

VISUAL DESIGN IN THE CREATION OF EDUCATIONAL INFOGRAPHICS

— A Case Study of Designing
Infographics for E-learning

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ABSTRACT

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This thesis was created to study the possibilities of improving digital learning materials through the visual design of infographics. This study is case-driven, as a design for infographics was developed as a part of this study and the potential improvements were studied via this case of practical application. The design was based on the research and literature on the visual content in Finnish learning materials and on the execution of infographics as visual and pedagogical material.

The history of the design and use of infographics in learning materials in Finland were first inspected to study the background. The setting in which the infographics were produced in was addressed by looking in to the technological shift from printed books to digital learning materials and the effects it has on the use and design of infographics. In the next part the infographics were studied as visual material, and how the design of infographics in learning materials can be improved based on research done on visual communication and human perception and behaviour.

The third part focused on the infographics and their design in relation to the demands of subject matter and specialized ways of visual communication associated with certain kinds of visual information. Maps are studied as an example. Matters such as representability, visual literacy and pedagogical ethics in the context of design were also discussed in these chapters. The aesthetic side of graphic design and the potential benefits these can bring to the design of infographics was studied in the fourth part, with the focus on the aspects of information value, company identity and productivity.

It was concluded that the design of infographics can bring numerous and significant advantages to the digital learning materials. Visual design affects both the content and the form of infographics, and through them, the appearance, quality and pedagogical value of the learning materials. The design of infographics can be beneficial in the terms of productivity, marketability and usability, and should be considered to be a part of developing modern learning materials.

Key words: graphic design, visual design, infographics, e-learning

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TERMS

E-learning	Learning based on electronic devices and digital learning materials
Infographics	Information graphics, or visual material that aims to convey information
Information design	The practice that seeks to communicate information efficiently through its content, language and form
Information literacy	The ability to gather, interpret and use information

1 INTRODUCTION

Infographics, or information graphics are used to convey information in a visual form. Infographics such as graphs, maps, mind maps and the like have been seen in Finnish learning materials for a long time, and now that digital learning materials are being produced, infographics will have an important role in them as well. However, the digital environment is quite different from the print media, and the technological shift greatly affects the use and execution of any visual content in the materials. This change requires reassessing the visual design of the infographics so that they can serve their purpose in an optimal way in the new circumstances. In addition to this, the change provides an excellent opportunity to consider how educational infographics could be improved even further by visual means. Infographics are a very visual medium, so studying the potential of visual design in developing them can bring significant benefits.

Infographics are currently already used extensively in different applications in the digital environment. Digital infographics can be viewed and used on many types of devices and they can be made into videos, animations, interactive applications and multimedia in addition to presenting them as different types of static images. Infographics are also used for several purposes ranging from advertisement to the display of scientific data. The purpose, the devices and the nature of the applications they are used in determine the way the infographics are designed in. Educational infographics have their own characteristics and e-studybooks are one specific field of digital publication. This thesis focuses on these applications, and studies infographics in them through a case-driven approach.

This thesis is a case-driven study on how the means of visual design can be used in the development of educational infographics for e-learning materials or e-studybooks. This includes finding ways to suit the visual educational content to the technical requirements and the pedagogical or other needs of the users in the best possible way, while also taking in to account any potential benefits in the production stage. As a part of this study, a visual design was created for the infographics in digital learning materials produced by the Finnish publishing company e-Oppe, and this design and the related project act as the case through which I explore the subject. The design was built so, that it is based on research and literature, user feedback and practical tests. The potential benefits of design choices are studied and demonstrated through this design project, and the

particular characteristics of this case determine the focus of the study. For example the design choices aim to suit the specific requirements of the publishing platforms and the needs of the users and creators of the content produced by e-Oppi in a best possible way in addition to attempting to apply more universal practices of creating quality visuals for infographics. Due this approach it is not my intention to cover all possible aspects related to developing infographics in e-learning materials. However, I aim to observe, demonstrate and employ the potential of visual design in infographics so, that the case makes a valid example of successful execution of visual design for infographics in e-learning. The results of this study and the visual design practices discussed and applied in the study and the related design project are also meant to be usable in any future applications.

The research used as the source material of this study and the accompanying practical design application include materials that build understanding of the subject from various perspectives. Studies done on the visual content of Finnish schoolbooks and a sample of infographics in printed learning materials were used to gather information on the infographics in Finnish learning materials, their pedagogical function and the use of infographics in learning and teaching. A publication in design research in the pedagogical field provides additional information in the practical application of innovations in the educational field. Literature focusing on infographics and visual design, and visual design in digital environment were used to give insight on the visual means in the design of infographics. The experiences and feedback received from the users in tests and pilot programmes provide additional information on which the study and the resulting design were developed. The design also evolved as more infographics were made, and the examples seen in the study are from varying stages of development. The examples demonstrate the different aspects of making infographics.

Education in Finland is going through changes that do not only affect the learning materials and the way the learning materials are produced and used, but also the practices of teaching and learning. I seek to harness the power of well-designed visuals in to being a part of making the switch to the digital environment an improvement for everyone involved, and in the following pages I hope to demonstrate the means of achieving this goal.

2 TECHNOLOGY, USERS AND INFOGRAPHICS

The technological shift from using printed books to electronic learning materials create the outlines of the environment for which the visual e-learning materials are created. The vast majority of learning materials used in Finnish primary schools and senior secondary schools at the moment are still printed books, but digital learning materials are being introduced to accompany and replace them.

The transition is taking place within a relatively short time period, as a very central part of the Finnish education, the matriculation examination is set to be digitalized starting in 2016. (Digabi, siirtymäaikataulu.) The students will be better prepared for this change, if they have learned to use computers efficiently as part of their studies well before they have to take the exams. The use of digital learning materials can be a convenient way to make people familiar with the use of computer technology in the context of learning.

For a large part, the needs of the users, the teachers and learners in this situation determine the priorities and the values when it comes to the practical side of developing an effective learning tool and a successful commercial product. The hopes and expectations of the users are then again largely based on what they are used to, and that's why it is necessary to also study the use and execution of infographics and visual content in the printed learning materials previously and currently used in Finland.

To gather exemplary printed material I randomly selected a small set of nine printed books produced by Finnish publishing companies. These consisted of history books for 7th grade primary school students, (Rinta-Aho, Niemi, Siltala-Keinänen & Lehtonen 2003 (2011); Hieta, Häikiö, Johansson, Putus-Hilasvuori, 2012) senior secondary school history books (Heikkilä, Mauriala, Hiedanniemi & Sahi 1998; Jussila, Marjomaa, Nurmiainen, Vätänen & West 2008; Saija, Laurila, Hiedanniemi, Kinnunen & Sahi 1991; Ukkonen, Edgren & Manninen 2005) and senior secondary school geography books, (Ervasti, Kytömäki & Paananen 2007; Brander, Hiekka, Ruth & Ruth 2012; Kakko, Kenno & Tyrväinen 2003 (2005)) all of which were published between 1991 and 2012.

2.1 Infographics in the traditional learning materials in Finland

For the past several decades infographics have been a prominent part of Finnish learning materials. They have been used for all kinds of study subjects, and there are infographics aimed for different age groups from primary school to senior secondary school and beyond. A study done by Jenni Kautto and Anne Peltoniemi suggests, that the amount of images in Finnish schoolbooks has increased and their quality has improved, but there is still a lot to develop especially in the execution and quality of the images. (Kautto & Peltoniemi 2006, 126—131)

As long as they have been made, printed study books have been predominantly textbooks in which images usually make up a relatively small percentage of the page layout space, even if visually dominant content has proved to be more effective in learning than verbally dominant. (Pettersson, Rune 2002, 255) In addition to these, there have been complimentary workbooks and other learning materials, such as large info boards and transparencies that are used on overhead projectors. Only a part of the illustrations in the materials are infographics, so despite their obvious presence, infographics have not traditionally gotten much room in the books. The informational value of visual content should however always be taken in great consideration. Illustrations can actually have a negative effect on learning, if they are not relevant enough and facilitate the understanding of the subject. Taking this in to account, it is obvious that the role of the visual content in learning materials should be more than just decoration. (Pettersson 2001, 26—27.)

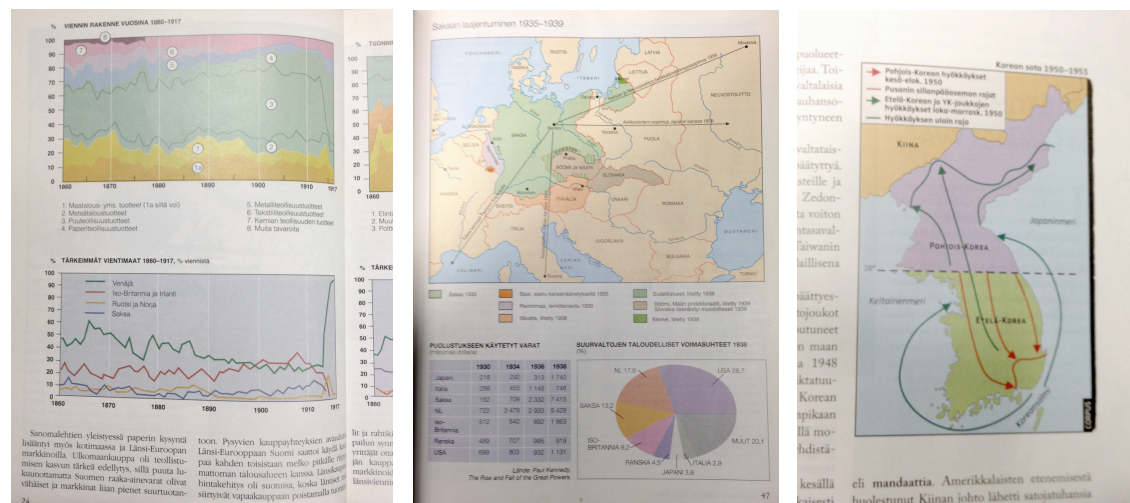
The secondary, supportive role the infographics have gotten in the printed books is not only visible in the relative space they get on the pages, but also in the content displayed in the infographics. They rarely deliver much new information in relation to the text areas, but instead act as supporting material in this perspective too. However, a Finnish study suggests that good visual learning materials can give a new point of view or a more in-depth look at the subject matter. (Kautto & Peltoniemi 2006, 112—113)

To a degree the somewhat modest use of infographics can be explained by the restrictions caused by the nature of the media used. It would be more expensive to print out larger images or more images, so they only get limited amount of space in the book.

However, if the cost effective approach deprioritizes images enough to affect the value of the content presented in them, infographics are hardly used in the most efficient way to promote learning. However, it has also been suggested that there are too many images in the books, as only a small amount of them are pedagogically valuable. Despite these claims, most studies done on Finnish learning materials encourage the ample use of visual content. (Kautto & Peltoniemi 2006, 34—36)

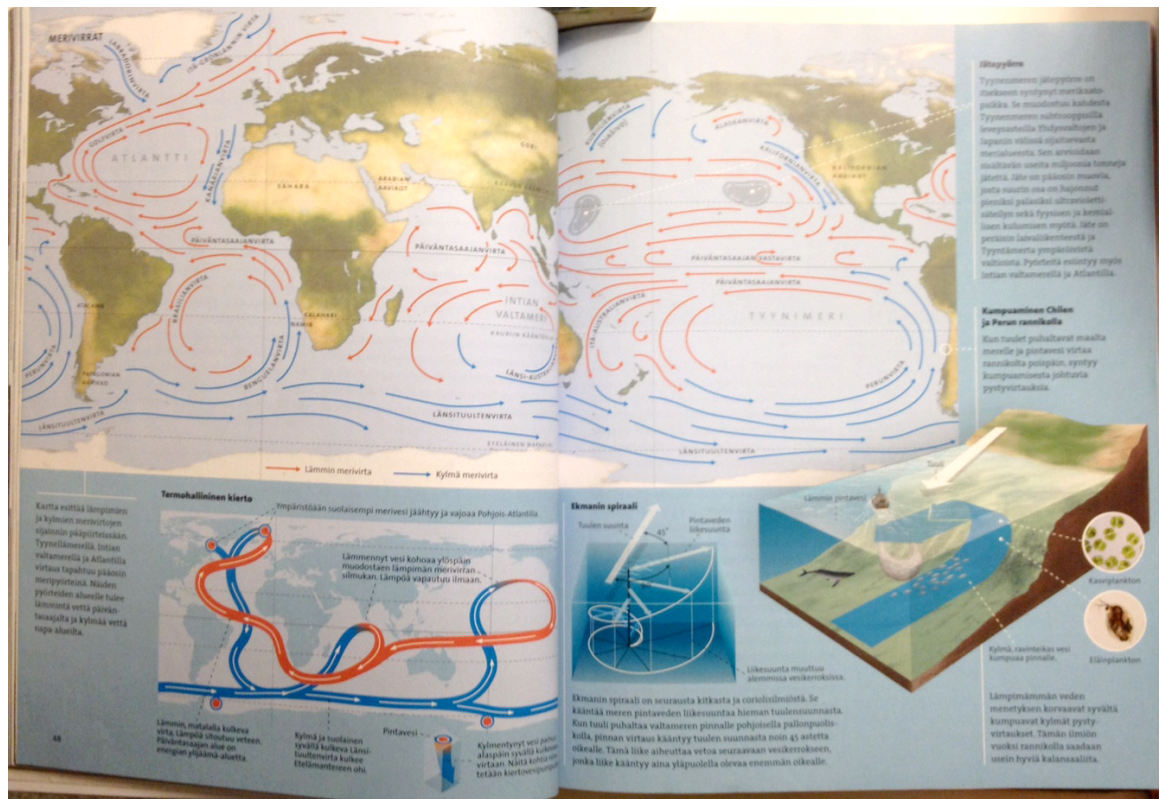
Most of the time the aesthetic side of the infographics seem to have been considered to be of very little importance. The graphs, maps and other types of informational images have a very utilitarian, minimalistic appearance and little attention has been given to how attractive or interesting they look. Colours used are often similar in all the books and chosen so that the colour reproduction in print can be maximized rather than to achieve aesthetic, informational or other types of benefits.

The similarities make it hard to tell individual books apart by the infographics, and neither can different publishers be identified through the design of the visuals in their books. Despite the similarities, it seems like little attention has been given on uniformity of the visuals within the book or the way the infographics contribute to the overall visual look.



PICTURE 1, 2 & 3. Photos of infographics in three different senior secondary school history books, the first from a book published by WSOY in 1991, (Saija et al. 1991) the second from a book published by WSOY in 1998 (Heikkilä et al. 1998) and the third one from a book published by Tammi in 2008. (Jussila et al. 2008)

The infographics in the learning materials seem to have changed very little in the past couple of decades. In only one of the books larger, more visual infographics that resemble infographic compilations seen on the Internet and editorial publications are occasionally used for an added effect. (Brander et al. 2012, 48—49) This stagnant approach to the infographics alone seems to prove that there is much that could be developed in the way infographics are done and used in learning materials.



PICTURE 4. In senior secondary school geography book published by Otava in 2012 (Brander et al. 2012, 48—49) there is some exceptionally rich visual content in the form of pages consisting mostly of detailed infographics. However, these were only occasional individual pages, and the text is still in the dominant position in the layout of the book.

There have been research projects on the image content of Finnish schoolbooks by Jenni Kautto and Anne Peltoniemi in 2006 (Kautto & Peltoniemi, 2006) and Eeva Rinne, (Rinne, Eeva 2011) that have sparked public discussions in the content of the images in learning materials and the problems seen in them. The media has been interested in the subject and the quality of the visual materials has gotten remarkable attention in Finnish media. (Isomäki Reetta 2013; Palomaa, Antti 2013) Images displaying stereotypes, misrepresentative world views, inequality, racial and cultural discrimination among other

severe issues have been found in the material, (Rinne 2011, 90—94) which makes the problems in the existing learning materials and their visual content quite apparent. Also it was noted that even if the books were rewritten to update the information in them, the images were often reused in an outdated form. (Kautto & Peltoniemi 2006, 15)

The findings of the research make it even more obvious that the usage of visuals in the learning materials is in a need of an update, and that a lot can be improved on that front. However, the research also reminds of the potential dangers of creating images that convey messages. Educational infographics may be an efficient way to display and reveal information, but when not done carefully, the interpretation might not be exactly what was intended.

