boundary resource since it aims to transfer knowledge about third-party application development (Dal Bianco et al., 2014; Foerderer et al., 2019). Both social boundary resources and knowledge boundary resources cover many of the same resources. If viewing it as a knowledge boundary resource, it would fall under the category Broadcasting. Broadcasting is a boundary resource that complementors can access without interacting with the platform owner (Foerderer et al., 2019).

Following the separation of platform architecture, according to Roland et al. (2017), the website developed could be viewed as a boundary resource to support the development of custom apps. Custom apps are known for having high design flexibility and low flexibility for use across tasks (Roland et al., 2017). The custom apps developed in DHIS2 today have very high flexibility regarding the look of the apps. Some of the custom apps developed are not reusable by other HISP groups. If the applications developed in DHIS2 were more standardized, there might be a greater possibility to reuse apps developed by other HISP groups. Since there are many similar use cases in health and education, there might be a greater possibility of utilizing custom apps developed by other teams. Regarding the platform architecture, this would mean that the

platform could increase the reusability of the custom apps. Still, there are other aspects to consider than the user interface. Therefore, I would still argue that the custom apps would have low reusability. Nonetheless, the design system might increase the reusability of the apps.

The DHIS2 design system and the learning resource developed in this thesis could be considered boundary resources that *resource* and *secure* the platform (Ghazawneh and Henfridsson, 2013). The DHIS2 design system intends to make it easier for developers to develop external contributions to the platform. Therefore it could be seen as a boundary resource that *resource* the platform. However, enforcing the usage of the DHIS2 design system will reduce the flexibility and could be seen as a way to *secure* the platform (Ghazawneh and Henfridsson, 2013). Securing the platform does not necessarily have to do with security; it can also mean securing what contributions the platform will accept. However, in DHIS2, the core team can't secure the platform entirely. It is possible to develop apps in an in-country instance without interfering with the official app store governed by the core team. There are also HISP teams that do not use the React library required to utilize the UI components. But it is impossible to use the design principles that are a part of the DHIS2 design system. Sometimes the developers of DHIS2 apps have clients that would like another visual interface than the DHIS2 design system provides. Enforcing everyone to use it will therefore not be possible, but they can encourage it.

Using the literature from ICT4D, the website developed could also be considered a tool to support innovation in the Global South (Heeks, 2002). It could also be considered pro-poor innovation since the development of the website has been taking place from the Global North. The aim is to promote innovation in the developing countries themselves. Having developers in the Global South develop their own products is supposed to reduce the design-actuality gap (Heeks, 2008). For the developers to produce content, Heeks (2008) propose developing tools to support developers. However, there are several issues related to this. Since the tools that should support developers in the Global South are developed in the Global North, it might also introduce a design-actuality gap. The website that I have developed as part of this thesis is developed by me in Oslo, or what is referred to as the Global North in the literature. Introducing the website to the Global South might also introduce a design-actuality gap (Heeks, 2008).

The DHIS2 design system itself could be in danger of introducing a design-actuality gap. As mentioned earlier, the DHIS2 design system is developed by the core team at UiO, far away from people in the HISP network. While they

also want the resources in the DHIS2 design system to be useful for people outside the core team, they have not received that much input from the community in the initial phase of developing the components. However, they have received feedback after the core team developed the initial components.

## 7.2 Revising the design principles

In this section, I will revise the initial design principles developed in section 5.2, based on the evaluation in chapter 6.

### 7.2.1 Design principle 1

Design principle one emphasizes that the website should appeal to the user as a way to encourage them to begin the courses. This design principle is fundamental due to the nature of the website. The developed website is a *social boundary resource* to learn about a design system that third-party developers do not need to use in order to develop apps for the platform. Therefore, they need to be presented with good arguments about the benefits of using the DHIS2 design system. The UX designer also mentioned this in the first design cycle, as seen in section 5.4.1. People in the focus group shared this view when they said there should be a design systems fundamentals course to promote why having a similar identity across apps are good. However, there needs to be a balance between presenting the website's benefits and not overflowing the user with information. As seen in the evaluation, the developer in Mozambique felt that the course description contained too much information.

One of the features that were developed to appeal to the user was receiving points and badges. However, feedback gathered from both the questionnaire and focus group suggests that this feature was not clear. Features that appeal to the user should be clear when the user first starts to use the website. It should not be something that the user has to search for.

Design principle one remains the same, but the website should appeal to the user when they first arrive at the website. They should not have to look for the benefits. However, since the website is developed globally by people with different backgrounds and preferences, it is also important to realize that what appeals to some might not appeal to everyone. Therefore, I have also developed new design principles that consider this in section 7.3.



### 7.2.2 Design principle 2

Design principle two was concerned with informing the user of the course objectives. One of the features implemented for this design principle was to inform the user how much time it takes to complete the course. I made the time estimate on the course overview page without input from users. Consequently, I had to guess how much time people would use to complete the courses. To get a better time estimate, multiple people should have completed the courses.

People might spend more or less time completing the courses. Since the software platform is used across many different countries with different backgrounds, deciding on a time estimate that fits everyone might be difficult. Therefore, having a time estimate represented as a range instead of a set time might be better.

The courses are not intended to be used as an encyclopedia to look up information. For this, using regular documentation might be better. But from the evaluation, it seems to be a theme that people would like to have the option to use it like this. The website is aimed towards a varied group who have different needs, so having the option to only learn about some parts of the course material could be good.

To summarize, people generally liked the features implemented to inform the user of the course objectives. However, having the option to learn more about one specific element in the course objective was emphasized. I, therefore, propose an adapted design principle:

*DP2 Principle of expectancy:* Provide the website with features that inform the user of the course objectives **and the option to learn about one course objective [material property]** in order for users to know what to expect **[action potential]**, given that the site has gained the users attention **[boundary condition]**

### 7.2.3 Design principle 3

This design principle was concerned with having features that provided links to prerequisites. From the evaluation, it seems that people would have liked to have even more of this. I view this as an implementation issue rather than an issue with the design principle. From the evaluation, people would like to have even more prerequisites inside each individual course.

### 7.2.4 Design principle 4

Design principle four is concerned with presenting the new material. Overall, many people felt that the navigation inside the course did not work correctly. Since the issue is more an implementation issue than an issue with the design principle, I did not change the design principle. But it highlights that people might use the website in different ways. Many people also reported feeling that the new material presented contained too much information. A couple of people mentioned that they would like less text per page. To highlight this finding, I created an adapted design principle:

*DP4 Principle of selective perception:* Provide the website with features that present the new material in **small bulks [material property]** in order for users to get familiar with the material to be learned **without feeling overwhelmed [action potential]**, given that the user has started a new course **[boundary condition]**

### 7.2.5 Design principle 5

Design principle five was concerned with affording learning guidance. People from the evaluation generally seemed to think that learning guidance is important, but the website should provide more features to afford learning guidance. The design principle remains the same, but the developer should put more thought into visualizing the design principle and ensuring that the user sees the possibility of receiving learning guidance.

### 7.2.6 Design principle 6

This design principle is concerned with eliciting performance. The people who evaluated the website had different views surrounding the type of tasks they liked. However, in general, people seemed to like having more practical tasks that would elicit performance, but not all the practical tasks seemed suitable for the people evaluating. I still view the design principle as appropriate. Still, I will discuss an additional design principle in section 7.3.1, which would allow for more tailoring of the learning content to fit the person's needs.

### 7.2.7 Design principle 7

Design principle seven is concerned with giving feedback on the users' performance. While I did not test this design principle to a great extent, people generally seemed to like the quizzes where the user would receive feedback for

why they had chosen the correct or incorrect answer. I have expanded the design principle to consider what was mentioned in the focus group. In the focus group, someone mentioned that there should be links in the feedback to learn more about the topic.

*DP7 Principle of reinforcement:* Provide the website with features that give feedback on the users' performance **and provide links to learn more about the subject [material property]** in order for the users to understand what they need to work on **and how they can work on it [action potential]**, given that the user has tried to solve a practical problem **[boundary condition]**

### 7.2.8 Design principle 8

Design principle eight is concerned with assessing performance at the end of the course. This design principle came to life in the website by receiving points and badges and seeing the progress bar increase. The design principle was very open and not specific about how assessment should be done. There are many ways to assess performance, and there might have been better ways to accomplish this.

A finding from the evaluations was that people found the progress bar confusing and wanted a progress bar for each course. This confusion was an issue related to the website and not the design principle.

### 7.2.9 Design principle 9

Design principle nine was not implemented, but it is concerned with generalizing the knowledge taught in the course, and use the knowledge in a new context. A suggestion for how to implement this task was to have a task where the user had to develop a full application. Some of the core developers who evaluated the website during the first design cycle wanted more significant tasks, to be able to see how everything is connected. However, I did not manage to accomplish this in the short timeframe. During the final evaluation of the website, people also reported wanting bigger coding tasks and a drag-and-drop interface that would allow the user see if the guidelines were followed. These features could fall under this design principle.

## 7.3 New design principles

After evaluating the initial design principles and reading more literature, I have received input to make new design principles. The three new design principles will be discussed below and include tailorability, offline mode, and feedback.

### 7.3.1 Tailorability

People who evaluated the website had different views on the learning material they liked. A proposal would be to have the possibility of tailoring the learning. I propose that this would not only apply to DHIS2 but also other courses consisting of users with high diversity. There needs to be an investigation into how developers can best accomplish this. As suggested in the focus group, one way might be to have the option to skip specific exercises. Another option might be to have the person complete a questionnaire beforehand to decide what kind of tasks and information the course will cover.

The tailorability design principle wants to facilitate so users with different backgrounds can take ownership of what I have created and change it further. This design principle aligns with Heeks (2008), which sees developers as active producers and innovators. They are not only passive consumers of the learning material but have the option to tailor it to their needs. For the development of online courses used globally, I propose a new design principle:

*DP10 Principle of tailorability:* Provide the website with features that allow the user to tailor the learning [**material property**] in order for the user to be able to customize it to their needs and preferences [**action potential**], given that they have some preferences [**boundary condition**]

### 7.3.2 Offline mode

From many of the interviews with core developers and students in the focus group, respondents suggested that using the website offline would be beneficial. The course's target a diverse audience, where not everyone have access to good internet connection. Internet connection is also something that is mentioned as a challenge in the literature on ICT4D (Heeks, 2002). Consequently, I argue that the proposed design principle could be applicable for global courses:

*DP11 Principle of offline mode:* Provide the website with features that allow the user to use the website offline [**material property**] in order

for the user to be able to use it when the internet connection is poor **[action potential]**, given that the user has a course they would like to begin **[boundary condition]**

### 7.3.3 Feedback

In the questionnaire, having a feedback system was mentioned as a suggestion for a new feature. While having the possibility to give feedback on the website is important regardless of the context. It is essential when trying to reduce the design-actuality gap (Heeks, 2008). Since the website is intended for a global user base, it might not be possible to get feedback from everyone before the development. However, to reduce the design-actuality gap after it is developed, I propose a new feedback principle. The feedback principle is more concerned with fixing the design-actuality gap than hindering it from appearing.

