



UNIVERSITETET I AGDER

VISUAL DESIGN AND VARIATION OF MEDIUMS IN E-LEARNING RESOURCES

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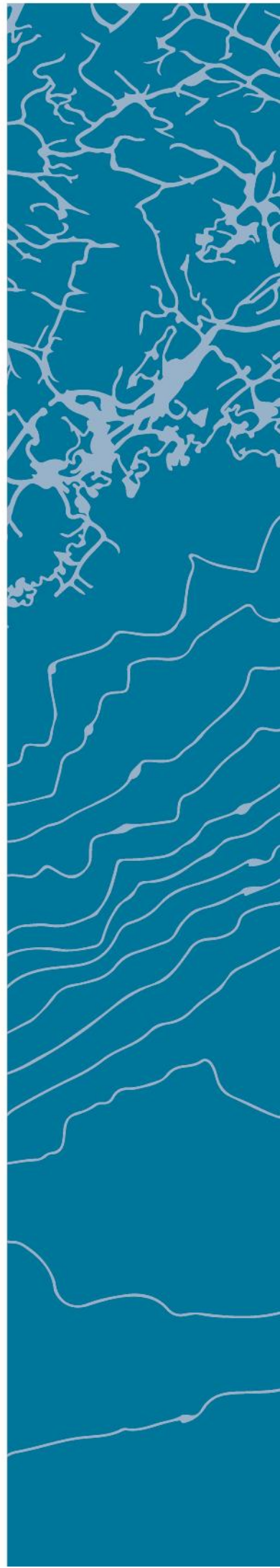
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Abstract

Education today can be described as plagued by a digital gap between the teachers and the learners. While E-learning is becoming more and more relevant, it is still being taught as if it was analogue, meaning the advantages digital media offers are neglected. Studies are also showing that students struggle to remember lectures presented in this way. This can be attributed to an incompatibility between the digital immigrants and digital natives.

The purpose of this study look at whether an increased focus on design and whether additional mediums in educational content will improve the learning experience. In order to achieve this, I will try to answer following research questions:

1. Will an increased focus on visual design create any positive feedback from students?
2. Will variation, such as the use of presentations, quizzes and videos be preferable to students compared to traditional presentations?
3. Does previous studies give any indication on how design and variation affects the learner

The theory in this thesis will also mainly revolve around digital media and how it is best applied in order to achieve an optimal user experience for the learner.

In conjunction with this thesis, I recreated three powerpoint presentations in Adobe Captivate, each covering one chapter for the course 3D CAD and material technology. These new presentations were to focus on design and layout, as well as include additional mediums, mainly videos and quizzes. The students in 3D CAD and material technology were to experience and utilize both the old and new presentations during their semesters, and would later fill out a quantitative web-based survey, comparing the presentations with each other.

Foreword

This master thesis is the final work of our Multimedia and Educational Technology Master education at the University of Agder (UiA), which marks the end of a challenging, yet valuable era in my life. The time spent here, the professors and the students, will all be remembered for a lifetime.

First, I want to thank Geir Grasmo for his cooperation, providing me with all the necessary material such as his presentations, allowing me to film, and letting me develop and test my resource on his students. I also want to thank the students who participated in the survey I released, whose responses were absolutely necessary for this thesis to have any data to evaluate. I also want to thank my study coordinator, Morgan Konnestad for helping me out on several occasions, and Rune Andersen, my supervisor, whose support and honesty was what made delivering this thesis possible.

I want to thank my friends and classmates for helping me out by sharing sources and their opinions on my work. A special thanks goes to Cassandra Haugen for her help and moral support! I also want to thank Håvard Thorsen for many fun and interesting discussions regarding our master theses.

Finally, I want to thank my family, who have been extremely supportive in numerous ways and throughout this period. It's been a huge help having you around me.

Thank you!

Petter Emil Jacob Knudsen,
Kristiansand, 2017.

List of Content

Abstract	1
Foreword	2
List of Content	3
1: Introduction	5
1.1 Problem Area	5
1.2 Background	6
1.3 Thesis and research questions	6
1.4 The Experiment	7
1.4.1 Resource	8
1.5 Previous Research in the Field	8
1.6 Limitations	11
1.7 Structure	11
2: Theory	12
2.1 Introduction	12
2.2 Learning theories	12
2.2.1 Connectivism	12
2.3 Cone of Experience	14
2.4 Learning Intelligences	15
2.5 Blended learning	17
2.5.1 Variations of Blended Learning	18
2.5.2 Flipped Classroom	19
2.6 Video theory	20
2.7 Gestalt Theory	21
2.9 Multiple choice	22
3: Method	23
3.1 Reliability and Validity	23
3.3: Quantitative Method	23
3.2 Process	24
4: Presentation, analysis of results and discussion	25
4.1 Introduction	25
4.2 Demographics	26

4.3 Presentation A	27
4.4 Presentation B	28
4.5 Comparing Presentation A and Presentation B	30
4.6 Analysis and Discussion	31
4.6.1 Visual Design	31
4.6.2 Quizzes	33
4.6.3 Video	33
4.6.4 Comparing the Presentation A and Presentation B	34
5: Summary and Conclusions	35
5.1 Introduction	35
5.2 Summary and Conclusions	35
5.2.1 Research Questions and Hypothesis	35
5.3 Future Research	37
Appendix list	38
Figure list	39
List of Tables	40
Survey	41
Collected Data from Survey	56
Literature	72

1: Introduction

1.1 Problem Area

Our students have changed radically. Today's students are no longer the people our educational system was designed to teach.

(Prensky 2001 p. 1)

Technology has gone through rapid developments since the introduction of the digital age¹, and E-learning has become a significant component of many school courses due to its potential as a tool for increased learning engagement. It can also serve as an effective way for learners to engage in the curriculum outside of the classroom. Because of digital tools like smart phones, tablets and laptops, as well as the expansion and increased accessibility of the internet². According to Statistisk Sentralbyrå³, homes with children have an increased access to internet compared to homes without children. (SSB, 2015). Learning has the possibility to expand because of the mobility and accessibility of the learning content produced by the teacher (Curtis J. Bonk, 2016). With the increased focus on E-learning, many teachers unfamiliar with the technology trying to join in. However, it's becoming evident that many of the teachers currently constructing of our education are often lagging behind their students in technological comprehension. This is what Marc Prensky defines as a digital immigrant: Someone who does not comprehend the tools and "language" that belongs in the digital age. Because of the students' frequent interaction with mediums such as computers, video games, smart phones, tablets and other various tools and gadgets available, one can argue that these tools have altered the younger generations thinking and learning process greatly compared to that of their predecessors (Marc Prensky, 2001), and while teachers try to keep up with the technological demand, they are often are less technologically capable compared to their students, resulting in suboptimal use of the E-learning tools. Marc Prensky goes to say:

¹ In this thesis, the start of digital age is depicted as 1970's, when the home computer first was introduced.

² From 2009 to 2015, the amount of people who accessed the internet (within a span of three months) increased from 88% to 96%. Likewise, the amount of people who accessed a computers in the same time span increased from 89% to 94%.

³ Statistisk Sentralbyrå (Statistics Norway) is the central office for norwegian official government statistics.

The single biggest problem facing education today is that our Digital Immigrant instructors, who speak an outdated language (that of the pre-digital age), are struggling to teach a population that speaks an entirely new language.

(Prensky, 2001, p. 2)

As learners have grown up with and responds to a vastly different style of teaching, the efficiency of these traditional lectures are at an all time low. In spite of wanting to learn, the average student seems to remember as little as 10% from an overall lecture, even if the lecture was as short as fifteen minutes. Carl Wieman argues that one of the major components to this inefficiency is the teachers placing an excessive cognitive load⁴ on the learners (Carl Wieman⁵, 2009). The technological demand keeps increasing, and the digital immigrants are falling further and further behind. Educational mediums are in desperate need of improvement.

1.2 Background

As a digital native, as well as someone with a passion for visual design, it can often be frustrating to see how neglected the user experience is in educational content. Teachers who, understandably, have no knowledge of design, layout or compositions, create learning content that is exhausting to consume, no matter what medium they presents it in, which typically is text format. Knowledge is at our fingertips, and improving the visual presentation is something many of are able to do if we just take our time to do it. There should be no reason for teacher-created content to be as outdated as it is, which is what lead to this thesis: I wanted to see whether students did care about these factors, or whether this was something only those in my field of study would notice.

⁴ Cognitive load refers to how much information the learner is expected to process in a short amount of time.

⁵ Carl Wieman directs the Carl Wieman Science Education Initiative at the University of British Columbia and the Colorado Science Education Initiative. He (along with Eric Allin Cornell) received the Nobel Prize in Physics in 2001.

1.3 Thesis and research questions

In this thesis, I have collected data from both qualitative and quantitative researches, articles and books that theorizes different studying models and their efficiency, as well as the impact technology can have for both the teacher and the learner in educational environments. For this thesis, the focus has been specifically on whether more thoughtful visual design, as well as variation in mediums (such as video, quizzes and text) would have a positive impact on the students.

This lead to the following hypothesis: *Improved design and variation in educational content will improve student motivation.*

Table 1: Research questions

1	Will an increased focus on visual design create any positive feedback from students?
	In order to measure the first research question, the data will first have to indicate that the students not only notice and prefer the differences in the test product, but also that they prefer the new version <i>because</i> of the differences.
2	Will variation, such as the use of presentations, quizzes and videos be preferable to students compared to traditional presentations⁶?
	Data will need to indicate that the students prefer using the a product that includes variation in content presentation.
3	Does previous studies give any indication on how design and variation affects the learner
	What does earlier research say regarding these topics?

1.4 The Experiment

In order to research and validate the hypothesis, a cooperation with Geir Grasmo⁷ was formed, and a both Grasmø and myself would simultaneously develop two different presentations, both covering the same three chapters for the book *Material Science and*

⁶ Traditional presentations refers to presentations that only presents its learning material through text.

⁷ Geir Grasmø is the professor in the department of Engineering Sciences at the University of Agder.

Engineering, by William D. Callister, Jr and David G. Rethwisch. The three chapters covered in these presentations were chapter one, ten and twelve. The initiation of the development was after the start of the course MAS130⁸, and the students were to experience the presentations while it was relevant to their curriculum. Because of this, the Presentation A for chapter one (due to Presentation B not being developed yet), and Presentation B for chapter ten and twelve. Once the class had completed these chapters, a survey was released, providing the students with both versions for comparison, and asking them a set of questions, mainly regarding what they liked and didn't like about the different presentation styles. Presentation B of chapter one was released in time for the students to utilize it before their exam.

1.4.1 Resource

Both presentation version would cover the same three chapters. Grasmø developed the PowerPoint⁹ lectures similar to the ones the class already had experience with (Presentation A), while the other version (Presentation B) was developed in Adobe Captivate¹⁰. Both presentations contained the exact same language and content, but Presentation B combined the presentations with more thoughtful design, quizzes and videos. They would be using Presentation B while reading the learning content outside of the classroom (this was released approximately one week before the the professor would lecture the students using Presentation A).



Figure 1: The two different versions, both displaying the same content

⁸ MAS130 is the subject code for “3D CAD and Material science” at the University of Agder (2016).

⁹ PowerPoint is a presentation graphics package developed by Microsoft. This software is typically used to develop and present lectures, studies or findings to a larger audience.

¹⁰ Adobe Captivate is a similar product provided by Adobe. Captivate allows much more freedom when creating the presentations, having a timeline for the user to observe their progress and changing the presentation format depending on what device the user is accessing the presentation from.

1.5 Previous Research in the Field

The primary method used to gather information and finding literature was by utilizing the google and google scholar search engines, as well as sharing various sources with students studying similar topics. Other master assignments have also been used, mainly located from Brage¹¹ which included looking at what sources were cited in these assignments.

Our system of public education—our curricula, teaching methods, and the tests we require students to take—were created in a different century for the needs of another era. They are hopelessly outdated.

(Wagner, 2008).

As technology progresses, new professions and jobs emerge and evolves rapidly. The need for a new set of skills to comprehend the technological advances happening in at a fast rate. In the digital age, there is need for learning skills in order to follow and comprehend the vast changes occurring each year. To address this issue, the definition and frameworks for 21st century skills were created to prepare students for their own future. P21¹² has since 2002 been working with educators, the business community, leaders and policymakers to address the importance of 21st century skills, and created a framework named P21 Framework for 21st Century Learning. This framework was developed in collaboration with teachers and educational experts and defines the skills needed to succeed in the 21st century society. The scheme consists of different types of skills required; research and information, creativity and innovation, communication and collaboration, as well as digital citizenship. Tony Wagner has worked with education for twelve years as a teacher in, high-school, as a K-8 principal, as university professor in education and founding executive director of Educators for Social Responsibility. He developed the recipe for becoming equipped for the future consisting of what he calls “the seven survival skills”. Wagner explains how young people he has encountered in his research which expect to earn more than minimum wage entering the world without these skills are crippled for life.

[...] they are similarly unprepared to be active and informed citizens or to be adults who will continue to be stimulated by new information and ideas. Parents and educators who

¹¹This is the link used to locate these assignments: <https://brage.bibsys.no/xmlui/handle/11250/152233>

¹² Non-profit organization which advocates future readiness for students.

do not attend to these skills are putting their children at an increased risk of not being able to get and keep a good job, grow as learners, or make positive contributions to their community”

(Wagner, 2008)

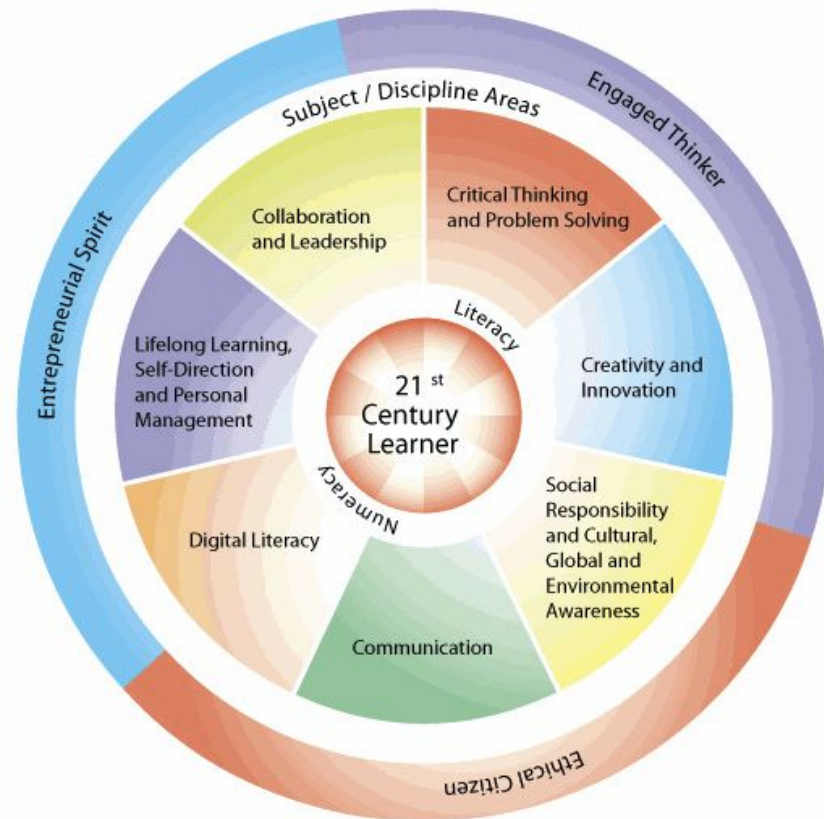


Figure 2: 21st Century Skills.

