Smart view

A study on students’ attitude toward employing smart glasses as a medium for e-learning

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Abstract

User attitude and their perceptions are increasingly being explored by a variation of methods. This thesis addresses the perception that one might have for employing smart glasses as a potential online educational tool. Furthermore, it explores the challenges that are associated with designing educational apps for smart glasses as a medium for e-learning in general. For addressing and identifying these challenges and exploring user attitude, this thesis employs two different approaches. Firstly, by identifying the current challenges associated with e-learning in literature-related studies and secondly, based on the related literature surrounding the topic of e-learning and augmented reality, this thesis conducts a field study using semi-structured interviews. This study proposes the final conclusion based on the field study and by reviewing identified challenges in literature.

Keywords: E-learning, augmented reality, smart Glasses, educational technology, user centered design

1. Introduction

1.1. Subject

Wearable technology devices are getting more attention these days. Such devices are numerous, such as the Apple Watch, wearable health devices, Google Glass, Magic Leap, Microsoft HoloLens and so on. Yet, it was with Google Glass and the Glass Explorer Program that wearable technology experienced a major breakthrough in 2013, where these devices are becoming more and more implicit (Ackerman, 2013).

Smart glass technology is not a totally new concept. Steve Mann, the father of wearable technology, has been developing and researching computer-based glasses for many years (Mann, 2012). Wearable technology is not only based on the fact that we carry around ubiquitous technology, it is also context aware and provides users with new experiences of reality (Binkley, 2003). As a wearable computing device, smart glasses could have enormous possibilities to which they may be used for.

In general, smart glasses are like normal glasses except for that they are computing devices, used as a digital medium to enhance the perception of users. As same as normal glasses, their displays move with the users head. In addition to that, users can see the world through a digital medium, which could provide augmented reality experiences as well as mobility (Due, 2014). Smart glasses are in their early stages, yet the possibilities are enormous and could help to transform the learning environment. In the future, these devices would more likely adopt and combine a multitude of factors like gesture recognition, voice, facial recognition, and other similar features, which could bring about huge possibilities to educational systems (Kurze et al., 2010).

Using education technology that electronically or technologically supports learning and teaching inclusively is defined as e-learning (Anaraki, 2004). According to Dix et al. (2006), the e-learning community’s central interest has been the technical qualities of e-learning.
systems; however, the e-learning community has neglected the usability and behavior of the users with such systems. However, Human Computer Interaction (HCI) theories and methods have the ability to support the research in those areas. Furthermore, since smart glasses could have the ability to change one’s behavior, using it in education could be assessed by HCI theories and methods. Smart glasses clearly have the potential to change e-learning systems. Additionally, there are lot of new possibilities and directions to be explored by researchers through multiple disciplines. Yet, this thesis focuses on possible end-users of this technology, exploring their attitude and challenges that might arise from their attitude.

1.2. Research questions
What is the current attitude of students in academia toward e-learning and could the introduction of smart glasses and its new possibilities as new medium for e-learning change their attitude? In their opinion, what are this new medium’s benefit and what its disadvantages? Would students prefer smart glasses over more conventional digital educational tool such as smart phones? These are the questions that this thesis focuses on.

1.3. Important factors
Knowing the current position of academia could help one to have a better picture of the possible future of using smart glasses in education. There are several factors that have to be taken into account. One of the main factors for analyzing the future of smart glasses in education is looking at the previous use of augmented reality in education.

According to Azuma (1997), augmented reality (AR) refers to a world view of computer-generated augmented or supplemented objects including sounds, graphic, and video which are directly or indirectly portrayed in one’s perception via digital devices (Azuma, 1997). Using AR in learning is defined as augmented learning where the actual learning environment adapts to the needs and personal preferences of the learners (Biggs, 2015). Augmented educational content can dynamically be tailored to the learner’s natural environment by altering their perception. Furthermore, the environment could refer to a physical or a digital environment, which could stimulate the discovery for users for gaining greater understanding (Klopfer, 2008).

E-learning is another important factor. To have a better overall picture about the values of e-learning, one should know about the important challenges and principles of designing educational digital applications. There are several design models for designing e-learning courses and applications, yet, as smart glasses could be a new medium, putting those models to practice needs some consideration.

The concept of design for learning arrived in literature of educational technology in the late-1990s and early-2000s (Fill, 2005). Designers and instructors should choose, according to the situation, the best mixture of designing and learning models for their online courses (Merrill et al., 1995). For designing educational applications, we must also consider concepts in educational psychology. Since new trends in technology expect new ways of learning, smart glasses as a new medium for education glasses should be grounded in educational psychology. According to Wang (2012) for a better learning experience for students to develop their needed skills as well as for engaging students, we need a transformation from a normal teaching
method to a more active and participatory learning method. Moreover, as Rosenberg (2001) importantly points out, “the skill we need our students to have is ‘learning to learn’. Because in today’s knowledge society we are constantly required to learn, unlearn and relearn”.

This thesis consists of two parts. In the first part, this thesis explains the relevant keywords and relevant contents to e-learning as well as its associated challenges and current suggested solutions. It also mentions the background of AR as well as related studies, which used augmented reality in education. Furthermore, it describes the relevant content and background in educational psychology. The first part concludes some principles for explaining the theoretical framework, which will be used in the discussion sections. In the second part of this thesis, a field study is presented and results are explored and reflected upon. After that, the results are discussed and the thesis finishes with a conclusion in order to answer the questions presented.

2. Background

For getting the attitude of students over using smart glasses in education, one should know about the possible future values that might arise from academia surrounding the topic of education. Furthermore, one should be able to incorporate those values in e-learning via using new tools. Before using smart glasses as a new trend, designers would have to address or solve the current issues that e-learning faces. Furthermore, it also would require different approaches for designing since it is a new medium. Smart glasses could offer new possibilities as well as facing new challenges and questions for designers.