*DP12 Principle of feedback:* Provide the website with a feedback system to improve the website further **[material property]** in order for the user to participate in improving the website **[action potential]**, given that the user has some suggestions for improvement **[boundary condition]**

To hinder the design-actuality from appearing, developers in the Global South should actively give feedback and possibly also partake in developing the website.

## 7.4 Final revised design principles

In table 7.1 and 7.2, I showcase all the old, new and adapted design principles.

#	Design principle	Design principle specification
DP1	Principle of reception	Provide the website with features that appeal to the user [ <b>material property</b> ] in order to capture the user's attention [ <b>action potential</b> ], given that the user has started using the website
DP2 (adapted)	Principle of expectancy	Provide the website with features that inform the user of the course objectives <b>and the option to learn about one course objective</b> [ <b>material property</b> ] in order for users to know what to expect [ <b>action potential</b> ], given that the site has gained the users attention [ <b>boundary condition</b> ]
DP3	Principle of retrieval	Provide the website with features that stimulate the recall of prerequisite learned capabilities [ <b>material property</b> ] in order for users to make sense of the new material [ <b>action potential</b> ], given that the user has some previous knowledge that could apply to the topic.
DP4 (adapted)	Principle of selective perception	Provide the website with features that present the new material in <b>small bulks</b> [ <b>material property</b> ] in order for users to get familiar with the material to be learned <b>without feeling overwhelmed</b> [ <b>action potential</b> ], given that the user has started a new course [ <b>boundary condition</b> ]
DP5	Principle of semantic encoding	Provide the website with features that offer learning guidance [ <b>material property</b> ], in order for users to receive assistance [ <b>action potential</b> ], given that the user has a problem to solve [ <b>boundary condition</b> ]
DP6	Principle of responding	Provide the website with features that elicit performance [ <b>material property</b> ] in order for users to practice the new material [ <b>action potential</b> ], given that the user has been presented with the material [ <b>boundary condition</b> ].

Table 7.1: Final revised design principles

#	Design principle	Design principle specification
DP7 (adapted)	Principle of reinforcement	Provide the website with features that give feedback on the users' performance <b>and provide links to learn more about the subject [material property]</b> in order for the users to understand what they need to work on <b>and how they can work on it [action potential]</b> , given that the user has tried to solve a practical problem <b>[boundary condition]</b> .
DP8	Principle of retrieval	Provide the website with features that assess performance <b>[material property]</b> , in order for users to test whether the expected learning outcome has been achieved <b>[activity of user]</b> , given that the user has completed a course <b>[boundary condition]</b>
DP9	Principle of generalization	Provide the website with features to enhance retention and transfer <b>[material property]</b> , in order for the user to generalize the knowledge taught to a new situation <b>[action potential]</b> , given that the user has completed the other courses <b>[boundary condition]</b>
DP10 (new)	Principle of tailorability	Provide the website with features that allow the user to tailor the learning <b>[material property]</b> in order for the user to be able to customize it to their needs and preferences <b>[action potential]</b> , given that they have some preferences <b>[boundary condition]</b>
DP11 (new)	Principle of offline mode	Provide the website with features that allow the user to use the website offline <b>[material property]</b> in order for the user to be able to use it when the internet connection is poor <b>[action potential]</b> , given that the user has a course they would like to begin <b>[boundary condition]</b>
DP12 (new)	Principle of feedback	Provide the website with a feedback system to improve the website further <b>[material property]</b> in order for the user to participate in improving the website <b>[action potential]</b> , given that the user has some suggestions for improvement <b>[boundary condition]</b>

Table 7.2: Final revised design principles

## 7.5 Reflections and limitations

Since I am very new to design science research, I was not aware of the initial design principles before developing the website. I had already developed the skeleton of the website when I found the initial design principles. However, as I was learning more about design science research, I found the initial design principles from Gagnes' nine events of instruction. I suggest that I should have made a thorough comparison before choosing the initial design principles. But at this point, I did not have time to make a thorough comparison as I had already initiated the development of the website. The initial design principles from Gagnes' nine events of instruction are also very general design principles for creating instructional content. There are many ways to instantiate the design principles, which will mean varying degrees of success.

A limitation that made it difficult to relate the findings to the design principles was using software quality attributes from ISO-9126 as evaluation criteria. In design science research, ISO-9126 is mentioned as a possible evaluation measure when evaluating a product (Pries-Heje et al., 2008). However, using ISO-9126 as evaluation measures made it more difficult to relate the findings to the initial design principles. Therefore, I think it would have been better to create the questionnaire with the design principles in mind instead of ISO-9126.

Another limitation of this research is the people who participated in evaluating the website. While I received input from people in the HISP network, I would have liked to receive more. A lot of the people that participated in the research were students or core developers. Since the research is also focusing on creating resources for the HISP network, more feedback from them would have been beneficial.

Many students working with DHIS2 in their master thesis have traveled abroad and visited different countries in the HISP network. However, this was not possible due to covid-19. When all the data collection methods need to be conducted online, it was difficult to get in touch with people outside the core team. This was also why I decided to use a questionnaire as an additional method to reach out to different people in the whole community. However, a positive thing with the research taking place in Oslo is that I have been able to talk to people from different countries and not relied on input from developers in one specific country.

Finally, another limitation was not receiving that many responses from the questionnaire. While the answers I got on the free-text questions were quite



good, I would have liked to receive even more responses. However, I have put in a lot of effort to get more people to answer the questionnaire by posting it a several times in different forums and specifically sending emails to relevant people.



# 8

## Conclusion

This research aimed to identify a set of design principles for an online app development course for use on a global scale. Through a design science research study, this research has developed a website with online courses based on initial design principles from instructional design. The developed website consists of different courses to learn about the design system for the innovation platform DHIS2. The website could be considered as a boundary resource to support innovation in the platform DHIS2. DHIS is used on a global scale with developers all over the world. The aim is that this website should support developers in developing apps that are standardized and good quality apps. Due to DHIS2 being used in health and education with similar use cases, it is also an aim that using this design system could help developers reuse apps developed by other teams.

The research question for this thesis was the following:

**RQ:** What are appropriate design principles for an online app development course used globally?

The initial design principles were identified in research on instructional design. Specifically, I have used design principles from Gagnes' nine events of instruction to develop the website. The initial design principles have been revised through three cycles of development and evaluation, and three new design principles have emerged. The initial design principles have been revised to consider what was mentioned in the evaluation of the website. The three new design principles that

emerged during the study bear in mind that the courses are meant to be used globally by users with different backgrounds, skillsets, and needs. These new design principles are related to reducing the design-actuality gap when an app is developed in one place but is supposed to be utilized in a different location. Since the intended app development course is supposed to be used on globally, there is a risk that a design-actuality might appear.

The three new design principles identified are the principle of tailorability, the principle of offline mode, and the principle of feedback. The *principle of tailorability* says that it should be possible to tailor the learning content, to support diversity and different needs. This design principle intends to make it easier for the users to customize the learning. The *principle of offline mode* states that the website needs to be able to be used offline so that more people can use the website, even though the internet connection is poor. The *principle of feedback* states that the website should consist of a feedback system to improve the website further. This principle is concerned with ensuring that it will be possible to receive feedback on the website after the initial development. It is essential to receive feedback during development as well. However, because the website is intended to be used on a global scale, not everyone might be able to partake in giving feedback during the initial development.

### **8.1 Limitation**

The main limitation of this research is that while the research question considers developing an online app development course that is supposed to be used both in the Global South and Global North, this is not reflected in the people who participated in this research. Most of the participants were students and core developers in the Global North. While I received input through an interview and some of the participants in the questionnaire, I would have liked to receive even more input from people in the Global South. However, it has not been easy to get in touch with people when the research took place in Oslo.

## 8.2 Future work

To conclude the research, I will give some recommendations for future research. The website developed in this thesis and the design system that the website aims to teach are developed in the "Global North" and could be seen as boundary resources. While results from the evaluation were positive, most of the people who participated in the evaluation were developers and students from the Global North. Consequently, the results from this study will not be able to say anything about the effectiveness of boundary resources deployed in the Global North for the Global South. Instead, the findings say something about overcoming challenges when developers consist of a diverse group of people. Therefore, in alignment with Bonina et al. (2021), I suggest more research on the effectiveness of developing boundary resources deployed in the Global North to foster a local ecosystem of third-party developers.

The DHIS2 design system is supposed to standardize the custom apps developed within the platform. However, it would be interesting to look more into people's views on standardization and design systems. Earlier findings suggest that some people like apps that do not look the same and contain more colors than the DHIS2 design system advice. If this is the case, then it might be challenging to introduce the design system.

Future research can also look into possible design principles when developing an online app development course for global use. The *first* suggestion is to use the design principles developed in this thesis as initial design principles when developing a website. This research could then further expand upon and evaluate the design principles specified in this thesis. The *second* suggestion for future research is to use other initial design principles to develop the website. A thorough review of the possibilities of initial design principles from the literature would be beneficial, including looking into appropriate design principles that consider that the instructional content is an online website.

# Bibliography

- Adams, W. (2015), *Conducting Semi-Structured Interviews*, Jossey-Bass, pp. 492–505.
- Adu-Gyamfi, E., Nielsen, P. and Sæbø, J. I. (2019), The dynamics of a global health information systems research and implementation project, in ‘SHI 2019. Proceedings of the 17th Scandinavian Conference on Health Informatics, November 12-13, 2019, Oslo, Norway’, Linköping University Electronic Press, pp. 73–79.
- Anyatasia, F., Santoso, H. and Junus, K. (2020), ‘An evaluation of the udacity mooc based on instructional and interface design principles’, *Journal of Physics: Conference Series* **1566**, 012053.
- Asadullah, A., Faik, I. and Kankanhalli, A. (2018), Digital platforms: A review and future directions., in ‘PACIS’, p. 248.
- Baldwin, C. Y., Woodard, C. J. et al. (2009), ‘The architecture of platforms: A unified view’, *Platforms, markets and innovation* **32**.
- Baumeister, R. F. and Leary, M. R. (1997), ‘Writing narrative literature reviews’, *Review of general psychology* **1**(3), 311–320.
- Bonina, C., Koskinen, K., Eaton, B. and Gawer, A. (2021), ‘Digital platforms for development: Foundations and research agenda’, *Information Systems Journal* .
- Braa, J. and Sahay, S. (2012), *Integrated Health Information Architecture: Power to the Users*, Matrix Publishers.
- Braa, J. and Sahay, S. (2013), ‘The process of developing the dhis’, <https://www.mn.uio.no/ifi/english/research/networks/hisp/hisp-history.html>. [Accessed 12 February, 2021].
- Braa, J. and Sahay, S. (2017), ‘The dhis2 open source software platform: evolution over time and space’, *LF Celi, Global Health Informatics* **451**.