Figure 2 displays the seven survival skills. One of the common denominators of these skills is the reliance on the student’s abilities to rely on themselves. The current educational system encourages learners to recycle information and perform in ways that have proven to already be working in order to pass a class. This leads to the stagnation of innovation, and rather than protecting the students from failure. Because of this, Wagner argues that the educational system is in of a dire need of reinvention (Wagner, 2012), wants teachers to encourage students to create, attempt and fail as much as possible, as that is what leads to innovation.

Tony Wagner addresses one of our most urgent questions: How do we create the next generation of innovators? ...Wagner shows that the answer isn't to double-down on outmoded, formulaic solutions--but to embrace the principles of play, passion, and purpose.

(Daniel H. Pink)

1.6 Limitations

Firstly, the survey had some questions that were deemed unhelpful upon receiving the responses. For example, for both Presentation A and Presentation B, the students were asked "What do you think this version did better than Presentation A/Presentation B". The data received was scattered for both versions, and it was impossible to draw a satisfying conclusion from it. Additionally, as these students have no studied graphic design or typography, it is possible that they were confused by what terms such as "layout" means, for example. The questions should have been combined and rephrased in order to gain any value. Because of this, the data on these questions were omitted from this research. There were also challenges with the software, and features like voice overs had to be omitted because they would be too time consuming. There are several features that would have further improved Presentation B and added more variation, but because of the time limitation, these were impossible, leaving still much to be desired. Some of the questions in the questionnaires also very restrictive available answers. One example of this is regarding video length. The user could only pick "Could be longer" or "Could be shorter". While they were constructed for the "could be longer" video to be the positive answer (considering that must have meant that the student felt the video covered the necessary material without them getting bored), confusing might have occurred for the tester, leaving response and responses similar to this up to interpretation, and might not actually reflect the testers true opinion.

1.7 Structure

This thesis is constructed with five primary chapters. The first chapter will introduce the the topic and purpose of the research, as well as an introduction to the product made in conjunction with the research. Chapter two will display the main theories that seem relevant in order to justify why the hypothesis was developed. Chapter two will revolve around the theories that served as a basis for both the hypothesis and the product created together with Geir Grasmø. Chapter three will present the methodology and thought behind the research conducted, present two different research methods and explain the strengths and weaknesses this different methods

have. It will also discuss the value of this research in itself. Chapter four will reveal the data gathered from the research and justify the results by connecting the data with the theories introduced in chapter two. Chapter five will discuss, evaluate and conclude the thesis based on the results from the data presented in chapter four.

2: Theory

2.1 Introduction

This chapter will focus on the learning theory relevant to the product created and the results. These theories will also serve as guidelines that on how the product is ideally practiced by the user (both teachers and students). The key theories will be 21st. Century Skills, Modern learning theory (focusing on connectivism), Blended Learning (focus on Flipped Classroom) as well as learning intelligences, video theory, gestalt theory and the benefits of multiple choice.

2.2 Learning theories

In *Connectivism: A Learning Theory for the Digital Age*, George Siemens brings forth what he calls the three most commonly used broad learning theories, behaviorism, cognitivism and constructivism. However, he argues that these theories are insufficient in the digital age. That they do not allow the learners learn fast enough compared to what is expected of them. He also explains that these theories concentrating more about the process of learning, rather than the value of what is learning learned, and argues that while learning theories can be altered and manipulated, the digital ages ecosystem is so different from what was before, that alterations to these theories is not enough. He therefore seeks to revise these traditional learning theories by introducing one that would be directly connected with the digital everyday life (George Siemens, 2005, p.).

2.2.1 Connectivism

Siemens argues that the three aforementioned traditional theories all share the same weakness, specifically that they do not take into account the impact technology can, and should have on the learning experience. Additionally, they are only concerned about the individual learner, and do not take into account how organizations can achieve learning (George Siemens, 2013, p.3).

“Experience has long been considered the best teacher of knowledge. Since we cannot experience everything, other people’s experiences, and hence other people, become the surrogate for knowledge. ‘I store my knowledge in my friends’ is an axiom for collecting knowledge through collecting people. ‘A friend of a friend is a friend’ or ‘an enemy of a friend is an enemy’ are two more axioms for knowledge transfer through people via their entrusted relationships.”

(Karen Stephenson, N.D., p. 1)

With the increased demand for knowledge, none of the aforementioned learning theories offer the efficiency required for the learner to keep up with said demands. Because of this, Siemens introduced a fourth learning theory: connectivism. The core of this theory is the importance of connecting several different mediums in order to gain the necessary understanding in a field. Knowledge, computer networks, power grids, friends, and communities are all examples of origins of information that a learner can use to gather intelligence from. Connectivism only can only function by the virtue of the accessibility technology grants the learner. Because of the access and mobility of information, learning through multiple sources and mediums can be accomplished with ease.

“We can no longer personally experience and acquire learning that we need to act. We derive our competence from forming connections”

(Siemens, 2013).

Table 2: *The principles of Connectivism.* Siemens (2004).

The Principles of Connectivism
Learning and knowledge rests in diversity of opinions.
Learning is a process of connecting specialized nodes or information sources.
Learning may reside in non-human appliances.
Capacity to know more is more critical than what is currently known
Nurturing and maintaining connections is needed to facilitate continual learning.
Ability to see connections between fields, ideas, and concepts is a core skill.
Currency (accurate, up-to-date knowledge) is the intent of all connectivist learning activities.

Decision-making is itself a learning process. Choosing what to learn and the meaning of incoming information is seen through the lens of a shifting reality. While there is a right answer now, it may be wrong tomorrow due to alterations in the information climate affecting the decision.

2.3 Cone of Experience

The American educator Edgar Dale, looked into the efficiency of various learning activities. He theorized that the learner attains more knowledge through active, rather than passive learning. In his book *Audio-Visual Methods*, Dale roughly illustrated the effectiveness the different learning activities typically has on the learner (Edgar Dale, 1946 p. 38).

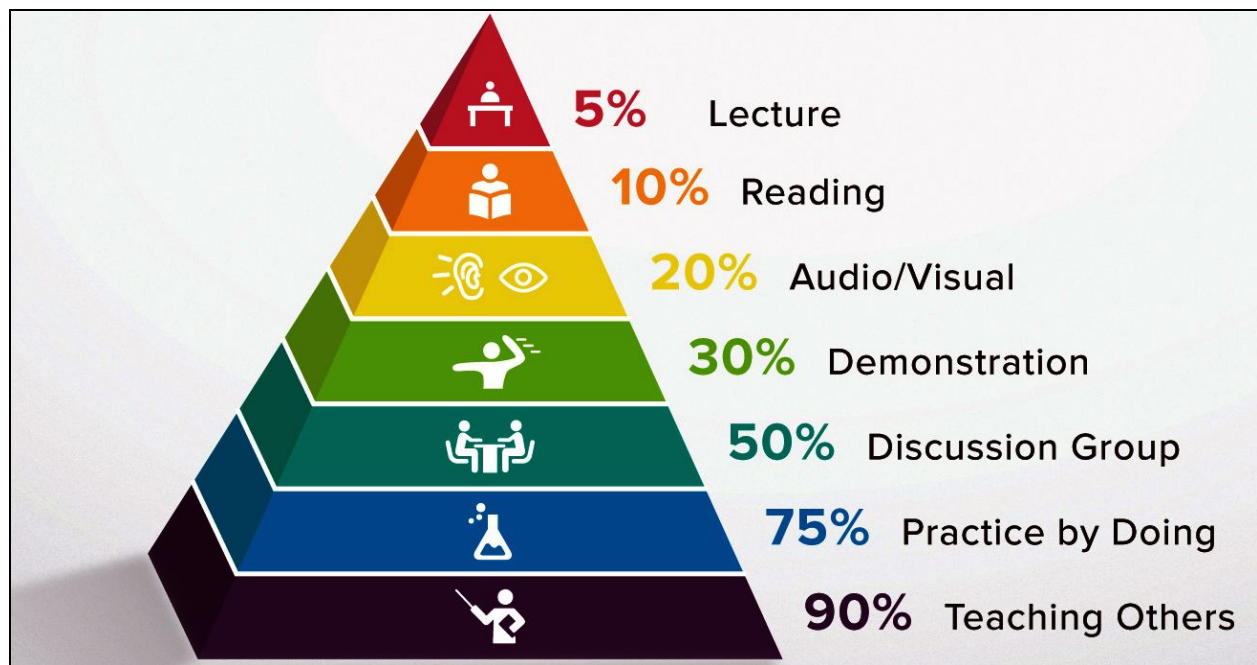


Figure 3: The Learning Pyramid/Cone of Experience¹³

Figure 3 illustrates the amount of information and knowledge the learner can recall after a two week period. The cone can also be divided into two categories. Active and passive learning. The four activities from the top and down are classified as passive learning. The teacher has the active role and will relay information to the learner. The

¹³ The pyramid displayed in figure 3 is a revised version of the pyramid.

last three activities; Discussions, practice by doing and teaching others are classified as active learning. The student is required to actively participate in the learning session. The cone of experience compares the different activities and their individual efficiency, while simultaneously comparing active and passive learning, suggesting that the more activity performed by the learner, the higher amount of knowledge is attained. It should be noted that Edgar Dale never placed the percentages regarding the amount of information obtained through the activities. These were introduced by D. G. Treichler, and there are neither disclosed any method of measurement or references that would suggests that these numbers are correct (Skaare 2009). Because of this, the percentages will not be included when analysing in chapter four. In addition to this, there are several other criticisms for the learning cone. There are for example various different activities that can qualify as a audiovisual experience. Does the individual remember better when they looked outside of their car window (audiovisual) compared to what they read a in a book (Daniel Willingham, 2013)?

2.4 Learning Intelligences

In addition to performing active and passive learning, cognitive psychologist Howard Gardner proposed a theory that takes into consideration that individual learners learn best through different mediums and activities. He called this Multiple Intelligence Theory (MI), and identified seven different learning styles that individuals benefit the most from (BBC, N.D.).

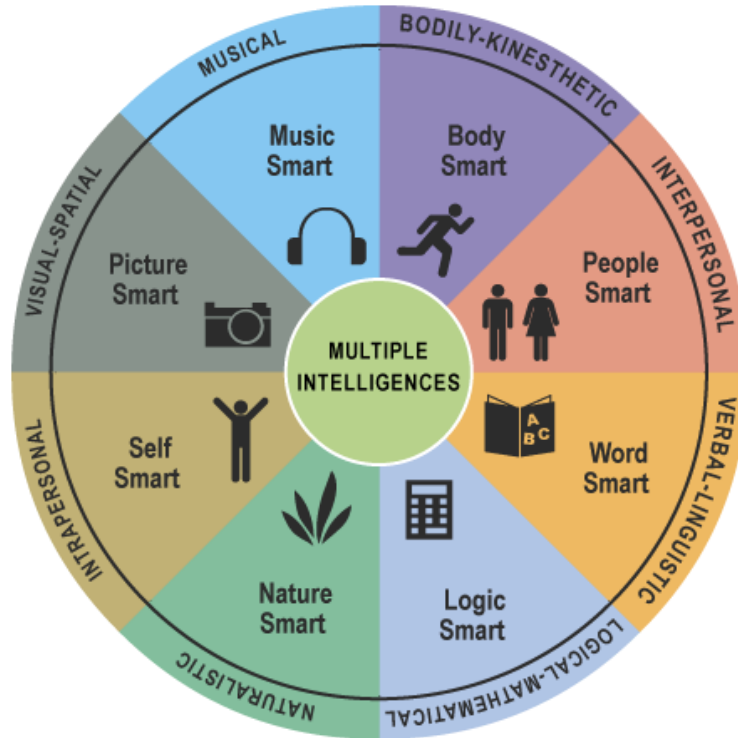


Figure 4: Multiple Intelligences

Verbal/Linguistic Intelligence

Learners who fall under the verbal/linguistic intelligence have the best outcome by reading, writing, speaking and conversing in their own or a foreign language. Mediums well suited for people in this category are books, word board/card games, listening on recordings, as well as participating in conversations and discussions (Howard Gardner, N.D., p. 4).

Logical/Mathematical Intelligence

Those who fall under this category learn best when numbers and computing skills are involved, recognizing timeliness, order and when a problem can be solved with logic. Logical/Mathematical learners may have the best learning outcome through classifying and sequencing activities, playing number and logic games, as well as solving various kinds of puzzles. (Howard Gardner, N.D., p. 4).

Visual/Spatial Intelligence

These learners prefer learning through visual perceptions of the environment, are proficient at creating and manipulating mental images, and the orientation of the body

in space. Visual/spatial learners might benefit the most by learning through experiences in the graphic and plastic arts, sharpening observation skills, solving mazes and other spatial tasks, and exercises in imagery and active imagination (Howard Gardner, N.D., p. 4).

Bodily/Kinesthetic Intelligence

Learners in this intelligence group are best suited at physical coordination and dexterity, using fine and gross motor skills as well as expressing themselves or learning through physical activities. This learning intelligence can be exercised by playing with blocks and other construction materials, dancing, playing various active sports and games, participating in plays or make-believe as well as using various kinds of manipulatives to solve problems or learn. (Howard Gardner, N.D., p. 4).

Musical Intelligence

Musical learners understand and express themselves best through music and rhythmic movements or dance, or composing, playing or conducting music. These learners respond well to listening to recordings, playing in rhythmic games and activities, singing dancing or playing instruments (Howard Gardner, N.D., p. 4).

Interpersonal Intelligence

These learners are good at understanding how to communicate with and understand other people and how to work collaboratively. This learning style can be enhanced by playing cooperative games, doing group projects and discussions, reading multicultural books and materials, as well as role playing (Howard Gardner, N.D., p. 4).

Intrapersonal Intelligence

Learners in this category are best at understanding their own emotions and thoughts, and can be great at controlling and working with this intrinsic emotions. These learners learn best through individual work, such as reading, individual projects, writing and performing activities that requires one's imagination (Howard Gardner, N.D., p. 4).

2.5 Blended learning

Blended Learning has been around since the late 1990s, but with no firm definitions, the connotations wasn't set before 2006. It has since then been commonly accepted as *a combination of face-to-face and technology-mediated instructional forms and practices* (Norm Friesen, 2012, p. 1). Specifically, the mixture of digital media and analogue teaching, such as classroom lectures, tutorials or labs. This also combines both synchronous and asynchronous communication. The analogue teachings made in the classroom, and the

resources found online, respectively. There are currently six different variations of blended learning: Face-to-Face Driver, Rotation, Flex, Online Lab, Self-blend and Online Driver (Horn, Staker. 2011, p 4).

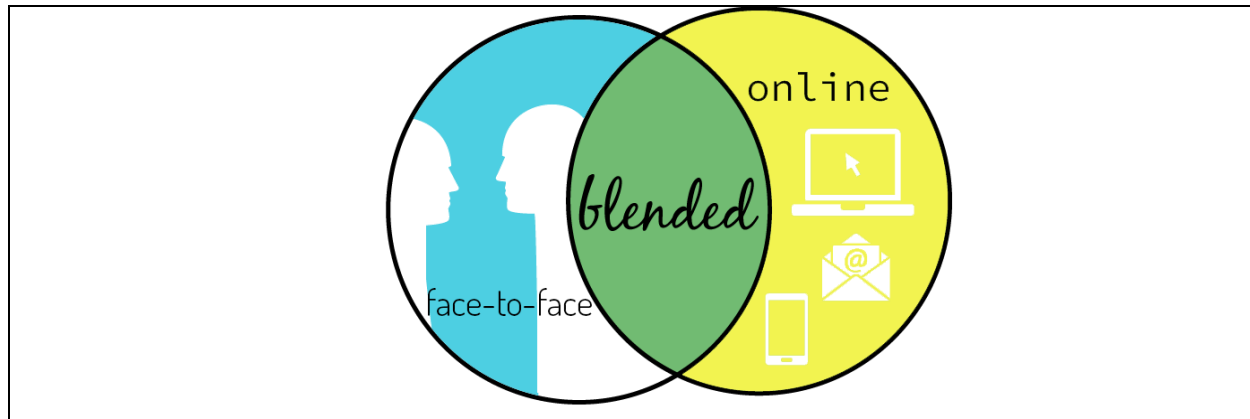


Figure 5: *Blended Learning*

2.5.1 Variations of Blended Learning

Face-to-face Driver

This model still has most of its emphasis on classroom teachings, and is also the most similar to traditional analogue teaching. For the majority of the class, face-to-face driver is the same as classroom teaching (Horn, Staker. 2011, p. 4). However, either exceptional or struggling learners can use additional content produced by the teacher in addition to either catch up or to keep challenging themselves (Dreambox, 2013).