2.1. Educational psychology

In general, the scientific study of human learning, by employing cognitive, psychological, and behavioral perspectives, is generally referred to as educational psychology (Snowman, 1997). Education has different domains and sub-domains. As Clark (2015) states, education can be defined in three main domains:

- **The cognitive domain**: mental skills (knowledge)
- **The affective domain**: growth in feelings or emotional areas (attitude or self)
- **The psychomotor domain**: manual or physical skills (skills)

When we traditionally refer to learning techniques, we mean acquiring new knowledge or new mental skills, which refers to the cognitive domain (Clark, 2015). Hence, most of the current educational curriculums dismiss the affective and psychomotor domain. This happens in education generally and especially in e-learning (O’Regan, 2003).

One of the concepts that are currently used for designing and explaining educational system is instructional design which is referred to the practice of designing instructional educational experiences in an effective, efficient, and appealing way (Lebow, 1993). There are several terms and models associated with human learning and educational psychology, yet covering all of those models is beyond the scope of this study. So this thesis defines and explains the recent
model that is associated with e-learning and education in general. According to Hendel et al. (2011), learning is a cycle of four stages:

1. **Gathering**
   The brain actively perceives the world and gathers data about surrounding objects through different sensory biological inputs

2. **Reflection**
   Through pattern recognition, the brain tries to find patterns among those data and tries to make sense of it based on prior knowledge

3. **Creation**
   After making sense of those data, the brain tries to create the same or new patterns based on acquired knowledge and put those patterns in the real world and compare them with real data

4. **Practice**
   In this part, the brain tries to change its approaches and makes several attempts in order to understand the concept better and to master it

To increase learning effectiveness, learning solutions should - according to Hendel – always contain the above named four stages. In addition to these, Hendel (2011) bases his model of learning on recent studies about neuroscience and therefore it might be justifiable to use his model and framework as the ground for further consideration of using smart glasses in education. According to Hendel, there are six principles that have to be considered for designing any educational system based on recent neurological studies and prior studies on education technology (Hendel, 2011):

1. Engage the entire learning circle. Make time for reflection, creation and active testing.
2. Make a connection with the learner’s prior knowledge and experience.
3. Create opportunities for social engagement and interaction as a part of the learning process.
4. Engage both feelings and thinking.
5. Actively gaining, holding and focusing the learner’s attention.
6. Engage a maximum number of senses—especially visual—when design learning.

### 2.2. E-learning: challenges and solutions

The Europe 2020 strategy acknowledges for Europe to remain competitive, to fundamentally reform educational systems for addressing the required skills and competences for today’s societies (Bocconi et al., 2012). Since new technologies which provide a rich media and interaction have shown their educational potential (Jackson et al., 2008) and as media and technology are increasingly becoming tools for learning in the education process, most of the literature on education is encompassing these changes referring to these new technologies. This includes devices as computers, smartphones, tablets, MP3-players, and the overall proliferation of gadgets and gizmos.
E-learning or digital-mediated learning is defined as the use of computers and digital media for education (Anaraki, 2004). There are growing numbers of universities, organizations, publishers, and industries aimed at developing and distributing online educational services. According to Barajas et al. (2007), in Europe, in particular, the use of e-learning has a great potential for building the future of the European knowledge society. Still, e-learning is in its childhood and has several main challenges that it has to overcome in order to be accepted as the new way of learning among the majority of people. There are four major categories in which one can summarize design challenges that e-learning has to overcome (Tynjälä et al., 2005):

- **Lack of human contact**
  E-learning is mediated by computers and lately also via mobile devices. So the learner might find this training alienating. The human being is by nature a social being. To take away all forms of interaction with other people might be a demotivating factor.

- **Lack of motivation**
  There are a lot of articles and discussions that focus on how to engage and motivate students. One of the main factors that current e-learning has is its disability to engage learners and give them a sense of responsibility.

- **Lack of focus**
  The role of a teacher or an instructor is vaguely defined within the current e-learning paradigm. When the learners use e-learning, they study from home; thus it is so much easier to lose focus as no one is actually watching them. The learners have all their personal items within their reach as well as other things that could distract them.

- **Lack of real world implications**
  Sometimes a learner is not able to see the value or benefit of the e-learning course; especially how the matter of the subject is going to help them in real world. For learners to become truly engaged in the overall e-learning process, they might need to go to a lab to discuss ideas and see the implications of their study.

There are several solutions and factors that have been pointed out by scholars for overcoming these challenges. The first factors are engagement and motivation, which are more associated with the affective domain rather than the cognitive domain. As Brophy (2008) states, the needed movement in educational curriculum reform should incorporate all aspects of learning including feelings, emotions, attitudes, motivations, and values to motivate student learning. Furthermore, and as Eric Parks suggested, the "e" in e-learning should stand for "everything, everyone, engaging, easy" (Parks, 2015). These general interpretations are more aligned with recent studies in learning theory and media psychology.

According to Hendel (2011), e-learning in the affective domain should also be addressed, since learners’ emotion and attitude could motivate and engage them in their learning process making them to peruse actively what they want to achieve. One way to involve the affective domain is gamification. As Muntean (2011) stated, gamification could provoke feelings and engagement and increase intrinsic motivation and is a so-called pleasurable design in e-learning.
Another important factor for e-learning is personalization. E-learning is described as a form of self-regulated learning and clearly self-regulated learning plays a major role in higher education. The act of teaching oneself about a subject in which one has a little or no formal education is often referred to as auto-didacticism or self-education. Self-learners mostly educated their self in a more personal learning environment (Aufrichtig, 2014). Personalization has been a subject of several studies and designers have been trying to create a more personalized environment for e-learning. Moreover, personal learning environments (PLE) are referred to as an environment where individuals control their own learning process and personalize it based on their preference. It seems like that PLEs are a more natural way to learn (Van Harmelen, 2006).

Socialization is an equally important factor in e-learning. According to Dunbar (1998), our brain is naturally a social system and we acquire most of our knowledge in social situations and we constantly need human social situations to learn. Based on Lieberman’s explanation about the social brain and learning, engagement of the individual is highly entangled with their involvement in social situations (Lieberman, 2012).

