Universiteit Utrecht

The Anti-Filter Bubble Application: Designing Activities to Raise Awareness of Filter Bubbles in Secondary Education

Master's Thesis
Human Computer Interaction

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Abstract

The polarising effect of social media and filter bubbles is a threat to modern society and democracy. The anti-filter bubble application aims to increase the digital literacy of teenagers in secondary education, to increase awareness of filter bubbles, and make students aware of the dangers they bring along. In this research, two activities for the application are designed, accompanied by an overall concept for the application. This research aims to find out how to design activities that effectively integrate into secondary education.

Semi-structured interviews were performed during two pre-studies, based on which requirements were established and two initial storyboards were designed. The iterative design process resulted in two prototypes for activities. During various iterations, 27 students and 15 teachers gave feedback on the prototypes in interviews and focus groups. Activity 2 was evaluated to find out whether collaboration would improve the knowledge of algorithms and the game experience. Six students played the activity alone, and three students played together as a group. Two interviews with teachers were conducted to gain additional insights.

The results of the evaluation with students are not conclusive given the low sample size. Based on the interviews with teachers, it is recommended to play Activity 2 collaboratively, because the value of the activity is in the discussion. Additionally, this research contributes recommendations for the design of educational applications. The designed activities can be further developed to be included in the anti-filter bubble application, and the recommendations can help others who design similar applications for teenagers in secondary education.

Contents

1 Introduction

Back in 2006, Internet Explorer was the main browser, Facebook just opened up for the general public, and the first iPhone still had to be announced. It is in this year that the curriculum of Dutch primary and secondary education was established. This curriculum is still used today, so the things children learn in school is based on guidelines from 15 years ago. Meanwhile, times have changed, and a large share of people's lives takes place online and on social media, especially for teenagers. Information personalisation is a key feature of social media, where algorithms try to recommend the best matching content to the user (Amrollahi, 2019). One consequence of this information personalisation is the rise of filter bubbles. When people only see information that confirms their own point of view, they get isolated in their own bubble (Pariser, 2011). In this bubble, people receive less varied information, and they will struggle to understand people belonging to other groups, which can eventually lead to polarisation.

Because the current curriculum was developed 15 years ago, topics like the filter bubble, or in general how to deal with the digital world and social media are lacking. Improving the digital literacy of people is one way to fight the polarising effect of filter bubbles (RAN, 2018). The importance of this topic is underlined by the current revision of the Dutch curriculum, where Digital Literacy is one of the nine proposed themes. Educating teenagers on the filter bubble and its dangers will provide them with tools to deal with this subject and prevent polarisation. This is exactly the goal of the anti-filter bubble project, an interdisciplinary research project of Utrecht University that aims to develop an application that raises awareness of filter bubbles. The application is aimed at teenagers enrolled in vmbo schools in the Netherlands.

This research reports on the design of an application, made in collaboration with teenagers in an iterative design process. The prototype will be tested and evaluated with the users and recommendations for embedding the application in class will be developed. This research will contribute to knowledge in the field of Teen Computer Interaction, a part of HCI that is often neglected in research. The contributions resulting from this thesis will be artefacts in the form of a prototype, and empirical results based on user studies, interviews and focus groups. At the same time, designing an application for teenagers and ensuring that it is effectively embedded in education, will result in best practices for future applications within the same domain or with a similar purpose.

2 Related Work

A general understanding of the phenomenon 'filter bubble' is necessary to design an application that raises awareness of filter bubbles. Therefore, first, the origin of this term will be discussed, what filter bubbles are, and what effects they have. The potential dangers filter bubbles bring along, show the relevance of the current study. Analysing existing tools and technologies that address the filter bubble, will provide the opportunity to learn from these applications. Once more is known about the filter bubble, the characteristics and preferences of teenagers are discussed in the second part of this section. It is important to build a first understanding of the users of the application, to take this into account during the design process. The remainder of this section will focus on Teen-Computer Interaction. Finding out how to design applications with- and for teenagers is at the core of this research. Learning from studies in this subfield of Human-Computer Interaction will benefit the current research.