Flex

When utilizing the flex model, the teacher will have created most of the learning content on an online platform. However, the students will be present in the classroom during class. This ensures that students can learn at their own pace while simultaneously having the teacher present for guidance and supervision (Friesen, 2012, p. 7)

A la Carte

A la Carte are labs strictly focused on using an online platform. The course requires attendance in the classroom and is supervised by non-instructional staff (Reading Horizons, 2015), but the class itself is performed through an online portal.

Self-Blend

Self-blend is solely performed online without any physical guidance from a teacher. This is typically taken as a supplement to a course.

Online Driver

The online driver model involves an online platform that the teacher utilizes to deliver the curricula. Learners will mainly work remotely. However, physical meetups are possible and sometimes required as part of the course.

Rotation

What distinguishes the rotational model is a fixed rotation between face-to-face interactions and working online (Horn, Staker. 2011, p. 4). There are five subcategories of the rotational model. They all embody the same principle, yet varies in their execution. These are Station Rotation¹⁴, Lab Rotation¹⁵, Individual Rotation¹⁶, and Flipped Classroom. (Staker, Horn. 2012, p. 10-13).

2.5.2 Flipped Classroom

Similar to the other subcategories of the rotation model, Flipped Classroom is set to a fixed schedule between physical meetups (typically in the classroom) and working online through a technological device elsewhere (typically a computer). The primary feature in flipped classroom is that the learning content is delivered, and often also instructed online. This allows the student to have a limited control over their own time and when to study, although the tasks are to be completed before a time limit, usually the next class meetup, where they will be prepared for the lecture and content the teacher will deliver. Kathleen Fulton developed a list of the advantages classes that utilized Flipped Classroom provided: (1) Students move at their own pace. (2) Doing “homework” in class gives teachers better insight into student difficulties and learning styles. (3) Teachers can customize and update the curriculum, and provide it to the students 24/7. (4) Students have access to multiple teachers’ expertise. (5) Teachers flip

¹⁴ A fixed schedule that the requires the learners rotating between different stations. With this, teachers can group learners with similar strengths and weaknesses and tailor the content in order to achieve a higher learning outcome (Doubet, 1016).

¹⁵ Lab rotation is similar to the other rotation models. The key difference is that in Lab rotation, students usually move outside of the classroom in order visit all stations.

¹⁶Individual Rotation is similar to Station Rotation. The main difference is that the learner’s don’t necessarily go through all of the same stations, unlike station rotation.

professional development by watching each other's videos and learning from each other. (6) Classroom time can be used more effectively and creatively. (7) Parents have a windows into the coursework. (8) Student achievement is increasing, so is interest and engagement in higher-level math. (9) Learning theory supports the new approaches. (10) The use of technology is flexible and appropriate for 21st century learning. (11) Last, but certainly not least is reason # 11: Students liked the flipped classroom! (Kathleen Fulton, 2012, p. 21 - 24). Clyde F. Herreid and Nancy A. Schiller surveyed 15 000+ members members of the National Center for Case Study in Science. Here, they found that 200 case teachers used flipped classroom for several reasons, matching the benefits in the list above. Specifically, the most relevant benefits in this studies were: (8), (9), and (10). The list continued to point (11) the method "promotes thinking inside and outside of the classroom", (12) students are more actively involved in the learning process and (13) they also really like it.¹⁷ However, in this study, they found that there are two major challenges when flipping the classroom. Firstly, learners who do not read at home will meet up to the class unprepared and unable to participate in the active learning phase. The second challenge relates to that most students and teachers preferred utilizing videos for the homework. The problem was that often the teachers said they found it difficult to find videos suited for their lectures, and some of them would create the videos themselves using various different softwares. However, the quality of these videos were often poor, and it took a significant amount of time to create and upload them (Clyde F. Herreid and Nancy A. Schiller, 2013, p. 62-63).

2.6 Video theory

Without question, this generation truly is the media generation, devoting more than a quarter of each day to media. As media devices become increasingly portable, and as they spread even further through young people's environments — from their schools, to their cars, to their pockets (e.g., cell phones with TV, audio, print, video gaming, and online capabilities) — media messages will become an even more ubiquitous presence in an already media-saturated world. Anything that takes up this much space in young people's lives deserves our full attention

Kaiser Family Foundation

¹⁷ These additional benefits (11, 12 and 13) were not present in the article by Kathleen cited in this thesis. It is possible that she has created another list with additional benefits, that the list in the cited article is incomplete or that Clyde F. Herreid and Nancy A. Schiller combined their her points with their own.

Audio/Visual mediums has been used as a learning tool as early as World War II. With the advancements of technology, video as an educational tool has evolved from studying filmstrips to cable television to VCRs, DVDs to virtually any screen, in various formats delivered through numerous means (Emily Cruse, N.D., p. 1-2). Considering how accessible digital media has become, video as a learning medium is becoming increasingly relevant in higher education, and for many, heavily tied with flipped classroom (Jon Bergmann, Jerry Overmyer & Brett Wilie, 2013). According to Cognitive theory of Multimedia Learning, people have separate channels that processes visual and verbal material, and because of this processes more information by utilizing both of these channels simultaneously compared to solely utilizing one of them (Stephen D. Sorden, N.D., p. 2). However, these channels can only process a limited amount of information at a time, meaning that the videos must be thoughtfully developed in order to encourage student learning (Richard E. Mayer, 2014, p. 47). In 2013, assistant professor of Computer Science at the University of Rochester, Philip Guo, tried to measure how long the learner would be engaged while watching educational videos. As visualized by the graph below, the students' interest had its peak after 6 minutes, but after that, it would gradually fall. He therefore concluded that the most beneficial video length would be no longer than six minutes (Philip Guo, 2013).

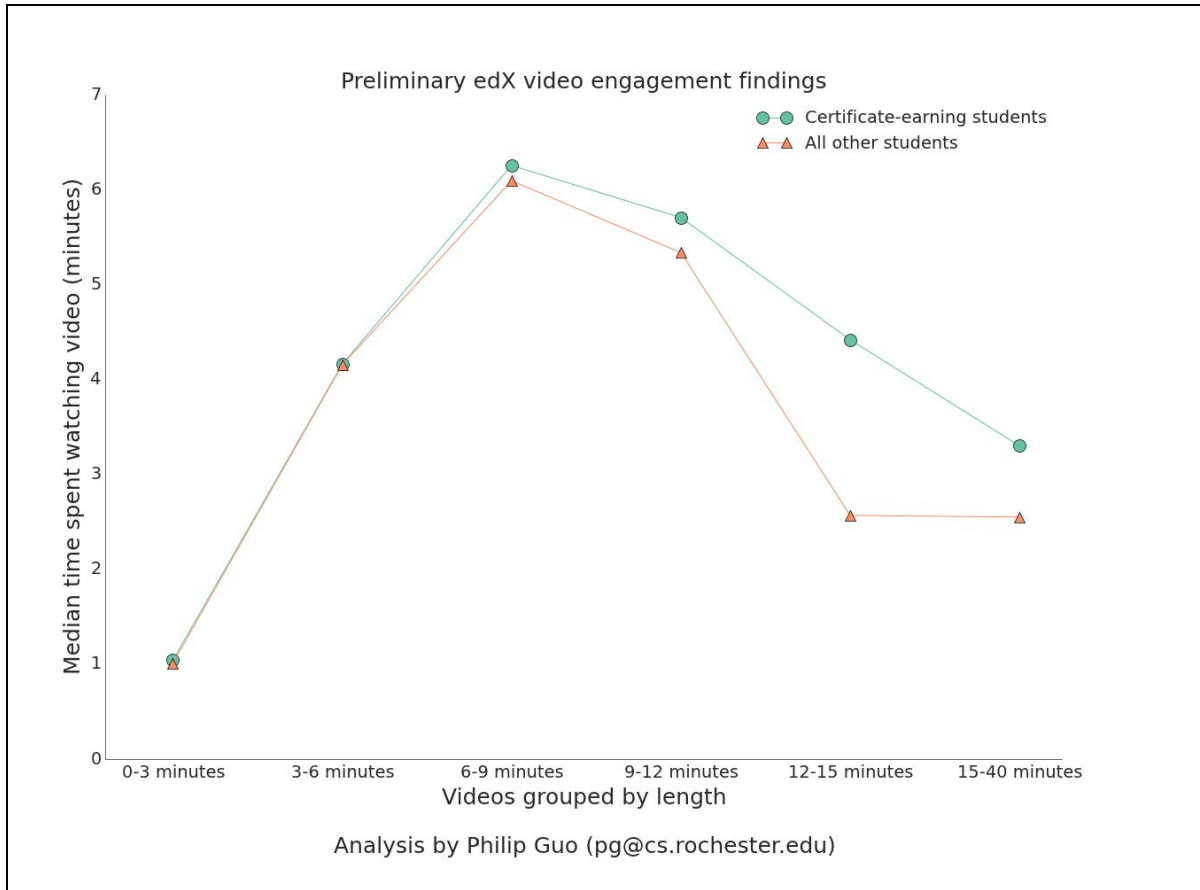


Figure: 6: Preliminary edX video engagement findings.

2.7 Gestalt Theory

Gestalt is a psychologically focused on cognitive behaviors, developed by Wertheimer, Koffka and Kohler, and has since then been adapted and utilized by various visual designers (Lisa Graham, 2008, p. 1). One of the most common aspects of Gestalt theory is that the whole is greater than the sum of its parts, meaning that human mind attempts to find harmony in chaos. For example, while we see all the different properties of a cat, such as its paws, head, ears and so on, our mind will bring these together under the category “cat” (howdesign, 2015). This theory has five design principles that should be followed: Proximity, Similarity, Continuity, Closure and Figure/Ground. This thesis will focus on the two that were utilized for Presentation B.

Proximity

Proximity refers to the density of objects. When close enough, they will be perceived as a group. When they are too far apart, they will be perceived as separate. In order to achieve proximity, certain visual objects must be closer to each other compared to other objects in the composition. In typography, proximity is created through the work of lines and density of text and objects (howdesign, 2015).

Similarity

Similarity is achieved when elements share similar shapes, sizes, color or are close in proximity. This will give the objects a relationship with each other, meaning they are more likely to be perceived as a group (howdesign, 2015, Lisa Graham, 2008, p. 9).

2.9 Multiple choice

The use of control questions in the form of multiple choice is something that has become a standard in many classrooms. One of the strengths multiple choice offers the students, is the ability to locate and correct mistakes because of instantaneous feedback. There are two forms of quizzes. Formative and Summative¹⁸. Formative quizzes' primary purpose is to monitor student learning, providing feedback on what areas they need to focus on. These quizzes are normally low-stake, meaning that the students overall grade is not affected by the results (Eberly Center, N.D.). Studies have also shown that developing frequent memory retrieval exercises can increase learning outcome for students significantly (Keith B. Lyle and Nicole A. Crawford, 2011, p. 96-97).

The Testing Effect

The Testing Effect is a finding that suggests that memory retrieval produces increased retention compared to repeatedly studying the same information (Henry L. Roediger III & Andrew C. Butler, 2011). This phenomenon has been reported as early as 1909, where Abbott, E.E. concluded in his master's thesis that "recitation was far superior to readings in learning value" (Abbot E.E, 1909). In later years, numerous studies have been conducted, often reporting similar results (Henry L. Roediger & Andrew C. Butler, 2011, p. 20-21).

¹⁸ Summative quizzes are created to evaluate the student, meaning that their grades are affected by the results of the quiz.

3: Method

3.1 Reliability and Validity

When conducting research, there are two important factors one has to take into account, and those are validity and reliability. Reliability refers to how easily the test can be repeated on different subjects. If the same or similar studies can be performed with ease and yield the same responses, then the research is qualified to be considered reliable. Validity encompasses the credibility of a research. Are the test subjects representable and varied? Are there enough participants for the data gathered to be representable? Are the questions asked and conclusions drawn from the answers genuine? There are two different sub categories of validity. Inner validity, meaning that the data gathered is consistent with what theory suggests they should find (Dag Ingvar Jacobsen, 2015, p. 228-236), and external validity, referring to external influences, such as the amount of testers utilized¹⁹ and whether these testers were representable compared to what they were testing (Dag Ingvar Jacobsen, 2015, p. 238-239).

3.3: Quantitative Method

While the project outline and process is described in chapter one (see 1.4: The experiment), this section will describe how data was gathered, how the questions were formed, the pinnacles and obstacles of the utilized method, as well as what could have been done in order to strengthen the validity of this research. For this research, a quantitative method formed as a survey. One important thing to keep in mind is the chance for misinterpreting the responses. This will be further touched upon in chapter four (see the analysis of 4.4 Presentation B (in the videos section), but as the testers are answering standardized forms, it is possible that what was developed created as a positive answer is interpreted as a negative answer for the tester. When the testers were asked to give a rating, the scale chosen was between one (unfavourable) and six (favourable). This was done in order for the students not to answer the middle number²⁰, encouraging them to decide whether they have a more positive or negative experience with the aspect of the product they are asked about. Additionally, very few neutral answers were available to them, meaning that they would either had to choose one positively or negatively loaded answer. The survey was distributed to the students

¹⁹ Using a political survey with ten respondents results in low validity and can not be used to represent what the people in general think about the political issue, for example.

²⁰ If, for example, the number scales ranged from one to seven, there is a possibility that many would pick four, as it is neither favourable nor unfavourable.

through the internet. One of the major flaws of internet surveys is an increased chance for dropouts. Likewise, people tend to delay responding to web-based surveys (Dag Ingvar Jacobsen, 2015, p. 280-281). As mentioned in the introduction to this chapter, the dropout rate was quite severe, ending the data collection with twenty three students, damaging the validity. Quantitative data collection

3.2 Process

Out of the total of ninety seven students participating in MAS130 (all of whom were given access to the questionnaire through Fronter)²¹, twenty three responded to the survey. This means that the validity of this research is severely limited. However, as the theory corresponds with the content of the answers received, the inner validity is slightly increased. It must be noted that the gathered data that is discussed in this thesis is not representative and further studies will have to be conducted in order to further test the hypotheses tailored in this thesis. The reliability of the data is relatively high, as it mostly focuses on comparing the different versions, both of which are available to both me and the professor of MAS130 as of 2017. While this specific test cannot be reproduced as easily, considering that it requires students to go through the different version simultaneously while the course progresses. This can be solved by conducting the research simultaneously with the next students taking the MAS130 course. However, similar tests can be conducted by requesting testers to only compare the versions to each other. This study was developed and researched on a class where the teacher had very little experience or interest in the design or layout of his content. It is also easy to assume that the general consumer will prefer a more planned and thought-out design of the presentations compared to what can feel like random design. The research doesn't specifically target motivation itself, but rather what the users liked and which version they preferred. Furthermore, as gathering this data was a lengthy process, and the students were requested several times to take the survey, it is possible that some of the responses are. Because of this, it is important to take into account that this research can suffer of a certain amount of contaminated data²², as the students could have responded negatively to either version out of frustration from being reminded numerous times to take the survey. Additionally, as many of the responses to the survey arrived months after the curriculum was relevant to the students, it is also possible that the data received is imprecise, as students might have forgotten how their user experience with the different versions were. In order to further strengthening the validity of this research, more tests should be conducted. In order to measure whether motivation actually increases, one can for example use a control

²¹ Fronter is the Learning Management System (LMS) that UIA uses as of 2017.