- Braun, V. and Clarke, V. (2012), *Thematic analysis.*, American Psychological Association, pp. 57–71.
- Ceccagnoli, M., Forman, C., Huang, P. and Wu, D. (2012), ‘Cocreation of value in a platform ecosystem! the case of enterprise software’, *MIS quarterly* pp. 263–290.
- Chandra Kruse, L., Seidel, S. and Gregor, S. (2015), ‘Prescriptive knowledge in is research: Conceptualizing design principles in terms of materiality, action, and boundary conditions’, *Proceedings of the Annual Hawaii International Conference on System Sciences* **2015**, 4039–4048.
- Chua, W. F. (1986), ‘Radical developments in accounting thought’, *Accounting review* pp. 601–632.
- Codesandbox (2021), <https://codesandbox.io/>. [Accessed 14 May, 2021].
- Cooper, J. (2021), ‘Dhis2 design system’, <https://github.com/dhis2/design-system>. [Accessed 21 April, 2021].
- Crang, M. and Cook, I. (2007), *Doing ethnographies*, Sage.
- Cusumano, M. A., Yoffie, D. B. and Gawer, A. (2020), ‘The future of platforms’, *MIT Sloan Management Review* **61**(3), 46–54.
- Dal Bianco, V., Myllärniemi, V., Komssi, M. and Raatikainen, M. (2014), The role of platform boundary resources in software ecosystems: A case study, in ‘2014 IEEE/IFIP Conference on Software Architecture’, IEEE, pp. 11–20.
- Design Lab (2021), ‘Dhis2 design lab’, <https://www.mn.uio.no/ifi/english/research/networks/hisp/dhis2-design-lab/>. [Accessed 14 May, 2021].
- DHIS2 (2018), ‘Setting up a new database’, [https://docs.dhis2.org/2.34/en/dhis2\\_implementation\\_guide/setting-up-a-new-database.html](https://docs.dhis2.org/2.34/en/dhis2_implementation_guide/setting-up-a-new-database.html). [Accessed 19 April, 2021].
- DHIS2 (2021a), ‘About dhis2’, <https://dhis2.org/about>. [Accessed 19 April, 2021].
- DHIS2 (2021b), ‘Dhis2 overview’, <https://dhis2.org/about/>. [Accessed 14 April, 2021].
- DHIS2 (2021c), ‘Dhis2 software overview’, <https://dhis2.org/overview>. [Accessed 19 April, 2021].

## BIBLIOGRAPHY

---

- DHIS2 (2021d), 'Information systems research and dhis2', <https://dhis2.org/research/>. [Accessed on 10 April, 2021].
- DHIS2 (2021e), 'Technology platform', <https://dhis2.org/technology/>. [Accessed 19 April, 2021].
- DiCicco-Bloom, B. and Crabtree, B. F. (2006), 'The qualitative research interview', *Medical education* **40**(4), 314–321.
- Evans, P. C. and Gawer, A. (2016), 'The rise of the platform enterprise: A global survey'.
- Firestore (2021), 'Firestore helps you build and run successful apps', <https://firebase.google.com/>. [Accessed 03 May, 2021].
- Foerderer, J., Kude, T., Schuetz, S. W. and Heinzl, A. (2019), 'Knowledge boundaries in enterprise software platform development: Antecedents and consequences for platform governance', *Information Systems Journal* **29**(1), 119–144.
- Gagne, R. M. and Briggs, L. J. (1974), *Principles of instructional design.*, Holt, Rinehart & Winston.
- Ghazawneh, A. (2012), Towards a boundary resources theory of software platforms, PhD thesis, Jönköping International Business School.
- Ghazawneh, A. and Henfridsson, O. (2013), 'Balancing platform control and external contribution in third-party development: the boundary resources model', *Information systems journal* **23**(2), 173–192.
- Goldkuhl, G. (2012a), Design research in search for a paradigm: Pragmatism is the answer, in M. Helfert and B. Donnellan, eds, 'Practical Aspects of Design Science', Springer Berlin Heidelberg, Berlin, Heidelberg, pp. 84–95.
- Goldkuhl, G. (2012b), 'Pragmatism vs interpretivism in qualitative information systems research', *European journal of information systems* **21**(2), 135–146.
- Goles, T. and Hirschheim, R. (2000), 'The paradigm is dead, the paradigm is dead... long live the paradigm: the legacy of burrell and morgan', *Omega* **28**(3), 249–268.
- Gregor, S. and Hevner, A. R. (2013), 'Positioning and presenting design science research for maximum impact', *MIS quarterly* pp. 337–355.



- Gustafson, K. (2002), 'Instructional design tools: A critique and projections for the future', *Educational Technology Research and Development* **50**(4), 59–66.
- Heeks, R. (2002), 'Information systems and developing countries: Failure, success, and local improvisations', *The information society* **18**(2), 101–112.
- Heeks, R. (2008), 'Ict4d 2.0: The next phase of applying ict for international development', *Computer* **41**(6), 26–33.
- Heeks, R. (2020), 'Ict4d 3.0? part 1—the components of an emerging “digital-for-development” paradigm', *The Electronic Journal of Information Systems in Developing Countries* **86**(3), e12124.
- Hevner, A. R. (2007), 'A three cycle view of design science research', *Scandinavian journal of information systems* **19**(2), 4.
- Hevner, A. R., March, S. T., Park, J. and Ram, S. (2004), 'Design science in information systems research', *MIS quarterly* pp. 75–105.
- Iivari, J. (2007), 'A paradigmatic analysis of information systems as a design science', *Scandinavian Journal of Information Systems* **19**, 39–.
- Karhu, K., Gustafsson, R. and Lyytinen, K. (2018), 'Exploiting and defending open digital platforms with boundary resources: Android's five platform forks', *Information Systems Research* **29**(2), 479–497.
- Koskinen, K., Bonina, C. and Eaton, B. (2019), Digital platforms in the global south: foundations and research agenda, in 'International Conference on Social Implications of Computers in Developing Countries', Springer, pp. 319–330.
- March, S. and Smith, G. (1995), 'Design and natural science research on information technology', *Decision Support Systems* **15**, 251–266.
- Marshall, P., Kelder, J. and Perry, A. (2005), Social constructionism with a twist of pragmatism: A suitable cocktail for information systems research, in 'ACIS', p. EJ.
- Material-UI (2021), <https://material-ui.com/>. [Accessed 14 May, 2021].
- McGee, A. (2019), 'What is this dhis2 application platform?', <https://dhis2.github.io/2019/07/what-is-this-app-platform/>. [Accessed 17 May, 2021].
- MDN (2021), 'Working with json', <https://developer.mozilla.org/en-US/docs/Learn/JavaScript/Objects/JSON>. [Accessed 03 May, 2021].
- Myers, M. (1997), 'Qualitative research in information systems', *MIS Quarterly* **21**.

- Niehaves, B. (2007), 'On epistemological diversity in design science: New vistas for a design-oriented research?', *ICIS 2007 Proceedings* p. 133.
- Nielsen, P. (2017), Digital innovation: a research agenda for information systems research in developing countries, in 'International Conference on Social Implications of Computers in Developing Countries', Springer, pp. 269–279.
- Orlikowski, W. and Baroudi, J. (1991), 'Studying information technology in organizations: Research approaches and assumptions', *Information Systems Research* **2**, 1–28.
- Peppers, K., Rothenberger, M., Tuunanen, T. and Vaezi, R. (2012), Design science research evaluation, in 'International Conference on Design Science Research in Information Systems', Springer, pp. 398–410.
- Peppers, K., Tuunanen, T., Rothenberger, M. A. and Chatterjee, S. (2007), 'A design science research methodology for information systems research', *Journal of management information systems* **24**(3), 45–77.
- Pries-Heje, J., Baskerville, R. and Venable, J. (2008), Strategies for design science research evaluation., pp. 255–266.
- Purao, S. (2002), 'Design research in the technology of information systems: Truth or dare', *GSU Department of CIS Working Paper* **34**.
- React (2021), 'A javascript library for building user interfaces', <https://reactjs.org/>. [Accessed 03 May, 2021].
- Reigeluth, C. (1999), *What is Instructional Design Theory and How Is it Changing?* (93), Vol. 2, Lawrence Erlbaum Associates, pp. 5–29.
- Ritchie, D. C. and Hoffman, B. (1997), 'Incorporating instructional design principles with the world wide web', *Web-based instruction* pp. 135–138.
- Roland, L. K., Sanner, T. A., Sæbø, J. and Monteiro, E. (2017), 'P for platform. architectures of large-scale participatory design', *Scand. J. Inf. Syst.* **29**, 1.
- Rosotto, C. M., Lal Das, P., Gasol Ramos, E., Clemente Miranda, E., Badran, M. F., Martinez Licetti, M. and Miralles Murciego, G. (2018), 'Digital platforms: A literature review and policy implications for development', *Competition and Regulation in Network Industries* **19**(1-2), 93–109.
- Simon, H. A. (2019), *The sciences of the artificial*, MIT press.

- Snyder, M. M. (2009), 'Instructional-design theory to guide the creation of online learning communities for adults', *TechTrends* **53**(1), 48–56.
- Suarez, M., Anne, J., Saylor-Miller, K., Mounter, D. and Stanfield, R. (2019), *Design Systems Handbook*, InVision.
- Tiwana, A. (2013), *Platform ecosystems: Aligning architecture, governance, and strategy*, Newnes.
- Tiwana, A., Konsynski, B. and Bush, A. A. (2010), 'Research commentary—platform evolution: Coevolution of platform architecture, governance, and environmental dynamics', *Information systems research* **21**(4), 675–687.
- Unwin, P. and Unwin, T. (2009), *ICT4D: Information and communication technology for development*, Cambridge University Press.
- Wicks, A. C. and Freeman, R. E. (1998), 'Organization studies and the new pragmatism: Positivism, anti-positivism, and the search for ethics', *Organization science* **9**(2), 123–140.
- Yoo, Y., Boland Jr, R. J., Lyytinen, K. and Majchrzak, A. (2012), 'Organizing for innovation in the digitized world', *Organization science* **23**(5), 1398–1408.



## **Data collection**

### **A.1 Appendix: The Final Website**

A major part of this thesis has been to develop a website to learn about the DHIS2 Design System. While I have gone through the major parts of the application in chapter 5: Artifact Description, there were not space for everything. In this appendix, I will show the screenshots of the two courses "DHIS2 components" and thte course "colors".

The complete source code will be available on Github using the following link:  
<https://github.com/dhis2designlab/dhis2-ui-tutorial>

#### **A.1.1 DHIS2 components**



[Home](#) / [DHIS2 Components](#)

## DHIS2 Components

DHIS2 has a collection of UI elements that should be reused across all DHIS2 applications. The components have been designed with DHIS2 use cases in mind. Using these components means more time spent focusing on building a positive user experience and less time redesigning and rebuilding common components. Each component has its guidelines for use. In this tutorial, you will learn how and when to use the different components.

**Expected duration:** 20 minutes  
**Possible points:** 12 points

The topics that will be covered in this module:

Section 1: Introduction	▼
Section 2: Action components	▼
Section 3: Data display components	▼
Section 4: Data entry components (coming soon)	▼
Section 5: Feedback components (coming soon)	▼
Section 6: Layout components (coming soon)	▼
Section 7: Navigation components (coming soon)	▼
Section 8: Utilities (coming soon)	▼

[Start Course](#)

Copyright © Hanna Evensen 2020.

Completion rate: 14%

[Home](#) / [DHIS2 Components](#) / [Introduction](#)

## Section 1: Introduction

In this section you will get an overview of how you can use all the components in DHIS2.

Some of the topics that will be covered in this module includes:

- Lesson: How to import components
- Lesson: Showcase of the DHIS2 components
- Lesson: Using the API for components

[Back](#)

[Next](#)

Copyright © Hanna Evensen 2021.