The largest publishing houses producing the printed learning materials in Finland have been slow in adapting to the changing circumstances. They have created very little new original content for digital platforms, and seem to have so far mainly settled for only making static e-books directly from the printed books. These adaptations are not presented to the public openly enough to allow much looking in to them. This approach takes very little advantage of the possibilities offered by the digital environment, and the visuals or infographics have not been re-created to be optimal for the use in e-learning.

E-Oppi has taken more progressive stance, and aims to take advantage of the technological innovations and pedagogical studies by making editable learning materials on a variety of responsive learning platforms with freely available demonstrative chapters. The design of the visual content in the materials is designed as a part of this thesis. The design aims to be an implementation of researched knowledge on infographics and recent developments in the field of graphic design, thus becoming a logical part of renewing and improving Finnish learning materials. However, the materials themselves and the platforms they are published on are still partly under development, which sets its own challenges and restrictions on the design of the visual content. The need to make a large amount of ready-to-use materials quickly also makes it necessary for the design to allow fast production of great number of individual infographics.

2.2 Technology changing the setting for learning and teaching

In order to be able to develop meaningful infographics for the users, one must consider the circumstances they will be used in and the purpose of the infographics for the users. *Information ergonomics* focuses on the aspect of information design where the information system is designed based on “the information user’s aims, knowledge, experience and way of working”, as described by Rune Pettersson in his book *Information Design — An Introduction*. (Pettersson 2002, 12) These principles should be taken into account also when designing just the visual parts of the puzzle in which technology, information and the user meet.

Even when created in connection with the new technology, design is a very human centred field. (Leinonen, Teemu 2013, 71.) The focus should therefore be on the user when starting to design infographics for e-learning. The setting in which the educational organizations in Finland are making transition from printed books to e-learning is both promising and challenging. Both, the potential and the challenges are to be addressed in the way the learning materials are designed, so that they can meet the demands of the users.

Individual teachers and students all have different levels of prior experience of for example using various devices, certain types of applications or interpreting different types of information. The target group of e-Oppi’s products is very diverse in this aspect, as there are students from first graders to senior secondary school students, and there are also teachers and school personnel of different ages, who all have individual histories of teaching methods and interests. The development and design of the materials, including the visual content, should encourage to the switch to the new kind of materials to all types of users.

The target group includes people who use computers frequently and have good knowledge on different types of digital devices and applications and are interested in e-learning. This segment can have high expectations, and may not be easily pleased despite their interest. However, according to the experiences received through pilot programmes and discussions with school personnel, conservative teachers and students have proved to make one of the most notable challenges in developing new kinds of

learning materials. New technology is not always easy to approach or to put to use, even if a great part of the target group shows genuine interest towards it.

People who have been doing things in a certain way for even decades may face difficulties in replacing their old routines with new ones, which require them to for example operate devices that they are not familiar with. Adaptations of new technology and new approaches to traditional, rather well established ways of performing everyday tasks can therefore seem intimidating to people. If a part of the target group sees digital learning materials as a source of difficulties rather than an improvement, the conservative attitudes can significantly hinder the use of digital learning materials in schools.

In order to be able to create successful products in the field of e-learning, the emerging of these conservative attitudes must be well understood, and the more conservative part of the target group must be taken in to account at all times. Printed books have been considered a norm in most classrooms in Finland until these days, and switching to digital learning materials would lead to changes the ways the teaching and learning is done. Changes always require a degree of adaptation, even if the change would be a positive one. The period of adjustment then again can cause stress and uncertainty, which can understandably raise scepticism toward the adaptation of new technology.

Even if trading an old overhead projector to a video projector may not seem like a big step, switching a stack of images printed on old transparencies to an image folder in the internet can become a major change in teacher's work routine. The design of the product like learning materials and its visual content is directly connected to these daily practices and the way they are organized, and through good design the existing practices can be evolved and improved. (Leinonen, 2013, 75) In addition to this, schools and students would have to invest in devices needed to use the materials. This might cause opposition in the beginning stage, but as the digital materials cost significantly less than printed books, the financial factor has also created a lot on interest in e-learning.

Testing of products done with pilot groups and introductory events arranged by e-Oppi showed that careful introduction to the new devices, programs and the educational materials themselves significantly lessens the issues of approachability and usability for those, who have had very little previous exposure to similar adaptations of technology. It is possible to introduce the potential users to the previously unknown benefits of the

new materials, and the new and improved often starts to seem more appealing than the old and familiar. The teachers have for example been pleased to see a collection of ready-to-use educational infographics provided for them online, as this way they can easily have access to visual materials in the Internet without the risk of intellectual property rights infringement.

The acquired experiences and research agree on the importance of letting the potential customers be part of the development process. Design research focusing on education done in Finland suggests that that renewing the methods of teaching and learning can be most successfully put to use when the educational institution and its employees are thoroughly instructed on the application of the innovation, there is open communication between the different parties of the experiment and the users are able to influence the development of the innovation already at its early stages, when the innovation is still far from completion. (Juuti, Kalle & Lavonen, Jari 2013, 54.) Pilot programmes and communicating with the customers are part of the development process of the learning materials produced by e-Oppi, because both result in mutual benefits.

Direct and quick customer service enables the users to communicate with the producers of the materials while it is also one way of making a new technology based learning product seem more attractive to users. The positive feedback and the sheer volume of messages received from customers and potential users showed that it was essential for them to be able to easily contact those who were in charge of the materials and get personal guidance or recognition of their views. As the main source of the potential challenge is in the human distress of getting out of one's comfort zone, the best possible way to cater to the problem is by trying to make the change as comfortable as possible to those who find it difficult.

The way the publisher of learning materials handles feedback can actually become a great way to compete in the business as well as a very convenient channel to receive constructive criticism and suggestions for future development of materials without any additional costs. There have been times when the new learning materials were at first met with criticism, but when the criticism was welcomed and dealt as a beneficial new insight the materials can be improved by, the attitudes towards the materials turned positive. The process of design is explorative in nature and proceeds through testing and trial, (Leinonen 2013, 72) and the users can be involved in this for mutual benefits.

According to the user feedback the process of updating printed books has traditionally been very slow, and the users have had very little possibilities to affect them in the past, even in the case of clear mistakes appearing in the books. Therefore the chance to be able to give feedback, be in direct contact with the publisher and potentially have an influence in the content of the learning materials has proved to be a very valuable thing for both the customers and the publisher.

Handling the feedback naturally increases the workload of those working with the materials, but then again making it easy for the users to give feedback from the beginning also lessens the need for larger changes in the further development of the product. This also applies for the visual elements of the materials, which have been commented by teachers and students alike. Any mistakes are quickly pointed out so they can be corrected, and for example the colours in the images have been redesigned according to the perspective brought up by the users. All of this has been helpful in fine-tuning the graphics, and made it possible to create better, user-friendlier visuals from a rather early stage of development of the overall visual look of the materials. Even when the design is based on research, only the people using the service or the product can really determine if the design choices were good or bad. (Leinonen 2013, 83)

2.3 Technology creates a new environment for infographics

E-Oppi is a publishing company that creates e-learning materials and focuses on the content instead of the platform. The company's products are at the moment published on three different platforms of the company's co-operation partners. Peda.net is an editable learning platform developed by the University of Jyväskylä, (<https://peda.net>) OneEdu platform has been created by the Finnish company Mobie, (<https://www.onedu.fi>) and Apple's iBookstore distributes the materials as e-books. (<https://itunes.apple.com>)

Rooman imperiumi murenee


Julkisuus Muokkaa Kopioi Siirrä Poista

Tilaa Jan Luo uusi

Rooman valtakunnan tuho

Muokkaa Siirrä Poista

Germaanijoukkojen päällikkö Odovakar pani Rooman keisarin Romulus Augustuksen viralta vuonna 476 jaa. Ja julisti itsensä Rooman kuninkaaksi. Jo tätä ennen olivat barbaarijoukot rystäneet Rooman kaupunkia. Taloudelliset vaikeudet ja poliittiset kriisit olivat heikentäneet valtakuntaa niin, ettei sen rajoja enää pystytty suojaamaan yhtä hyvin kuin ennen. Kansainvaelluksiksi sanotun väestöjen liikkehtimisen aikana 380-luvulta 550-luvulle jaa. lukuisat eri germaaniset ja slaavilaiset heimot lähtivät liikkeelle vanhoilta asuinsijoiltaan ja tämän seurauksena monet poliittiset ja väestölliset suhteet muuttuivat.



Rooman imperiumin läntinen osa luhistui poliittisesti 470-luvulla mutta valtakunnan kreikankielinen itäinen osa säilytti Rooman valtakunnan ideaalia vielä pitkään kristillistyneessä itä-Roomassa Bysantin valtakuntana aina islamilaisen ottomaanien tulon 1450-luvulle saakka.

Pidä mielessä!

Muokkaa Siirrä Poista

Rooman imperiumin hajoamiselle ei löydy yhtä selittävää tekijää.

Valtakunta kärsi ympäristöongelmista ja inflaatiosta sekä valtakunnan rajoilla uhanneista vihollisista.

Länsi-Rooma tuhoutui 400-luvun lopulla, mutta itä-Roomassa antiikin perintö säilyi aina 1450-luvulle saakka.

Siirry tehtävään.

Lisätietoa

Muokkaa Siirrä Poista

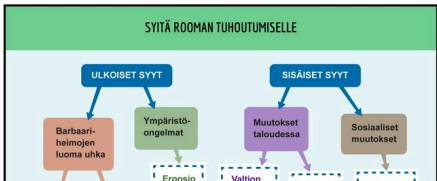
Vertaa TimeMapin karttaa Euroopasta vuonna 200 verrattuna vuoteen 500. Mitä muutoksia havaitset?

Miksi Rooma tuhoutui?

Muokkaa Siirrä Poista

Historiatieteen vanhimpia ja kenties kuluneimpia kysymyksiä on varmaankin Miksi Rooma tuhoutui? On jopa laskettu, että erilaisia selityksiä valtakunnan rappioon ja tuhoon on yli 200. Syyllisiä ovat vuoron perään olleet kristitty, passifitit, sukupuolimorali tai lyijy juomavedessä. Toisaalta on pohdittu, tuhoutuliko Rooma sanan varsinaisessa merkityksessä. Rooman valtakunnan läntiset osat rappeutuivat, mutta itä-Rooma säilyi aina 1450-luvulle saakka.

Rooman tuhon syyt voidaan kahteen pääkategoriaan: ulkoisiin syihin, kuten ympäristöongelmiin ja kansainvaelluksiin tai sitten sisäisiin syihin, kuten talouselämän muutoksiin ja sosiaalisiin muutoksiin. Yhtä yksittäistä syytä valtakunnan rappioon ei ole, vaan kyse on usean tekijän yhteisvaikutuksesta.



PICTURE 5. A screenshot of infographics on the current layout of Peda.net platform.



3.5. Euroopan talous

KESKIAJAN KAUPANKÄYNNIN HYÖDYKKEET POHJOIS-EUROOPAN JA ITÄISEN VÄLIMEREN VÄLILLÄ



3.4b. Keskiajan kauppa: hyödykkeet.

Kaupankäynnin elpyminen oli eräs keskiajan jälkipuoliskon suurta kehityksaika. Tätä ennen laajamittainen kaupankäynti (kaukokauppa ja eri maantieteellisten alueiden välinen kaupankäynti) oli romahtanut keskiajan alussa 400-luvulla tapahtuneen Länsi-Rooman tuhoutumisen myötä.

Rooman valtakunnan yhtenäisyyden pirstoutuminen lukiakiksi pieniksi kuningaskunniksi teki mahdolltomaksi koko Välimeren kattavan kaupankäynnin – ja sitä kautta myös kaukokaupan. Toisaalta Rooman valtan loppuvuosisatoina ravonnut valtava inflaatio oli tuhonnut rahan ostovoiman, minkä seurauksena myös lähialueiden välinen kaupankäynti oli romahtanut.

Kaupankäynnin kuituessa keskiajan alun Euroopassa oli palattu takaisin luontalautouteen: se vähäinen ja paikallinen kaupankäynti, mitä ihmiset harjoittivat, perustui hyödykkeiden vaihtamiseen toisen hyödykkeeseen.

Kaupankäynnin ehytminen vaikutti suoraan kauppaä harjoittavien kaupunkien kokoon

Länsi-Euroopassa: keskiajan alkupuolen kaupunkien koko ja asukasmäärä olivat pienet verrattuna edeltävään antiikin aikaan. Kaupankäynnin käynnistyttyä raha palasi takaisin, ja samalla myös kauppaä harjoittavien kaupunkien koko alkoi kasvaa.

Miksi kaupankäynti alkoi elpyä 1000-1100-luvulla?

Muutos aikaisempaan oli se, että ensin Euroopassa syntyi kasvanut tarve alueiden väliselle kaupankäynnille.

Mikä sitten synnytti aikaisempaa suuremman tarpeen alueiden väliselle vaihdannalle?

Tämä liittyy edellä esillä olleeseen väkiluvun kasvuun, mikä oli kiihtynyt 1000-1100-luvulla. **Maaseudun väestö** alkoi hakeutua kaupunkikeihin, koska peltaja ei kyetty rivaamaan lisää eikä viljely antanut näin paljon tuloja kaikille. Kun kaupunkien alkoi muuttua lisää väkeä, niissä syntyi samalla lisääntyä kysyntä maaseudun tuottamalle

ruualle. Näin tarve alueiden välillä tapahtuvalle vaihdannalle kasvoi. Kaupunkilaiset ostivat aikaisempaa enemmän maaseudulta tuotettua ruokaa, johon varausuutta alkoi kerääntyä maaseudulle.

Nyt maaseudun asukkaat puolestaan saattoivat ostaa aikaisempaa enemmän kaupungeissa toimivien käsityläisten tuotteita, mikä puolestaan loi edellytykset kaupunkien varausuuden kasvulle. Varausuuden kasvu molemmissa – sekä maaseudulla ja kaupungeissa – loi puolestaan edellytykset sille, että nyt syntyi kysyntä kaukokaupan välittämille hyödykkeille. Aikaisempi vaihdanta oli ollut luontevaa paikallista kaupunkien käsityläiset olivat myyneet tuotteitaan markkinoilla, ja ostajat olivat olleet kaupungin tai läheisen maaseudun asukkaita.

Kaupankäynnin olesseä pysähdyksissä ei kaupungeissa ollut yksinomaan kaupasta elantonsa saavaa ryhmää eli porvareita – tai sitten se oli lukumääräisesti hyvin pieni. Aasiat alkoivat muuttua. Uusi pimeä oli se, että nyt ihmiset halusivat kauempaa tuottuja hyödykkeitä. Kun kaupankäynti oli lähtenyt liikkeeseen tiivakalle tai paremminkin sanottuna – sille oli syntynyt aikaisempaa suurempi tarve – otettiin uudestaan käyttöön vaihdantaa helpottava väline, raha.

1200-luvulla eteeräpän Euroopassa käytävä kauppa poikkei aikaisemmasta. Nyt oli kysyntää sekä ylellisyyshyödykkeiksi katsottaville tuotteille, naka-ainelle, elintarvikkeille ja Euroopan sisällä valmistetuille käsityötuotteille. Mistä näitä hyödykkeitä saatiin ja ketä niitä väliin?