Thus, it could be argued that, for e-learning to be successful, systems should involve the affective domain as well as the cognitive domain in a more personalized and connected way.

2.3. Augmented reality (AR)

As stated before, smart glasses could provide a rich and real world AR. AR is defined as a view of a physical real-world environment in direct and indirect way, with alteration of one’s perceptions given some supplemented or added elements by computer-generated sensory input such as sounds, video, graphic, or GPS data (Yuen et al., 2011).

There are several proposed implications of using AR in education. Researchers believe that it has a vast potential and numerous benefits for augmentation of teaching and learning environments (Yuen et al., 2011). According to Billinghurst (2002), AR-applications can be used as both a complementary system to the standard curriculum and standalone indented systems. As he continues, text, graphic, sound, virtual, or digital objects and videos could be added to a student’s real time environment by altering students’ perception using digital medium.

As Biggs (2015) states, using AR as an on demand solution for education or in other words e-learning is referred to as augmented learning. As he mentions by providing solution on-demand and by stimulating discovery and learning in real world, learners can gain a greater understanding of a topic.

For instance, based on Zhou et al. (2008), there are many proposed applications for using AR in education. For instance, constructing 3D graphical shapes in a real world environment provides a new way for students to learn concepts in mechanical engineering including math or geometry in a more tangible way.

As Maier et al. (2009) states, AR can also be used as a tool for chemistry students for understanding chemistry. This tool could visualize the structure of a molecule and at the same time make it interactive. As he shows, AR can also be exerted to enable physiology students to understand and visualize different physiologic systems such as of human body in three dimensions.
Furthermore, AR-technology allows students to have remote collaboration, which enables them to interact with virtual or augmented representations of each other or their instructor in a shared common learning environment populated by virtual objects or augmented objects (Kaufmann, 2003). There are many applications and uses proposed for using AR in education. AR applications in e-leaning still need further investigation in applications and theories surrounding the topic.

Dunleavy (2014) states, using AR in education comes with two existing learning theories as it places the learner within a real-world physical and social context. These are grounded on two concepts in educational psychology:

- **Situated Cognition**
  In short, situated cognition refers to the concept that learning and doing are inseparable and thinking, knowing, and understanding is the result of socio-historical experience (Brown et al., 1989).

- **Constructivist Learning Environments**
  Constructivism points out that knowledge is individually constructed by learners based on their interpretations of experiences in the world (Honebein, 1996).

And as Lebow (1993) proposes, four principles as constructivist values influence the designing for education:

- Engaging the affective domain of learning
- Provide a narrative for learning which offers personalization as well as collaboration
- Support self-regulated learning
- Strengthen the learner’s internal motivation

These principles, as well as other factors, will influence the future of smart glasses in education and have to be considered.

### 2.4. Smart glasses

As stated before, depending on the medium that AR has, we might need to address e-learning challenges in a different way. One of the current trends, which have been recently known by the public, is smart glasses. Smart glasses are computing devices designed for providing AR experiences. As it is stated before, they are like normal glasses except for that they put a digital layer of information in front of user’s eyes Therefore, smart glasses are the only devices which can alter or enhance the wearer’s perception.

According to Schweizer (2014), there are currently two main paradigms for smart glasses of how to alter the visual information for wearer:

- **Virtual reality**
- **Augmented reality**

![Figure 1, Oculus Rift](image)
A famous example of a virtual reality device is Oculus Rift (see figure 1). A well-known example of an augmented is Google glass. An example of smart glasses with augmented reality features is Google Glass (see figure 2). In medical education, there are several examples of using Google Glass that have appeared to be promising. Using Google Glass as a tool for medical students has been proven to be successful and it is believed to revolutionize higher medical education (Glauser, 2013; Sapargaliyev, 2014).

Although Google Glass is supposed to be used in combination with smartphones, it is not commercially available yet. In the near future we might see lots of features that smart glass or Google Glass, per se, could offer such as incorporating pattern recognition or better graphical displays.

Smart Glass as a particular branch of AR has its own challenges to be addressed. This study focuses on AR and the use of smart glasses in e-learning. Based on the prior studies in e-learning, educational psychology, and AR, we might conclude that there are nine principles that have to be considered:

- Engage the entire learning cycle. Make time for reflection, creation and active testing
- Promote self-regulated learning for motivating and engaging students
- Personalization and tailoring courses dynamically to the learner’s need and level
- Socialization, make connection with others
- Connecting the learner’s prior knowledge and experience to new information
- Social collaboration meaning to create opportunities for social engagement and a interaction as part of the learning process
- Engage both feeling and thinking
- Actively attend to attention gaining, holding and focusing the learner’s attention
- Engage a maximum number of senses especially visual

3. Study

3.1. Methods

3.1.1. Literature review

For getting the attitude of students over using smart glasses in education, one should know about the possible future values that might arise the related literatures. A literature review is getting the current knowledge surrounding a specific topic (Cooper, 1998). In this thesis, related knowledge to e-learning and augmented learning is considered and as a conclusion, nine principles emerge that have to be considered for the study part as well as discussion.

3.1.2. Method of data gathering
This questions this thesis presents are closely related to understanding and to the opinions of students about E-learning and the use of smart glasses in e-learning. It is not hard to predict that the data on this topic would be rich and multifaceted. While observational studies could have been able to portray a better picture and better understanding, this thesis employs semi-structured interviews (Blandford, 2013) as the main data gathering method.

Since smart glasses are still not available on the market and it is quite hard to make a smart glasses prototype, this thesis uses examples to inform users about the use of AR education. The future possibilities of smart glasses in personal education have also been taken into consideration.

For getting the participants to talk about advantages and disadvantages that could be offered via smart glasses for changing their personal learning, they were asked if they had ever participated in any kind of online course before. Every participant was then shown an example of an e-learning app, in this case Duolingo (2016), a language application. In addition they were shown a video of smart glasses, Magic Leap (2015), and also different possible examples of augmented reality in education (see appendix).