2.1 The filter bubble

With the rise of the internet and social media, Eli Pariser defined the concept of 'filter bubble' back in 2011. He vaguely defined this concept as "a unique universe of information for each of us" (Pariser, 2011, p.10). The filter bubble has the following characteristics: you are alone in the bubble, the bubble is invisible, and you do not choose to be in the bubble (Pariser, 2011). Ever since Pariser defined the term filter bubble, it has been up for debate. In general, two research streams can be noted (Amrollahi, 2019). The first research stream is based on the idea that filter bubbles primarily arise from algorithms and recommender systems (Geschke, Lorenz & Holtz, 2019; Pariser, 2011). Based on previous actions of the user and information that has been

derived, new items are suggested to the user. The second research stream is based on the idea that users themselves cause the filter bubble through a selection bias (Bruns, 2019; Spohr, 2017; Zuiderveen Borgesius et al., 2016). A selection bias presumes that people prefer information they agree with, and consequently select this type of information more often (Spohr, 2017; Zuiderveen Borgesius et al., 2016). Zuiderveen Borgesius et al. define these two streams respectively as pre-selected and self-selected personalisation (Zuiderveen Borgesius et al., 2016).

One can also look at filter bubbles using the triple-filter-bubble model, as defined by Geschke et al. (2019). This model covers the process of filtering on three different levels: the individual, social and technological level. First, "an individual's information search, processing, and memory" (Geschke et al., 2019, p.132) lead to selective exposure on the individual level. Second, Geschke et al. mention that people prefer to form friendships with like-minded people, both in real life and online. This results in homogeneous networks, where the variance of shared content is limited: filtering on the social level. Lastly, technological filters -algorithms- tailor the information to each individual, based on assumptions the algorithm has of the user. The filters on the technological level make use of pre-selection as described by Zuiderveen Borgesius et al. (2016). To summarize, filters on all levels can decrease the variety of information that is available to the user.

Technical filters, or algorithms, primarily exist on social media. On social media such as Facebook, Instagram, and TikTok, algorithms recommend content to users (Burbach, Halbach, Ziefle & Calero Valdez, 2019; Mahrt, 2020). These personalised algorithms ensure that when a user interacts with certain content, more of this type of content is presented to the user. While studies show that users of Facebook are aware filter bubbles exist, users barely take action to defeat them (Burbach et al., 2019; Rader & Gray, 2015; Plettenberg et al., 2020). A reason for this is that strategies for breaking out of the bubble, for example, deleting cookies and browser history, and (not) liking specific posts, are found to be too time-consuming and not user-friendly (Burbach et al., 2019; Plettenberg et al., 2020).

The filter bubble brings along potential dangers. In short, the decrease in variety of information, and thus the increase of selective exposure, can lead to polarisation (Stroud, 2010). Modern democracies require people to have different opinions, listen to each other, and discuss opposing viewpoints (Geschke et al., 2019). Given the fact that filter bubbles isolate groups of people from each other, and communication between groups decreases, this phenomenon does not benefit democracies (Geschke et al., 2019; Spohr, 2017). The polarizing effect that filter bubbles bring along therefore poses a threat to modern democracies. A concrete example of the polarizing effect of filter bubbles can be seen when looking into online news consumption. When comparing news articles found directly via the news site and articles found via social media, the latter is associated with higher polarisation (Flaxman, Goel & Rao, 2016). Likewise, political discussions on social media show polarisation, "when people are stuck in a bubble that prevents them from receiving outsider information" (Amrollahi, 2019, p. 19).

For several years, the debate on the role of Facebook and Twitter in preventing polarisation and the spread of fake news has been prevalent in society (Bahara, Kranenberg & Tokmetzis, 2019). Recently, the attention to the responsibilities of YouTube in this matter grew. In 2019, Dutch newspapers Volkskrant and De Correspondent studied the ease of coming across extreme right views on YouTube (Bahara et al., 2019). In 2020, the Dutch tv-show Zondag met Lubach covered the so-called online 'Fabeltjesfuik' (translated: the online trap of tales), explaining how the videos people watch quickly get more extreme (vpro zondag met lubach, 2020). Both the research and the video helped to address the issue of polarisation and radicalisation on YouTube. It stands out that there is a much larger share of right-wing extremist videos, compared to the left-wing alternatives (Bahara et al., 2019). In addition, Bahara et al. (2019) found that the speed and ease at which users reach ever more extreme videos is problematic. Raising awareness of these issues is necessary, and educating teenagers is one way to do this.

2.2 Tools and technologies to burst the filter bubble

Several measures can be taken to burst the filter bubble and examples of this are found on various levels. Both researchers and organisations developed tools and technologies with the goal to visualise- and raise

awareness of the filter bubble. To get an idea of the field and the tools available, I discuss some of them below. Analysing them might offer insights or best practices that can be used in the current study. The tools discussed here are selected either because they are still accessible and in use, or because they have an extensive scientific basis.