Kysyntää vastaamaan syntyi Pohjois-Euroopasta, Itämereltä, Keski-Euroopan halki aina Välimeren rantaan asti ja sieltä eteeräpän kulkeva kaupankäynnin ketju. Eteläisten hyödykkeiden viita kulki modernin suoran. Itämeren alueella kauppaä hoiti Hansa-liitto, Itämeren kauppaäkaupunkien yhteisliittymä. Suurimillään siihen kuului yli 70 itämeren ja Pohjanmeren kaupunkia. Hansaan kuuluivat kaupungit sopivat keskenään hinnoista, kauppaähdöistä

ja –ollais pannonit (toisin sa standardit järjestämi

Aikaa myöskin – Itämerellä kipeillä ajankunmanhan takaan siltä Hansa

Hansa välellä ten turkkien Etelä ja dykkeitä käsityö

Maustalla puolekon vat maust mi, inkä se tekijä pungi se väittäimä teellisen väittäimä maustet

3.5c. Kauppa

3.5d. Kauppa

EPOOKKI 1 - Ihminen, ympäristö ja kulttuuri – 3.5. Euroopan talous

PICTURE 6. A screenshot of infographics on the current layout of OnEdu platform.

Giving several options on platforms on which the materials can be used provide flexibility for the prospective user, but it also requires more work in making several adaptations of the materials. The variety of platforms allows the users to use the materials according to their personal habits and preferences. The educational institutions are often bound to use certain platforms assigned for them, so it is important to have options available. In addition to this, basing the materials on responsive web design while making them accessible on basically any device with an Internet connection requires scalability from the infographics as well. The materials may be used on anything from big screens to tablets with high-resolution displays to relatively small mobile devices and also in offline state.

The schools and students have different resources in acquiring devices, and in order to make the materials available for as many as possible, the developers of the platforms aim to have them work on even relatively old devices and software. This means that the content needs to be usable on three platforms and almost all devices that have access to the Internet. This can be beneficial for many users, but it also creates significant restrictions on what kind of content can be included in the materials. At this point, it for example rules out the use of more dynamic or interactive content. Interactivity can be visually and pedagogically effective in infographics, but currently static images are more reliably displayed by the range of the devices and software used by the potential customers. However, as the platforms are developed further, the oldest generations of devices and software currently used are eventually left out and the core of the visual content is executed in a static form, other types of applications can be added to complement the existing content. For this reason, the design of the visuals should also be easy to adapt to any future applications.

Creating learning materials for a huge number of users and a broad range of different devices and platforms is bound to be challenging from many perspectives. First of all, it is recommendable to execute the design of the infographics so that the visuals and colours are compatible with the design of the platform. However, attempting to match the visuals is difficult when there are three platforms with different layouts. In addition some of the platforms and their appearance are still being developed, which will change the way they will look in the future. Luckily this also means that there might be opportunities to influence the design of the platforms in the future so that their design could be made compatible with the visuals in the learning materials. One of the biggest diffi-

culties of dealing with many types of devices is that there is no realistic possibility of making absolutely sure, that the individual devices that the user has work as they are supposed to, or that they are displaying all the materials in an optimal way despite the best efforts of the publisher. It is impossible for the publisher to fully control things that are dependent on the users, service providers or the hardware, but still only potential problems on these fronts can prevent the effective use of the learning materials or harm the reputation of the e-learning or individual producers in a massive extent.

The successful usage and displaying of the e-learning materials and the visual content in them is dependent on the technical devices, so any potential issues with these must be taken in to consideration. People belonging in the target groups have proven to be very interested in the reliability of technical devices and the risks involved in relying on technology. For example, one of the most frequently reoccurring questions in this area is that what would happen in case of a failing Internet connection.

One of the most important solutions to these concerns is being easy to contact, should any problems occur. Even if it cannot be guaranteed that electronic devices or applications will always work perfectly, it makes a huge difference for the user to know that the company providing the materials will continue to support its customers after the purchase, and that help is offered also with those matters that affect the use of the materials even if the company isn't directly responsible for them.

With infographics one of the greatest concerns is the quality and the settings of display devices in the classrooms and users homes. Especially video projectors have proved to be prone to cause difficulties in tests e-Oppl has done on different devices. With wrong settings, the projector can make images lose a significant amount of colour depth and saturation, making them look entirely either very light or very dark. In worst cases, the colours are distorted so much that the informational value of the image is lost almost completely, and for example the readability of the text within the image is lost.

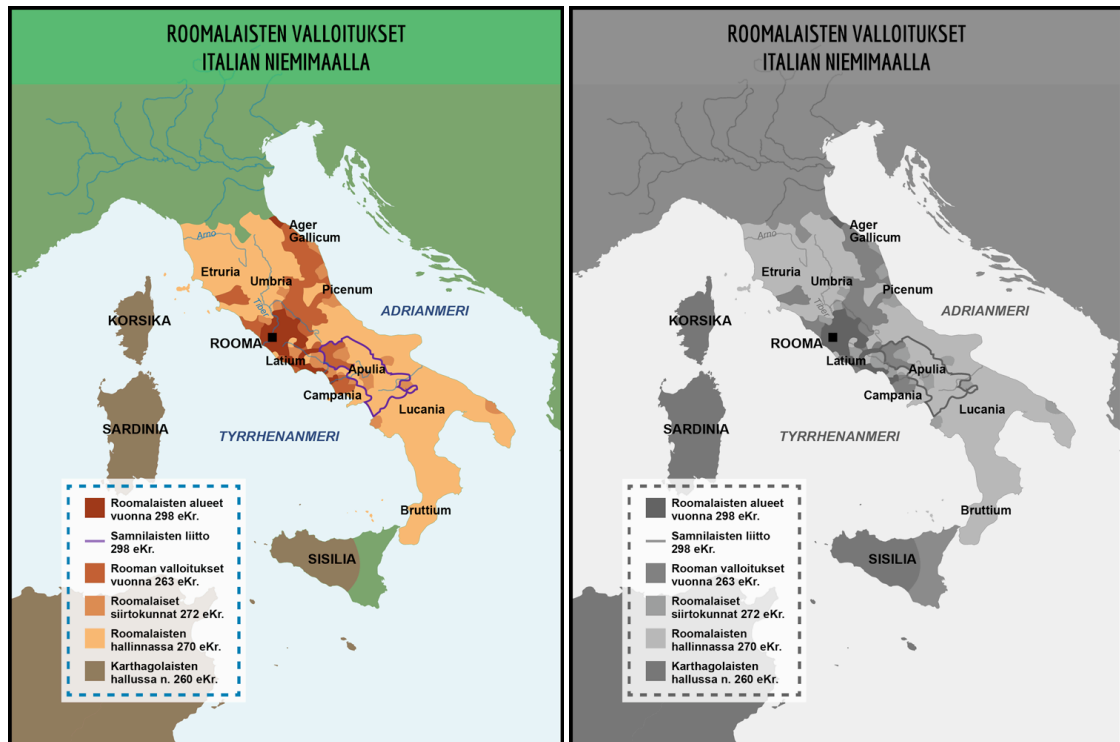
Being prepared for certain difficulties with setting up the devices correctly can be a significant help. For example, providing at least a rough guide on adjusting the settings of a video projector will help the school personnel make the colour on the learning materials display in a better way, in case the projector settings would make them unrecognizable. Making clear illustrated tutorials or video tutorials on the correct use of the

materials on most common devices and writing instructions on how to do troubleshooting should provide some guidance on how to avoid the most common technical problems.

Sketching, making prototypes and testing the material are an integral part of the design process. (Leinonen 2013, 72) Testing is also the most important way to locate any potential problems should they occur. The visual materials need to be viewed on different platforms, browsers, displays and in different sizes while the images should be able to remain representable. Series of tests have been done for the visuals in the beginning stage of designing a graphic style that was going to form the base template for the infographics in all learning materials produced by the company.

Practical tests were performed on a wide range of devices commonly used by the prospective users such as video projectors, different types of computers and laptops, tablets and mobile phones. The infographic prototypes and colour samples were viewed on them using several different display settings to inspect the visibility of the colours and colour combinations and text elements such as font faces and font sizes. Through these tests and a necessary amount of adjusting in iterations it could be ensured that the key elements maintain their informational value as independent of quality and settings of different displays as it is humanly possible.

Even if one is creating infographics predominantly for the digital environment, it must be taken into account that there is also a possibility to print the materials on paper. The ability to print the materials can be important to some users and aid in the transformation towards using digital learning materials, so it is recommendable to have the visuals retain their usability also in printed form. It is not uncommon that printers lack the possibility to use colour, so the visuals should remain informative also in greyscale. This can be ensured by keeping reasonable differences in the tints and shades of colours selected for shapes and markings positioned next to each other.



PICTURE 7. A map in full colour and in greyscale. The varying tints and shades allow the markings to retain their informational value even when seen or printed in greyscale.

3 INFOGRAPHICS AS VISUAL MATERIAL

Infographics or information graphics are visual representations of different types information or data. Infographics are used widely and in varied ways globally, in anything from traffic signs to maps, tables and charts, while they can also be complex compilations of text and images to create powerful displays of news events, to list just a few examples. What do infographics consist of and what does one operate with when designing infographics? These questions are addressed in the following chapter.

3.1 Infographics as a form of communication

Like stated earlier, infographics are a combination of text, images and graphic design which are used to convey information. According to Rune Pettersson's book *Information Design — An Introduction*, infographics and the practice of infography can be summed up in the following manner:

Infography is the actual, practical formation and execution of structured combinations of text, pictures and graphic design. (Pettersson 2002, 30.)

Rune Pettersson describes the work of a person creating infographics in a following way:

...Infographer needs to have skills in writing comprehensible, clear and consistent texts, in creating clear illustrations, and in creating clear, transparent typography and layout that aids understanding and learning. (Pettersson 2002, 30.)

In the 1950s and 1960s images, words and graphic design related to them started to be studied as a means of producing messages that would be easy to understand. This was labelled as “informative layout”, “lexi-visual layout” or the “third language”, which solely by the choice of words reveals the significant advantages the design appeared to have in conveying messages. (Pettersson 2002, 25.) Today the design work involved in making infographics can be categorized as information design and graphic design, both of which focus mainly on the slightly different aspects of design. Rune Pettersson describes information design in the following way:

In order to satisfy the information needs of the intended receivers information design comprises analysis, planning, presentation and understanding of a message — its content, language and form. Regardless of the selected medium, a well designed information set will satisfy aesthetic, economic, ergonomic as well as subject matter requirements. (Pettersson 2002, 9.)

According to Pettersson, graphic design could be defined in this manner:

...the art and craft of bringing a functional , aesthetic and organized structure to groups of diverse elements. (Pettersson 2002, 167.)

Both of these are then again subject to the general term of visual design, which comprises the design of all kind of communication that takes a visual form.

Infographics act as illustrations and help to create a more attractive layout to publications. However, they should always be more than just a decoration or an added bonus to the text, (Pettersson 2011a, 26—26) and when designed appropriately, they can be used as a powerful educational tool. Their aesthetic qualities can also help in learning, as infographics can create added interest in the learning materials simply by making them look more interesting by providing an occasional break to the often quite text-oriented learning experience. (Lankow et al. 2012, 30)

Infographics are a way of presenting information in a visual form, and this stimulates human senses in a different way than a read or spoken text does. Infographics add another dimension to the experience of learning, and bring more variety in the way the information is presented. Information received through several sensory channels is perceived more effectively than it would be through just one channel. (Pettersson 2002, 248) Some may be more inclined to perceive information more efficiently through visual stimuli. However, all students (Excluding those who are suffering from a severe impairment of visual senses, such as blindness) are capable of effectively learning from information that is offered in a visual form. (Lankow et al. 2012, 44)

Images express information differently than text, and it is often possible to for example reveal the relations of different matters in a more concrete way in a form of an image than it would be through text. A Finnish study suggests, that educational information can be at its best when offered in visual form. According to their experiences, teachers

believe that sometimes image is the only effective way to convey certain messages. (Kautto & Peltoniemi 2006, 24)

3.2 Design choices based on human perception and behaviour

Intrinsic characteristics of human interpretation of visual information make up the foundation on which anyone operating within the field of visual design should base their work on. These include understanding the ways the human eye and the brain interpret images. When dealing with infographics these principles might become even more important, as the value of the image as a source of information is dependent on how easy it is to perceive, process and remember the information provided in the image. (Lankow et al. 2012, 30) Even seemingly small decisions, like for example individual colour choices or the way the different elements are placed in the composition of the image can have massive implications on how people interpret the things they see.

The technology sets the boundaries for the display and the use of the learning materials, and it also creates the framework for the conditions for which the visual content is designed. The very first and probably the most obvious thing to take into consideration is the visibility of the images, it being the basic requirement for the successful use on any visual content. Clarity and simplicity were also listed as the most important design features teachers hoped to see in the visual content of learning materials. (Rinne 2011, 113—114; 132)

As the materials produced by e-Oppi are used on different types of responsive platforms and devices, scalability is an important matter. Relevant details must retain their informational value regardless of the device, as the materials can be used on a high-resolution tablet screen, video projector or a mobile phone. Making choices that promote the readability of the text in the images is also of crucial importance, as most infographics do more or less rely on written content.

Adobe Illustrator was chosen as the program on which the graphic templates for the infographics were to be created. Vector images are easy to scale and edit to different sizes without loss of any information, and they are also well suited to making simple and clear graphics. Designers and illustrators, including the freelancers who occasion-

ally create additional image content for e-Oppli, commonly use Adobe software. Using compatible software between co-workers keeps the workflow fluid, and the materials can be easily transferred from a person to another and also between different Adobe programs for any potential needs to combine for example digital paintings, vector images and animation. Due to their adaptability vector graphics are a good choice also because they can be easily put to new uses in any potential new applications in the future, and for example videos or interactive infographics are easily created from vector elements.

Type is a very important element in infographics, as it influences greatly both the looks and the usability of the image. The typeface used in the main content needed to be very easy to read even on demanding situations, like when placed on a busy background on a map. Simple Sans Serif fonts work well in uses like this, and their minimalistic appearance fits well for the aesthetic qualities of the infographics. (Pettersson 2011c, 59) Of this category of fonts, Arial is widely available in all computers, so it was chosen as the main font to be used in the text content of the infographics. It is often used in bold for emphasizing words and for even better readability.

The same font that was used in the book covers, *Economica* was chosen for the headlines in the infographics, as it would create continuity within the materials and emphasize the headlines even more. The size of the font affects the legibility greatly, and the letters must be big enough to be as readable as possible even when the image is scaled down or displayed in less than optimal circumstances. However, the text elements should not be made so large that they would be disproportionate in relation to other elements in the image and the informational value they possess.

Colours have a massive impact on how an image is viewed and understood. In order for the colours to be displayed appropriately, they must be produced on settings that are best suited for the digital environment and the particular requirements set by the platforms the infographics will be published on. Using RGB colour space settings and converting the vectors to web-friendly PNG-24 format for the final publication retain the colours and details well on digital displays. Additional benefits of PNG images are that they are readily supported by different web browsers and all the platforms used by the publisher.

The way the colours are chosen and reproduced on the displays of the users first of all affect the legibility of the text and visibility of the elements. There must be a stark contrast between text elements and key elements in the image and the background to retain the informational value. For this reason, the background colours chosen for the infographic template are light, while the text is usually black, and the main elements are done in bright colours that are easy to distinguish from each other and the background.