²²

group, each with either of the two versions, and log each individual time a unique user enters the presentation and the amount of time they spend there.

4: Presentation, analysis of results and discussion

4.1 Introduction

This chapter will focus on the data that was gathered through the research and bring forth the key findings of the empirical data, and connect the results from the survey to the theories that were brought up in chapter two. The survey was conducted on students in who participated in Material Science and Engineering (MAS130) in 2017. The survey was handed out to every student who were enrolled in the class. 135 students had access to the course through frontier, and ninety one of them took the exam for the course, and the survey was accessible between 22. December 2016 until 27. March 2017. The amount of respondents ended up as twenty three. The software used to gather, analyze and illustrate the data was Google Forms²³. This chapter will be divided in several subchapters, all focusing on specific themes in the survey. First, the participants demographics will be introduced, and then a separate presentation of data on both Presentation A and B will be conducted, moving on to the students comparing them. Finally, the data will be analyzed and discussed categorically. The presentation and analysis will be separated in order to easier separate the numbers, as many of the responses can be explained using the same theory. The analysis will refer back to the presentation for more accurate numbers.

²³ Google Forms is a free survey software provided by Google that allows its users to create polls and surveys, and the data gathered from the testers is automatically connected to a spreadsheet.

4.2 Demographics

While this survey was not intended to look at gender differences, should be noted that out of the twenty three participants, 100% (23) were male, which was revealed after receiving the data. This survey will therefore have a skewed representation of the sexes and can not be used as any indication on similarities or differences men and women share for this particular subject.

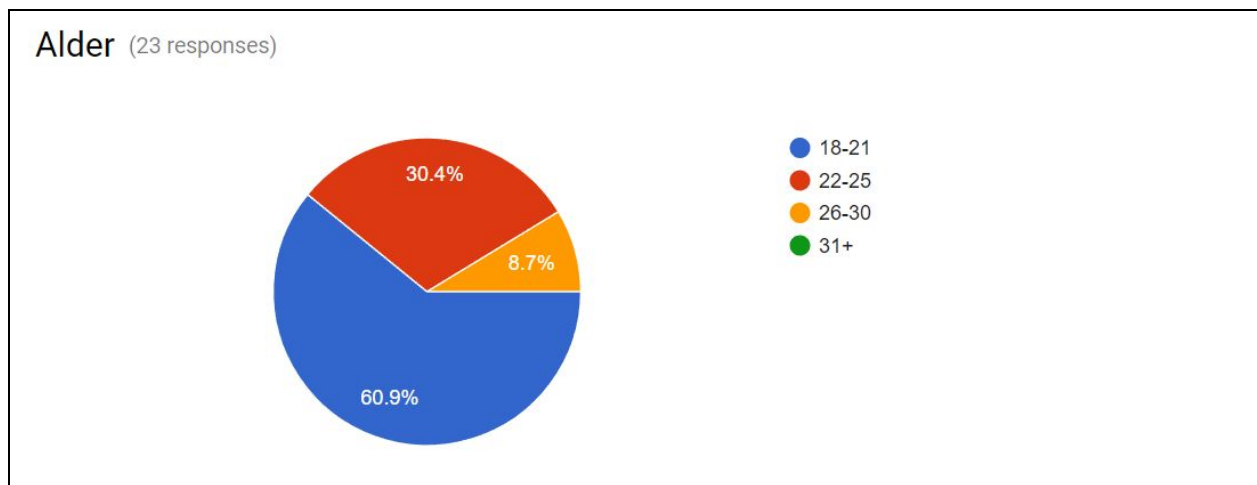


Figure 7: Age: A pie diagram visualizing the different ages of the participants

Figure 7 displays the ages of the testers. None of the participants are old enough to be considered a digital immigrant (Prensky, 2001). Because of this, a technological disconnect between the lecturer²⁴ and the students is to be expected. Because of this, it is more likely that the students will have a higher preference for the more digitally competent version.

²⁴ The lecturer was born in 1959, and would fall under Marc Prensky's category as a digital immigrant.

4.3 Presentation A

When asked about the clarity of the design of Presentation A (developed by the professor in MAS130), the testers seemed to be generally dissatisfied with the layout choices made. 56.4% (13) rated the correlation between the learning content and the figures as confusing (meaning that they rated it 3/6 or below). 30.2% rated it as 2/6. However, 43.6% (10) of the students rated it favourably, with only 4.3% (1) rated it the highest score (6/6).



Figure 8: Visual clarity between figures and text regarding Presentation A.

Regarding the clarity provided by the images and figures, the testers generally collected rated them average in terms of understandability. 34.8% (8) rated the clarity as 3/6 and 43.5% (10) rated it as 4/6. The testers also seemed to find the amount of text per slide to be excessive with 65.2% (15) wanting less text per slide contra 34.8% (8) who could tolerate more information on the slides.

4.4 Presentation B

The students were asked similar questions on their experience with both Presentation A and B. The responses were generally more favourable when questioned about their opinions on Presentation B. For example, when asked about the correlation between the learning content and the figures, the 39.1% (9) rated it as a 4/6. 34.8% (8) rated it as 5/6, and 26.1% (6) rated it as favourably as 6/6. This means that none of the testers rated it as 3/6 or below. The testers were also questioned on how they experienced the general amount of information presented in the slides, and 69.6% (16) answered that the amount could have been increased. 30.4% (7) responded that they would prefer less.



Figure 9: Visual clarity in Presentation B

Additionally, as Presentation B used colour as a tool to differentiate between topics, the students were asked specifically if they found this use of colour to improve or decrease their experience with the presentations. The majority rated the use of colour positively, with 30.4% (7) rating it as 6/6, 26.1% (6) as 5/6 and 17.4% (4) as 4/6. However, 26.1% (6) scored it 3/6.

As Presentation B contained additional features (quizzes and videos) compared to Presentation A, the testers were asked specifically about their experience with said features. Their responses to the quizzes (present in chapter ten) was favourable, with 95.7% (22) finding the quizzes to be a complementary addition to the presentation. The testers also responded positively to the frequency the quizzes would appear with 65.2% (15) claiming they were satisfied by the amount. However, 34.8%(8) requested them to appear more frequently. Whether the testers found the quizzes to be a competent tool for validating whether they had learned the content was also positively reviewed. 91.3% (20) scored it 4/6 or higher, leaving the remaining 8.7% (2) rating it 3/6. In spite of this 100% wanted quizzes to be featured in future presentations, with 13% (3) wanting “better questions” than those presented in chapter ten.

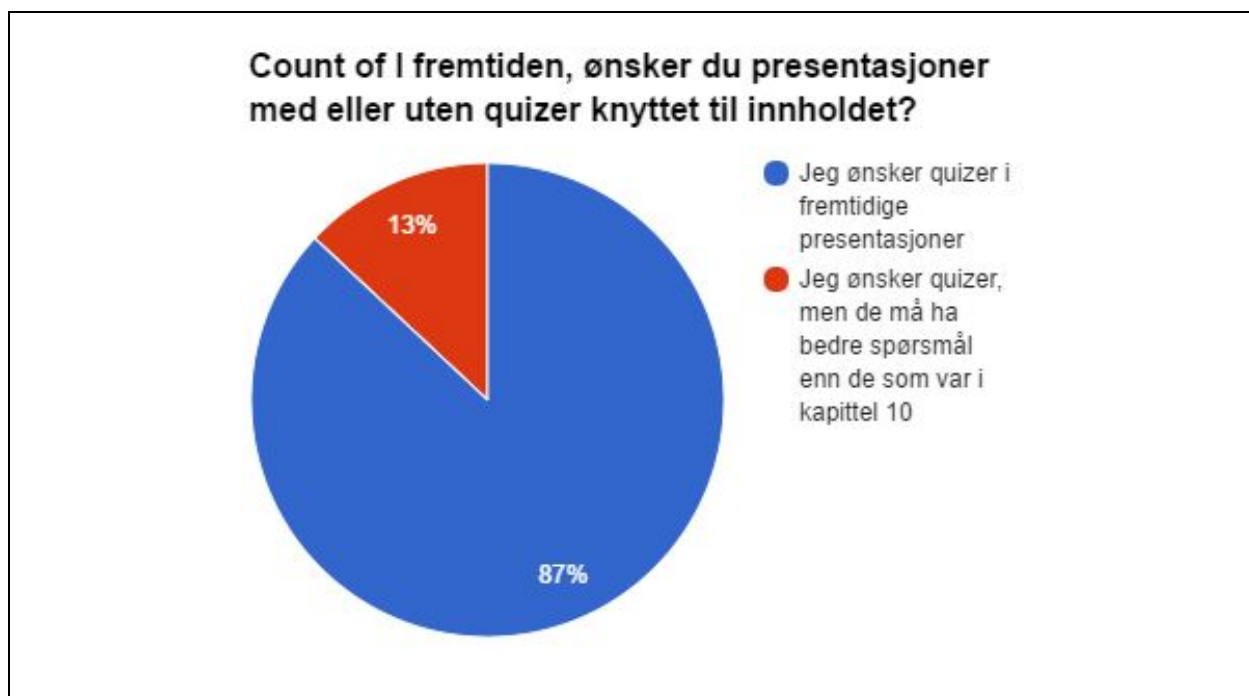


Figure 10: Quizzes in future content

The addition of videos were be generally accepted by the testers as well. They were asked whether they found the additions of videos to be positive or negative. 87% (20) scored the the videos between 4/6 and 6/6. The remaining 13% (3) scored it 3/6. Similar responses were collected on whether the videos had a positive impact on the students’ comprehension of the subject content. The majority (87%) (20) did find the videos to help their comprehension by giving the 4/6 rating or higher. However, 13% (3) gave 3/6 or below. The general response to the videos length was positive. 60.9% (14) believed

the length not to be excessive, answering that the videos could have longer durations. 39.1% (9) did find the videos too long considering what they were presenting. It should be noted that the question regarding video length left the users with two responses. “Could be longer” and “Could be shorter”. The responses here are left up to interpretation, as one student did comment that they were frustrated by not being allowed to answer that the duration was good. 95.7% (22) acknowledged that they wanted videos to be featured in future presentations. The remaining 4.3% (1) preferred if videos were omitted.

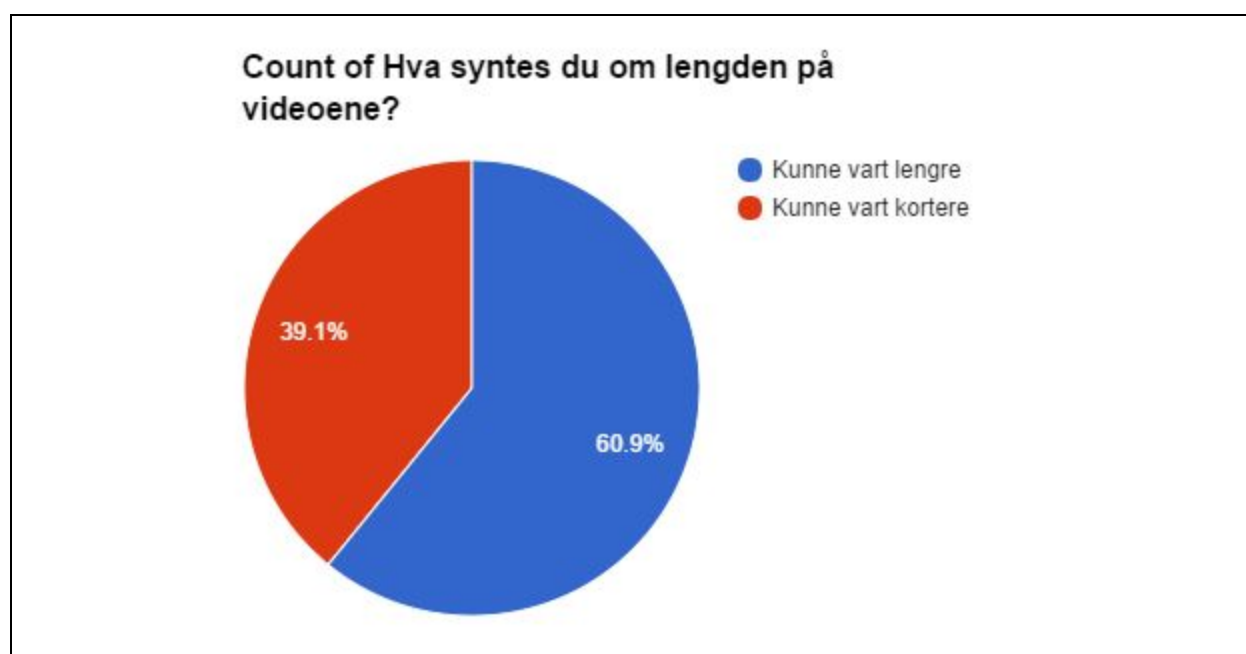


Figure 11: Video length

4.5 Comparing Presentation A and Presentation B

The testers were asked which version of the presentations they preferred for the three individual chapters. For all three chapters, the users overwhelmingly voted in favour of Presentation B. For chapter one, 87% (20), chapter ten, 91.3% (21) and chapter twelve, 95.7% (22) expressed their preference for Presentation B. The remaining percentage for each of the questions preferred Presentation A. When asked generally if they would prefer future presentations (in other courses than MAS130), 95.7% (22) chose presentations similar to Presentation B. 82.6% (19) preferred if the lecturer in MAS130 had used Presentation B in their classes, and 87% (20) wanted to use Presentation B when studying outside of the classroom. The testers were also questioned on whether

they preferred to use the same version for both lectures and reading outside of the classroom (for example being lectured in Presentation A and reading Presentation B at home). 73.9% (17) preferred the same version to be used regardless of environment, 21.7% (5) preferred different versions depending on environment and 4.3% (1) did not care. The students were asked whether they preferred to be presented with all of the information on the slide immediately upon entering it, or whether they wanted to click in order to add more information to the slide (typically like a powerpoint slide). 56.5% (12) wanted all of the information to be displayed immediately and 43.5% (11) wanted to be presented with limited information, clicking in order to add more. They were also asked whether they preferred light coloured backgrounds (like Presentation A) with dark coloured text or the opposite (Like Presentation B). 52.2% (13) preferred the light coloured background with dark text, while 47.8% (11) preferred the dark coloured background with light coloured text.