Completion rate: 14%

[Home](#) / DHIS2 Components / Introduction

## Lesson: How to import components

@dhis2/ui

To be able to use the components, you need to import them. There have been different ways to import the components until recently, depending on the type of component you want to import. @dhis2/ui unifies all of the dhis2 ui libraries, and you can now import everything that you imported previously from ui-core, ui-widgets and ui-forms directly from @dhis2/ui

```
// Before ui version 5:
import { Button } from '@dhis2/ui-core'
import { HeaderBar } from '@dhis2/ui-widgets'
import { composeValidators } from '@dhis2/ui-forms'

// With ui version 5:
import { Button, HeaderBar, composeValidators } from '@dhis2/ui'
```

[Back](#) [Next](#)

Copyright © Hanna Evensen 2021.

Completion rate: 14%

[Home](#) / DHIS2 Components / Introduction

## Lesson: Showcase of the DHIS2 components

All the components have its own properties you can use to define how you want the component to look and behave. In the showcase below, you will see some examples of what is possible. If you want to get the most updated overview of all the components go to: <https://ui.dhis2.nu/demo/?path=/story/alertbar-default>

The showcase displays the following components and their variations:

- Buttons:** Basic button (white), Primary button (blue), Secondary button (light gray), Destructive button (red), Disabled button (light gray), Small button (small), Large button (large).
- InputField:** Default label (empty), Default label with placeholder text, Default label with validation message, Default label with error message, Default label with disabled state.
- ButtonStrip:** A horizontal row of buttons: Save, Save, Save, Label?, and a dropdown menu.
- Checkboxes:** Default (unchecked), Checked (checked), Densed checked (checked).
- DropdownButton:** Default (white), Primary (blue), Secondary (light gray), Destructive (red).
- Switch:** Default (unchecked), Checked (checked), Disabled (disabled), Default - Dense (checked).

Completion rate: 14%

[Home](#) / [DHIS2 Components](#) / [Introduction](#)

## Lesson: Using the API for components

All the components have their own properties to define how you want the component to look and behave. In the next steps in this tutorial, I will go through some examples of using the API. If you want to use other DHIS2 components, you can find their documentation here <https://ui.dhis2.nu/#/api>

Below you can see the API for the dhis2 Checkbox component. In the first column named 'Name,' you can see what type of properties the Checkbox component can take. Each of the properties has a type, as specified in the 'Type' column.

Name	Type	Description
value	string	
[label]	Node	
[onChange]	function	called with the signature <code>object, event</code>
[name]	string	
[className]	string	
[tabIndex]	string	
[disabled]	boolean	
[checked]	boolean	
[indeterminate]	boolean	
[initialFocus]	boolean	
[valid]	boolean	<code>valid</code> , <code>warning</code> , and <code>error</code> are mutually exclusive
[warning]	boolean	
[error]	boolean	
[dense]	boolean	
[onFocus]	function	
[onBlur]	function	
[dataTest]	string	

Back

Next

Completion rate: 14%

---

[Home](#) / [DHIS2 Components](#) / [Action components](#)

## Section 2: Action components

Action components consist of components that the user will be able to interact with. When a user clicks on the component, an action will be performed.

Some of the topics that will be covered in this module includes:

### Buttons:

- Lesson: The different types buttons and their usage
- Lesson: Button Api
- Example: The different types of buttons in action
- Lesson: Different button options
- Coding Exercise: Find the button mistakes and fix them

### Chip:

- Lesson: Chip
- Lesson: Chip Api
- Coding Exercise: Chip in use

### FlyoutMenu:

- Lesson: FlyoutMenu
- Lesson: FlyoutMenu Api
- Coding Exercise: Add more functionality to the flyoutMenu

### End of section quiz

[Back](#)

[Next](#)

Copyright © Hanna Evensen 2021.










Completion rate: 14%

[Home](#) / [DHIS2 Components](#) / [Action components](#) / [Buttons](#)

## Lesson: The different types of buttons and their usage

Buttons are used for triggering actions. There are different types of buttons in the design system which are intended for different types of actions.

Each type of button has a specific usage:

Type	View	Usage
Basic		The most often used button that will suit the majority of actions. Should be the default choice. Several basic buttons can be in the same area.
Primary		Used to highlight the most important/main action on a page. A 'Save' button for a form page should be primary, for example. Use sparingly, rarely should there be more than a single primary button per page.
Secondary		Used for passive actions, often as an alternative to the primary action. If 'Save' is primary, 'Cancel' could be secondary. Not intended to draw user attention. Do not use for the only action on a page.
Destructive		Used instead of a primary button when the main action is destructive in nature. Used to highlight to the user the seriousness of the action. <b>Destructive buttons must only be used for destructive actions.</b>
Dropdown		Presents several actions to a user in a small space. Can replace single, individual buttons. Should only be used for actions that are related to one another. Ensure the button has a useful level that communicates that actions are contained within. Dropdown buttons do not have an explicit action, only expanding the list of contained actions.
Split		Similar to the dropdown button, but can be triggered independently of opening the contained action list. The main action may be 'Save' and the contained actions may be "Save and add another" and "Save and open".
Text		Text only button. This style of button should only be used for auxiliary actions, for example clearing the content of an input. Text only buttons should not be used for main actions.

[Back](#)[Next](#)

Copyright © Hanna Evensen 2021.

Completion rate: 14%

---

[Home](#) / [DHIS2 Components](#) / [Action components](#) / [Buttons](#)

## Lesson: The Button Api

Here you can see the Api for the button component. Have a look at what is possible. You will use this in later exercises.

Name	Type	Default	Description
[children]	Node		The children to render in the button
[onClick]	function		The click handler
[onBlur]	function		
[onFocus]	function		
[className]	string		
[name]	string		
[value]	string		
[tabIndex]	string		
[small]	boolean		<code>small</code> and <code>large</code> are mutually exclusive
[large]	boolean		
[type]	string	"button"	Type of button: <code>submit</code> , <code>reset</code> , or <code>button</code>
[primary]	boolean		<code>primary</code> , <code>secondary</code> , and <code>destructive</code> are mutually exclusive boolean props
[secondary]	boolean		
[destructive]	boolean		
[disabled]	boolean		Disable the button
[icon]	Element		
[dataTest]	string		
[initialFocus]	boolean		Grants the button the initial focus state

Back

Next

Copyright © Hanna Evensen 2021.

s2

Completion rate: 14%

[Home](#) / [DHIS2 Components](#) / [Action components](#) / [Buttons](#)

## Example: The different types of buttons in action

Here you can see some of the possible button types in DHIS2. Familiarize yourself with the code and try to change some of the props the button uses (f.ex make all the buttons be primary buttons)

The screenshot shows a code editor on the left and a live preview on the right. The code editor displays the following code:

```
1 import React, { useState } from "react";
2 import "./styles.css";
3 import { Button } from "@dhis2/ui";
4
5 export default function App() {
6   const [output, setOutput] = useState("Click on one of the buttons");
7
8   function handleClick(button) {
9     setOutput(button.value);
10  }
11  return (
12    <div className="App">
13      <Button
14        dataTest="dhis2-uicore-button"
15        name="Basic button"
16        type="button"
17        value="Basic button clicked"
18        onClick={handleClick}
19      >
20        Basic button
21    </Button>
  
```

The live preview shows four buttons: "Basic button" (white), "Primary button" (blue), "Secondary button" (grey), and "Destructive button" (red). Below the buttons is the text "Click on one of the buttons". At the bottom right of the preview, there is an "Open Sandbox" button. The code editor interface includes tabs for "App.js", "index.js", "styles.css", "index.html", and "package.json", and a footer with "Console", "Problems", and "React Dev Tools".

[Back](#)[Next](#)

Completion rate: 14%

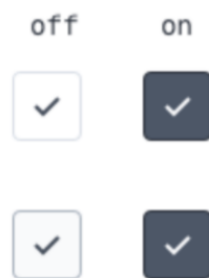
---

[Home](#) / [DHIS2 Components](#) / [Action component](#) / [Buttons](#)

## Lesson: Different button options

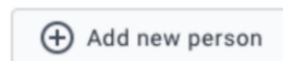
### Toggle

A button can represent an on/off state using the toggle option. Use a toggle button when the user can enable or disable an option and a checkbox or switch is not suitable. This will most often be in the case of a toolbar, such as bold or italic options in a text editing toolbar. A toggle button in this example uses an icon and does not need text. A text label should be provided in a tooltip on hover. The toggle option is available for basic and secondary type buttons.



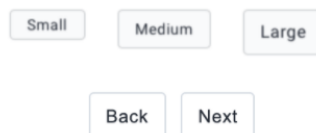
### Icons

Icons can be included in Basic, Primary, Secondary and Destructive buttons. Use an icon to supplement the text label. Remember that the user may not be fluent in the working language, so an accompanying icon on an important action can be a welcome addition. Buttons with icons only should be used for supplementary actions and should include a text tooltip on hover.



### Size

Buttons are available in three sizes: small, medium, large. Medium is usually the correct choice. Use small button in an information dense ui. Large buttons can be use on very simple, single action pages.



Copyright © Hanna Evensen 2021.

## Coding Exercise: Find the button mistakes and fix them

Use the information from the page about the different types of buttons and their usage to improve the code example below.

Tip: You will find some hints to the solution below the coding exercise and a possible solution

```

1 import React, { useState } from "react";
2 import "./styles.css";
3
4 import { InputField } from "@dhis2/ui";
5 import { Button } from "@dhis2/ui";
6 import { spacers } from "@dhis2/ui";
7
8 const input = {
9   marginBottom: spacers.dp16
10 };
11
12 const button = {
13   marginRight: spacers.dp8
14 };
15
16 export default function App() {
17   const [firstName, setFirstName] = useState("");
18   const [lastName, setLastName] = useState("");
19
20   return (
21     <>
```

First name

Last name

Create
Save
Cancel

Show hint
Open Sandbox

Show hint

Hide solution

```

import React, { useState } from "react";
import "./styles.css";

import { InputField } from "@dhis2/ui";
import { Button } from "@dhis2/ui";
import { spacers } from "@dhis2/ui";

const input = {
  marginBottom: spacers.dp16
};

const button = {
  marginRight: spacers.dp8
};

export default function App() {
  const [firstName, setFirstName] = useState("");
  const [lastName, setLastName] = useState("");

  return (
    <>
    <div style={input}>
      <InputField
        dataTest="dhis2-uiwidgets-inputfield"
        label="First name"
        name="Default"
        onChange={(e) => setFirstName(e.value)}
        placeholder="Enter the firstname"
        value={firstName}
      />
    </div>
    <div style={input}>
      <InputField
        dataTest="dhis2-uiwidgets-inputfield"
        label="Last name"
        name="Default"
        onChange={(e) => setLastName(e.value)}
        value={lastName}
        placeholder="Enter the lastname"
      />
    </div>
    <span style={button}>
      <Button primary>Save User</Button>
    </span>
    <span style={button}>
      <Button secondary>Cancel</Button>
    </span>
  </>
  )
}
```

Completion rate: 14%

[Home](#) / [DHIS2 Components](#) / [Action component](#) / [Chip](#)

## Lesson: Chip

Chips are useful for displaying a selection of defined choices and filters to the user.