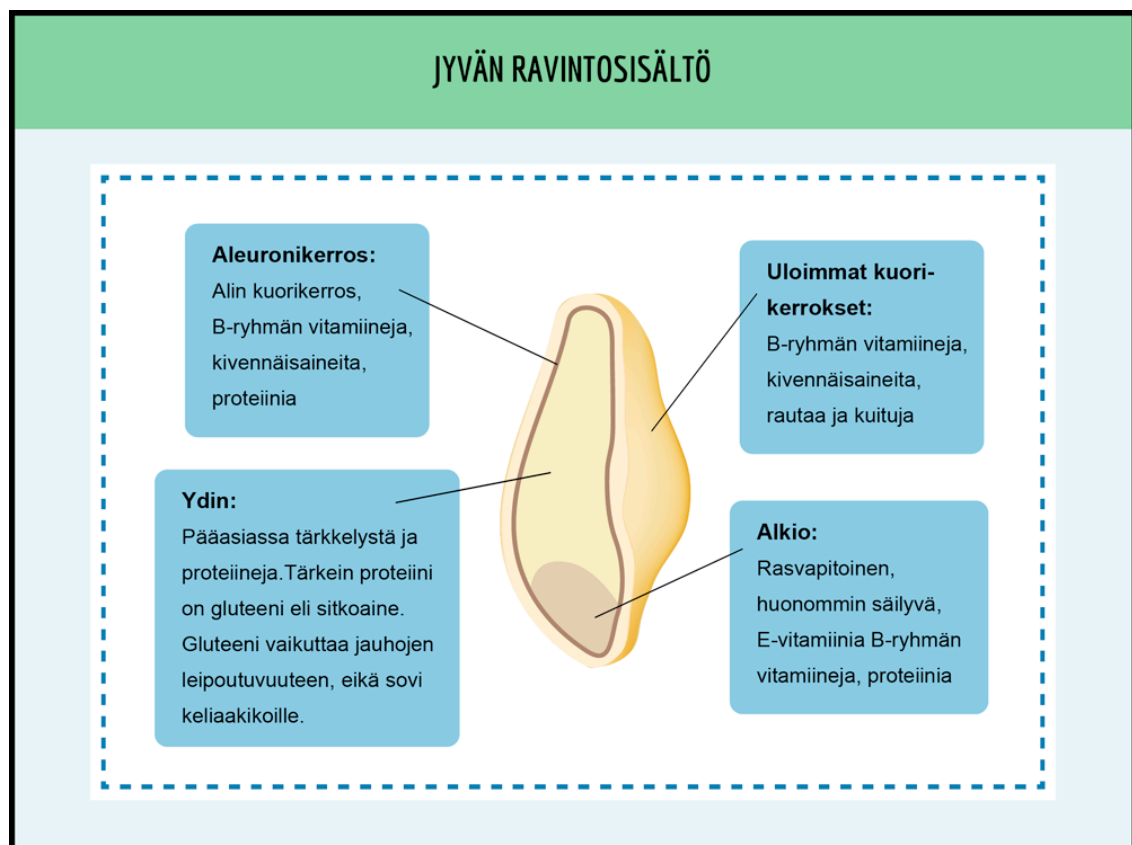
There is a group of users that requires special attention in the choices of colours used in learning materials. Visual impairment such as colour blindness can weaken a student's ability to learn by visual materials. The most common form of it, red-green colour blindness affects a relatively large proportion of the population. It is estimated that up to 8-10% of the male population and 1% of female population suffer from these anomalies. (Pettersson 2002, 226.) The potential problems caused by these conditions can be addressed by favouring less risky colour choices and through the same means that enable printing in greyscale, the use of tints and shades in values that vary enough to keep individual elements and shapes recognizable even without saturated colours.

Colour is also always relative and dependent on the environment. The perception of colour is based on light, and light can change the appearance of colour drastically. Colours situated next to each other also influence the way both of them look. (Hashimoto, Alan 2003, 200—202.) Therefore it was important to first choose the colours for the most significant parts of the design, and make sure that those fit together with the rest of the materials and the colours seen in them.

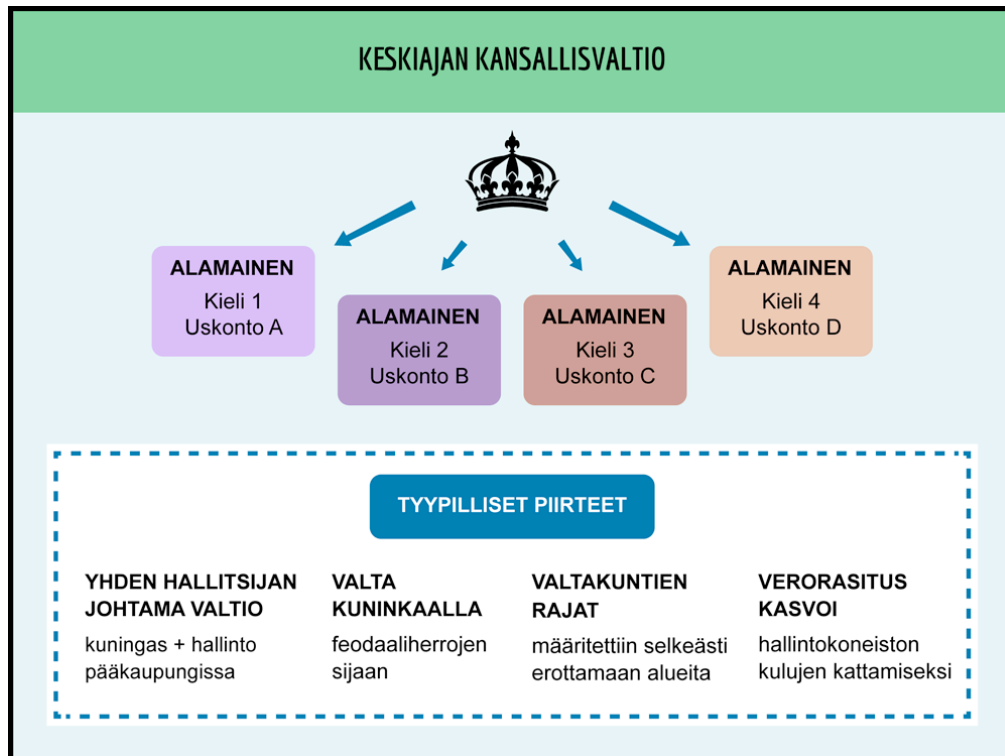
The background and the header are elements that remain the same in all infographics and act as a base on which other colours in the image constantly compare to. Due to this it was meaningful to choose a light version of e-Oppl's signature blue as a background colour for the template and somewhat more intense semi-transparent cool green for the header section. The brighter colour in the header emphasizes the header, while the transparency subtly connects it to the content, should there be elements on the background below it. The blue forming the background of the template keeps the infographics harmonious with the rest of the company materials. The human eye is naturally attracted to large clear elements and elements with bright colours and contrast. (Pettersson 2002, 225) Using a light tint of the blue allows the use of stronger colours on the informational elements of the image while it keeps them easily distinguishable from the

background, shifting the attention of the viewer towards the content. Black borders were added in the infographics to make them stand out more.

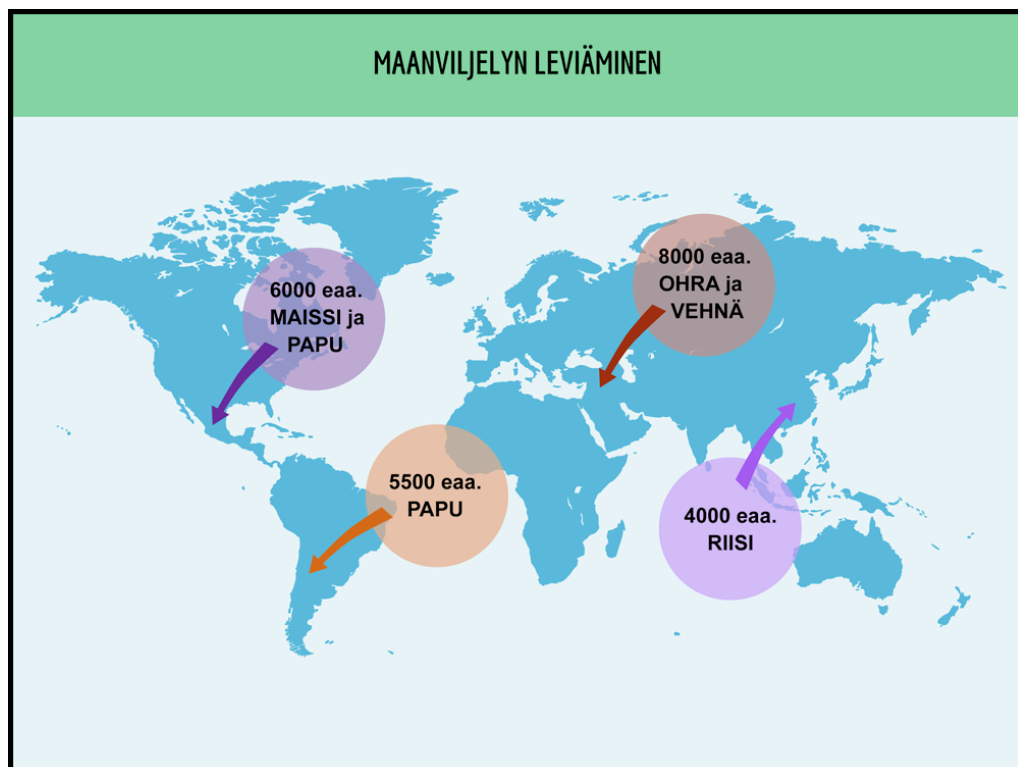
The purpose of the design is to make the infographics both pop out from the materials and to also fit within them seamlessly. A large part of the challenge in communication through infographics is often in including lots of information in a small space while keeping it easily understandable and visually appealing. Retaining a reasonable amount of contrast and variety between coloured elements while avoiding overly chaotic amount of colours and different types of elements in one image keeps the images clear and harmonious, and helps maintain the focus on the central content and the message it is supposed to convey. Easily recognizable visual elements that we connect to the things we see in the natural world capture our attention and convey messages easily. For this reason including images and pictures in the infographics make improve their effectiveness.



PICTURE 8. Home economics illustration as an example of the design of the infographic template.



PICTURE 9. History illustration as an example of the design of the infographic template. In this infographic colours are used for categorization, but company colours are still present and the same style is seen in the text box elements.

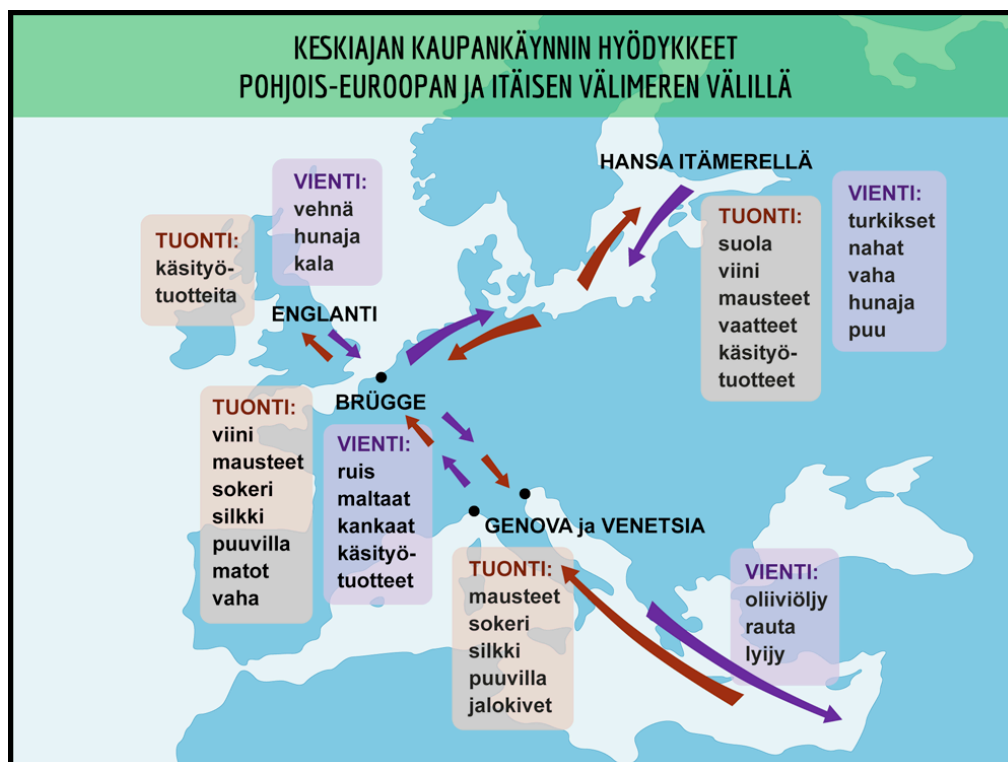


PICTURE 10. A history map as an example of the design of the infographic template applied to a map. Type, text boxes and colours are used in the same manner as in the previous examples.

People have a tendency to look for a relationship or an order in the combinations of different elements within an image, and instead of focusing on smaller elements they seek for a larger form consisting of these parts. This phenomenon is called the Gestalt principle, and it has been widely researched and used in graphic design to create desired impressions and messages with images. (Hashimoto, 2003 25—26.) The Gestalt principle must be taken in consideration when designing infographics as well, as the information is often built on the combination of several elements. All elements and colours within an image should be well balanced, as the human brain intuitively looks for balance in the structure. (Pettersson, 2011c, 21) Through the arrangement and design of the elements within the image both of these phenomena can be used to build better infographics.

The cultural background of a person has a great influence in the way an individual interprets visual information. (Pettersson 2002, 228—229.) For example the writing system that a person uses has a great effect on how he or she looks at images and how they process the information provided in the image. For example, in the western world the writing system of Latin script has accustomed people to look at pictures from left to right and receive information from them starting from the left and proceeding to the right. In Middle-Eastern and Asian cultures it is however customary to interpret visual images in an opposite direction, as Arabic alphabet is read from right to left. The placement of elements on infographics should be done based on this behaviour, so that the information is delivered in a meaningful order and manner.

These learned cultural habits set the basic rules on the way people are inclined to proceed when interpreting information within an image. However, through design choices the order and direction in which the content of the image is processed can be affected to some extent, and through the same method the content can be categorized and certain kinds of information can be expressed more effectively. The human eye observes the surroundings through the basic shapes they see in it, dots, lines and areas. (Pettersson 2011b, 182.) These can be employed effectively in infographics. For example clear lines within an image steer the viewer's eyes towards and along them, making it possible to lead the viewer's eyes within the image to the desired direction. (Pettersson 2011c, 185)

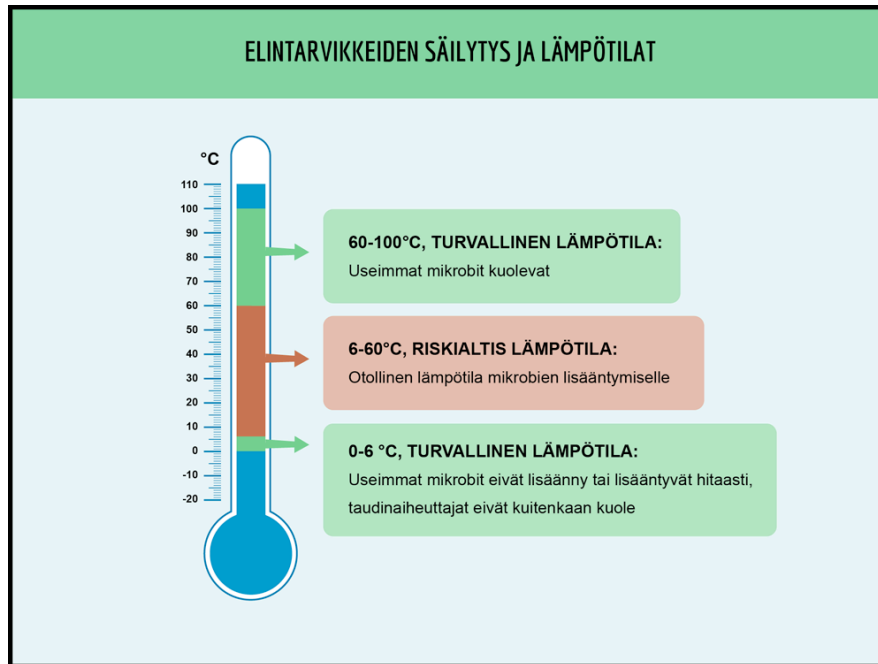


PICTURE 11. A history map as an example of the design leading the viewer's eyes within an image through the use of lines. The viewer's eyes are directed through the image by the lines that the arrows create.