4.6 Analysis and Discussion

4.6.1 Visual Design

Correlation between figures and text

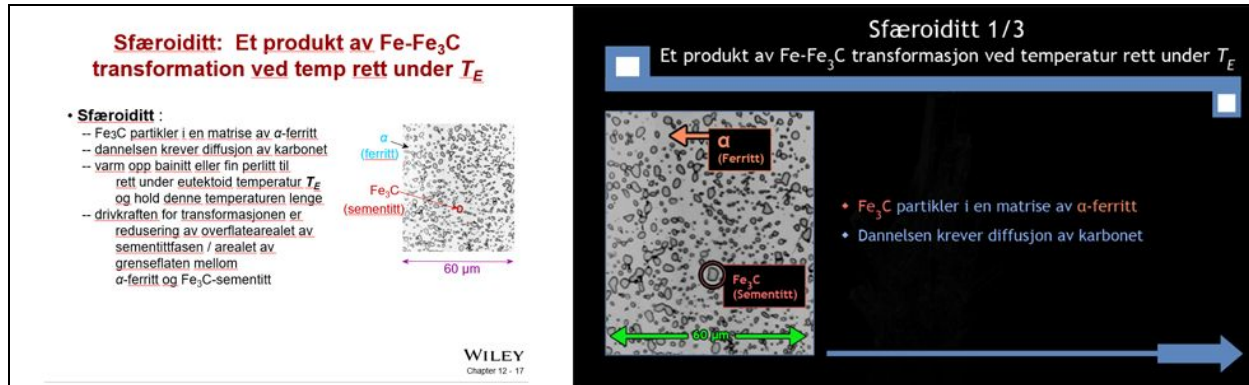


Figure 12: Use of color in Presentation A (left) and Presentation B (right)

Figure 12 displays the how colour was applied in the presentations. The figure in both version A and B have used colour to draw attention to the “ α (ferritt)” and “Fe₃C (Sementitt)”. However, what version B does differently, is employing Similarity (Geralt Theory) by repeating the colours when referencing the figure, making it easier for the learner to develop a connection between the figure and the body text (howdesign, 2015, Lisa Graham, 2008, p. 9). The effect of Similarity can be seen in the responses, considering that the students did have an easier time connecting the text and figures in Presentation B (see figure 8 and 9).

Use of Colour

This use of Similarity in colours can also be observed in the chapter structure for Presentation B. For example, chapter one will have its text coloured red, and chapter two will use green in order for its text. The intention of this was to increase the visual clarity, giving the learner aesthetic cues regarding change of topics. Titles, headlines, bread text and subsections were also colorized by using a lighter gradient of the chapter colour for each subsection. This was done in order for the user to easily notice the subsections affiliation (howdesign, 2015, Lisa Graham, 2008, p. 9).

Størkning og kritisk kinstørrelse

$$r^* = \frac{-2 \gamma T_m}{\Delta H_f \Delta T}$$

r^* = kritisk radius
 γ = fri energioverflate (overflatespenning)
 T_m = smeltetemperatur
 ΔH_f = latent størkningsvarme
 ΔT = $T_m - T$ = underkjøing

NB: ΔH_f og γ er svakt avhengig av ΔT

- r^* minker når ΔT (mindre kim kreves for stor underkjøing)
- $r^* \sim 10$ nm for typisk observerte ΔT

Figure 13: Use of color in Presentation B

Additionally, as visualised in Figure 13, Similarity was tool to increase the visual connection between symbols and their explanation (howdesign, 2015, Lisa Graham, 2008, p. 9). However, as displayed in chapter 4.4, 26.1% (6) scored it unfavourably, grading it 3/6. There is a possibility that the amount of colours could be excessive for the tester, meaning that the layout ended up having too much visual noise. However, it should be noted that out of the six people who rated it 3/6, five of them (83.33% of the 6 who rated it negatively) preferred light backgrounds with dark text. This means that there is a possibility that the main reason they found the use of colour in Presentation B to be more confusing than Presentation A might be rooted in their dislike for dark backgrounds with light-coloured text.

4.6.2 Quizzes

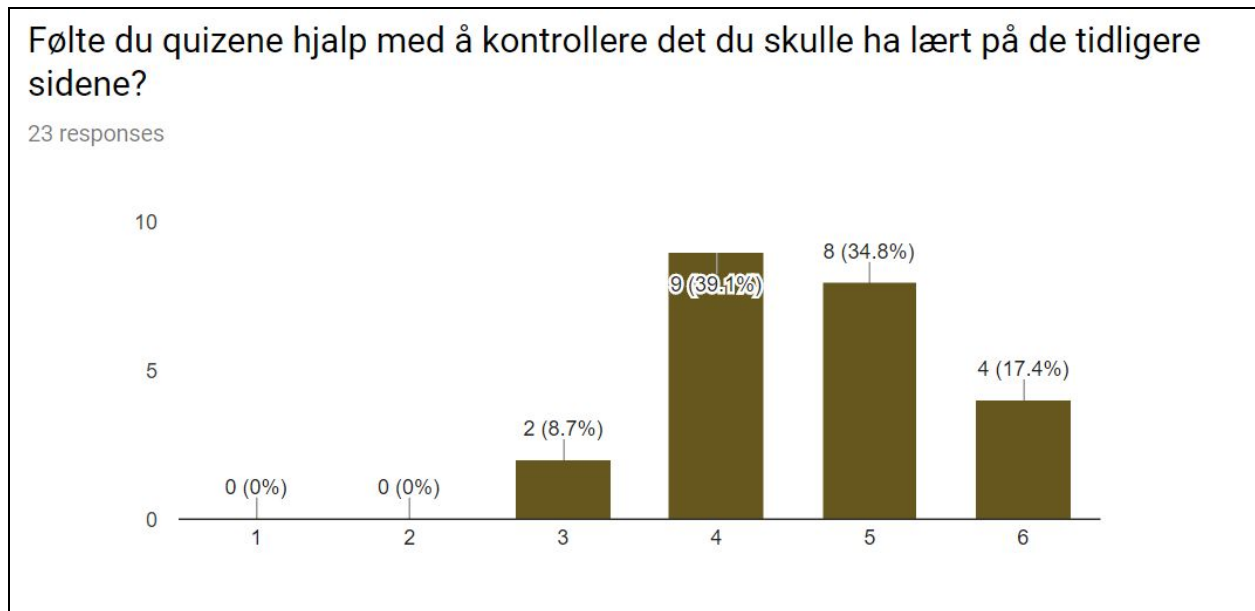


Figure 14: Quizzes and learning

As shown in chapter 4.4 and figure 10, quizzes were very well received by the testers, with 95,7% (22) stating that the quizzes complemented Presentation B. One of the reasons for this positivity could be that the quizzes offer immediate feedback. Taking into consideration that all of the students are digital natives, who normally prefer instant gratification compared to delayed responses (Prensky, 2001). Additionally, as displayed in figure 14, the students felt that they were more aware of what they were supposed have learned in the previous slides. While this thesis does not measure the effect of the quiz, but rather asking the testers on their personal opinions, it is difficult to know if that actually is the case. However, as mentioned in chapter 2.9, several studies do report similar results (Henry L. Roediger & Andrew C. Butler, 2011, p. 20-21).

4.6.3 Video

87% (20) of the students found the videos to help them understand the subject content. This was expected, as the result correlates with what was Emily Cruse wrote in her article, that while the video format may appear as passive learning (Emily Cruse, N.D., p. 3), it can promote high cognitive activity necessary for active learning, as it can utilize both the visual and verbal channels (Stephen D. Sorden, N.D., p. 2). Likewise, as suggested by Gardner's Learning Intelligences, the learning method best suited for the

learner depends on the individual. Unlike a purely linguistic format (Presentation A), videos can make use of several other the intelligences, such as aesthetics, audio and narration (Howard Gardner, N.D., p. 4). Additionally, taking into consideration what Edgar Dale illustrated in the Learning Cone of Experience (figure 3), audio/visual stimuli is more effective compared to both lectures and reading (Edgar Dale, 1946 p. 38). Considering the lengths of the two videos (68 and 120 seconds respectively), this coincides with Philip Guo's research on optimal video length (Philip Guo, 2013). It should be noted that according to his study, six minutes was the optimal lengths for educational videos. This might be one of the reasons why 39.1% believed that the videos would benefit from a longer duration. The reasons for this is likely that the students either felt that information sacrificed in order to achieve the short video duration, or that the pace of the videos were suboptimal.

4.6.4 Comparing the Presentation A and Presentation B

When looking at the reception of both Presentation A and B, the testers were overwhelmingly in favour of Presentation B on every account. This was expected. While both Presentation A and B are variations of flipped classroom, presentation B took inspiration from connectivism, by using more than one medium to present the material (Siemens, 2013). One of these mediums were videos, which is often heavily associated with flipped classroom (Jon Bergmann, Jerry Overmyer & Brett Wilie, 2013). In addition to this, one of the fundamental differences between Presentation A and B was the amount of information contained per slide (see figure 12). Presentation A places a significantly higher cognitive load on the students (Carl Wieman, 2009), compared to B, which the same amount of information over several slides. Additionally, as Presentation B contained numerous unique mediums, such as text, videos and quizzes, there is a chance that the students cognitive load was further reduced due to the variation it offered.

5: Summary and Conclusions

5.1 Introduction

The take-home message for instructors is that, to maximize student engagement, they should work with instructional designers and video producers to break up their lectures into small, bite-sized pieces.

(Philip Guo, 2013)

This survey only included students from 3D CAD and Material science at Universitetet i Agder (2016). The results and data in this research may not be representative for the general student. Additionally, as approximately 31,05% of the students in the class completed the survey, the data may not represent the opinions and experience of the overall class. As they were tested in an uncontrolled environment, it is also possible that unforeseen complications (such as technical difficulties, misunderstandings or other factors) altered their experience. Both producing the resource and gathering the data were lengthy processes.

5.2 Summary and Conclusions

This section will summarize and conclude the findings obtained during this experiment, as well as try to answer the research questions developed for this thesis. As this research was only conducted on a small section of the desired user base, one must take into account that the data retrieved in this study is not representable, and further research in this field should therefore be conducted. In spite of this, the testers that did respond to the survey were part of the audience this specific research was intended for.

5.2.1 Research Questions and Hypothesis

The first research question for this thesis was as follows: *Will an increased focus on visual design create any positive feedback from the students?* As the data from the survey shows, the visual aspects of Presentation B did leave a positive impression on the testers. All of the questions related to design were rated in favour of Presentation B, which means that the design was appreciated by the learners.

The second research question: *Will variation, such as the use of presentations, quizzes and videos be preferable to students compared to traditional presentations?* While the testers weren't specifically asked whether they wanted more variation of mediums in future content, 100% (23/23) of the participants said they wanted quizzes in future presentations, and 95,7% (22/23) wanted videos. This is a clear indication that presenting the learning content through various means leaves a positive impression on the learner.

The third research question: *Does previous studies give any indication on how design and variation affects the learner?* This has been brought up in the introduction and theory chapters. The very basis of Connectivism is to use numerous mediums in order to obtain information, and according to Siemens, is the only learning theory that prepares the student for the modern age (George Siemens, 2013). In addition to this, one of the seven survival skills in 21st century skills are "digital literacy", which requires the learner to comprehend and utilize different digital mediums. The foundation of blended learning relies on utilizing various mediums for the same subjects, and Clyde F. Herreid and Nancy A. Schiller found out that practicing flipped classroom, students became more involved in the learning process (Clyde F. Herreid and Nancy A. Schiller, 2013, p. 62-63). Philip Guo has explained how the video medium should be handled (Philip Guo, 2013), and Quizzes have also been shown to be an effective method to increase learning outcome because of the testing effect (Henry L. Roediger & Andrew C. Butler, 2011, p. 20-21). Gestalt Theory also goes to explain how visual design can enhance the user experience. Looking back at both chapter one and two, it becomes clear that a lot of literature already exists on this subject, and very little of it speaks in favour of both design. However, many of these theories do indicate that one has to be careful when adding new mediums to a learning course. Adding a medium without utilizing the strengths it offers can just harm the experience rather than enhance.

These three research questions all feed into the hypothesis, which was *Improved design and variation in educational content will improve student motivation..* While motivation in itself wasn't targeted in the survey, judging by the responses, the data does suggest that Presentation B would likely lead to increased motivation for the learner. Also, considering that 95,6% (22) of the testers answered that they would prefer future presentations in their courses to be similar to Presentation B, one can conclude that this version was successful. All of the data gathered in this research suggests that Presentation B presented the testers something they wanted in a learning resource.

5.3 Future Research

As mentioned above, especially the time limitation was something that hindered Presentation B to become what it was originally envisioned to be. Creating these resources is a lengthy process, and some of the features can increase the development time exponentially. To further expand upon variation, interactive experiences should be top priority in order to try to increase student engagement, furthering them as active learners. The survey itself would benefit greatly from a larger pool of testers, and it could prove valuable to have the testers in a controlled environment in order to observe them and what they like/dislike, or if there are any technical difficulties that hinders their process. In addition to this, post test interviews and other qualitative research methods would be beneficial in order to get specific and precise feedback. In spite of this, from that data gathered, and the amount of positive feedback regarding Presentation B, it is safe to conclude that design and variation has a positive impact on the the learner, and hopefully, teachers in the future will put a higher emphasis on these aspects.

Appendix list

Appendix 1: E-learning resource (Presentation A)

Appendix 2: E-learning resource (Presentation B)

Appendix 3: Survey

Appendix 4: Data collected from survey

Figure list

Figure	Title	Page
1	The two different versions, both displaying the same content	8
2	21st Century Skills	10
3	The Learning Pyramid/Cone of Experience	14
4	Multiple Intelligences	15
5	Blended Learning	17
6	Preliminary edX video engagement findings.	21
7	Age: A pie diagram visualizing the different ages of the participants	26
8	Visual clarity between figures and text in Presentation A	27
9	Visual clarity between figures and text in Presentation B	28
10	Quizzes in future content	29
11	Video length	30
12	Use of color in Presentation A (left) and Presentation B (right)	31
13	Use of color in Presentation B	32
14	Quizzes and Learning	33

List of Tables

Table	Title	Page
1	Research questions	7
2	The Principles of Connectivism	13

Survey

QUESTIONS RESPONSES 23

Section 1 of 8

Sammenligning av presentasjoner A og B i materialteknologi (MAS130)

Tusen takk for at du tar deg tiden til å svare på dette spørreskjemaet! Hovedfokuset her er om utseendet på faginnhold påvirker hvordan du forholder deg til det. Om du føler at det er et større fokus på design (layout, farger og informasjonsmengder på de forskjellige sidene) og variasjon (som videoer og quizer) hjelper på motivasjonen når du leser gjennom presentasjonene.

Dere har fått to forskjellige versjoner (A og B) av tre kapitler (Kapittel 1, 10 og 12). Spørsmålene i denne undersøkelsen vil fokusere på disse. Linker til de forskjellige presentasjonene kan dere finne her:

1
A: <https://drive.google.com/open?id=0Bx0JFrEIW482dEFQcDBmSXpuNVk>
B: https://dl.dropboxusercontent.com/u/110089088/MAS130/material_science_kap1/index.html

10
A: <https://drive.google.com/open?id=0Bx0JFrEIW482dGdVZDIRSmgxOEE>
B: https://dl.dropboxusercontent.com/u/110089088/MAS130/material_science_kap10/index.html

12
A: <https://drive.google.com/open?id=0Bx0JFrEIW482bmxMVHJQSmkweIE>
B: https://dl.dropboxusercontent.com/u/110089088/MAS130/material_science_kap12/index.html


Ha dem gjerne tilgjengelig mens du går gjennom spørreskjemaet!

Undersøkelsen er relativt kort - kan regne med at det ikke tar stort lengere enn 5 minutter.

En sammenligning av to sider som inneholder den samme informasjonen. Versjon A er øverst, og versjon B er nederst.

Hofter-implantat

- Viktige problemer å overvinne
 - Festemiddel til lårbenet
 - Festemiddel for å holde hofteskålen
 - Glatt foring i hofteskål
 - Unngå slitasjerester i hofteskålen



Adapted from chapter-opening photograph, Chapter 22, Callister 7e. (Photograph courtesy of Zimmer, Inc., Warsaw, IN, USA.)

WILEY
Chapter 1 - 13

A

Eksempel: Hofterimplantat 4/4



- Viktige problemer å overvinne
 - Festemiddel til lårbenet
 - Festemiddel for å holde hofteskålen
 - Glatt foring i hofteskål
 - Unngå slitasjerester i hofteskålen

B

Kort om deg

Denne undersøkelsen er helt anonym. Det blir ikke samlet mer data enn deg du blir spurt om her.