### Usage

Chips are used to display a list of defined options, filters or views for a related view. Chips are always secondary content to the main element, for example a data table or a dashboard. A common usage of this that can help to understand the pattern is a table with a set of filters:

Registered events for Antenatal Care Visit in Ngelehun CHC

Saved filters

Overdue patients High Risk Visitors Child visits last 2 weeks Female visits last month

First name	Last name	Incident date	Last updated	Age	Registerin
Omondi	Kayode	03/30/1981	09/29/2005	89	Mogbass
Abeba	Afolabi	07/03/1990	05/19/1980	60	Fiama
Kwasi	Babatunde	04/17/1976	06/16/2006	26	Joru CHC
Kwasi	Okafor	09/11/2010	02/26/1991	38	Mokassik
Siyabonga	Abiodun	07/21/1981	02/06/2007	98	Bathurst
Chiamaka	Okoro	01/22/1982	07/16/2002	?	Musella

In this example, the chips act as filters for the table. By selecting the 'Overdue Patients' chip will display only that data in the table below. To deselect the chip the user can click again, or a 'Clear filters' control could be provided.

Registered events for Antenatal Care Visit in Ngelehun CHC

Saved filters

Overdue patients High Risk Visitors Child visits last 2 weeks Female visits last month

First name	Last name	Incident date	Last updated	Age	Registerin
Onyekachukwu	Kariuki	02/06/2007	05/25/1972	66	Jawi
Kwasi	Okafor	09/11/2010	02/26/1991	38	Mokassik
Siyabonga	Abiodun	07/21/1981	02/06/2007	98	Bathurst
Chiamaka	Okoro	01/22/1982	07/16/2002	?	Musella

### Chip VS Button

- Chips should only be used for filtering or selecting an option. Do not use filters to trigger actions such as 'Save', 'Exit' or 'Open'. Use a button to trigger actions.

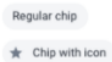
### Displaying chips

- Chips should be displayed in a horizontal list, where space permits.
- Do not stack single chips on top of one another if there is space to display them inline.
- Do not use horizontal scrolling to display a large number of chips. Always wrap chips onto a new line below.

### Options

#### Icon

A chip can display an optional icon. Use icons in chips to highlight special/unique chip items. Do not use the same icon on all chips, otherwise it will be meaningless. To clarify what a group of chips are, use a title or header instead.



### Single vs Multiple Selections

A group of chips can be set up for single or multiple selection, it depends on the usage. When using chips for selecting the active dashboard it makes sense to only allow a single selection at a time. You may choose to allow the user to select multiple chips, or filters, for a table displaying data.

### Examples in use

The screenshot shows a dashboard for 'Antenatal Care' in Sierra Leone. At the top, there are navigation tabs for 'Antenatal care', 'Delivery', 'Cases Malaria', 'Disease Surveillance', 'EE Maps', and 'Expenditures'. Below the navigation, there are 'Edit', 'Share', and 'Add Filter' options. The main content area features a bar chart titled 'ANC: ANC 3 coverage by districts last 12 months'. A filter chip is applied to the chart, labeled 'ANC: ANC 3 coverage by districts last 12 months'. The chart shows data for various districts. Below the chart, there are 'Back' and 'Next' navigation buttons.

Copyright © Hanna Evensen 2021.

Completion rate: 14%

[Home](#) / [DHIS2 Components](#) / [Action component](#) / [Chip](#)

## Lesson: Chip Api

Here you can see the Api for the Chip component. Have a look at what is possible, you will use this in later exercises

Name	Type
[children]	string
[className]	string
[icon]	Element
[onClick]	function
[onRemove]	function
[selected]	boolean
[dense]	boolean
[disabled]	boolean
[dragging]	boolean
[overflow]	boolean
[dataTest]	string

[Back](#)[Next](#)

Copyright © Hanna Evensen 2021.

[Home](#) / [DHIS2 Components](#) / [Action component](#) / [Chip](#)

## Coding Exercise: Change the Chips from multiple select to single select

Here is an example of chips using the multiple selection options. If we remember the introduction lesson about Chips, Chips can either be used as single or multiple select depending on their usage. How would you make the Chips single select? Try to change the code

There are many possible ways to accomplish this, but you will see one possible solution by clicking the 'show solution' button below. If you are not familiar with React's useState, you can read about it here: <https://reactjs.org/docs/hooks-state.html>

The screenshot shows a code editor with the following code:

```
1 import React, { useState } from "react";
2 import "./styles.css";
3 import { Chip } from "@dhis2/ui";
4
5 export default function App() {
6   const [chipOne, setChipOne] = useState(false);
7   const [chipTwo, setChipTwo] = useState(false);
8   const [chipThree, setChipThree] = useState(false);
9
10  const handleClick = (value) => {
11    if (value === "chipOne") {
12      setChipOne(!chipOne);
13    }
14    if (value === "chipTwo") {
15      setChipTwo(!chipTwo);
16    }
17    if (value === "chipThree") {
18      setChipThree(!chipThree);
19    }
20  };
21 }
```

The rendered output shows three chips: "Chip one" (active), "Chip two", and "Chip three". Below the chips are buttons for "Open Sandbox", "Console", "Problems", and "React DevTools".

Show solution

Back Next



Completion rate: 14%

[Home](#) / [DHIS2 Components](#) / [Action component](#) / [FlyoutMenu](#)

## Lesson: FlyoutMenu

A menu provides user access to options that are available when clicking the menu toggle. A menu toggle can be almost anything: button, table row, avatar etc.

### Usage

Use menus to provide access to options and actions where space is limited and displaying all the options would be impractical. For example, providing access to a range of actions for every dashboard item displayed. Containing all those actions in menus keeps the page manageable.

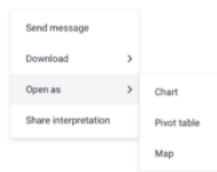
The menu component is flexible in where it can be used and its contents can be flexible too. However, the most common use case is a menu containing menu items.

Make sure the menu item labels are short and easy to understand. One word is often enough to describe an action or option. Do not use sentences as labels. Some examples of good menu item labels:

- 'Save'
- 'Open as map'
- 'Export PDF'
- 'Duplicate'

### Menu levels

Splitting menus into several levels with child menus makes sense when there are a lot of options that can be grouped together. An example may be an option in level 1 menu of 'Download' that has several different download formats as child menu items. Make sure that child menu items relate to their parent item, otherwise a user will struggle to discover them. A menu item with children is not selectable/actionable itself, it serves only as a container for the child elements. Try to keep menus to a maximum of three levels. More than three levels can easily confuse the user.



### Ordering og menuitems

There is no enforced ordering of menu items, but present them in order of relevance. Put the most commonly used items at the top of the menu for easy discovery and access.

### Options

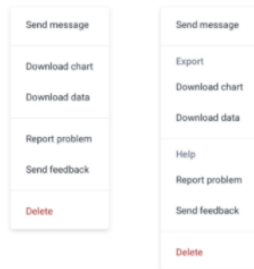
#### Size

Menus are available in regular or dense sizes. Use dense menus in data-heavy applications used by users comfortable with technology. Use regular menus in apps that are less complex or have few controls.



### Dividers & Section Headers

Items in a menu can be split into separate sections by using dividers. Group relevant menu items together to help the user understand the options quickly. A divider can be used alone. If using a section header, a divider will be automatically included. Try not to group single menu items together. An exception to this is a critical destructive menu item, like 'Delete', which can be separated from other menu items.



### Examples in use



Copyright © Hanna Evensen 2021.

Completion rate: 14%

[Home](#) / [DHIS2 Components](#) / [Action component](#) / [FlyoutMenu](#)

## Lesson: FlyoutMenu Api

### FlyoutMenu

Name	Type	Default
[children]	Element	
[className]	string	
[dataTest]	string	"'dhis2-ucore-menu'"
[dense]	boolean	
[maxWidth]	string	"'380px'"
[maxHeight]	string	"'auto'"

### MenuDivider

Name	Type	Default
[className]	string	
[dataTest]	string	"'dhis2-ucore-menudivider'"
[dense]	boolean	

### MenuItem

Name	Type	Default	Description
[active]	boolean		
[chevron]	boolean		
[children]	Node		
[className]	string		
[dataTest]	string	"'dhis2-ucore-menuitem'"	
[dense]	boolean		
[destructive]	boolean		
[disabled]	boolean		
[href]	string		
[icon]	Node		
[label]	Node		
[showSubMenu]	boolean		
[target]	string		
[toggleSubMenu]	function		
[value]	string		
[onClick]	function		Click handler called with <code>value</code> in the payload

### MenuSectionHeader

Name	Type	Default
[className]	string	
[dataTest]	string	"'dhis2-ucore-menusectionheader'"
[dense]	boolean	
[hideDivider]	boolean	
[label]	Node	

[Back](#) [Next](#)

Copyright © Hanna Evensen 2021.

[Home](#) / [DHIS2 Components](#) / [Action component](#) / [FlyoutMenu](#)

## Coding exercise: Add more functionality to the flyout menu

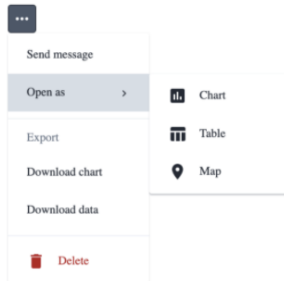
In this exercise, you are supposed to add more functionality to the flyoutMenu. Try to transform the code snippet to represent the image. You need to use the FlyoutMenu, MenuItem, MenuSectionHeader and MenuDivider as described on the previous page to reflect the image

For the the Chart, Table and Map icons I have used material-ui/icons

Tip: Below the code sandbox, you will find a possible solution if you are stuck

To import the icons I have used, you can use these import statements:

```
// Chart icon
import AssessmentIcon from "@material-ui/icons/Assessment";
// Table icon
import TableChartIcon from "@material-ui/icons/TableChart";
// Map icon
import RoomIcon from "@material-ui/icons/Room";
// Delete icon
import DeleteIcon from "@material-ui/icons/Delete";
```



```
App.js
1 import React, { useState } from "react";
2 import "./styles.css";
3 import { MenuItem, FlyoutMenu, Button } from "@dhis2/ui";
4 import MoreHorizIcon from "@material-ui/icons/MoreHoriz";
5
6 export default function App() {
7   const [showMenu, setShowMenu] = useState(false);
8
9   return (
10    <>
11      <Button
12        dataTest="dhis2-uicore-button"
13        name="Toggled button"
14        icon=<MoreHorizIcon />
15        onClick={() => setShowMenu(!showMenu)}
16        toggled=(showMenu)
17        type="button"
18        value="default"
19      />
20    <div>
21      (showMenu && (
```

Show solution

[Back](#) [Next](#)

Copyright © Hesperus 2021

Completion rate: 14%

---

[Home](#) / [DHIS2 Components](#) / [Action components](#) / End of section quiz

## End of section quiz: Action components

### When should you use the primary button?

- Primary buttons should be the default choice for the majority of actions. Several primary buttons can be used in the same area
- Primary buttons should be used to highlight the most important/main action on the page. Should rarely be more than one primary button
- Primary buttons should be used when you want to highlight to the user the seriousness of the action
- Primary buttons should be used for passive actions, often as an alternative to the secondary action. If 'Save' is secondary, 'Cancel' could be primary. Do not use as the only action on a page

### When should you use the destructive button?

- Destructive buttons should be the default choice for the majority of actions. Several destructive buttons can be used in the same area
- Destructive buttons should be used to highlight the most important/main action on the page. Should rarely be more than one destructive button
- Destructive buttons should be used when you want to highlight to the user the seriousness of the action
- Destructive buttons should be used for passive actions, often as an alternative to the primary action. If 'Save' is primary, 'Cancel' could be destructive. Do not use as the only action on a page

### When should you use the secondary button?

- Secondary buttons should be the default choice for the majority of actions. Several secondary buttons can be used in the same area
- Secondary buttons should be used to highlight the most important/main action on the page. Should rarely be more than one secondary button
- Secondary buttons should be used when you want to highlight to the user the seriousness of the action
- Secondary buttons should be used for passive actions, often as an alternative to the primary action.