The interpretation of colours and the symbolic use of colours also often have a connection to the cultural background of a person viewing them. Sometimes there is also a relatively universal symbol value in certain colours and colour combinations, which can be used to convey messages, either intended or unintended. One of the most well known examples of this kind of colour symbolism is the trio of red, yellow and green of the traffic lights. One must be aware of these connotations while choosing the colours used in the design, and only use them when they clearly and obviously support the message, like stated by Rune Pettersson.

It must always be clear and easy to understand for the receiver when colour and typography is used for decoration and when the use is meant to have some cognitive importance. (Pettersson, 2011a, 27.)

Distinct symbols can be used to improve communication through images, (Pettersson 2011c, 43.) and the symbolic use of colours has been occasionally applied in the infographics in the learning materials produced by e-Oppi. The practice is demonstrated through the examples provided below:



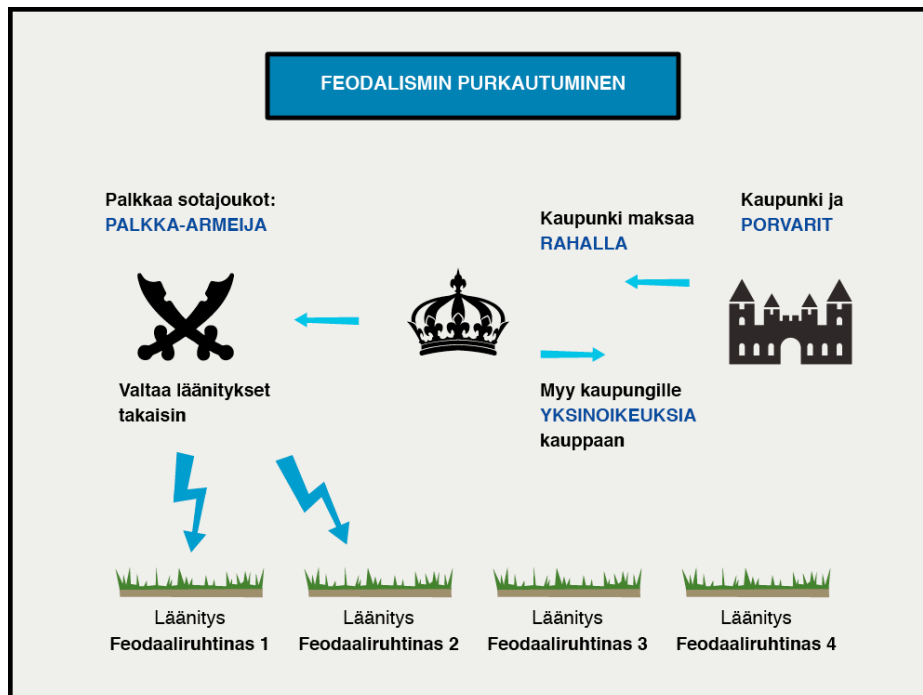
PICTURE 12. Home economics illustrations that utilize symbolic colours to enhance their communicative power, example 1. In order to be informative to those suffering from impaired vision such as colour blindness, the simple forms in the graphics remain functional also when desaturated.



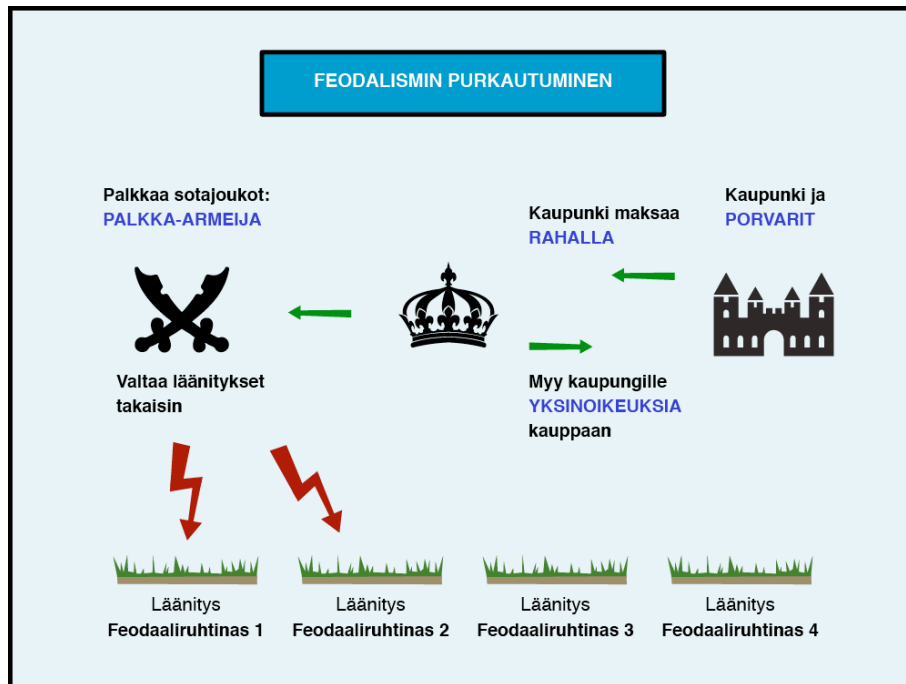
PICTURE 13. Home economics illustrations that utilize symbolic colours to enhance their communicative power, example 2. In this case the colours are an added effect that is helpful for the majority. Simple visuals with recognizable images are also informative without colours, so the visually impaired will be able to understand the messages.

At the early stage of development of the graphics template three colour scheme options were created for the infographics, each operating on slightly different logic and each of them therefore having a slightly different theme. The first one uses neutral colours that are familiar from the company colours and the colours seen on the learning platforms used by the company. The second one uses symbolic colours according to the rules discussed above and the third one is relying on strong contrast colours without direct and obvious symbolic meanings. Of these alternatives, the contrast colours were chosen to be used on the infographics, and the design was developed further and used for new applications.

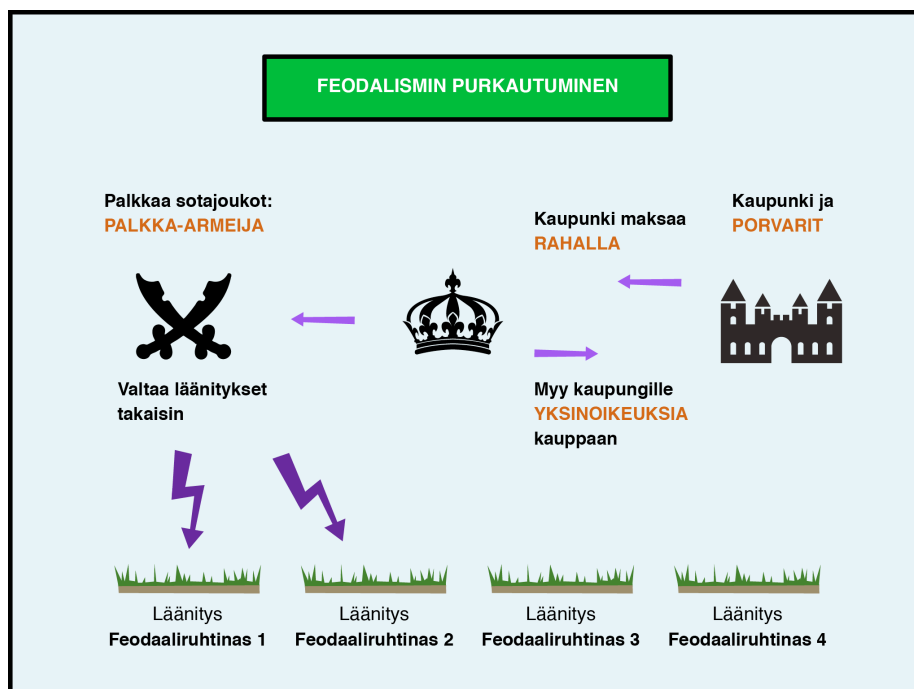
The different colour scheme options for the infographic template prototype are displayed below:



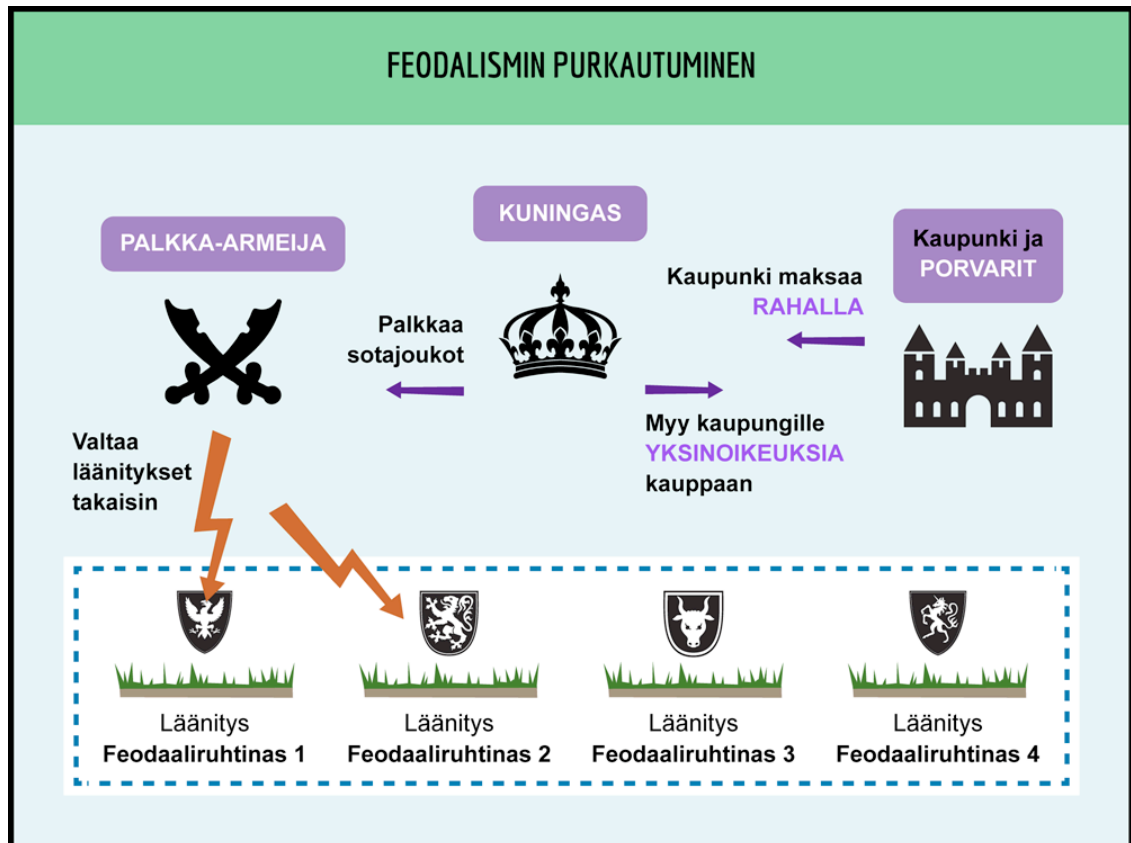
PICTURE 14. The colour scheme executed in neutral company colours. These colours look harmonious and fit well on the company's previous materials and the learning platforms used by the company. However, they are not as effective in capturing the attention of the viewer as stronger colours could be, and are more likely to blend in the background.



PICTURE 15. The colour scheme built on symbolic colours. This colour scheme takes advantage of the most well-known and least culture-dependent use of colour symbolism. The reds depict aggression, the green co-operation and the blue markings are neutral. These colour choices are usually well understood, but they do not look very original and in many applications they might prove problematic or judgemental.



PICTURE 16. The colour scheme consisting of contrast colours. This colour scheme operates on bright, strongly contrasted colours that seek to capture the attention of the viewer. This colour scheme was chosen, as it was seen as effective and easily adapted to most applications.



PICTURE 17. After the colour scheme for the graphic template was chosen, the style of the graphics was developed further.

A good design must also be designed according to its target group. In case of learning materials produced by e-Oppi, the infographics and their design must be applicable to many age groups ranging from 6-year old first graders to 18-year old senior secondary school students. The template of the graphics should be easily adapted for the needs of different types of learners.

The youngest primary school students have very different capabilities to process information based on their biological level of development and learning history than senior secondary school students, (Pettersson 2002, 83) but content aimed for either of them should be easy create on the same template. This can be done by adjusting the amount and complexity of information delivered within the images without having to change the basic elements of the template or for example the colour scheme. The execution of adjustments is studied in the following chapter through examples.

To sum it up, good design of infographics recognizes the rules of visual perception that are based on the human senses and the biological and behavioural factors that affect the

processing of information provided in visual format, and takes advantage of them to produce more effective visuals. When infographics are designed for educational materials, the design should above all encourage learning and convey messages that are easy to understand. The needs of the digital environment and the different devices must be taken into account and the design must also enable the use of visuals in new applications in the future. Adaptations to different types of content require the graphic templates to be versatile, while the visuals should still look harmonious and compatible with the rest of the materials.

4 INFOGRAPHICS AS VISUALISED SCIENTIFIC INFORMATION

As the use of the Internet has become more common and the amount of all kinds of information on the Internet has increased, also the use of infographics in many types of applications done for different purposes in wildly varying quality have spread all over the web. (Lankow et al. 31.) This not only makes it logical to also extend the generous use of infographics into learning materials, but it has also made it even more important to teach people to understand infographics in order to successfully use them in learning.

Infographics are used as visualizations of very different types of information for varying purposes. Subject to the general rules of information design, all infographics must be efficient and clear in displaying information to be effective in fulfilling the needs they were created for. However, depending on the purpose, it may greatly change the priorities in the design of the infographic. The comprehension, appeal and retention are the requirements of a good infographic in all types of uses, but they are prioritized according to the use. For example in marketing appeal and retention are more important aims than the comprehension of the content, while in infographics created for academic research comprehension and retention are valued far more than the appeal. Then again in editorial use the appeal and comprehension are the most significant factors. (Lankow et al. 38.)

The infographics made for learning materials do not belong strictly to any of the groups mentioned above, however educational materials do share a close relation to academic and scientific material. Most of the learning materials are based on academic research, and understanding the scientific nature and the background of the information provided is also an important part of learning. The learning materials are also commercial publications, but compared to the informational value marketability and related aspects are of secondary importance in the design of the content.

The great variety in study subjects offered for students in Finland means that there are significant differences also in the ways the different fields of study present the information. These conventions should be reflected in the way the learning materials are made for certain study subjects in school. Infographics in learning materials can be considered as visualizations of several fields of science, being educational representations of scientific information. Good design in infographics involves knowledge in the substance and

statistics besides the artistic skills. (Pettersson 2011b, 148) These determine the framework on which reliable content can be built. The authors and editors who specialize in the content provide a plan on the content and execution of the infographics they hope to include in the materials. However, the visual designer creating the graphics can only make the best possible design choices if he or she is also aware of rules that affect the design.

In a study teachers were asked what is required of good visual learning materials. The demonstrative nature of the images and relevance were the most sought after features. The demonstrativeness should be also extended so, that the visuals also reveal the relationship of the context and the subject matter. (Kautto & Peltoniemi 2006, 108—109.) Alongside the informational value, learning materials should include ethical values as a part of their educational goals to be pedagogically complete. (Kautto & Peltoniemi 2006, 19.) All of these aspects make the design of the infographics very content-driven.

Communicating efficiently in any manner requires skills in creating and receiving messages through that particular method of communication. This also applies to the educational infographics, which should be built to encourage the development of the ability to use many different types of infographics such as tables, charts, graphs, mind maps and maps.