It might be hard for students to imagine the possible future of smart glasses in education. Therefore, based on the literature presented in the previous part, eight different examples (see the appendix) were shown to them so they would realize the possibilities.

Since we are not sure about the future values that educational apps for smart glasses have to hold, it seems ideal to get the users' feedback through examples. Examples in the study were intended to give the respondents a platform that they can elaborate on using smart glasses in education without having an actual device.

### 3.2. Participants

In this thesis, 11 students with different background and nationality took part in semi-structured interviews. However, there was no limitation for the participants except for that they had taken part in an online course before and were willing to participate.

<table>
<thead>
<tr>
<th>Nr.</th>
<th>Gender</th>
<th>Nationality</th>
<th>E-learning course</th>
<th>Major</th>
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<td>Learning how to learn</td>
<td>Medical science</td>
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<td>Swedish</td>
<td>Language</td>
<td>Physics</td>
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<td>3</td>
<td>Male</td>
<td>Swedish</td>
<td>Programming</td>
<td>Computer science</td>
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<td>Biology</td>
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<td>8</td>
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<td>German</td>
<td>Language</td>
<td>Business Administration</td>
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<td>9</td>
<td>Female</td>
<td>Swedish</td>
<td>Business communication</td>
<td>Social science</td>
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</table>
Table 1, Overview of participating interviewees

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<th>Nationality</th>
<th>Language</th>
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<td>11</td>
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<td>Iranian</td>
<td>Language</td>
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</table>

### 3.3. Procedure
The 11 semi-structured interviews were conducted over two weeks. The participants were found inside KTH university campus by randomly asking present students and also via an announcement on social media. All interviews were conducted in different areas, including the university campus, library, and also the participants’ private apartments. These were held in English and each participant was interviewed privately. The interviews were recorded via the interviewer’s smartphone. On average, every interview took between 20 to 45 minutes, even though it was planned to take less than 20 minutes.

### 3.4. Method of analyzing
For analyzing the gathered data and to generalize the themes of the respondents’ ideas, thematic analysis has been employed (Blandford, 2013). Through listening to the interview recordings and from reflecting upon the data, this thesis identifies a set of themes that illustrates a better picture of the respondents’ opinion. Finally, the data is summarized and used to populate the table found in the result section.

### 3.5. Limitation
Admittedly, the group of people who have been studied was small and not having an actual smart glass was a big problem. Despite the fact that the device was not available and the number of participants was small, the study showed some good factors that need to be taken into consideration. Yet, further investigations are still needed to address the whole concept of using smart glasses in education since implementing educational contents can be done in different ways. It is difficult to set an approach that designs scientific contents without having to write codes. Nevertheless, several patterns have been emerged from the study.

### 3.6. Pilot study
This thesis has tried to use user-enactment (Odom et al., 2012) as its main method. However, it had failed to address the research questions in a productive way. Hence, the direction of this thesis is changed and a semi-structured interview is chosen as the data gathering method. Nevertheless, the result of the previous study guided this one and a new set of questions emerged from the previous attempt to address the main questions of this thesis.

### 4. Results
In this part, using thematic analysis for the interviews, a number of recurrent themes have emerged that are outlined in different sections. Some quotes are also used in the result-part, which have been grammatically changed for readers to have a clear understanding. However, the results section is mainly consisting of the participants’ opinion about the subject of the
study. In this section, the results are also summarized and used to populate the reference table (Table 2).

4.1. E-learning

**General knowledge:** All of the respondents had taken part in an online course before and they had basic knowledge about e-learning.

**General interest:** Most participants had a general interest in using new technology for their self-regulated studies. However, they expressed their interest to only learn some subjects that wouldn’t require a teacher. “...*I wanted to take a programming course online because I wanted to be able to code. It is easier to learn it online*” (Participant 2)

**General dissatisfaction:** Most of the participants also expressed their dissatisfaction with current e-learning apps. One of the participants mentioned a lack of instructions in the taken online course in academic English writings. It made the participant to stop the course. “...*I had a problem finding subjects and if there were good instructions that I could follow the course would have been better, probably*” (Participant 5)

Half of the participants questioned whether a digital education could replace traditional learning in some subjects or not.

“For some subjects like chemistry or biology you need to go to a laboratory and experience it. I think computers or even mobiles aren’t supposed to change anything. They are just supposed to help” (Participant 4)

**Lack of teacher to ask:** More than half of the participants wanted to have someone that they could ask questions to and get their answers from if further information was needed. “...*it is all good to interact with interactive media but sometimes I had some questions. It wasn’t easy to find a real person to get more information*” (Participant 9)

**Personalization:** Four of the participants mentioned that the application should adapt to their needs and personalize its content to their growth so they could choose which subsections they need to work on the most. “...*if it could show in which area I am weak in, I would be able to work on this area the most*” (Participant 5)

**Lack of motivation:** Most of the participants mentioned in one way or another that they lacked motivation to stay focused and organized in their online course. “...*I didn’t continue my academic writing course, I had lot of other things to do and also the course was free.*” (Participant 5)

4.2. Smart glasses

**General knowledge:** Most of the respondents didn’t know the term augmented reality. However, they were familiar with Google Glass. Therefore, they had to be informed about AR
This was done via the examples and videos to enable them of being aware of possibilities. Only one person knew about AR before.

**General interests:** All of the respondents showed their general interest on this new technology and they believed that they would use it for their learning if it were available. They also believed that it would take time for them to be able to use it and be familiar with it. “...maybe at start it will be hard to get to know the technicality but I think eventually I will learn how to use it” (Participant 9)

Three of them believed that it had potential to replace traditional teachers. Furthermore, two mentioned that in some subjects that are hazardous, using glasses in laboratory, AR might as well be able to replace lab experiments.