### When should you use the toggle button?

- The toggle button should be used for auxiliary actions, for example clearing the content of an input.
- When you want the user to be able to enable or disable an option in a toolbar
- When you want to add filtering in a table

### How should you display Chips?

- Chips should be displayed in a horizontal list, where space permits
- Chips should always be stacked on top of each other
- Chips should have horizontal scrolling when a large number of chips are used

### How should you use Chips?

- When you want to trigger an action, like 'Save' or 'Open'
- When you want to be able to filter or select an option
- Chips should only be used as a way of describing an element, and should not be interactive
- A group of chips should all have the same icon to show that they belong together

### When should you use single-selection chips over multiple-selection chips?

- When you want to use chips for filtering
- When you want to use the chip as a button
- When you want to use chips for selecting the active dashboard

[Back](#) [Next](#)

Completion rate: 14%



---

[Home](#) / [DHIS2 Components](#) / [Data display components](#)

## Section 3: Data display components

Data display components consist of components that have the purpose of displaying some kind of data

Some of the topics that will be covered in this module includes:

**Data table:**

- Lesson: usage of the Data table
- Lesson: composition of the Data table
- Lesson: the Data table Api
- Example: the DHIS2 table component
- Lesson: Data table search
- Lesson: Data table filtering
- Lesson: Data table actions

**Tag:**

- Lesson: Tag
- Lesson: Tag Api
- Lesson: Tag options
- Quiz: Tag
- Coding exercise: Tag

**End of section quiz**

Back

Next

Copyright © Hanna Evensen 2021.

Completion rate: 14%

[Home](#) / [DHIS2 Components](#) / [Data display components](#) / [Data table](#)

## Lesson: composition of the Data table

### Composition

A data table is made up of multiple elements, some of which are optional

Patients on your watchlist

1

First name ▾ Last name ▾ Incident date ▾ Last updated ▾ Age ▾ More ▾ Print ⋮

First name ▾	Last name ▾	Incident date ▾	Last updated ▾	Age ▾	Registering unit ▾	Assigned user ▾	Status ▾	⋮
Onyekachukwu	Kariuki	02/06/2007	05/25/1972	66	Jawi	Sofie Hubert	Incomplete	⋮
Kwasi	Okafor	08/11/2010	02/26/1991	38	Mokassie MCHP	Dashonte Clarke	✓ Complete	⋮
Siyabonga	Abiodun	07/21/1981	02/06/2007	98	Bathurst MCHP	Unassigned	Incomplete	⋮
Chiyembekezo	Okeke	01/23/1982	07/15/2003	2	Mayolla MCHP	Wan Gengxin	Incomplete	⋮
Mtendere	Afolayan	08/12/1994	05/12/1972	37	Gbangadu MCHP	Gvozden Boskovsky	✓ Complete	⋮
Inyene	Okonkwo	04/01/1971	03/16/2000	70	Kunike Barina	Oscar de la Cavalleria	✓ Complete	⋮
Amaka	Pretorius	01/25/1996	09/15/1986	32	Bargbo	Alberto Raya	Incomplete	⋮
Meti	Abiodun	10/24/2010	07/26/1989	8	Majithun MCHP	Unassigned	Incomplete	⋮
Eshe	Okeke	01/31/1995	01/31/1995	63	Mamblama CHP	Shadrias Pearson	🔒 Locked	⋮
Obi	Okafor	06/07/1990	01/03/2006	28	Dalakuru CHP	Anatoly Shcherbatykh	✓ Complete	⋮

Show  per page 3 Viewing 81–90 of many ◀ Prev Page  of 20 Next ▶

1. Toolbar, optional
2. Data rows and header, required
3. Footer, optional

[Back](#) [Next](#)

Copyright © Hanna Evensen 2021.

lhis2

Completion rate: 14%



[Home](#) / [DHIS2 Components](#) / [Data display components](#) / [Data table](#)

### Code example: the DHIS2 table component

```

1 import React from "react";
2 import "./styles.css";
3 import {
4   Table,
5   TableHead,
6   TableRowHead,
7   TableCellHead,
8   TableBody,
9   TableRow,
10  TableCell
11 } from "@dhis2/ui";
12
13 export default function App() {
14   return (
15     <Table>
16       <TableHead>
17         <TableRowHead>
18           <TableCellHead>First name</TableCellHead>
19           <TableCellHead>Last name</TableCellHead>
20           <TableCellHead>Incident date</TableCellHead>
21           <TableCellHead>Last updated</TableCellHead>

```

First name	Last name	Incident date	Last updated	Age	Registering unit	Assigned user
Onyekachukwu	Kariuki	02/06/2007	05/25/1972	66	Jawi	Sofie Hubert
Kwasi	Okafor	08/11/2010	02/26/1991	38	Mokassie MCHP	Dashonte Clarke
Siyabonga	Abiodun	07/21/1981	02/06/2007	98	Bathurst MCHP	Unassigned
Chiyembekezo	Okeke	01/23/1982	07/15/2003	2	Mayolla MCHP	Wan Gengxin
Mtendere	Afolayan	08/12/1994	05/12/1972	37	Gbangadu MCHP	Gvozden Boskovsky
Inyene	Okonkwo	04/01/1971	03/16/2000	70	Kunike	Oscar de la

[Back](#) [Next](#)

Copyright © Hanna Evensen 2021.

Completion rate: 14%

[Home](#) / [DHIS2 Components](#) / [Data display components](#) / [Data table](#)

## Lesson: Data table search

Search	First name ↕	Last name ↕	Incident date ↕	Last updated ↕	Registering Organisation Unit ↕
	Rumbidzai	Kamau	07-21-2014	05-25-1972	Ola Daring Clinic
	Dakarai	Okorie	05-12-1972	08-13-1991	Komboya
	Kwasi	Afolabi	01-05-1973	05-17-1983	Jaiama Sewafe CHC
	Chiyembekezo	Okonkwo	01-23-1982	08-21-1984	Kathanta Bana MCHP
	Kabelo	Pretorius	04-10-2001	03-16-2000	Kychom CHC

### What is search?

Search allows a user to search for a specific term across the entire data table.

### How is search used?

A search input can be included inside the table toolbar area or made available outside of the table. The location of the search input depends on the importance of search and how it relates to the task. If searching is a logical step performed before looking at the table the input should be shown outside, above the table. If searching is a secondary action it can be included inside the table.

Be sure to inform the user with an empty state if there are no results for a search term.

### When to use search?

Include search whenever a user might need to find a specific data record in the table. Search can be quicker than filtering if the user knows the exact data item they are looking for. Often search and filtering work well in combination.

[Back](#)[Next](#)

Copyright © Hanna Evensen 2021.

Completion rate: 14%

[Home](#) / [DHIS2 Components](#) / [Data display components](#) / [Data table](#)

## Lesson: Data table filtering

### Filtering

Filters allow a user to view a precise, focused set of data. Filtering is a very effective way of finding the right data. Enabling filtering on a data table means that a single data table can fulfill several different functions for varying users and use cases.

Filtering works best when a user wants to return multiple results that fit some criteria. If a user is looking for a single result, especially where they know a name/title/attribute, then provide search functionality outside of the table.

Never filter data in a table without informing the user, the user must know they are viewing a filtered set of data.

There are two ways to filter data in a data table: standalone or inline.

### Filtering: Standalone

First name	Last name	Last updated	Registering Organisation Unit
Rumbidzai	Afolabi	05-25-1972	Ola During Clinic
Dakarai		08-13-1991	Komboya
Kwasi	Afolabi	01-05-1973	Jaiama Sewafe CHC

#### What are standalone filters?

Standalone filters are buttons that can be used to filter on a column in a data table.

#### How are standalone filters used?

Standalone filter buttons should be displayed inside the table toolbar area. The available filters must be defined, none will be provided by default. Clicking a filter button opens a popover with input controls. An actively filtered column is highlighted with an active button and text indicating the applied filter.

#### When to use standalone filters?



Completion rate: 14%



---

[Home](#) / [DHIS2 Components](#) / [Data display components](#) / [Tag](#)

## Lesson: Tag

A tag is used to display categorizing labels or information for other elements in a collection.

[Processing](#) [Complete](#) [Missing info](#) [Accepted](#)

### Usage

Tags are used whenever an element in a collection needs to display its category or status. Tags should not be used for one-off, unique information. Tags can be displayed in any kind of component.

Tags are useful when displaying multiple elements in a collection that have the same basic attributes but belong to different categories or have different statuses. Do not use tags for elements that will always be the same, instead use a heading or other grouping method.

Tags are never used for primary interaction and should not be used as buttons. Clicking a tag could sort a collection by that tag, or open a page to display all elements that have that tag type. Tags should not be used as navigation elements.

[Back](#)

[Next](#)

Copyright © Hanna Evensen 2021.

Completion rate: 14%

[Home](#) / [DHIS2 Components](#) / [Data display components](#) / [Tag](#)

## Lesson: Tag options

### Color

Tags are available in four different colors. The color of a tag depends on its content and the meaning of that tag. The following system is used for tag coloring:

Tag	Meaning
<span style="background-color: #cccccc; padding: 2px;">Default</span>	Default. The grey tag is default and has its color should not imply meaning.
<span style="background-color: #add8e6; padding: 2px;">Neutral</span>	Neutral. Blue is used when a tag could have valid or error status but is currently neutral.
<span style="background-color: #ffcccc; padding: 2px;">Error</span>	Error. Red tags imply an error or a problem.
<span style="background-color: #ccffcc; padding: 2px;">Valid</span>	Valid. Green tags should be used to indicate validity or success.

### Icons

Tags can contain icons. Use icons where they will help users easily identify the content of the tag. Tags must have a text label and cannot display only an icon.



### Bold

Tags have an optional bold property. Use bold tags where it is important that the tag is seen by the user in an information dense interface. Bold tags should be reserved for edge cases and not overused.

### Example in use

Age ▾ Assigned user ▾ More filters ▾

Registering unit ⇅	Gender ⇅	Status ⇅	
Masamboi MCHP	Male	Active	...
Seidu MCHP	Male	Active	...
Mano Gbonjeima CHC	Female	Active	...
Bakeloko CHP	Male	Inactive	...
Motema CHP	Female	Active	...
Makoba Bana MCHP	Male	Inactive	...
Mokellav MCHP	Female	Inactive	...