4.1 Infographics as a representation of information

Quality infographics in learning materials can help the students become more skilled in learning. Results like this are achieved when the infographics promote and help build the skill of information literacy of the learner. Information literacy is a complex ability to find, recognize and analyze reliable factual information and use it in decision-making and practical applications. Rune Pettersson describes information literacy shortly as “the ability to access evaluate, and use information from a variety of sources.” (Pettersson 2011a, 17.) Information literacy is therefore essential for students in order for them to be able to develop as learners. Information literacy also forms the basis of source criticism. The importance of source criticism can then again hardly be overestimated in modern learning, as the overabundance of information in the Internet and the world sur-

rounding us makes it much more difficult to determine the validity of the information that is offered to us than to find information in general.

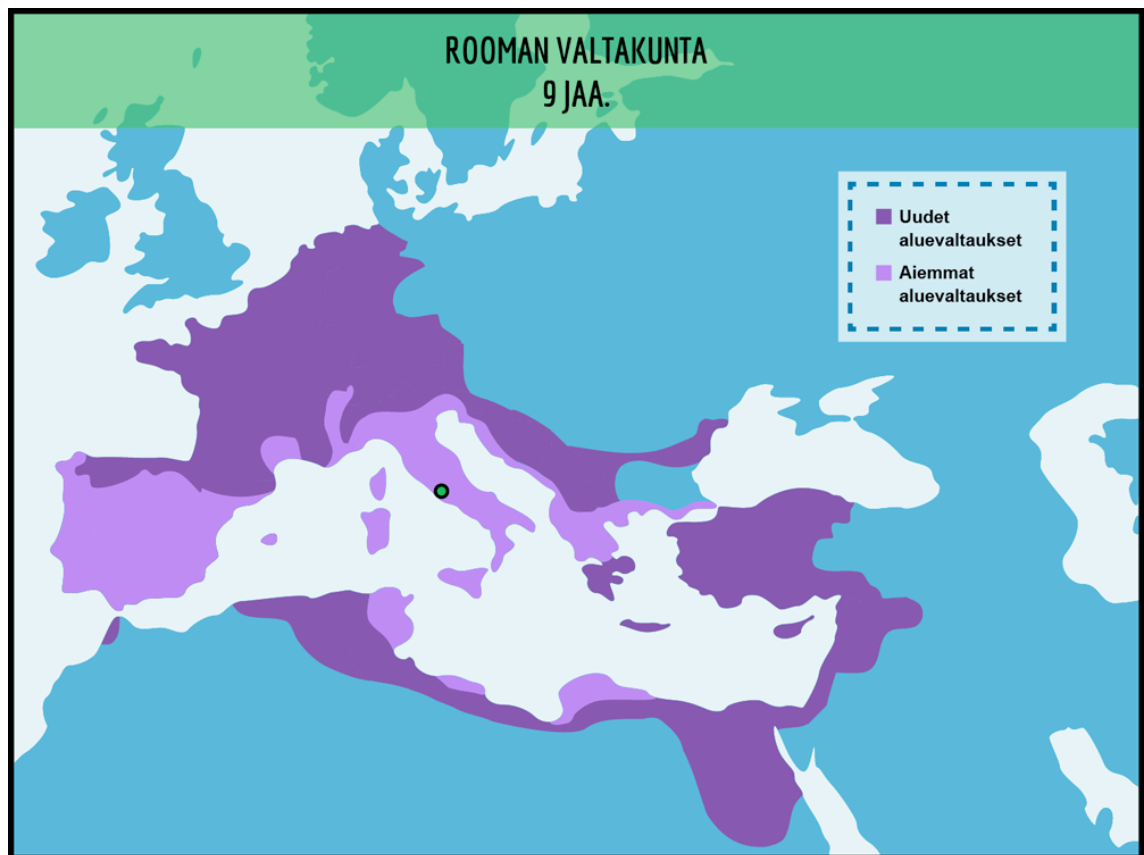
How do well-designed infographics help in building these all-important skills? Infographics convey messages through visual language, which consists of a set of rules and norms. These are defined by common practices and the conventions followed within individual fields of study that produce the data. Students learn to identify, read and analyze the visual data if the infographics are made recognizable, competent representations of these ways of expression and enable the viewer to interpret the information provided in the image. The students will not only come to understand the content, but also learn from the form it is presented in.

Like any means of communication, infographics always require a degree of understanding on how to interpret the information provided by them. Different types of infographics usually follow certain patterns of expression typical for them. For example maps are visual demonstrations of geographic data executed in a certain manner. These executions follow certain patterns that one must learn and recognize in order to be able to read the information in the picture. (Pettersson 2002, 48.) Therefore, the ability to read maps is a skill that one acquires by learning how to interpret visual information delivered through certain visual variables like shapes, colours and symbolic images. (Pettersson 2011b, 53—54; 67.)

What kind of level of ability to interpret certain type of visual information can be expected from the viewer to begin with? The level of information literacy varies between different age groups and levels of prior education, but even within the same target group, the capability to process for example information in maps might be quite different between individuals. Sometimes making design decisions that expect a certain level of information literacy for large groups of learners can cause problems in learning for those who face more challenges in the interpretation of the information.

The colours originally chosen for the maps made for senior secondary school history courses were based on e-Oppe's signature colours, using lighter blues for water and darker blue for the land areas as the base of the map. For some students in the pilot user group these colours were difficult to understand, as they saw the lighter blue as white (if this was due to for example devices displaying the light blue as white because of their

settings or their technical qualities, or due to the relative lightness of the water areas compared to those of the land when only the water areas were expected to be blue, is unknown to me) and were inclined to consider water to be marked as blue on maps, therefore confusing the land with water. The maps were rather simple in design, and the assumption that the students are very familiar with the shapes that form the map of Europe was proved false for some students when the colours were used differently than expected. In order to avoid problems like this and to support conformity and easy interpretation of information, the colours of even simpler maps were later executed in more conventional colours.



PICTURE 18. A map in company signature colours that was difficult to understand for some students due to the colour choices. A more conventional base colouring was later chosen for this type of maps.

However, producing representable visual learning materials can prove to be challenging, as has been proved by the studies done on the visual content on printed schoolbooks in Finland. Eeva Rinne has studied maps and the ways worldviews are reflected in them. Maps are always based on some kind of interpretation of areas and phenomena, and these can affect the content and convey messages. (Rinne 2011, 7) There have also been

cases of potentially controversial content in the illustrations that have been created for the materials produced by e-Oppi. In these the representation of information must be executed with a special consideration to the content and the context. Rinne sees unintentional, subconsciously formed biased content as a difficult and persisting problem that needs to be assessed. (Rinne 2011, 94)

Even if the authors of the materials are knowledgeable on the subject and give good instructions on which to base the graphics on, the following examples also demonstrate the importance of being aware of the subject matter and the communication between the team members. In the cases is used as examples the problems were present in the reference material provided for the visual designer, and in the first case the problem was discovered by the graphic designer (me) and in the second case by another team member. After discussing the matter in team, solutions were found. The examples are provided below.

The naming of cities in the map of China and the neighbouring regions for primary school history took careful consideration. It is nowadays more recommendable to use the official Chinese versions of the names of some of the major cities such as Beijing and Guangzhou instead of the Europeanized versions of Peking and Canton that have their origins in the colonial era. However, the Europeanized names are still in wide use, and for example both are still used in the Finnish version of Wikipedia. (fi.wikipedia.org/wiki/peking; fi.wikipedia.org/wiki/kanton) For this reason it was decided to include the both versions of the names, and the solution also allowed to add an explanation of the two versions and their historical background, therefore adding even more informational value to the content.



PICTURE 19. A map of China with different name translations can be seen as conveying different cultural messages. For the final edition both versions of the city names were included, the Chinese ones and the Europeanized versions in brackets.

Another example of a potentially problematic content showed up with another primary school history map that depicted European peoples. The map was meant to be very simplistic and only the largest ethnic and cultural groups were included, but there are always risks in simplifications like this. For example only Russians were marked to reside in the broad area of modern day Russia and its neighbours, while there is a large number of other ethnicities living in the area. In Central Europe then there were no ethnicities marked at all around the area of Switzerland and Austria. What is included and what is left out can be easily be seen as a political statement or a misrepresentation of information, and one must take this in to account. The map, as shown below, needs a revision with either more complete content, or a very clear explanation of the content attached to the map.



PICTURE 20. A simplified map of European cultural and ethnic groups with for example only Russians marked to reside in the area of Russia and no ethnicities marked in parts of Central Europe. Content decisions like this could be considered controversial, and the map requires a revision.

4.2 Adapting to the needs of several fields of expertise

Individual fields of study employ similar tools to visualize slightly different matters. Maps are a very common type of infographics in learning materials, and they are used in a great extent within many study subjects. That's why maps make a convenient example on how infographics should be adapted to the subject so that the focus on the image is visually shifted to the information that is the most important in that particular context.

As stated in the previous chapter, all infographics, maps included are demonstrations of data laid out in a visual form that people learn to interpret. There are often descriptive elements such as a legend attached to the image to help in the interpretation of the information, (Pettersson 2011b, 14) but for a large part people rely on recognition of certain symbolic patterns on the map. Some of this visual information is created in a way that stays quite similar from one map to another, and then there is some variation in the

ways that some of the information might be executed in. There are no set rules on which colours are to be used on a map, but it is considered a norm in cartography to use for example light blues for shallow water, darker blues for deeper waters and greens for land of low altitude and browns for land areas of higher altitude when depicting differences in altitude. However, different colours are frequently picked for maps used to depict different types of information.

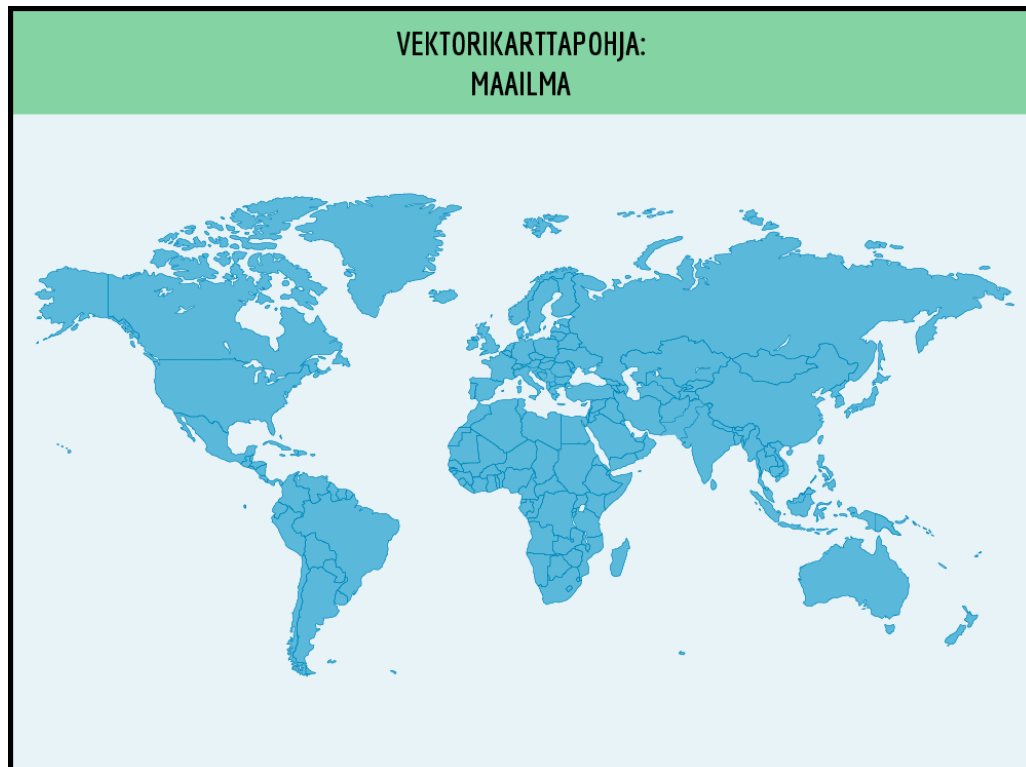
There is also a set of scientific standards how the visual forms on the map are built on in order to be able to represent valid geographical data. However, even when these are strictly followed, the shape and the looks of different maps are likely to vary in very noticeable ways. For example using different map projections changes the way the globe, as a spherical shape is reproduced on a plane surface. Inevitably, in every type of map projection there is a degree of distortion. For example, the proportions of different areas on the map might seem significantly different depending on the method used to represent the relations of different parts of the globe. (Pettersson 2011b, 344.)

There are no clear patterns on which map projections are most used in the Finnish educational materials, as the preferred projections vary between books and even within the books. E-Oppi has chosen to use the Robinson projection and the Mercator projection as the basis of its map templates. These two are fairly common and well known, and there is a large amount of information available displayed in these projections. Some projections can be more functional for certain types of uses than others. The decision on which projection to use should be considered carefully according to the content, for a map might also be considered biased or controversial due to the projection, even if it was unintended.

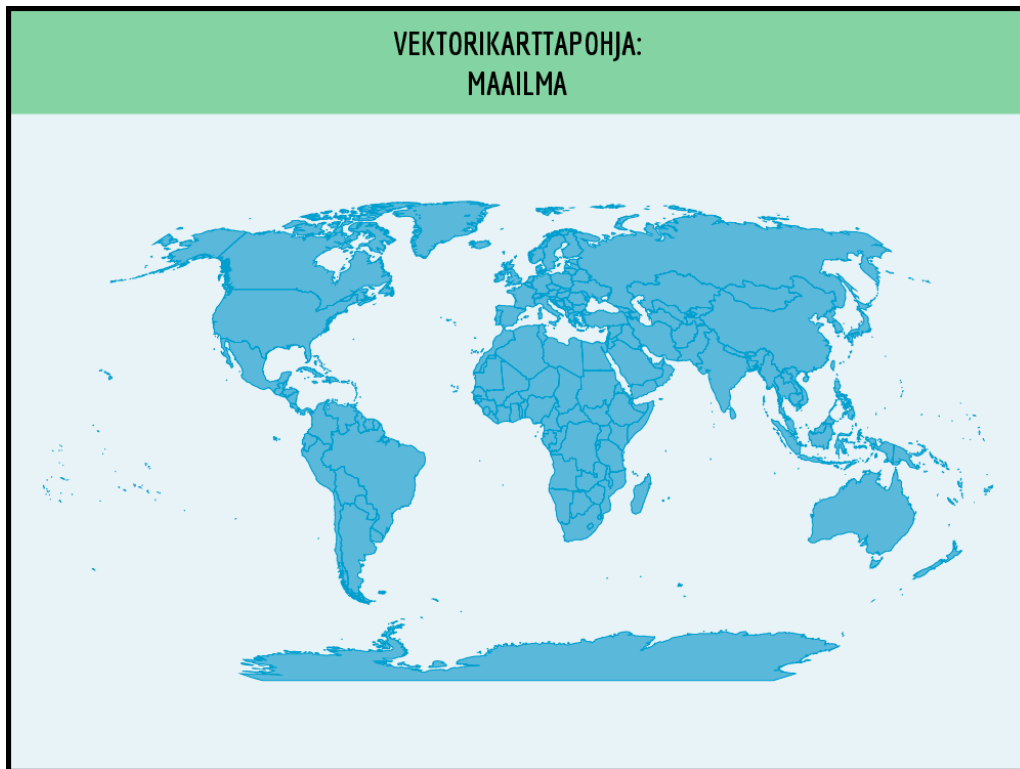
Since map projections all have intrinsic distortions in them, in some cases the quality of these inaccuracies might be interpreted as a bias. For example the Mercator projection greatly exaggerates the size of both northern and southern areas in comparison to the equatorial areas. This projection has earlier been in a rather wide use, and is still quite a popular choice for maps in different contexts, despite having been criticised for having an effect on how people view the world. There has been a debate on the Mercator projection not only distorting the people's understanding of the relative size of geographic areas, but also contributing to the ideas of superiority of the northern cultures over the ones closer to the Equator. In Finland, the topic has recently been discussed very publi-

cally by science author Ari Turunen. (Römpötti, Harri 2013a; Römpötti, Harri 2013b.) Therefore, it is very important to understand the formulas on which the basic forms of maps are built on, and to take in consideration what kind of interpretations could be made based solely on these.