“For some chemistry experiment sometimes you don’t need a teacher to tell you what to do and we should be able to do it on our own. But sometimes it is dangerous some material you are not supposed to mixed them up” (Participant 4)

**General dissatisfaction:** However, most of the participants did believe that smart glasses wouldn’t change anything in terms of real time experience. One participant mentioned that he wanted to feel the object so he wouldn’t be afraid of doing so in real life. They also mentioned that there should be some instruction how to use the potential apps since smart glasses have not been on the market yet. “...I want to feel the object and not just see the result of what would happen in a chemistry lab” (Participant 10)

Additionally, they didn't like the idea of smart glasses measuring their feelings and emotions based on biological signs they might have while studying, “...I don’t want smart glasses or anybody to tell me what am I [...] when I am studying. This could probably distract me” (Participant 6)

### 4.3. Advantages

**Visualizations:** In comparison to current e-learning media, most participants believed that smart glasses would be a great medium for delivering educational content. Additionally, it would be a better medium than mobiles apps. One participant mentioned that 3D visualization would be great to see in front your eyes and not just only on screen. “...in a lot of subjects you need 3D-visualization and it is great to see, for example in architecture, the result of your work in 3D” (Participant 4)

**Convenience:** All of the participants believed that it would be hard for them to use smart phones all the time. It might be better to use smart glasses in some specific subjects, such as languages.

“For example, when I am learning a language I want to be able to see the objects around me and focus on it and then see the word above it and then hear the pronunciation.” (Participant 8)
**Flexibility:** As mentioned before, most participants believed that smart glasses would be a great tool for learning languages. In addition, some participants expressed that they wanted to have actual information on demand in specific moments without using their smart phones, since it is hard to use it in some situations. They would rather look at an object to get the information if they wanted to.

“Sometimes I see a word and I want to google it. But it takes time for me to get my cellphone out and do it. I would prefer to look at the word, point on it and get the information” (Participant 11)

**Referencing:** All of the participants liked the idea of interactive augmented books and that having smart glasses would make it easier for them to read. Depending on the subject, they could find extra resources and references. They also expressed their interest about 3D-visualization and real time interaction. It could be useful to have smart glasses to visualize some procedure and graph. One participant mentioned that smart glasses could show augmented graphic pictures in mathematics and another participant mentioned that he would love to see the flow of water after his project was done.

“I liked the idea of interactive links on a books page for more information. [...] My major is hydrology and sometimes I want to see the flow of water for better understanding. If smart glasses could stimulate that flow in front of my eyes that would be great.” (Participant 4)

**Mobility:** All participants expressed that they would like to use smart glasses everywhere. It should not be limited to indoor learning process.

**Better focus:** More than half of the participants described a difference between mobile apps and smart glasses as they easily could be distracted by the surrounding while they try to learn with their cellphones. They would rather see the learning process in front of their eyes. “...I am learning German via Duolingo. Sometimes in a subway I do it with my cellphone and I have to look at my cellphone all the time and I bump into people” (Participant 2)

**Ability to interact with a real teacher:** All participants also liked the idea of having an interactive augmented teacher. They believed that either a real teacher or a realistic representation of a teacher would be better for them to have. “...if I want to have a teacher, I prefer a realistic hologram of a teacher. If it is too childish or too gimmicky I prefer to not have one” (Participant 6)

**Real world implications depending on a subject:** All participants expressed their interests about navigating through an augmented world. This could enrich their learning. One participant mentioned also that, especially in medical science, it might be very useful to see and interact whilst studying human anatomy. “...it would be great for surgeons because they could try it several times before they perform a real surgery” (Participant 1)
Motivations: Some participants expressed that smart glasses would be more fun and it would be easier for them to follow as they would not have to carry their cellphones or desktop around since this new technology might be more novel and immersive for them. “...because it is new probably I will use it and of course it will be fun at start. You would be in new world but I don't know what happens after that” (Participant 9)

4.4. Disadvantages

Subject dependency: All of the participants mentioned that they don’t see any benefits of 3D-visualizations of an object using smart glasses in their online education since sometimes they wanted to study a text. 3D-visualizations of the actual object seemed then unnecessary. “...I cannot see any benefit of it in the course that I took online. It wouldn't be useful for academic English writing for example” (Participant 5)

One participant mentioned that for programming it is important to write a code and see the result. It should be possible with smart glasses to stimulate typing. “...in programming it would be good to type and see the result and it would be good if I could somehow type with smart glasses” (Participant 3)

Distraction: Four participants expressed their concern about distraction that might occur while they are having smart glasses on and trying to learn a subject. “...with a personal computer there is no active background so I can read what I want to read” (Participant 5)

Technicality and price and moral issues: Over half of the participants expressed their concerns about the price of possible smart glasses and that it would require wireless internet networks. “...if it was cheap I would use them but probably it wouldn’t be cheap” (Participant 6)

Some participants were concerned about becoming dependent on smart glasses and to not be able to learn without them.

Gamifications and exam: Most participants liked the idea of playing a game to learn. However, most of the participants were not sure if they would use smart glasses as help for studying before an upcoming exam and also expressed their concern about getting distracted. They would rather see a simple or interactive text to read for their upcoming exam.

“I prefer to interact simpler when I am studying for an exam and maybe an interactive book with a teacher I can ask if needed to would work for me. If I was wearing glasses and seeing the world around me with games all over it, it might be distracting” (Participant 6)

It is still not natural: Most participants didn’t believe that smart glasses could one day replace teachers or laboratory experiences. One participant mentioned that, even if he had a hologram of a teacher, it still wouldn’t be like a situation with a real teacher.