Completion rate: 14%

---

[Home](#) / [DHIS2 Components](#) / [Data display components](#) / [Tag](#)

## Quiz: Which of the images uses tags correctly? Click on the correct image

**Patient A**  
Adedayo Okafor

**Patient B**  
Inyene Adebayo

**Patient C**  
Kweku Okeke

**Patient A**  
Inpatient Overdue

**Patient B**  
Outpatient

**Patient C**  
Inpatient Referral

Back

Next

Copyright © Hanna Evensen 2021.

Completion rate: 14%

[Home](#) / [DHIS2 Components](#) / [Data display components](#) / [Tag](#)

## Lesson: Tag API

Here is the API for the tag component. You will find an example of the tag in use on the next page

Name	Type	Description
[bold]	boolean	
[children]	Node	
[className]	string	
[dataTest]	string	
[icon]	Node	
[neutral]	boolean	<code>neutral</code> , <code>positive</code> , and <code>negative</code> are mutually exclusive boolean props
[positive]	boolean	
[negative]	boolean	

Back

Next

Copyright © Hanna Evensen 2021.

dhis2

Completion rate: 14%

[Home](#) / [DHIS2 Components](#) / [Data display components](#) / [Tag](#)

### Code example: Tags

The screenshot shows a CodeSandbox environment. On the left, there's a file explorer with folders like .codesandbox, public, src, and dependencies. The main editor shows the following code in App.js:

```

1 import React from "react";
2 import { Tag } from "@dhis2/ui";
3
4 const styles = {
5   paddingRight: "12px"
6 };
7 export default function App() {
8   return (
9     <div>
10      <span style={styles}>
11        <Tag>Default</Tag>
12      </span>
13      <span style={styles}>
14        <Tag neutral>Neutral</Tag>
15      </span>
16      <span style={styles}>
17        <Tag positive>Positive</Tag>
18      </span>
19      <Tag negative>Negative</Tag>
20    </div>
21  );

```

On the right, there's a rendered output showing four tags: Default (grey), Neutral (light blue), Positive (light green), and Negative (light red). Below the rendered output, there are buttons for 'Open Sandbox', 'Console', 'Problems', and 'React DevTools'.

Back

Next

Copyright © Hanna Evensen 2021.

[Home](#) / [DHIS2 Components](#) / [Data display components](#) / [Tag](#)

### Coding exercise: add more functionality to the table

In the code sandbox below, you will see an example for how you can use the Data table and the chips together to create a filterable table. Your task is to use the tag component to display status.

The screenshot shows a CodeSandbox environment with the following components:

- Code Editor:** Displays the following code in `App.js`:
 

```

1 import React, { useState, useEffect } from "react";
2 import "./styles.css";
3 import { Chip } from "adhis2/ui";
4 import {
5   Table,
6   TableHead,
7   TableRowHead,
8   TableCellHead,
9   TableBody,
10  TableRow,
11  TableCell
12 } from "adhis2/ui";
13
14 import data from "../data.json";
15
16 export default function App() {
17   const [overdue, setOverdue] = useState(false);
18   const [highriskPatient, setHighRiskPatient] = useState(false);
19   const [childVisit, setChildVisit] = useState(false);
20   const [filteredData, setFilteredData] = useState(data.p
      
```
- Table:** Titled "Registered events for Antenatal Care Visit in Ngelehun CHCz". It features three filter chips: "Overdue patients" (selected), "Highrisk Patient", and "Child visits last two weeks". The table has the following columns: First name, Last name, Incident date, Last updated, Age, Registering unit, Assigned user, and Status. The data rows are:
 

First name	Last name	Incident date	Last updated	Age	Registering unit	Assigned user	Stat
Person 1	Kariuki	02/02/20	Kariuki		Javi	fdf	Inco
Person 2	Kariuki	02/02/20	Kariuki		Javi	fdf	Inco
Person 3	Kariuki	02/02/20	Kariuki		Javi	fdf	Inco
Person 4	Kariuki	02/02/20	Kariuki		Javi	fdf	Inco

[Back](#) [Next](#)

Copyright © Hanna Evensen 2021.

Completion rate: 14%

---

[Home](#) / [DHIS2 Components](#) / [Data display components](#) / End of section quiz

## End of section quiz: Data display components

**When should you use the data table?**

- When you want to control the page layout instead of using Cascading Style Sheets (CSS)
- When you want to get an overview of your numerical data and show a pattern
- When the user needs to see all the available data

**When should you use standalone over inline filters in a table?**

- When filtering is not one of the main actions on a page
- When filtering is one of the main actions available on the page.
- When filtering in data-heavy and compact tables

**When should you use the Tag component?**

- When you know that the element will always be the same
- When you want a button with more subtle colors than the button component provides
- When you need a component for navigation
- Whenever an element in a collection needs to display its category or status
- When you want to display one-off, unique information

**When should you use the color blue for the tag component?**

- The color blue tags should be used for content that displays an error
- The color blue for tags should be used for neutral information
- The color blue for tags should be used to indicate validity or success
- The color blue for tags should be used as the default color that should not imply meaning

Back

Next

Copyright © Hanna Evensen 2021.

## A.1.2 Course colours

Completion rate: 14%

---

[Home](#) / Color

### Color

In this section you will be taken through how to use colors when developing applications for DHIS2. Some examples and explanations will be given as well as some coding tasks for you to try out, and some quizzes to check that you have understood the topics correctly

**Expected duration:** 20 minutes

**Possible points:** 5 points

The topics that will be covered in this module:

DHIS2 Color scale	▼
Quiz about colors	▼
How to use the colors	▼
Accessibility	▼

[Start Course](#)

Copyright © Hanna Evensen 2021.

Completion rate: 14%

---

[Home](#) / [Color](#) / [Color](#)

### Color

Color is used in DHIS2 to support effective communication. DHIS2 applications use color to help the user understand information, feedback and more. The colors used in an application should not be chosen based primarily on how they look, but how they convey information and aid understanding

It is important to maintain consistent usage of colors throughout the DHIS2 platform. Globally, color meanings are relative. It is not possible to say 'red = danger'. However, using a consistent color palette we can establish that 'red in DHIS2 = danger'.

Color alone should not be relied upon to communicate effectively.

[Back](#)

[Next](#)

Copyright © Hanna Evensen 2021.



Completion rate: 14%

[Home](#) / [Color](#) / DHIS2 color scale

## DHIS2 color scale

The DHIS2 color scale contains 7 colors. Each color has 10 shades. This color system provides enough colors for most situations. Each color in the DHIS2 color scale has a purpose.

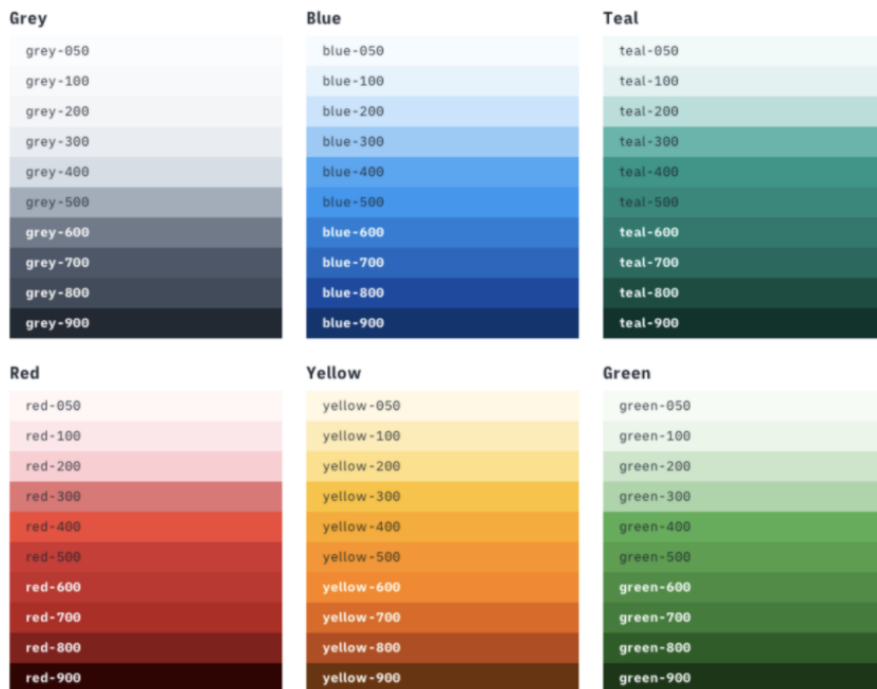
Color usage in DHIS2 applications should be subtle. Reserve colors for when they need to communicate effectively

Put simply:

- Grey: general interface elements, neutral information
- Blue: important neutral information, primary actions
- Teal: selected or active element
- Red: danger, error, destructive action
- Yellow: warning, non-blocking error
- Green: positive feedback, valid, success

Generally speaking, for all colors, the values also have a purpose

- 900-700: text, information, active or highlighted content
- 600-300: icons, states (inactive, disabled etc.)
- 200-050: backgrounds, tints, accents



[Back](#)

[Next](#)

Copyright © Hanna Evensen 2021.

Completion rate: 14%

---

[Home](#) / Color

## Quiz: Which of the images uses colors correctly? Click on the correct image

Patient Summary
This patient is newly registered and requires a reference.
First name: Tjaart
Last name: Okafor
Registering unit: Rokulan CHC

Patient Summary
This patient is newly registered and requires a reference.
First name: Tjaart
Last name: Okafor
Registering unit: Rokulan CHC

Back

Next

Copyright © Hanna Evensen 2021.

Completion rate: 14%


---


[Home](#) / Color

## Quiz: Which of the images uses colors correctly? Click on the correct image

 Error processing patient data.

 Error processing patient data.

 Program is not available in this unit.

 Program is not available in this unit.

Delete patient data

Delete patient data

Back

Next

Copyright © Hanna Evensen 2021.

Completion rate: 14%

---

[Home](#) / Color

## Quiz: Which of the images uses colors correctly?

User	<input type="text" value="Search for a user"/>	<input type="button" value="Search"/>
Location	<input type="text" value="Approx. location"/>	<input type="button" value="Search"/>
<input type="button" value="Save"/>		

User	<input type="text" value="Search for a user"/>	<input type="button" value="Search"/>
Location	<input type="text" value="Approx. location"/>	<input type="button" value="Search"/>
<input type="button" value="Save"/>		

Copyright © Hanna Evensen 2021.