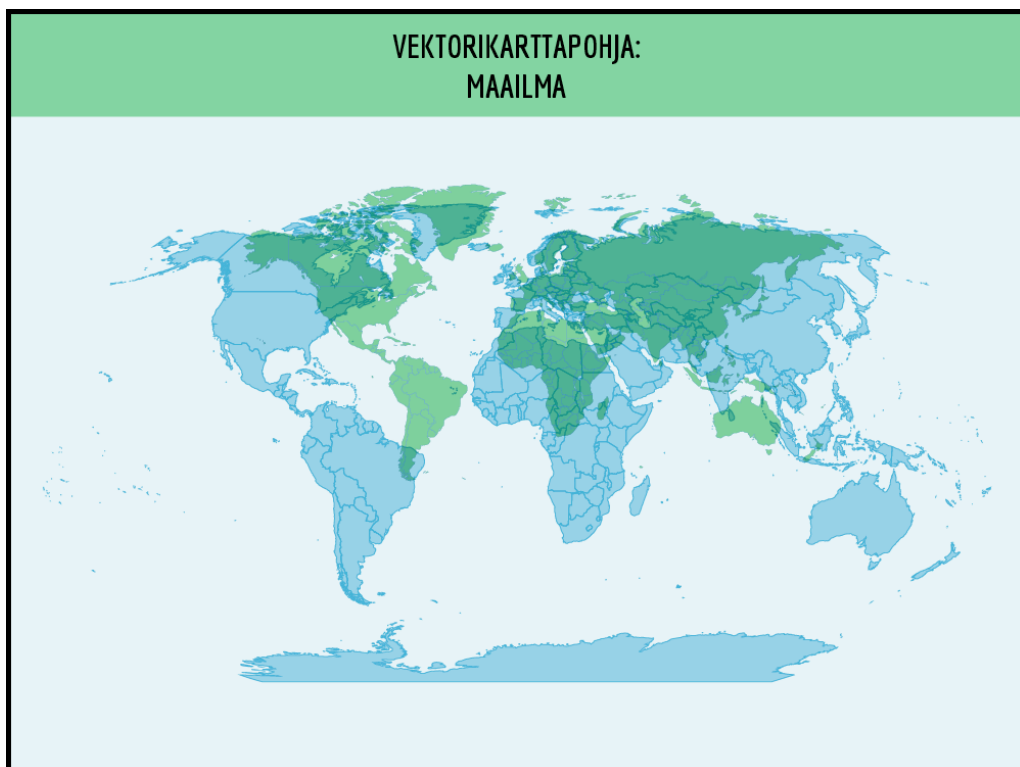
The images below demonstrate the differences in world maps done in Mercator and Robinson projections.



PICTURE 21. A world map in the Mercator projection.



PICTURE 22. A world map in the Robinson projection.



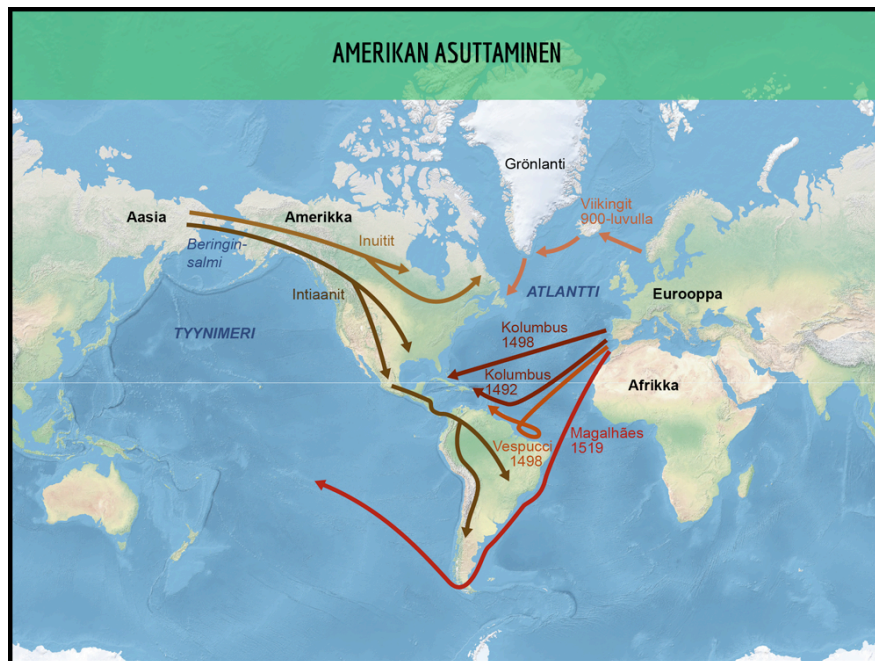
PICTURE 23. Example of relative distortions in the Mercator projection and the Robinson projection maps. The continents in the Mercator projection world map are pictured in green and placed on top of the blue continents in the Robinson projection. The maps are aligned based on the location of Finland, and scaled so that the area of Finland in both maps is roughly the same size.

Each of the projections seen in the exemplary images makes valid visualizations of the same geographical data in a slightly different way. Like stated earlier, the Mercator map significantly exaggerates the size of northern and eastern areas while it undermines the areas around the equator. The Robinson projector then again stretches the north and the south horizontally. Choosing the suitable map template with a projection that suits best for displaying that particular area helps in creating infographics with proportions that have the best possible informational value. The Mercator projection has proved to be well suited for maps that depict single continents or smaller areas, but the Robinson projection is often more suitable when larger areas need to be pictured at the same time. Attaching the information about the map projection used in the image is also recommendable. This way information can be provided on the methods used to represent information, which can help build the information literacy of the user.

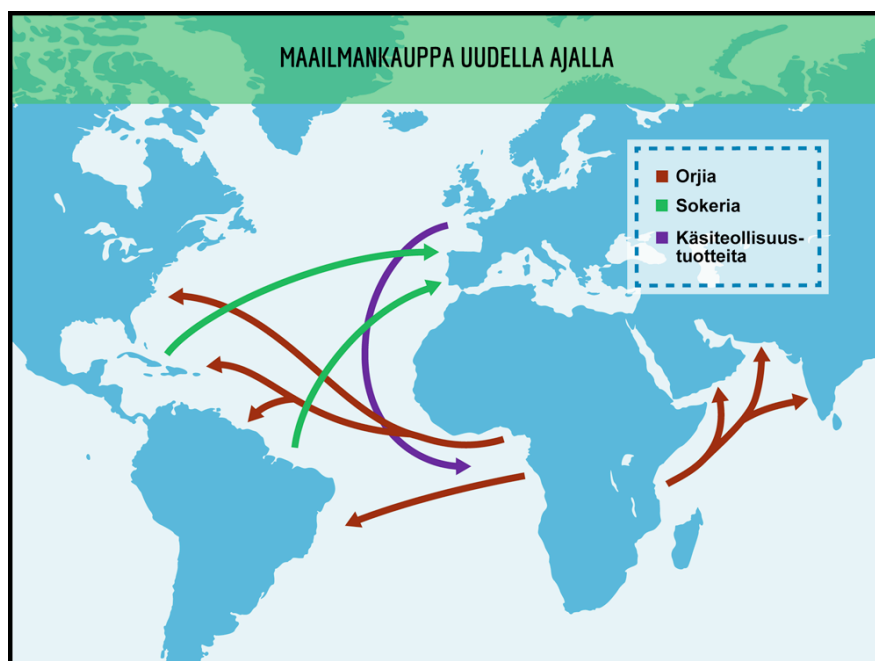
Creating maps that efficiently communicate the most relevant information for each field of study can be a challenge for the designer. Maps have different priorities in for example geography and history, as they are often used to demonstrate different things. Varying levels of amount and accuracy in geographic data are required to direct the focus of the viewer to the desired content, as too much information offered in the same time can be distracting and obstruct the learning process. (Pettersson 2002, 226) Using an excessive amount of visual variables on a map also affects the readability of the information negatively. (Pettersson 2011b, 13; 67.) Often different types of details need to be presented and available depending on what kind of information is brought up in the image, and the relevance for the subject determines what to focus on.

Building a reserve of a few types of map templates is an effective way to control the amount of details and the focus when creating maps for different purposes. In the cases where lots of geographic information and data are needed, the necessary information can be conveniently included by choosing a map template with lots of details. When it is more meaningful to avoid the needless clutter of extra information, one can then again choose a simpler template as the base of another infographic. For example the use of colours on the map can significantly increase the amount of information within the image, but in the same time it might cause difficulties in interpretation. (Pettersson 2011b, 54.)

The use of different map templates with varying levels of geographic details applied for infographics created for different study subjects and different age groups is illustrated below through the following examples:



PICTURE 24. Example of different levels of detail adjusted to keep focus on the most relevant information: in primary school geography attention to detail is important, so the students can understand the geographic characteristics of the area.



PICTURE 25. Example of different levels of detail adjusted to keep focus on the most relevant information: in senior secondary school history the geographic details are minimized to bring focus on the historical information.



PICTURE 26. Example of different levels of detail adjusted for different age groups: in senior secondary school history a medium level of geographic details are sometimes needed to be able to represent the nature of information in a way that promotes the understanding of a more complex matter. Here some geographic details are added to help envision how wide and diverse the area of the Roman Empire was.



PICTURE 27. Examples of different levels of detail adjusted for different age groups: in primary school history simpler maps steer the attention of the viewer towards the essential information.



PICTURE 28 & 29. Examples of different levels of geographic detail seen in one image. For example longitudes, latitudes and city locations are all valid geographical information, but in some context they can drive the focus away from the most important content in the image, therefore making it more difficult to process the information. If the purpose of the image is to display the South American states and their borders in a map, there probably is no need to display any more information than just those mentioned above.

5 AESTHETICS AND GRAPHIC DESIGN IN INFOGRAPHICS

It is often emphasized in the literature that in information design, “Form follows function“, (Pettersson 2002, 40) but even the form can have functional uses. Focusing on the more aesthetic side of the infographics might at the first glance seem like putting effort into something rather irrelevant or maybe even counter-productive. Creating attractive visuals for a material that is supposed to be informational and matter-of-fact in style is also a somewhat controversial subject in the literature, as seen in a statement by Rune Pettersson:

Today many visuals are too complicated and would communicate better if designers valued simplicity over decoration. Aesthetically pleasing visuals may deceive the learners about their instructional value. (Pettersson 2011a, 27.)

However, simplicity and adhering to the conventions of expression when such is required does not rule out the possibility of making the designs also aesthetically pleasing. In addition to this, appealing appearance of the images can instead of acting as a distraction bring attention to the image, and therefore enhance learning. (Lankow et al. 2012, 30.) Attractive design of the message can also encourage processing it on a higher cognitive level, (Pettersson 2002, 244) resulting in more effective learning.

This chapter seeks to find out how an aesthetic design can add more value to infographics in learning materials. The design can have positive effects on many fronts including enhanced communication and improved product and company image. The design does not only affect the looks and the impression, as a thoughtfully executed practical design can also improve efficiency, workflow and productivity within the company producing the materials. Each of these aspects is studied in their own subchapters.

5.1 Combining attractive and informational

Aesthetics can add to the educational experience, as appealing graphics can be more engaging and more memorable. (Lankow et al. 2012, 30.) Grabbing the student’s attention, creating genuine interest in the material and helping memorize the content can improve learning results and the overall quality and appeal of the learning materials to the

target group. The aesthetics and visuality are not only important matters for the learners, but also for the teachers, who are in the key role in choosing the materials used in schools. In Rune Pettersson's *Information Design — An Introduction* it is noted that in teacher's manuals and teacher's textbooks this aspect of images is especially highlighted. (Pettersson 2002, 117)

The design can actually even change the way people feel about a product, as the way how an item looks may cause an emotional response. (Lankow et al. 2012, 40) The design has been used by immense amount of companies to add interest and appeal to their products. Some of the world's biggest companies, like for example Apple, have based a great deal of their success to the combination of application of new technology, usability and attractive design. Modern e-learning materials can definitely abide to these same values, and be made more approachable and more inviting for people to acquire and use through good design. In the context of learning materials and infographics, this means that an attractive design can make the infographics more effective in conveying information, as the design has the potential to make people more motivated to first of all get in touch with the materials, and use the materials to learn from them.

It can be said that aesthetics are a matter of taste and preference, but as our senses interpret the world around us, they also influence how we feel about the things we see. The effective ways to convey information visually are often naturally also in the same time attractive to look at. Logical simple images employ the biological and behavioural features of the human brain and eye in a meaningful way to make the information easily understandable, and these mechanisms are also aesthetically effective.

Balanced, logical and harmonious visual information is both effortless to understand and pleasant to look at, because our eyes naturally look for these features. If the elements on the infographic seem like they are out of balance, irregular or either too prominent or indistinct, this will make the image uncomfortable and laborious for the reader to interpret it, and as a result of this, the image will also will probably seem unappealing. (Pettersson 2002, 210) Therefore, good graphic design in infographics combines aesthetics with usability and effective communication. It should also be noted, that teachers also define aesthetic appearance as one criterium of good visual learning materials. (Kautto & Peltoniemi 2006, 114)

5.2 Building and applying corporate identity in infographics

Even if the representational and communicative values of the image are most essential for the illustration to serve its purpose, the conspicuous presence and large number of infographics within the learning materials make them an important visual element that has a very significant role in the visual appearance of the product. Partly due to their volume and easily observable nature, the visuals even give an impression about the quality of the content. It can be observed that infographics have potential to become an effective marketing tool, as using infographics and their design directly for marketing purposes has recently become more popular than ever with the increased Internet usage. (Lankow et al. 2012, 31) For a company that specializes in producing educational materials also in visual form, the design of those materials is a very convenient way to develop an idea of a company that creates interesting, thought-provoking and pedagogically adept materials.

The image viewers develop of a product is influenced by the content and the appearance of the product, and infographics and their design in learning materials contribute to both of these. The mental image people form of a company is then again strongly dependent on the products it produces and how people perceive these products. Therefore the design of infographics can affect an e-learning company's image, and they can be used to intentionally develop a positive corporate identity. After all, being able to create positive connotations to a brand is very valuable in marketing. As stated by Rune Pettersson, one part of a single product can influence how people feel about the credibility of larger operators connected to it:

The credibility of the message is influenced by the credibility of the specific medium, and the credibility of the medium is influenced by the credibility of the message. (Pettersson 2002, 115.)