Alder *

- 18-21
- 22-25
- 26-30
- 31+

Kjønn *

- Mann
- Kvinne

Versjon A

Denne delen handler spesifikt om versjon A. Spørsmålene vil omhandle den totale opplevelsen du hadde av versjon A i de forskjellige kapitlene (1, 10 og 12).

Et eksempel på en av sidene i kapittel 10, versjon A.

Sprekkvekst under utmattingsforhold

- Inkrementell (trinnvis) sprekkvekst:

$$\frac{da}{dN} = (\Delta K)^m$$

← typisk 1 to 6

$$\sim (\Delta\sigma)\sqrt{\pi a}$$

← Økning av sprekk lengde per last-syklus
- Svikt i roterende aksling
- sprekk vokser selv om $K_{max} < K_c$
- sprekker vokser raskere dersom
 - $\Delta\sigma$ øker
 - sprekk lengden a øker / sprekken vokser
 - lastfrekvensen øker.

Fig. 10.22, Callister & Rethwisch 9e.
(From D. J. Wulpi, Understanding How Components Fail, 1995. Reproduced by permission of ASM International, Materials Park, OH)

WILEY
Chapter 10 - 3

Hvor lett eller vanskelig var det å se sammenheng mellom tekst og figurer? *

	1	2	3	4	5	6	
Vanskelig	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Lett

Hva syntes du om mengden informasjon og tekst per side i presentasjonene *

- Kunne vært mer
- Kunne vært mindre

Syntes du figurene var vanskelige eller lette å forstå? *

	1	2	3	4	5	6	
Vanskelig	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Lette

Hva syntes du versjon A gjør bedre enn versjon B? *

- Fargebruk
- Tekstmengde per slide
- Layout (plassering av tekst, bilder)
- Other...

Versjon B

Denne delen handler spesifikt om versjon B. Spørsmålene vil dreie seg om den totale opplevelsen du hadde av versjon B i de forskjellige kapitlene (1, 10 og 12), i tillegg til noen spørsmål knyttet til de mer unike aspektene i de forskjellige presentasjonene.

Et eksempel på en av sidene i kapittel 10, versjon B (samme side som eksemplet av versjon A i forrige del).

Sprekkvekst under utmattingsforhold

Sprekk startet her

Inkrementel (trinnvis) sprekkvekst

$$\frac{da}{dN} = (\Delta K)^m$$

Økning av sprekk lengde per last-syklus
 $\sim (\Delta\sigma)\sqrt{\pi a}$
 m Typisk 1 til 6

Svikt i roterende aksling
 Sprekk vokser selv om $K_{\max} < K_c$
 Sprekker vokser raskere dersom:

- $\Delta\sigma$ øker
- Sprekk lengden a øker/sprekken vokser
- Lastfrekvensen øker

Hvor lett eller vanskelig var det å se sammenheng mellom tekst og figurer? *

1 2 3 4 5 6

Vanskelig Lett

Hva syntes du om mengden informasjon og tekst per side i presentasjonene *

- Det kunne vært mer
- Det kunne vært mindre

Følte du at fargebruken på tekst gjorde det lettere eller vanskeligere å lese presentasjonene? *

	1	2	3	4	5	6	
Vanskeligere	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Lettere

I kapittel 1 og 12 kunne du klikke hvor som helst på skjermen for å gå videre til neste side. Likte du dette, eller foretrekker du å klikke på menyen nede til venstre? *

- Foretrekker å kunne trykke hvor som helst på skjermen
- Foretrekker å kun kunne bruke menyen nede til venstre
- Jeg skulle ønske det var et designert punkt på presentasjonen jeg kunne trykket på for å gå videre til neste side

Opplevde du at bilder eller grafiske elementer så ut som knapper du kunne klikke på, selv om de ikke var det? *

	1	2	3	4	5	6	
Aldri	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Ofte

I kapittel 1 og 12 ble overskrifter nummerert for å illustrere at det ville være flere sider med informasjon innenfor samme tema. Var dette tydelig? *



- Jeg forstod det tidlig
- Det tok litt tid før jeg forstod det
- Jeg forstod det ikke
- Jeg la ikke merke til nummereringen

I kapittel 12 ble det brukt piler i høyre hjørne for å signalisere at innholdet på siden kom til å bli visket ut. Var dette tydelig? *

Start av størkning: To typer kimdanning 1/2



Homogen kimdanning

- ♦ Kim formes i hoveddelen av flytende metall
- ♦ Krever betydelig underkjøing
 - Typisk 80 - 300 °C



- Jeg forstod det tidlig
- Det tok litt tid før jeg forstod det
- Jeg forstod det ikke
- Jeg la ikke merke til pilene

Hva syntes du versjon B gjør bedre enn versjon A? *

- Fargebruk
- Tekstmengde per slide
- Layout (plassering av tekst, bilder)
- Other...

Section 5 of 8



Quizer

I versjon B av kapittel 10 var det quizer. Denne delen av spørreskjemaet kommer til å fokusere på dem og din mening rundt quizer generelt

Eksempel på ett av spørsmålene som ble spurt i kapittel 10

Quiz

Siging fører til

- A) Oppløsning av utfellinger og dermed høyere fasthet
- B) Slappe bindinger mellom atomer
- C) Varig utflyting av metaller ved relativt høye temperaturer

Back Submit

Hvordan var din opplevelse av quizene i presentasjonen? *

	1	2	3	4	5	6	
Negativ	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Positiv

Følte du at quizene komplementerte eller distrahererte fra presentasjonen? *

- Distraherte
- Komplementerte

Hva syntes du om hyppigheten til quizene (hvor ofte de kom i presentasjonen) *

- Kunne kommet sjeldnere
- Kunne kommet oftere
- Jeg syntes quizene kom på passende tidspunkt
- Jeg vil ikke ha quizer i det hele tatt

Følte du quizene hjalp med å kontrollere det du skulle ha lært på de tidligere sidene? *

	1	2	3	4	5	6	
Lite	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Mye

⋮

I fremtiden, ønsker du presentasjoner med eller uten quizer knyttet til innholdet? *

- Jeg ønsker quizer i fremtidige presentasjoner
- Jeg ønsker ikke quizer i fremtidige presentasjoner
- Jeg ønsker quizer, men de må ha bedre spørsmål enn de som var i kapittel 10

Section 6 of 8



Video i presentasjonene

I versjon B av kapittel 1 og 10 er det videoer ment for å komplementere faginnholdet. Denne delen kommer til å omhandle dem og din mening om videoer generelt.

I kapittel 1 og 10 var det videoer. Opplevde du dette som positivt eller negativt? *

	1	2	3	4	5	6	
Negativt	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Positivt

Syntes du at videoene hjalp forståelsen av faginnholdet de var knyttet til? *

	1	2	3	4	5	6	
Hjalp ikke	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	Hjalp

Hva syntes du om lengden på videoene? *

- Kunne vart lengre
- Kunne vart kortere

Ønsker du videoer i fremtidige presentasjoner? *

- Ja
- Nei

Section 7 of 8



Hvilken versjon likte du best alt i alt?

Denne delen sitt formål er å sammenligne de to versjonene mot hverandre.

Hvilken versjon foretrakk du i kapittel 1? *

- A
- B

Hvilken versjon foretrakk du i kapittel 10? *

- A
- B

Hvilken versjon foretrakk du i kapittel 12? *

A

B

Ønsker du at fremtidige presentasjoner i fagene dine skal være mer som versjon A eller versjon B? *

A

B

Foretrekker du at foreleser hadde undervist i versjon A eller versjon B? *

A

B

Foretrekker du at når du går gjennom det hjemme, å bruke versjon A eller B? *

A

B

Foretrekker du at versjonen foreleser underviser i, og versjonen du går gjennom hjemme er lik eller forskjellig? *

- Foretrekker at de er like
- Foretrekker at de er forskjellige
- Det har ingen betydning for meg

Generelt - Liker du best mørk tekst på lys bakgrunn (slik som versjon A), eller lys tekst på mørk bakgrunn (slik som versjon B). *

- Lys tekst på mørk bakgrunn
- Mørk tekst på lys bakgrunn

Hvordan foretrekker du informasjonsmengden du møter når du går inn på en ny side? *

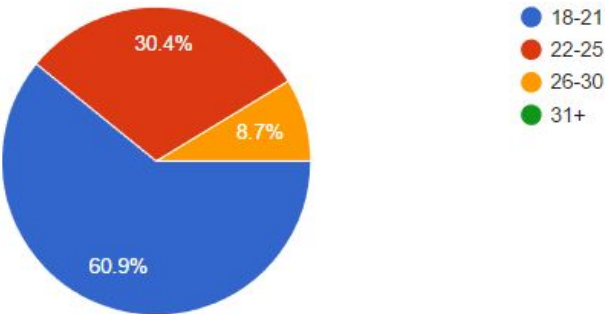
- Jeg foretrekker å klikke for hvert nye punkt
- Jeg foretrekker at all informasjonen på siden er synlig med en gang jeg kommer inn på den

Collected Data from Survey

Kort om deg

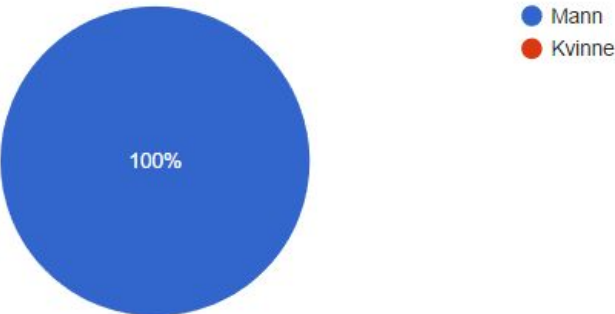
Alder

23 responses



Kjønn

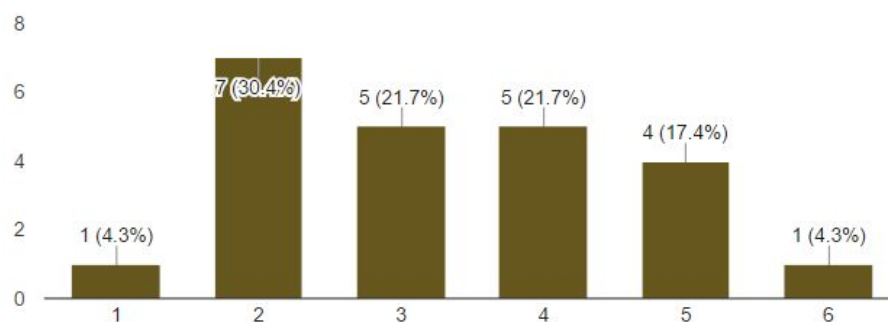
23 responses



Versjon A

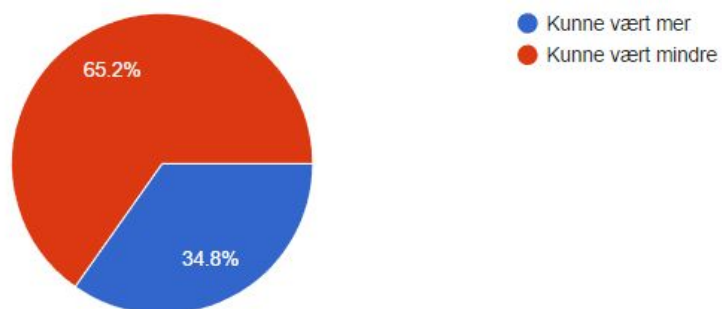
Hvor lett eller vanskelig var det å se sammenheng mellom tekst og figurer?

23 responses



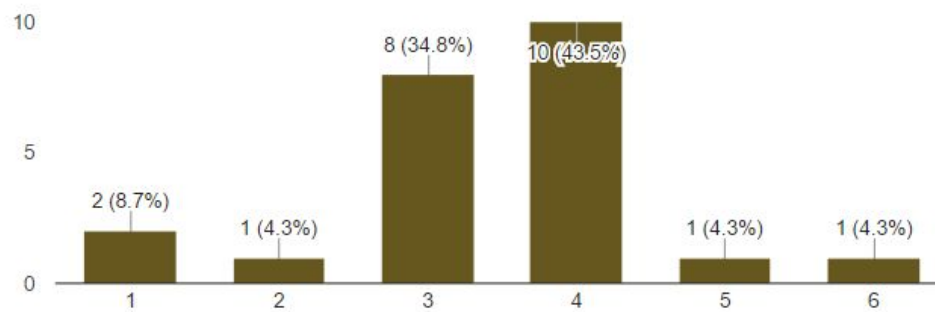
Hva syntes du om mengden informasjon og tekst per side i presentasjonene

23 responses



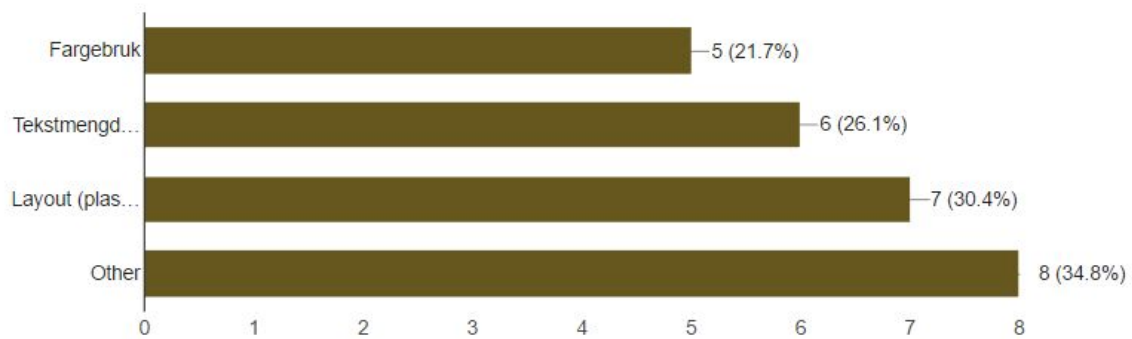
Syntes du figurene var vanskelige eller lette å forstå?

23 responses



Hva syntes du versjon A gjør bedre enn versjon B?

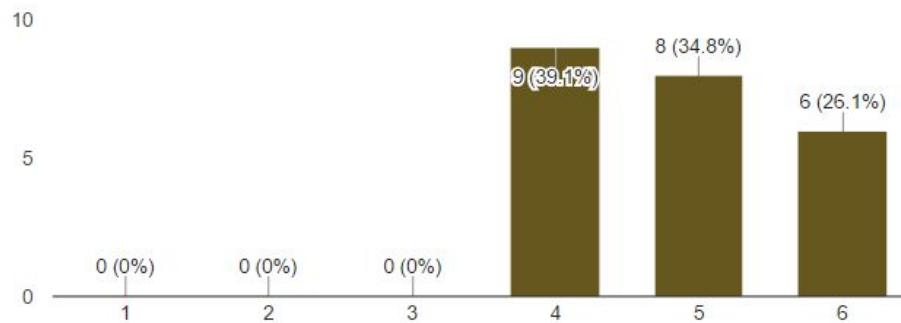
23 responses



Versjon B

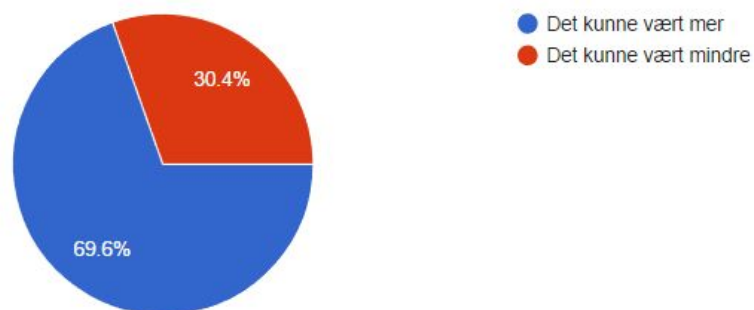
Hvor lett eller vanskelig var det å se sammenheng mellom tekst og figurer?