“It is something about that how you feel. For example if I had a virtual teacher I wouldn’t know when I am supposed to ask questions or talk, in a class you feel
when it is appropriate to talk and to ask your teacher. You read each other’s clues” (Participant 4)

4.5. Comparison between Duolingo and possible smart glasses language learning applications

**Difficulty of imagining future**: Every participant mentioned their disability in order to imagine what it would be like to use smart glasses for digital educational content. It is easier for them to imagine using Duolingo. “...it is hard to imagine how I could use it before having it for a while and get use it” (Participant 3)

**Low cost and availability of mobile apps**: Most respondents mentioned that in current situations it might be easier and probably cheaper to use mobile apps. “…in the beginning smart glasses might be too expensive to use and when it is cheaper I will use them” (Participant 11)

**The level of abstraction**: Some participants talked about how they would like to read a text.

“If I wanted to read or write I would use smart phones. I mean, smart glass might just give you a picture and show the meaning. If I could read and type with it in that sense, it would be so much better to have smart glasses” (Participant 6)

**Implementations**: All of the participants mentioned that they would prefer a possible smart glasses learning language tool before a mobile application. However, they wanted to have a degree of freedom for their learning experience with smart glasses. Most participants mentioned that they would like to click or point on objects to then see the word in their chosen language. “...I would want to be able to focus on an object maybe three seconds and then see and also hear the word in the language I was learning” (Participant 10)

**Limitations**: Some participants expressed their concerns about some subjects, such as writing. Since Duolingo is a mobile app, you are able to type and learn how to spell the word. There might not be specific ways to type and see the results with smart glasses. “…I want to be able to work on my writing skills also when it comes to learning a language. It is a big part of it” (Participant 5)

4.6. Result table

In this table (Table 2) general themes and opinions of the interviewees are summarized.

<table>
<thead>
<tr>
<th>E-learning</th>
<th>All of participants had taken an online course</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENERAL KNOWLEDGE</td>
<td></td>
</tr>
<tr>
<td>GENERAL INTERST</td>
<td>Most participant had general interest in self-regulated e-learning</td>
</tr>
<tr>
<td>General Dissatisfaction</td>
<td>Most participants described that computers are not supposed to replace learning. Half of the participants questioned whether a digital education could replace real-time physical experience.</td>
</tr>
<tr>
<td>-------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>Lack of Teacher</td>
<td>More than half of the participants expressed that it would be good to have a teacher.</td>
</tr>
<tr>
<td>Personalization</td>
<td>Four participants wanted to have a more personalized environment for their learning.</td>
</tr>
<tr>
<td>Lack of Motivation</td>
<td>Most participants had hard a time to stay motivated.</td>
</tr>
</tbody>
</table>

### Smart Glasses

<table>
<thead>
<tr>
<th>General Knowledge</th>
<th>Most participants did not know about smart glasses possibilities.</th>
</tr>
</thead>
<tbody>
<tr>
<td>General Interest</td>
<td>All participants had a general interest toward smart glasses.</td>
</tr>
<tr>
<td>General Dissatisfaction</td>
<td>Most participants didn’t believe that smart glasses’ possibilities could replace normal learning.</td>
</tr>
</tbody>
</table>

### Advantages

<table>
<thead>
<tr>
<th>Visualizations</th>
<th>Most participants believe that smart glasses are better medium for visualization.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convenience</td>
<td>Most participants believe that smart glasses would be easier to use.</td>
</tr>
<tr>
<td>Flexibility</td>
<td>Some participants believed that smart glasses would give them more flexibility in the meaning of where and how to use it.</td>
</tr>
<tr>
<td>Referencing</td>
<td>All of the participants liked to have more information around them while learning. All of the participants liked the idea of augmented books.</td>
</tr>
<tr>
<td>Mobility</td>
<td>All participants believed that they could use smart glasses everywhere.</td>
</tr>
<tr>
<td>Better Focus</td>
<td>More than half of the participants believed that smart glasses would give them a better focus than smart phones.</td>
</tr>
<tr>
<td>Ability to Interact with Teacher Hologram</td>
<td>Most participants liked the idea of having an augmented teacher.</td>
</tr>
<tr>
<td>Real World Implications Depending on Subject</td>
<td>All of participants expressed that, depending on the subject, real world implication would be easier.</td>
</tr>
<tr>
<td>Motivation</td>
<td>Some participants believed that, because of the novelty and the more enriched experience, they would be more motivated.</td>
</tr>
</tbody>
</table>

### Disadvantages
## SUBJECT DEPENDENCY
All participants believed that smart glasses could be useful for some subjects but not for all.

## DISTACTION
Four participants believed that smart glasses might be more distracting compared to having a physical text in front of them.

## TECHNICALITY, PRICE AND MORAL ISSUES
Over half of the participants were concerned about the price. Some participants were concerned, if they would be able to use it everywhere. Some participants were also concerned that they could be too dependent on it.

## GAMIIFICATIONS AND EXAMS
Most participants liked the idea of gamifications but they believed that it wouldn’t work for exams. One participant believed that games sometimes could be distracting.

## STILL NOT NATURAL
Most participants believed that smart glasses could not replace traditional real-time learning.

### Comparison: Duolingo app vs. possible smart glasses language app

<table>
<thead>
<tr>
<th>Subject</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DIFFICULTY OF IMAGINING FUTURE</strong></td>
<td>All participants had difficulties to imagine the possibilities of a smart glasses language app</td>
</tr>
<tr>
<td><strong>LOW COST AND AVAILABILITY OF MOBILE APP</strong></td>
<td>Most participants believe that it would be easier and probably cheaper to access mobile apps</td>
</tr>
<tr>
<td><strong>LEVEL OF ABSTRACTION</strong></td>
<td>Some participants talked about different levels of abstractions</td>
</tr>
<tr>
<td><strong>IMPLEMENTATIONS</strong></td>
<td>All participants mentioned that they would use smart glasses apps to learn a language if it is implemented the right way</td>
</tr>
<tr>
<td><strong>LIMITATIONS</strong></td>
<td>Some participants expressed their concern about writing with smart glasses, mobile apps might be better</td>
</tr>
</tbody>
</table>

### Table 2, Results of semi-structured interview study

## 4.7. Reflection on the result
As stated in the introduction, this thesis tries to answer, “What is the current attitude of students toward e-learning and could the introduction of smart glasses and its new possibilities as a new medium for e-learning change their attitude?” Through semi-structured interviews this thesis is believed to have generated some information that could be useful to answer this question.
4.8. Attitude on e-learning

All interviewees seemed to have a positive attitude toward online education. However, they talked about some improvements that could take place in the future. Regarding e-learning they wanted a more personalized and ‘easier to follow’-instructions. “...most of time it is just some simple game or some text and videos and you don’t know where to start” (Participant 3)

They also seemed to have a lack of motivation and a lack of focus in their previously experienced online education. They didn’t mention anything about a lack of real time experience. “...I feel that the pace was slow. I wanted to know more when sometimes [...] it might be boring. Real classes are more fun but I like to have the options” (Participant 8)

4.9. Use of smart glass in e-learning

Regarding the students’ perspective toward employing the current e-learning educational system, the students’ ideas were different – while they all seemed to like the idea of using smart glasses rather than smartphones or their personal computer for online education, they were not sure if, depending on their previous online course subject, it could be any useful for them.