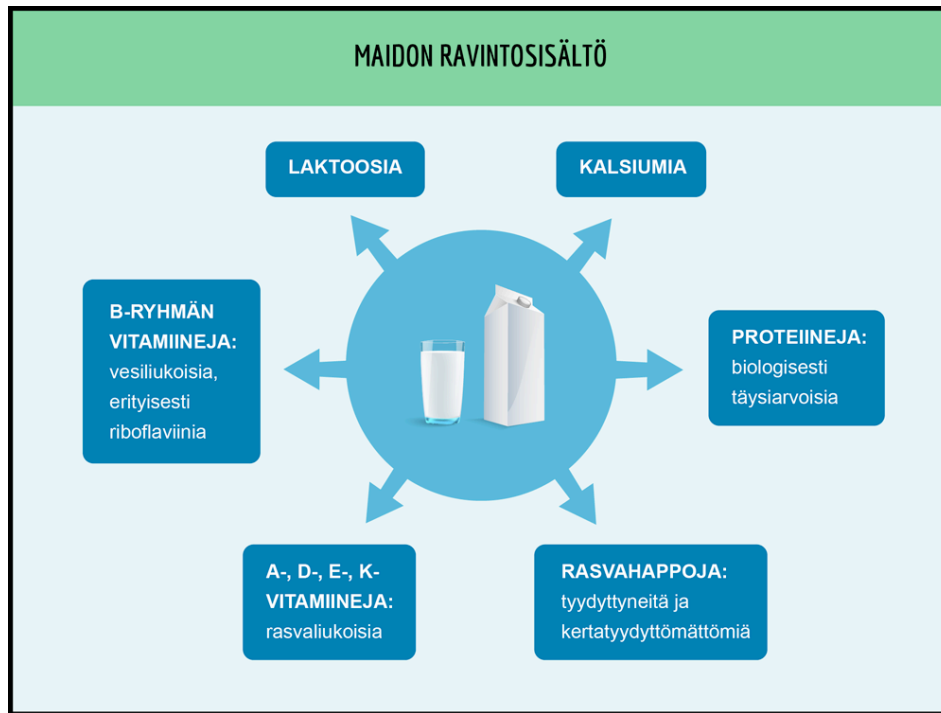
The presumed competence and credibility of the materials can be increased by well-designed visuals, making them appear more convincing as sources of information. Graphics can help the product look modern and professional, when designed in a way that supports these ideas. This can be achieved through a careful adherence to the scientific standards related to any particular types of visualization, and other types of requirements related to representability and the subject matter while taking advantage of the visual possibilities employed in contemporary digital media. The information should

always be depicted in a way that is relevant and appropriate to the content, while keeping them easily understandable and properly referenced to gain credibility to the message. (Pettersson 2002, 115)

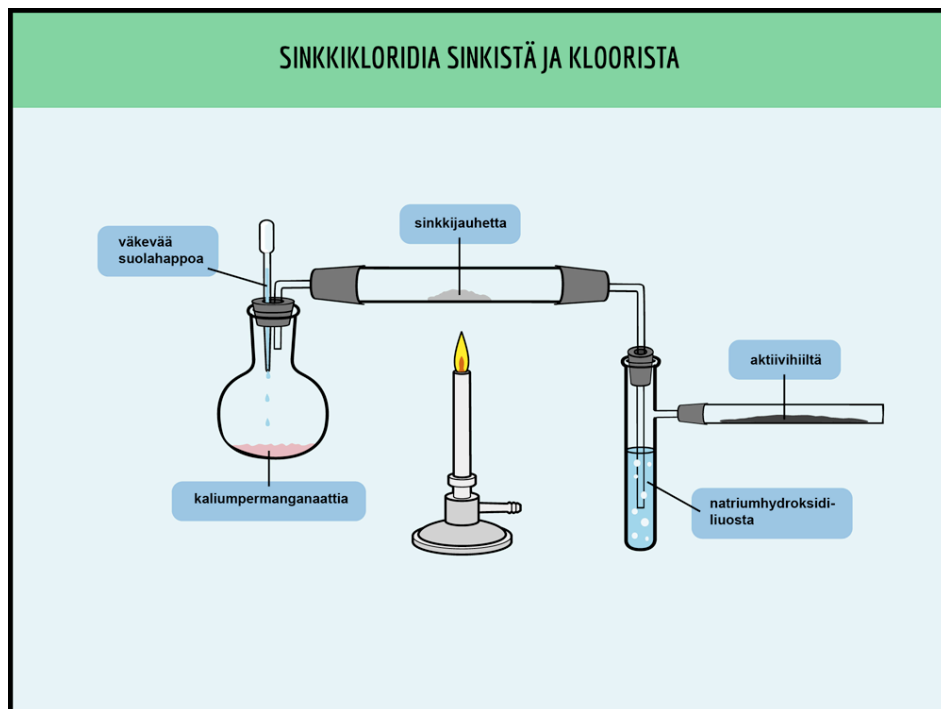
The latest visual guidelines of influential companies like Apple and Google (IOS Design Resources; Google Visual Assets Guidelines.) make good references on the recent trends in making visuals for the digital environment. Using simplistic, flat design and partially transparent visual elements as recommended in the guides can give the visuals a contemporary look. If the visual appearance gives an impression that thought and effort has been put into making it, this is easily also reflected in the way people perceive the content. Logical, uniform and polished graphics are effective in promoting these ideas, while irregularity, imbalance or ambiguous graphics might be seen in an opposite way. Therefore, stylishly designed infographics can both increase the attractiveness of the product to the prospective buyer and encourage people to see it as a trustworthy source of information for learning.

Recognizable brand identity can also be enhanced through the infographics in learning materials. Keeping the visuals, including the infographics uniform and compatible with the company's overall visual look act as a part of building a brand that is easy to recognize. However, the infographics must not be seen as a channel of advertising company or the products. (Lankow et al. 2012, 114) The visual connections to the brand identity must be constructed in a subtle rather than a pushy way. Using the company colours as determined in the company's graphic guidelines and seen in the company logos create a connection, but are not overly underlining it. Making the infographics compatible with the overall visual content and look of the learning materials (and also for example product or company advertising seen elsewhere) in this way makes it easy for the viewers to identify them without the feeling of direct advertising.

The means employed to achieve brand recognisability through subtle means is demonstrated below through three different types of infographics made for materials of different study subjects. The content of each varies in type, complexity and also somewhat in colour, but all can be easily indentified as products of the same company. This has been achieved by keeping the style of the main graphical elements such as the text boxes, the typefaces and the base template of the graphics constant.

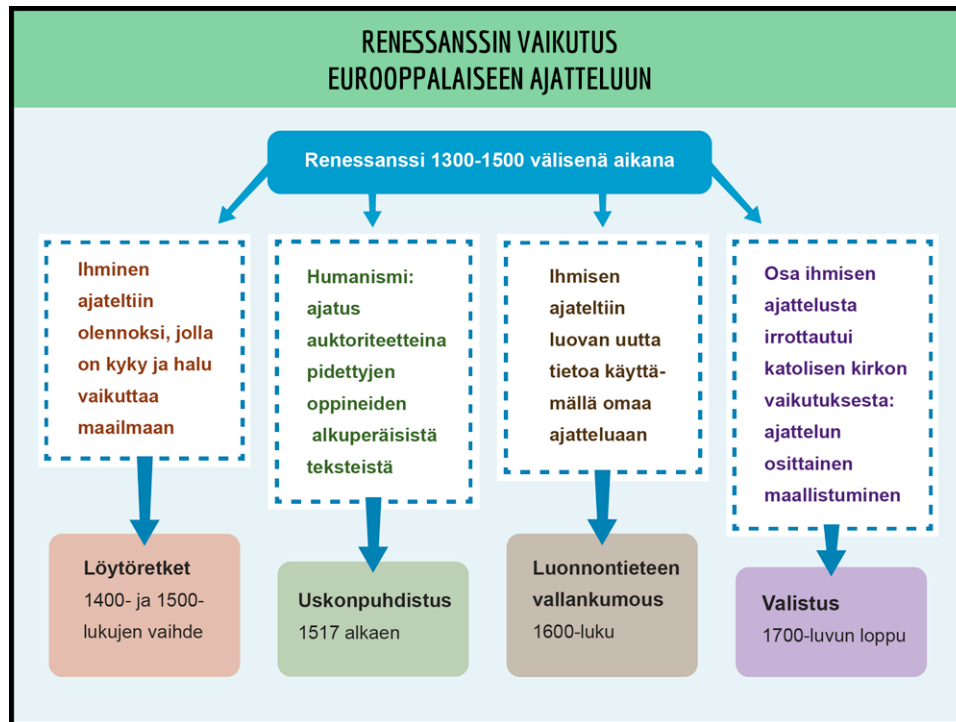


PICTURE 30. Infographic made for primary school home economics, a simple and straightforward combination of image and text done in company colours.



PICTURE 31. Infographic made for primary school chemistry. The graphic is meant to act as a guide, and relies strongly on an exemplary picture with explanatory text. The nature of the picture determines the colouring, as a reliable guide needs to be informative also in the way the colours are represented. However, the colours are picked according to the graphic guidelines and swatches that were predetermined to be used in

the content, so that the image remains harmonious and compatible with the rest of the materials. The company colours are used in text boxes and other possible applications.



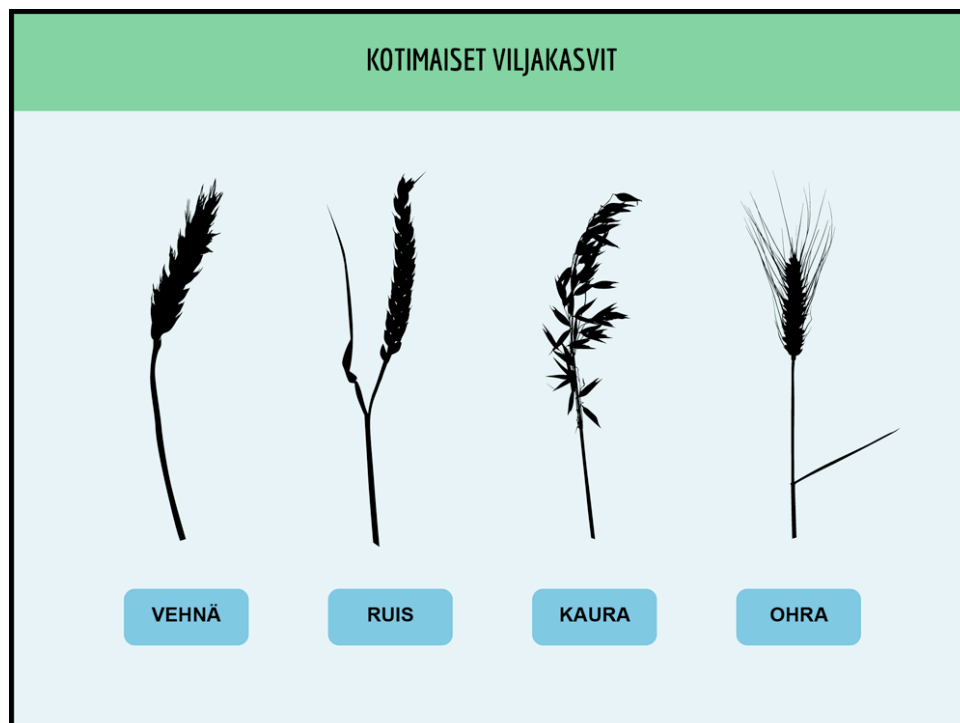
PICTURE 32. An infographic made for senior secondary school history. There is a lot of text-based content, and in order to make the information easy to process as patterns, the content is categorized through colours. (Pettersson, 2002, 226) The image retains its recognizability though, as the shapes, typefaces and the basic template in the image are familiar from all other infographics. The company colours are again used when applicable, and the colours that highlight the content are also based on the graphic guidelines and predetermined swatches.

5.3 Developing productivity through design

Efficiency and an economical use of time are essential matters for any commercial design work. Infographics are numerous in modern learning materials and the materials need to be published on a tight schedule, so the process of creating them should take up as little time as possible. The educational quality and appearance of the images must remain constant and appropriate despite of this. With design choices, one can greatly influence the work methods used and the amount of time and work it takes to make the graphics.

When creating the design, simplicity and uniformity can become tools that promote efficiency and sustainable design, in which the same graphical elements can be re-used and applied to new uses over and over again, all the while keeping the materials attractive and easy to understand. Vector graphics allow easy scaling as well as copy and paste –type of compiling of images from elements. As can be seen, the choice of format in which the graphics are created can have a significant effect on not only how the images look and how they fulfil their purpose as learning material, but also on the workflow of the person responsible of the visuals and the amount of time consumed producing them.

Images in infographics often make them more effective in visualizing the content and also make them look more attractive, but drawing illustrations can be relatively time consuming. With a small investment in stock image account one can gain an access to a wide amount of ready-made vector graphics suitable for most uses in learning materials. Taking advantage of materials freely available in the Internet with appropriate licensing can also easily make the infographics more informative through richer content without any additional costs.



PICTURE 33. Adding vector stock images acquired from an image bank (www.shutterstock.com) can be a cost-effective way to add more complex visual elements in infographics.

In a small company with just one visual designer in the team, it can be a great asset to be able to share some of the workload of building the content when needed. Easy to use vector graphic templates with ready-to-use graphic elements like different types of text boxes, arrows and markers complete with instructions and graphic guidelines help even those with little experience in graphic design to create basic level images, while ensuring that the material can still act as a representative contribution to the overall visual look of the materials.

Templates determine the visual framework of the image and allow simple maps, graphs and other types of visual information to be created by those who are responsible mainly for other types of content. This can help keep the connection between the images and the rest of the materials firm, as a person who is familiar with the subject matter can for example write the text and make a simple chart to accompany it. The templates have allowed the editors to make infographics for the materials, which has for several occasions made it is easier to make large amounts of images quickly. Dividing the workload can also allow illustrators and visual designers to have more time to focus on more demanding visual tasks such as creating more complicated infographics and advertisements when needed. It has become clear that a simple, scalable and reusable design in infographics can certainly help increase productivity within a company producing digital learning materials.

6 CONCLUSIONS

Well-designed infographics are an effective tool for learning, and they should be an integral part of modern day e-studybooks and digital learning materials. Quality infographics take into account the needs of the users, the operating environment defined by technology, and employ methods that support reliable representation of the content. Practices of visual design are essential in producing infographics that are successful in all these areas. First of all, adapting the design to the technical environment requires that the designer is familiar with the technology relevant to the project, as one must be able to produce visual material that performs well on the various publishing platforms and the range of devices used by the target group. A number of adjustments done after testing and co-operation with the users ensure that the graphics fulfil their purpose in the practical every-day setting of the final users.

Creating successful educational content in visual format requires understanding of many other fields for the designer, in addition to understanding the technological framework. Knowledge of the principles of visual communication and the processes of interpreting visual information are vital in the development of high quality visual design. Through design choices based on this knowledge it is possible to create efficient, accurate representations of information that are easily processed and clearly understood by the viewer, while the visuals also promote the development of visual literacy skills. A good designer also takes in the account the future development and potential new applications of the visual content. In this context the design and the format in which the graphics are made should be easily adapted to creating for example animated or interactive infographics.

The designer of infographics should be mindful of the processes of learning and teaching, as the main purpose of the visual content in the digital learning materials is to support these functions. In order to be successful as educational material, infographics must be created so that they follow the conventions of fields of science presented in the materials. It is also vital to be aware of any potential ethical or subconscious dimensions the images might be representing. Therefore, the visual designer responsible for the design of infographics must be familiar with the subject matter and the intrinsic characteristics of any particular types of visualization methods used in infographics and the pedagogical aspects related to these. Different types of content require adaptability from

the graphic style to retain uniformity while adapting to the requirements set by the content. A set of editable templates with varying basic components such as different types of map data or graph elements can conveniently answer to the needs of different study subjects and target groups.

Carefully designed, attractive looking visuals in infographics can be beneficial in many ways. The design and the means of graphic design can be used to gain interest, improve representability, enhance recognisability and build the public image of the materials even while keeping the informational value of the image as the first priority. Due to their visible presence and educational value infographics and the way they are designed are definitely matters of commercial importance for the companies making learning materials. It can be concluded that good design can improve the quality of the products and attractive, progressive-looking learning materials can help develop a positive image of the company whose public image is partially built on them.

Besides taking into account the end users and the public image of the company, a graphic designer should try to construct the graphics so, that they are practical also from the point of view of those who work with them in the production stage. The foundation of the design of infographics should be built on editable graphic templates that can be used as a basis on which individual infographics are created. The design is to be kept simple, and the content should be made of reusable elements as often as possible. This approach allows quick and convenient production of new good quality visual materials and easy adjusting to different sizes and platforms.

This study has shown that through the visual design of the infographics, numerous and very significant advantages can be achieved in the content and appearance of the digital learning materials. Good design can bring benefits that start as an added efficiency at the production stage and continue by enabling more successful marketing. Probably the most valuable effect of relying on design choices that are based on research of several fields of study is that the better form and content in infographics result in improved user experience and more effective learning and teaching. The design of infographics has great potential to improve learning materials, and it can be concluded that the design of visual content should be considered an important part of developing learning materials.

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