23 responses



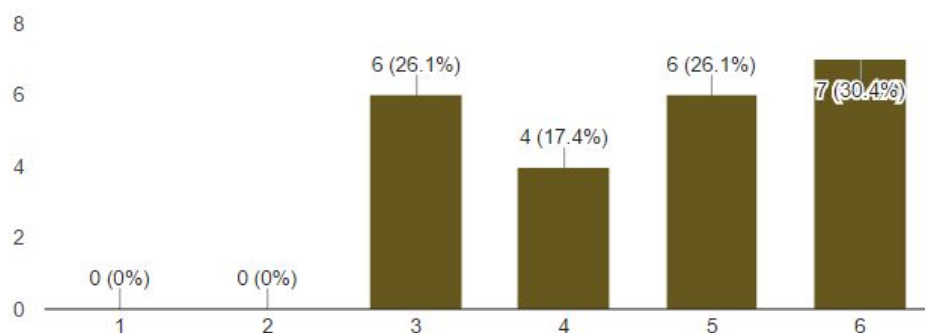
Hva syntes du om mengden informasjon og tekst per side i presentasjonene

23 responses



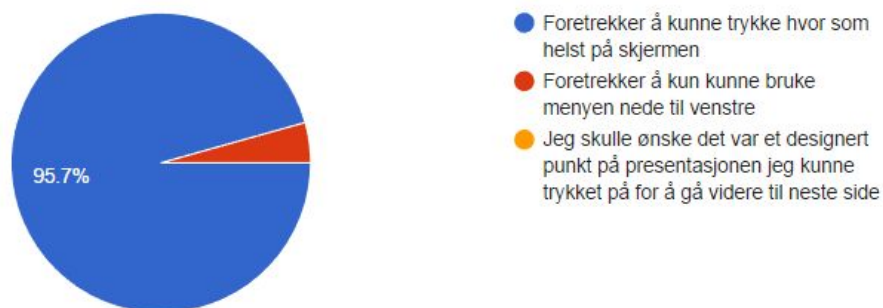
Følte du at fargebruken på tekst gjorde det lettere eller vanskeligere å lese presentasjonene?

23 responses



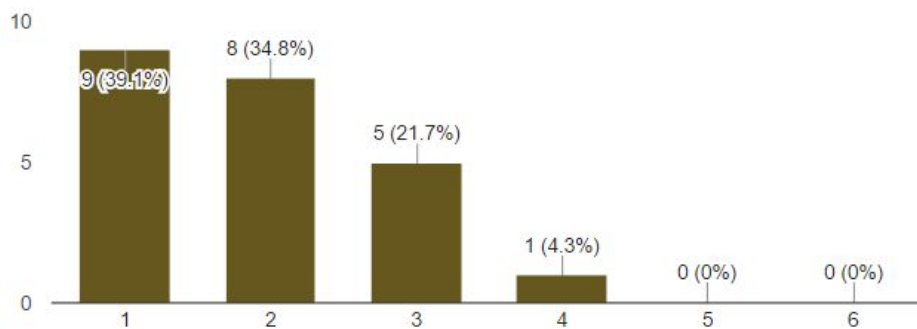
I kapittel 1 og 12 kunne du klikke hvor som helst på skjermen for å gå videre til neste side. Likte du dette, eller foretrekker du å klikke på menyen nede til venstre?

23 responses



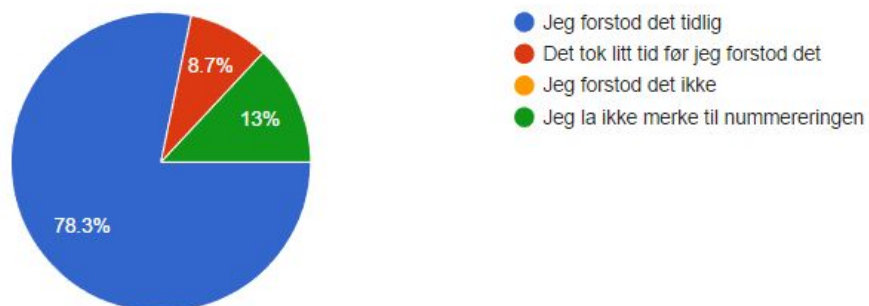
Opplevde du at bilder eller grafiske elementer så ut som knapper du kunne klikke på, selv om de ikke var det?

23 responses



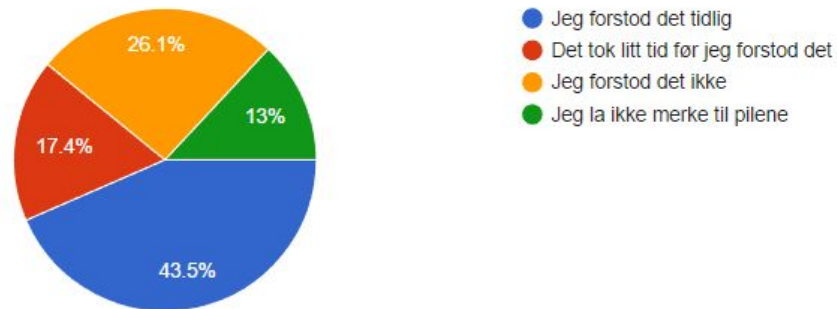
I kapittel 1 og 12 ble overskrifter nummerert for å illustrere at det ville være flere sider med informasjon innenfor samme tema. Var dette tydelig?

23 responses



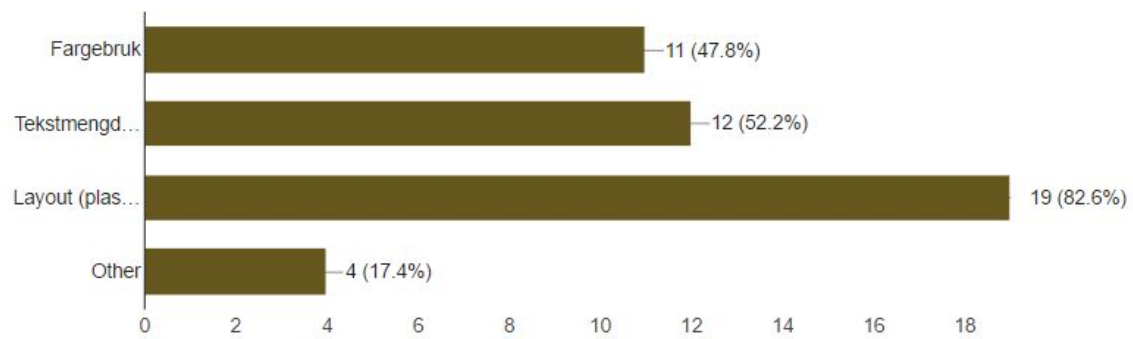
I kapittel 12 ble det brukt piler i høyre hjørne for å signalisere at innholdet på siden kom til å bli visket ut. Var dette tydelig?

23 responses



Hva syntes du versjon B gjør bedre enn versjon A?

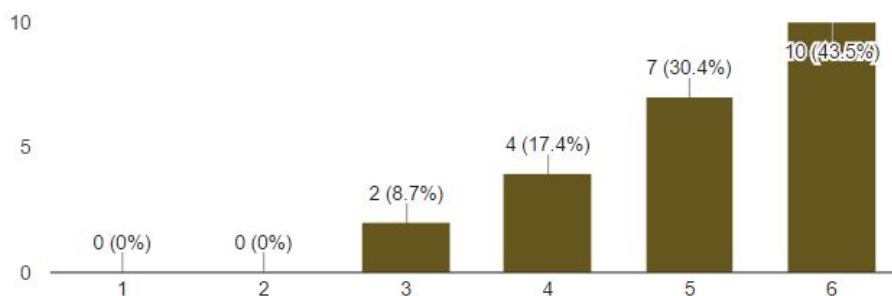
23 responses



Quizer

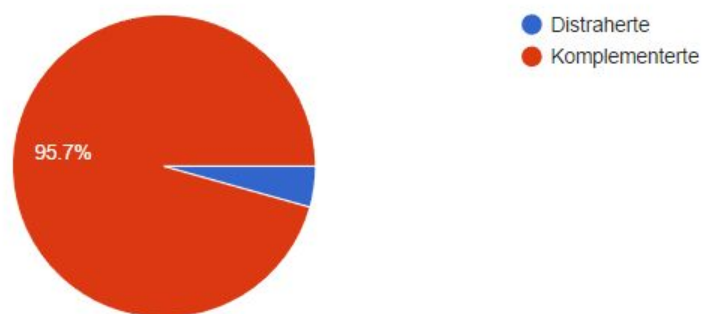
Hvordan var din opplevelse av quizene i presentasjonen?

23 responses



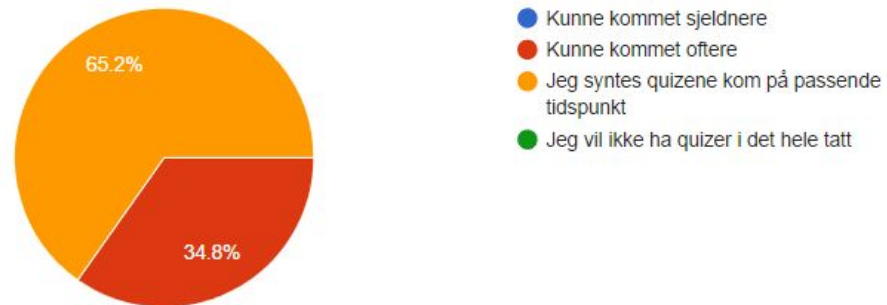
Følte du at quizene komplementerte eller distraherete fra presentasjonen?

23 responses



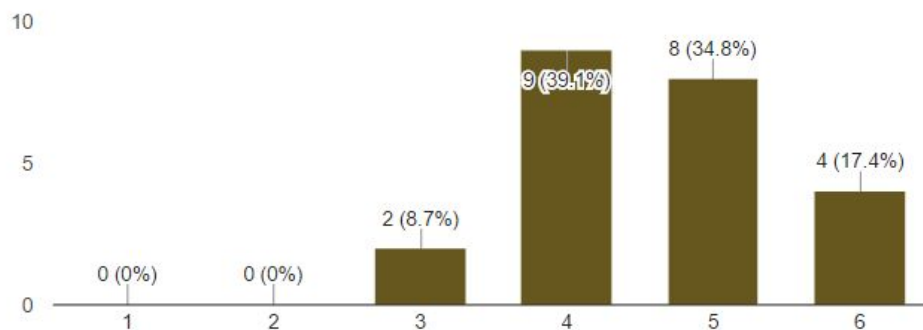
Hva syntes du om hyppigheten til quizene (hvor ofte de kom i presentasjonen)

23 responses



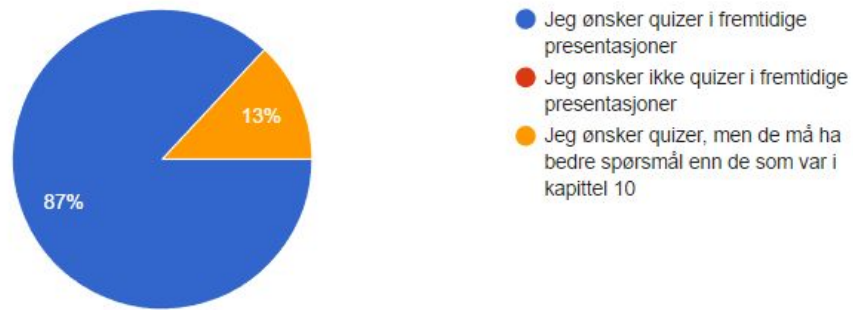
Følte du quizene hjalp med å kontrollere det du skulle ha lært på de tidligere sidene?

23 responses



I fremtiden, ønsker du presentasjoner med eller uten quizer knyttet til innholdet?

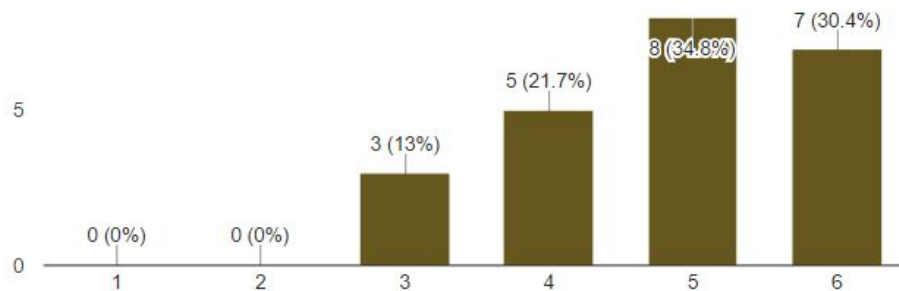
23 responses



Video i presentasjonene

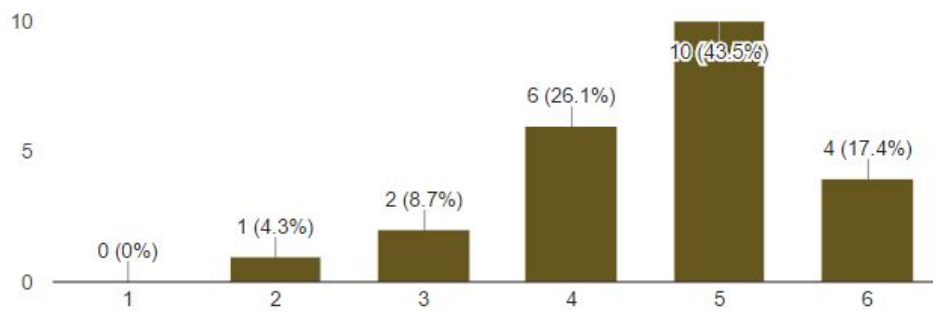
I kapittel 1 og 10 var det videoer. Opplevde du dette som positivt eller negativt?

23 responses



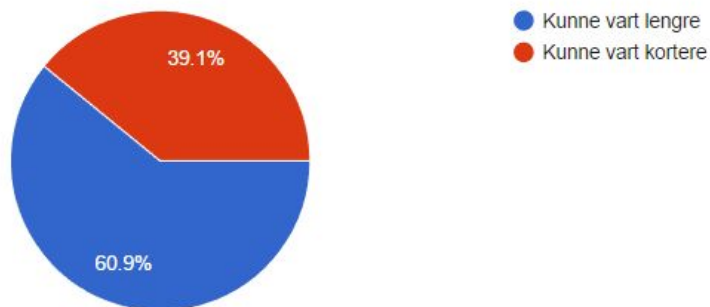
Syntes du at videoene hjalp forståelsen av faginnholdet de var knyttet til?

23 responses



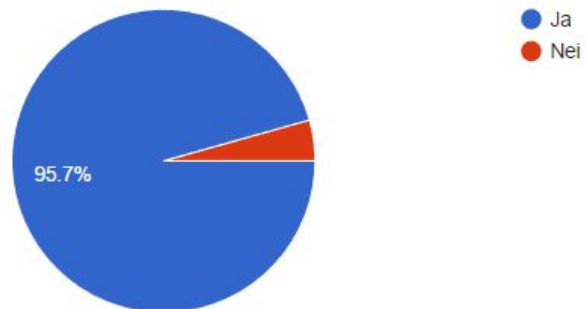
Hva syntes du om lengden på videoene?

23 responses



Ønsker du videoer i fremtidige presentasjoner?