Although they had a hard time imagining how it would be like to have smart glasses for online education, all of the respondents expressed that they will eventually see the value of this new technology and use it. Although they had a different attitude and ideas how this new technology could play role in their education, they did implicitly asked for specific things that could help them. Their ideas depending on particular subjects were different. They expressed some ideas about what they wanted to have in possible smart glasses applications, including realistic teachers or realistic representations of teachers, ability to socialize with others, having a personalized content, a degree of freedom for choosing a level of visualization, auditory experience, and a degree of freedom for the level of information that would be presented to them and also the ability to write or type.

They also expressed that they wanted to be able to use educational apps everywhere, any time and it shouldn’t be dependent on a place. Although they liked the idea of gamifications of their content, most of them wanted to have the ability to choose a right strategy.

From the general research of e-learning it could be assumed that the development and design of e-learning systems seem to be user-centered. As smart glasses are providing new ways of autonomous digital learning, these results show the importance of getting the general ideas of students, respectively end-users.

5. Discussion

In this thesis several themes have been visited: educational psychology, e-learning, its challenges, previous studies of the use of AR in education as well as the potentials of smart glasses as a specific AR medium in digital-mediated education. To understand the current issues, values, and projections of these fields, this thesis looks at the potentials end users’ attitude for comparing it to the content produced in academia. As stated before, there are several challenges that smart glasses should firstly address and overcome.
5.1. **Existing challenges**

The lack of human contact is an initial problem that has to be addressed. The results confirm that having social connection with a peer group who study the same subject is one of the requests for the future of smart glasses in education. In addition, the respondents would prefer to have a teacher to keep them informed. This is basically the first challenge that e-learning has to overcome and smart glasses are no exception. However, smart glasses have the potential to provide different end users with different and novel experiences in real time. Having a possible realistic augmented teacher not only could provide the students with better learning experiences, it could also be a way for students to have human contact.

Lack of focus is another challenge. Distraction could be a major issue for either the traditional way of e-learning or possible future smart glasses educational applications. Although smart glasses seemed to be more promising for students, it seems that distraction has nothing to do with the medium or the way of presenting the information.

Lack of motivation is the third challenge that has to be mentioned. Even though e-learning games have shown their potential to motivate competitive users in augmented learning (Perry et al., 2008), based on students attitude toward gamification, we can conclude that gamification could work for some specific users on specific subjects. A designer has to specify a degree of freedom for students to choose based on their level of expertise. They also should consider what students want to accomplish for their courses and subjects. However, generally introducing smart glasses as a medium for e-learning and implementing new concepts such as having an augmented teacher, social connections, and gamification could be a better choice for increasing motivation. Since the role of a teacher is necessary for engagement, teachers can impact their students’ learning and growth in study achievement (Guiney, 2001). We may be able to engage students with those approaches. Yet, with normal devices like laptops, iPad, or desktop computers, we might not achieve the natural way of interacting with a teacher in an immersive real world environment.

This brings us to the last challenge that every e-learning system has to overcome: none of the participants mentioned anything about their desire to have a real time implication for their educational content. However, based on participants’ attitude, in some subjects, such as learning a language or chemistry or architecture, smart glasses could give participants some sense of real time implications. Even though, this might show that using smart glasses have the capacity to overcome this challenge, most participants believed that the ability to touch and feel the objects or write could not be replaced by 3D-visualizations. Thus, it could be concluded that haptic senses play an important role for the future of smart glasses in educations.

5.2. **Identified challenges**

Although by using smart glasses we might be able to overcome some challenges that e-learning faces, one might argue that e-learning regardless of a medium fundamentally has a lack of real interaction and social situations, such as student-teacher interactions. Smart glasses could help to simulate the learning environment but it could not replace the traditional way of learning. All participants thought they would use them for educational purposes but smart glasses couldn't offer overall satisfying learning conditions.
Another challenge is the lack of sense of touch. Even though it seems easier to touch and feel the objects in an augmented environment, they are some issues that have be thought through including the possibility for students to type or write and the ability to touch and feel 3D-visualizations of objects.

Another conclusion that could arise from the results is, depending on the subjects of study, implementation and level of abstractions could be varied. In some subjects, students would rather read a text and then possibly click on some links. In other subjects they would prefer to have some augmented interactive information surrounding them.

According to Dunleavy et al. (2011), the majority of the findings related to designing AR experiences, future designs and stories fall within four major categories: location, narrative, roles and experience. Furthermore, the use of smart glasses in education is not an exception. Dunleavy et al. also state that there are two types of AR-designs based on location-place-depended or place-in-depended design. Since, based on the location and people subjects of study, students’ use of smart glasses as a digital educational tool could be different. Thus, some questions need to be taken in consideration, such as where, when, and how to use smart glasses instead of a desktop or smart phone learning apps.

5.3. In regard to educational psychology

Based on literature studies, engaging both feeling and thinking as a new approach for education also has to be considered for designing applications for smart glasses or basically any educational process in the future. As the result of interviews shows, most participants wanted to increase their level of interaction and possible gamification if appropriate. Another factor that has to be taken into consideration is enriching experiences by extending or involving more senses, which could be done, for example, via visualizations and gamifications.

As Shute and many others stated, games are a powerful tool for learning. They also maximize the number of senses by adding virtual objects in the environment or create more realistic situations than a normal educational process. It can engage feeling and thinking at the same time as well as altering perceptions and offering challenges for learners to provide them with better experiences (Prensky 2000; Kirriemuir et al. 2004; Shute et al. 2011).