Completion rate: 14%

---

[Home](#) / Color

## Lesson: How to import and use the colors

To use the colors in DHIS2, you can either use the colors hex value or you can import colors from @dhis2/ui

```
import { colors } from "@dhis2/ui"
```

Copyright © Hanna Evensen 2021.

his2

Completion rate: 14%

[Home](#) / [Color](#) / Code example: the colors in use

## Code example: the colors in use

Here you can see the DHIS2 colors in use

Try to see if you can change some of the color values

The screenshot shows a CodeSandbox environment. On the left, there's a file explorer with folders like 'Files', '.codesandbox', 'public', 'src', and 'App.js'. Below it, a 'Dependencies' list includes packages like '@dhis2/app-runtime', '@dhis2/d2-i18n', '@dhis2/ui', 'react', 'react-dom', 'react-scripts', and 'styled-jsx'. The main editor shows the code for 'App.js' with the following content:

```

1 import React from "react";
2 import "./styles.css";
3
4 import { colors } from "@dhis2/ui";
5
6 export default function App() {
7   return (
8     <div className="App">
9       <h1>DHIS2 Color Scale</h1>
10      <div style={{ backgroundColor: colors.grey050 }}
11        <div style={{ backgroundColor: colors.grey100 }}
12          <div style={{ backgroundColor: colors.grey200 }}
13            <div style={{ backgroundColor: colors.grey300 }}
14              <div style={{ backgroundColor: colors.grey500 }}
15                <div style={{ backgroundColor: colors.grey600 }}
16                  <div style={{ backgroundColor: colors.grey700 }}
17                    <div style={{ backgroundColor: colors.grey800 }}
18                      <div style={{ backgroundColor: colors.grey900 }}
19                        <div style={{ backgroundColor: colors.blue050 }}
20                          <div style={{ backgroundColor: colors.blue100 }}
21                            <div style={{ backgroundColor: colors.blue200 }}

```

On the right, the preview shows a 'DHIS2 Color Scale' with a vertical gradient of colors. The colors listed are:

- grey050 (#FBFCFD)
- grey100 (#F8F9FA)
- grey200 (#F3F5F7)
- grey300 (#E8EDF2)
- grey400 (#D5DDE5)
- grey500 (#A0ADBA)
- grey600 (#6E7A8A)
- grey700 (#4A5768)
- grey800 (#404B5A)
- grey900 (#212934)
- blue050 (#5fbff)
- blue100 (#e3f2fd)
- blue200 (#c5e3fc)

At the bottom of the preview, there are buttons for 'Back', 'Next', and 'Open Sandbox'.

[Back](#) [Next](#)

Copyright © Hanna Evensen 2021.

Completion rate: 14%

[Home](#) / [Color](#)

## Accessibility

Do not rely on color alone to communicate. Not everyone sees color the same. Relying on color to communicate will restrict access for partially sighted, color blind and users with low-quality display hardware.

In addition to using color to communicate as described in the previous sections, you always need to use color with another communication method. That can for example be text formatting or icon usage

Relying on color alone to signal an error to a user is problematic. For example:

Pay attention to contrast too. Information dense text needs to satisfy a minimum contrast ratio of 7:1 to be accessible to all users and headers and secondary text should pass a 4.5:1 ratio:

Remember, when dealing with accessibility issues that designs may work or be understandable on your screen, but not necessarily on others. Make sure to think of all kinds of users with all kinds of hardware when designing with accessibility in mind. Use an WCAG2.0 standard accessibility checker to check contrast. Aim for AAA rating for all essential interface elements.

[Back](#) [Next](#)

Copyright © Hanna Evensen 2021.

Completion rate: 14%

---

[Home](#) / [Color](#) / Quiz: accessibility

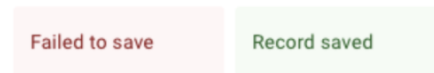
## Quiz: accessibility

Which image uses correct usage of color? Click on the correct image

Normal vision



Normal vision



Colorblind (Protanopia)



Colorblind (Protanopia)



Back

Next

Copyright © Hanna Evensen 2021.

Completion rate: 14%



[Home](#) / Color

## Quiz: Click on the image that uses contrast correctly



1.9:1 — REGISTRATION SUMMARY  
3.7:1 — Patient AA00239 will be registered in Ngelehun CHC.

6.7:1 — REGISTRATION SUMMARY  
13.2:1 — Patient AA00239 will be registered in Ngelehun CHC.

Back

Next

Copyright © Hanna Evensen 2021.

Completion rate: 28%



**Congratulation! You have now finished the quiz!**

You got 0 points

Start over

Copyright © Hanna Evensen 2021.

## A.2 Appendix: Questionnaire

# Evaluation of DHIS2 UI tutorial

The work with the website and this survey are a part of my master thesis at the University Of Oslo (UiO).

Before answering this survey, please go to: <https://dhis2-ui-tutorial.firebaseio.com> to test the website. Sign up as a new user and complete the course "DHIS2 components" and the course "Colors". The course "DHIS2 components" is considerably larger than the course "Colors". Click on the settings page after having completed a course. You will not be able to try the other courses, since the button is disabled. The estimated time to complete the tutorials will be around 30 minutes, so ensure you have set away enough time.

Your participation in this study is entirely voluntary. If you feel uncomfortable answering any question, you can withdraw from the survey at any point. Your information will be coded and treated confidentially. When the results of the study are reported, you will not be identified by name or any other information that could be used to infer your identity. By filling out this survey, you agree to participate in this research project.

If you have any questions about the survey or are having trouble with the website, please contact me at [hannaev@ifi.uio.no](mailto:hannaev@ifi.uio.no)

\* Required

Background  
information  
(Section 1 of 5)

Before beginning with the questions related to the website, I would like to get some background information about you and your previous experiences

1. Where do you work/study? \*

*Mark only one oval.*

- Core developer in DHIS2    *Skip to question 7*
- Student at UiO    *Skip to question 6*
- HISP    *Skip to question 7*
- Other: \_\_\_\_\_



2. How experienced are you with the JavaScript library React? \*

*Mark only one oval.*

- No experience
- Somewhat experienced
- Experienced
- Very experienced

3. How experienced are you with DHIS2? \*

*Mark only one oval.*

- No experience
- Somewhat experienced
- Experienced
- Very experienced

4. How experienced are you with the DHIS2 Design system? \*

*Mark only one oval.*

- No experience
- Somewhat experienced
- Experienced
- Very experienced

5. Have you used any other Ui components apart from DHIS2 specific (F.ex material UI, bootstrap) \*

*Mark only one oval.*

- No
- A little bit
- Yes, a lot

Questions due to answering being a student at UiO

Extra question: student at UiO

6. Have you taken the course Development in platform ecosystems? \*

*Mark only one oval.*

No

Yes

Section  
(2 of 5)

Go to <https://dhis2-ui-tutorial.firebaseio.com> to test the website. Sign up as a new user and complete the course "DHIS2 components" and the course "Color". Click on the settings page after having completed a course.

7. How was it to get familiar with the website? \*

*Mark only one oval.*

Very difficult

Difficult

Neutral

Easy

Very Easy

8. Was there any use of language that was not familiar to you? \*

*Mark only one oval.*

Yes

No

9. if yes, please give some examples?

---

---

---

---

---

10. Was there any use of icons that were not familiar to you? \*

*Mark only one oval.*

Yes

No

11. If yes, please give some examples

---

---

---

---

---

12. Do you think the course would be suitable for beginners wanting to learn to use the DHIS2 design system? \*

*Mark only one oval.*

Yes

No

Somewhat

13. If you answered no or somewhat to the previous question, why?

---

---

---

---

---

Section (3 of 5)

14. In the coding examples, were you familiar with the coding syntax used? \*

*Mark only one oval.*

Yes

No

15. If no, did you feel that this hindered you to being able to solve the task?

---

---

---

---

---

16. How engaging did you find the course? \*

*Mark only one oval.*

Not at all engaging

Not very engaging

Mediocre

Quite engaging

Very engaging

17. How visually attractive did you find the course? \*

*Mark only one oval.*

- Not at all attractive
- Not very attractive
- Mediocre
- Quite attractive
- Very attractive

18. How useful did you find the text-based lessons? \*

*Mark only one oval.*

- Not at all useful
- Slightly useful
- Moderately useful
- Very useful
- Extremely useful

19. How useful were the multiple-choice questions? \*

*Mark only one oval.*

- Not at all useful
- Slightly useful
- Moderately useful
- Very useful
- Extremely useful

20. How useful were the coding tasks? \*

*Mark only one oval.*

- Not at all useful
- Slightly useful
- Moderately useful
- Very useful
- Extremely useful

21. How useful were the tasks where you were supposed to click on the correct image? \*

*Mark only one oval.*

- Not at all useful
- Slightly useful
- Moderately useful
- Very useful
- Extremely useful

#### Section (4 of 5)

22. I think the website could be a good supplement to the other dhis2 resources \*

*Mark only one oval.*

- Strongly disagree
- Disagree
- Neither disagree nor agree
- Agree
- Strongly agree

23. How did you find the distribution of the different question/lesson types?

---

---

---

---

---

24. How did you find receiving badges for completion of courses? \*

*Mark only one oval.*

- Very unnecessary
- Unnecessary
- Neutral
- Exciting
- Very exciting
- I did not receive any badges

25. What was the best thing about the courses?

---

---

---

---

---

26. What was the worst thing about the courses?

---

---

---

---

---

27. How easy was it to find the information needed? (f.ex signing in, settings page, going back to home page)?

---

---

---

---

---

28. How would you describe the response time of the website?

---

---

---

---

---

Section (5 of 5)

29. Do you have any ideas for how the courses could be improved?

---

---

---

---

---

30. Did you experience getting any sort of error while using the website? \*

*Mark only one oval.*

Yes

No



31. If yes, what was the error about? Was it appropriately handled?

---

---

---

---

---

32. Is there anything else you would like to add about the website?

---

---

---

---

---

33. Do you have any comments about the questions asked in this survey?

---

---

---

---

---

---

This content is neither created nor endorsed by Google.

Google Forms

### **A.3 Appendix: Focus group consent form**

# Focus Group Consent Form

Evaluation of artifact developed to learn about the Design System for the District Health Information System Software (DHIS2)

## Purpose of the study

You have been invited to participate in a focus group conducted by Hanna Evensen as a part of my master thesis at the University of Oslo (UiO). The purpose of this focus group is to evaluate an artifact developed to learn about the Design System for the District Health Information System Software (DHIS2). The information learned from this focus group will be used to create some principles for how similar artifacts can be developed in the future.

## Procedure

As a part of the study, you will be placed in a group of approximately five individuals. The moderator will ask you several questions while facilitating the discussion.

Please note that there are no right or wrong answers to any of the questions. The researcher wants to hear many varying viewpoints and would like everyone to contribute with their thoughts. Feel free, to be honest even though your responses might not align with the other group members.

## By signing this consent form:

1. You agree to take part in the research project.
2. You confirm that your participation is entirely voluntary.
3. You understand that you can choose not to answer questions without any consequences.
4. You understand that you can leave the focus group at any time. However, it will not be possible to identify or remove any comments you made before withdrawing.
5. You agree to the statement that you have had the purpose and nature of the study being explained in writing and that you have had the opportunity to ask questions about the study.
6. You understand that the signed consent forms will be stored until the exam board confirms the dissertation results.
7. You understand that you are entitled to access all the notes taken from this focus group upon request by email.
8. You respect other focus group members' privacy by not disclosing any content discussed during the focus group.
9. You understand that the researcher will analyze the focus group's data, but your responses will remain confidential. The final report will not include any names.

If you have any questions or comments about the focus group, please feel free to contact me at [hannaev@ifi.uio.no](mailto:hannaev@ifi.uio.no) or message me on Mattermost

## Navn

Fornavn

Etternavn

## Dato



Måned    Dag    År