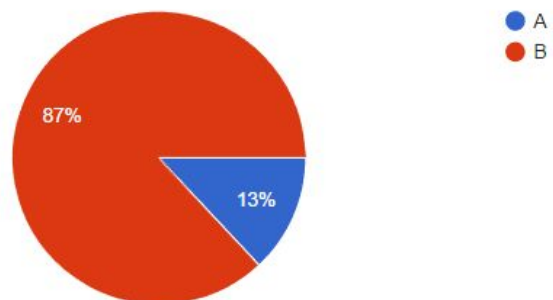
23 responses



Hvilken versjon likte du best alt i alt?

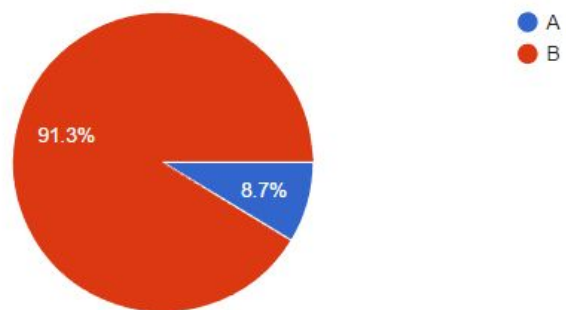
Hvilken versjon foretrakk du i kapittel 1?

23 responses



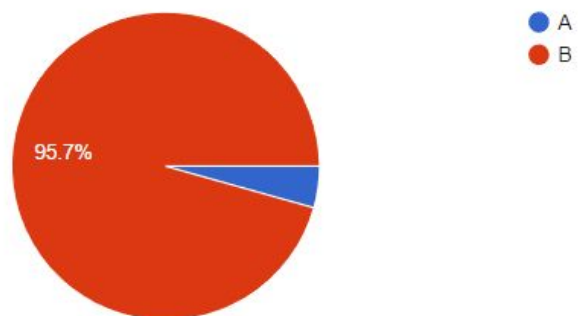
Hvilken versjon foretrakk du i kapittel 10?

23 responses



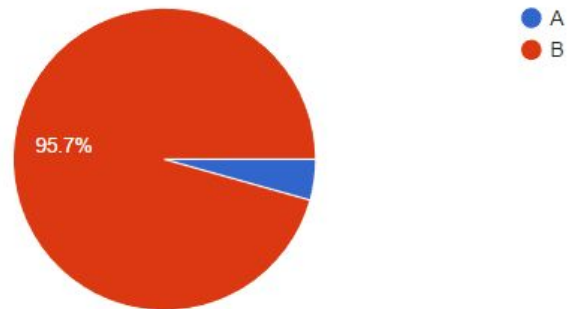
Hvilken versjon foretrakk du i kapittel 12?

23 responses



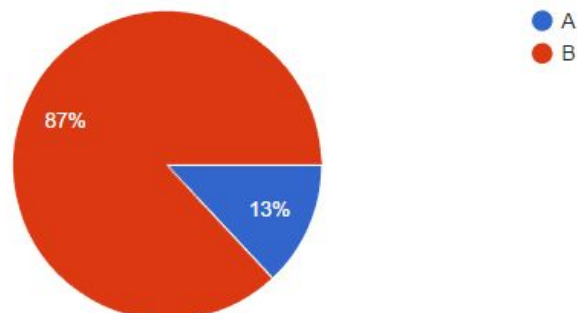
Ønsker du at fremtidige presentasjoner i fagene dine skal være mer som versjon A eller versjon B?

23 responses



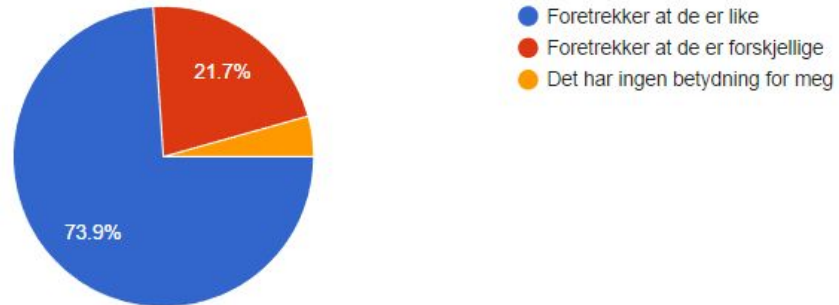
Foretrekker du at når du går gjennom det hjemme, å bruke versjon A eller B?

23 responses



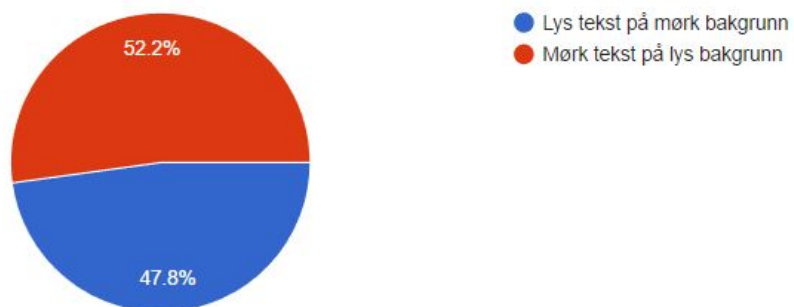
Foretrekker du at versjonen foreleser underviser i, og versjonen du går gjennom hjemme er lik eller forskjellig?

23 responses



Generelt - Liker du best mørk tekst på lys bakgrunn (slik som versjon A), eller lys tekst på mørk bakgrunn (slik som versjon B).

23 responses



Hvordan foretrekker du informasjonsmengden du møter når du går inn på en ny side?

23 responses



Literature

Abbas Pourhossein Gilakjani. (2012). *Visual, Auditory, Kinaesthetic Learning Styles and Their Impacts on English Language Teaching*. Retrieved from <http://brainbutter.com.au/wp/wp-content/uploads/2013/01/Visual-Auditory-Kinaesthetic.pdf>

Abbott, E.E. (1909). *On the Analysis of the Factor Of Recall in the Learning Process*. Retrieved from <https://www.ideals.illinois.edu/bitstream/handle/2142/53176/onanalysisoffact00abbo.pdf?sequence=2>

Alison Doubet. (2016). *Blended Learning with Station Rotations*. Retrieved from <http://creativeeducator.tech4learning.com/2016/articles/blended-learning-with-station-rotations>

Audrey Deterding. (2012, January 26). *A New Kind of "Space" for Quizzes*. Retrieved from <https://www.facultyfocus.com/articles/teaching-and-learning/a-new-kind-of-space-for-quizzes/>

B. F. Skinner (1976). *About behaviorism*. Retrieved 17.04.2017 from http://fitelson.org/prosem/skinner_2.pdf

BBC. (N.D.) *Education videos: Ten ways to use them well: Retrieved from* <http://www.bbcactive.com/BBCActiveIdeasandResources/EducationvideosTenwaystousehemwell.aspx>

Cambridge University Press. Retrieved from <http://homepages.gac.edu/~dmoos/edtech/introtomultitheory.pdf>

Carl Wieman. (2009 march 23). *A scientific Approach To Science Education - Reducing Cognitive Load*. Retrieved from: http://www.science20.com/carl_wieman/scientific_approach_science_education_reducing_cognitive_load

Caroline Fell Kurban. (N.D). *Taking a Flipped Approach to Higher Education: Designing Universities for Today's Knowledge Economies and Societies*

Clyde Freeman Herreid & Nancy A. Schiller. (2013). *Case Studies and the Flipped Classroom*. Retrieved from:
<http://edtech2.boisestate.edu/williamstewart287/512/module6/assets/CaseStudiesAndTheFlippedClassroom.pdf>

Cynthia Brame. (2017). *Effective Educational Videos* Retrieved from
https://s3.amazonaws.com/vu-wp0/wp-content/uploads/sites/59/2017/05/03132258/Effective_Educational_Videos.pdf

Daniel Willingham. (2013, February 25). *Cone of learning or cone of shame?* Retrieved from
<http://www.danielwillingham.com/daniel-willingham-science-and-education-blog/cone-of-learning-or-cone-of-shame>

Dreambox (2013, October 23) *6 models of Blended Learning*. Retrieved from
<http://www.dreambox.com/blog/6-models-blended-learning>

Eberly Center. (N.D.). *What is the difference between formative and summative assessment?* Retrieved from
<https://www.cmu.edu/teaching/assessment/basics/formative-summative.html>

Edgar Dale. (1946). *Audio-Visual Methods in Teaching*. New York: Dryden Press.

Emily Cruse. (N.D). *Using Education Video in the Classroom: Theory, Research and Practice*. Retrieved from
<https://www.safarimontage.com/pdfs/training/UsingEducationalVideoInTheClassroom.pdf>

Family Kaiser Foundation. (2013). *Generation M: Media in the Lives of 8-18 Year olds, Report,, Section 8, conclusion*. Retrieved from
<https://kaiserfamilyfoundation.files.wordpress.com/2013/01/generation-m-media-in-the-lives-of-8-18-year-olds-report-section-8-conclusion.pdf>

Heather Staker & Michael B. Horn. (2012) *Classifying K-12 Blended Learning*. Retrieved from
<http://www.innosightinstitute.org/innosight/wp-content/uploads/2012/05/Classifying-K-12-blended-learning2.pdf>

George Siemens. (2005). *Connectivism: A Learning Theory for the Digital Age*. Retrieved January 04, 2016, from http://er.dut.ac.za/bitstream/handle/123456789/69/Siemens_2005_Connectivism_A_learning_theory_for_the_digital_age.pdf?sequence=1

Heidi M. Anderson (N.D), Dale's cone of experience
http://www.queensu.ca/teachingandlearning/modules/active/documents/Dales_Cone_of_Experience_summary.pdf

Helen Beetham & Rhona Sharpe. (2007) *Rethinking Pedagogy for a Digital Age*.

Henry L. Roediger & Andrew C. Butler. (2011). The critical role of retrieval practice in long-term retention. *Trends in Cognitive Sciences*, Vol. 15 20-27. DOI: 10.1016/j.tics.2010.09.003

Howard Gardner. (N.D.) *Intelligence in Seven Steps*. Retrieved from: <http://ocmatours.net/wp-content/uploads/2007/Gardner.pdf>

Howdesign. (2015, may 11). *Gestalt Theory in Typography & Design Principles*. Retrieved from <http://www.howdesign.com/resources-education/online-design-courses-education/gestalt-theory-typography-design-principles/>

Jacob L. Bishop & Matthew A Verleger. (2013). *The Flipped Classroom: A survey of the Research*

Jon Bergmann, Jerry Overmyer & Brett Wilie (2013, July 9). *The Flipped Class: Myth vs. Reality*. Retrieved from <http://www.thedailyriff.com/articles/the-flipped-class-conversation-689.php>

Jon Rosewell (2005) *Learning Styles*. Retrieved from http://www.open.edu/openlearn/ocw/pluginfile.php/629607/mod_resource/content/1/t175_4_3.pdf

Karen Stephenson. (N.D.) *What Knowledge Tears Apart, Networks make Whole*. Retrieved from <http://www.netform.com/html/icf.pdf>

Kathleen Fulton. (2012). *10 Reasons to Flip*. Retrieved from <https://jlajeunesseeduc3412.files.wordpress.com/2015/05/10-reasons-to-flip.pdf>

Kathleen Fulton. (2012). *Upside Down and Inside Out: Flip your Classroom to Improve Student Learning*. Retrieved from <http://files.eric.ed.gov/fulltext/EJ982840.pdf?ref=bulabul.com>

Keith B. Lyle & Nicole A. Crawford. (2011). Retrieving Essential Material at the End of Lectures Improves Performance on Statistics Exams. *Teaching in Society*, 38(2) 94-97. DOI: 10.1177/0098628311401587

Knewton. (2011). *Flipped Classroom*. Retrieved from <https://www.knewton.com/infographics/flipped-classroom/>

Lisa Graham. (2008). *Gestalt Theory in Interactive Media Design*. Retrieved from <https://pdfs.semanticscholar.org/4719/da4f55d4a4633b7f81ca1eea5571c5364504.pdf>

Lisa M. J. Lee, Rollin W. Nagel, Douglas J. Gould. (2011). *The Educational Value of Online Mastery Quizzes in a Human Anatomy Course for First-Year Dental Students*.

Marc Prensky. (2001, October). *Digital Natives, Digital Immigrants*. Retrieved from <http://www.marcprensky.com/writing/Prensky%20-%20Digital%20Natives,%20Digital%20Immigrants%20-%20Part1.pdf>

Michael B. Horn & Heather Stalker. (2011). *The Rise of K-12 Blended Learning*. Retrieved from <https://www.christenseninstitute.org/wp-content/uploads/2013/04/The-rise-of-K-12-blended-learning.pdf>

Norm Friesen. (2012). *Report: Defining Blended Learning*. Retrieved from http://learningspaces.org/papers/Defining_Blended_Learning_NF.pdf

Partnership for 21st Century Learning. (2016) *21st Century Student Outcomes and Support Systems*. Retrieved from http://www.p21.org/storage/documents/docs/P21_framework_0816.pdf

Partnership for 21st Century Learning. (2017). *P21: Partnership for 21st Century Learning*. Retrieved from <http://www.p21.org/>

Partnership for 21st Century Learning. (N.D.). *Framework For 21st Century Learning*. Retrieved from <http://www.p21.org/our-work/p21-framework>

Peggy A. Ertmer & Timothy J. Newby. (2013). *Behaviorism, Cognitivism, Constructivism: Comparing Critical Features from an Instructional Design Perspective*. Retrieved from <http://edtech2.boisestate.edu/williamstewart287/512/module1/assets/ertmerandnewby.pdf>

Philip Guo. (2013 november 13). *Optimal Video Length for Student engagement*. Retrieved from <http://blog.edx.org/optimal-video-length-student-engagement?track=blog>

Philip J. Guo, Juho Kim & Rob Rubin. (2014, march 4-5). *How Video Production Affects Student Engagement. An Empirical Study of MOOC Videos*. Retrieved from: <http://up.csail.mit.edu/other-pubs/las2014-pguo-engagement.pdf>

Reading Horizons. (2015). *Blended Learning Models*. Retrieved from <http://www.readinghorizons.com/blended-learning/blended-learning-models>

Richard E. Mayer. (2014). *Multimedia Learning*. University of California, Santa Barbara.

Sigrun D. Skaare (2009, 28.10.). *Vil forkaste læringspyramiden*. Retrieved from <http://forskning.no/pedagogiske-fag-skole-og-utdanning/2009/10/vil-forkaste-laeringspyramiden>

Statistisk Sentralbyrå. (2015). *Bruk av IKT i husholdningene, 2015, 2. Kvartal*. Retrieved from <https://www.ssb.no/teknologi-og-innovasjon/statistikker/ikthus/aar/2015-10-01>

Stephen D. Sorden. (N.D.) *The Cognitive Theory of Multimedia Learning*. Retrieved from http://sorden.com/portfolio/sorden_draft_multimedia2012.pdf

Sven Åke Bjørke. (2014, February 26). *Pedagogical Approaches in online education*. Retrieved from <https://ufbutv.com/2014/02/26/pedagogical-approaches-in-online-education/>

Tony Wagner (N.D.) *Wagner on New Workplace Capacities*. Retrieved from <http://neamathisi.com/literacies/chapter-2-literacies-purposes/wagner-on-new-workplace-capacities>

Tony Wagner. (N.D.) *Tony Wagner's survival skills*. Retrieved from <http://www.tonywagner.com/7-survival-skills>

Wagner, T. (2008). *The global achievement gap : why even our best schools don't teach the new survival skills our children need—and what we can do about it*. New York: Perseus Books Group.