However, according to the participants, different levels of abstraction are needed when it comes to how interactive the content could be. Additionally, all of participants expressed their interests in having some levels of visualization. As stated before, 3D-interactive visualization would not give the whole answer.

Another challenge that both e-learning and smart glasses have to address is having a personalized environment and a personalized way of learning to promote self-regulating learning. According to Robinson (2010), using an industrial metaphor is outdated for describing the new educational systems. New educational systems should be the one that use Robinsons’ agricultural metaphor, where educational systems play the role of gardeners who provide nutrition and water to the plants. The same idea applies to e-learning: if enough resources and a natural way of learning were available for learners, the outcome of learning might be sufficient and enhanced.

Based on existing challenges, identified challenges, and analysis of the results, this thesis concludes that smart glasses would not lead to a major change of students’ attitudes toward e-
learning. But they would have a general positive attitude toward using smart glasses in education. For them, using a different form of e-learning, it is dependent on the subjects and they don't think smart glasses could be an alternative for classrooms or a real teacher. Although using smart glasses could enrich ones e-learning experience, it simply cannot give students an unconditional replacement of current teaching methods. Furthermore, smart glasses, as well as other e-learning systems, still share some challenges that have to be overcome. Even though real time experiences and human contact could be enriched via interactive augmented information and interactive augmented teachers, they are still not sufficient enough. Smart glasses also seem to have some potential to put new ideas, emerged from recent education psychology, into practice and enriching e-learning experiences. However, these new ideas and possibilities based on the result of this thesis would not have major effects on students' attitudes toward e-learning.

6. Conclusion

There are enormous possibilities for using smart glasses in education, in particular e-learning. It also has the potential for putting new ideas, emerged from recent educational technology. However, this thesis shows these new possibilities could not make a major change on the attitude of students toward e-learning. Even though smart glasses have the capacity to overcome some current e-learning challenges, students would rather use smart glass than another form of e-learning media depending on the need of visualization, 3d-visualization or on the speed and efficiency of getting information.

Smart glasses as a form of wearable devices have recently got so much attention. Yet, there is only a little understanding in how one could employ smart glasses for education. Designing educational applications for smart glasses is a form of design that includes e-learning and augmented learning. Thus, any attempt to design educational applications would require an understanding of multiple disciplines including educational psychology, augmented reality, e-learning's current practices, and also attitudes of possible end users for this new technology. This thesis tried to address the last discipline. Nevertheless, more studies are required since having an actual device and making an in-depth experiment around it might identify further challenges and specify information.
References


Schweizer, H. (2014). *Smart glasses: technology and applications.*


Appendix 1: semi-structured interview questions

Questions

- What was your online course about and can you describe out of your experience what could have been better?
- What problems did you have with your online course?
- What could have been better?
- Did you finish the course?
- Do you know about the term augmented reality?
- Do you know about smart glasses?
- What would be major problems for students while using smart glasses for their learning experience?
- What major advantages would you see out of your experience?
- In current e-learning we see mobile apps and desktop apps. What aspect of e-learning could be assessed by smart glasses?
- Look at the video and examples. First of all, which scenario is applicable? Which would you just remove based on your current attitude toward e-learning and smart glasses? And why?

Examples:

12.1. Universal language translator: imagine you have the glasses on and it could give you every word translated in your specific language that you try to learn.

12.2. Research/study assistance: imagine you have the glasses on and it could give you everything and every words that related in your or specific subject of study.

12.3. Interactive books: imagine you have the glasses on and it could visualize everything and every word interactive. (video)

12.4. Interactive museum:

12.5. Interactive teacher

12.6. Exercise guide in the gym: imagine you go to gym and you see through the smart glass how to use it and the amount of calorie you would consume of each machine that you choose.

12.7. Interactive lab: imagine you sit at a lab and the smart glass shows you some guidelines that you can follow with your hand to do some experiment and you would get points for doing it right.

12.8. Interactive piano: imagine you sit at home and the smart glass highlights a note and you could play and get point for doing it right.

- The possibilities are enormous but what do you think might be problematic with these scenarios or what do you think are their advantages? Can you come up with a new idea?
- Could any of these possibilities solve any of the problems you might experience in your online course? If yes what? If no why?
- Do you prefer real teacher or virtual teacher or none on your augmented world? For example both virtual teacher could be represented as real person in your augmented world?
Appendix 1: semi-structured interview questions

- What are smart glasses disadvantages as an online course educational device?
- If you had smart glasses for educational purposes where do you think it’s appropriate to use it? Classrooms? Lab? Or everywhere? And why?
- Should you be allowed to talk to a friend about not specified subject while you’re using smart glasses to study another subject? Should be any force while you are using it for example a beep sound or a notice from augmented teacher?
- Should you be able to talk and ask questions or you prefer to have interactive objects in your frame of vision?
- Do you think smart glasses could replace teachers?
- Do you think smart glasses could replace lab experiment?
- Would you like smart glasses to analyze your feeling based on your for example heart rate?
- Would you ask smart glasses to help you with your schoolwork?
- Do you prefer play game while learning with smart glasses or interact with augmented world?
- Do you prefer seeing other students learning progress on screen? If yes how do you like to see them as an avatar or their real picture or their video?
- Would you like to see them as augmented virtual people in the augmented world or not?
- Would you like to be able to socialize with others who study the same thing? Would you like to compete with others playing games?
- Imagine you were studying a language with the universal language translator app in a park with For example mandarin with an augmented hologram of a teacher and you were be able to click and point on the objects around you and get the word meaning, words and pronunciation and more information, how would you compare that to Duolingo?
Appendix 2: examples

1. Example e-learning

![Duolingo](image)

What is duolingo?

2. Examples of AR in educations

![Interactive museum](image)

Interactive museum
Interactive laboratory

Interactive universal language translator
Appendix 2: examples

Interactive book

Interactive/augmented teacher
Appendix 2: examples

Interactive gym guide

Interactive music guide