TheirTube This website offers "a YouTube filter bubble simulator that provides a look into how videos are recommended on other people's YouTube" (Kihara, 2020). Based on interviews with real people and their viewing history on YouTube, six new YouTube profiles were created: Fruitarian, Prepper, Liberal, Conservative, Conspiracist, and Climate Denier. On TheirTube (www.their.tube/), you can select one of the profiles and see what their homepage of YouTube looks like on different dates. The project is still running and every day the new homepages of the profiles are retrieved from YouTube. The primary goal of this project is to offer people insights into the filter bubbles of other people. Usually, we only see our own homepage and TheirTube offers a preview of other people's homepage as well.

AllSides AllSides (www.allsides.com) is an American website that covers news from both left, central and right perspectives, to give the reader a balanced overview of the news. The mission of this website is to "Strengthen our democratic republic by freeing people from filter bubbles so they can better understand the world- and each other." (AllSides, 2020). Part of AllSides is AllSides for Schools (https://allsidesforschools.org/) which offers a variety of classes and activities, for example on news literacy and critical thinking. Presenting multiple points of view to students and clearly displaying whether an article is left-, center- or right-oriented can increase awareness.

Balancer Munson, Lee and Resnick (2013) developed the browser extension Balancer: a tool that visualizes how balanced the news consumption of a user is. The balance is calculated based on a predefined whitelist of news websites, which are either liberal, conservative, or centrist. A man walking on a rope, carrying a stick that is heavier on the blue (liberal) or red (conservative) side, literally shows the imbalance. The goal of this tool is to increase awareness of news reading habits and the (lack of) diversity. A user study using Balancer showed that a small number of users did moderately change their behaviour after interacting with Balancer (Munson et al., 2013).

Instawareness For his master's thesis Fouquaert (2019) developed a tool that provides insights into the algorithm of Instagram. After connecting the tool with your own Instagram account, your current feed is shown (constructed by the algorithm), next to an uncurated feed (in reverse chronological order). Each photo is accompanied by information about the ranking, stating whether the post has a higher, lower, or similar position when comparing the curated to the uncurated feed. A quasi-experiment using Instawareness (https://instawareness.ugent.be/) showed that the awareness of the Instagram algorithm was enough to increase critical concerns of participants (Fouquaert, 2019). Despite these concerns, users did not change their behaviour.

Filter bubble visualisation Nagulendra and Vassileva (2014) developed an interactive visualisation of the filter bubble, which was used in an online social network for research purposes. The visualisation offers two views, one of the friends a person has, and one of the categories of posts (e.g. health or sports). Some friends or categories are displayed inside the bubble, while others are placed outside the bubble. Users can interact with the visualisation, for example by choosing different categories or by dragging friends inside the bubble. The goal of this interaction is to give users control over their own filter bubble. A user study found that after the use of this visualisation, users were more aware of the filter bubble, understood the filtering mechanism better, and felt more control over the content they saw (Nagulendra & Vassileva, 2014).

2.2.1 Lessons learnt

When comparing the five tools and technologies discussed above, two different ways of raising awareness of filter bubbles can be noted. First, TheirTube and AllSides let the user explore different bubbles. Second, Balancer, Instawareness, and the visualisation of Nagulendra and Vassileva show the personal bubble or biases of the user. While the first category broadens the view of the user by showing what people in other

bubbles experience, the second gives the user direct insight into his or her own bias. For the current research, it might be useful to incorporate both methods, to achieve the best results possible. The tools that were evaluated in a user study showed that users were more aware of the filter bubble but did not take any action to break out of the filter bubble. While methods to raise awareness, improve understanding, and facilitate reflection are implemented, the step to "learn the actionable alternatives" is not yet made (Yap & Lee, 2020).

2.3 Teenagers

The anti-filter bubble project is currently aimed at Dutch teenagers in pre-vocational education, short vmbo (voorbereidend middelbaar beroepsonderwijs). In 2020, there were more than 570.000 teenagers, aged 12-15, living in the Netherlands (Centraal Bureau voor de Statistiek, 2020d). 51% of people in the third year of secondary school (which is the moment of measuring) was enrolled in the vmbo in 2020 (Centraal Bureau voor de Statistiek, 2020c). These statistics provide some preliminary insight into the target group. In order to get a better understanding of teenagers, their characteristics are discussed in this section.

Being a teenager goes hand in hand with various changes, both cognitive, biological, and social (Fitton et al., 2014). It is a difficult phase in life, where you have to deal with themes like identity, autonomy, and achievement (Fitton et al., 2014). During this time, the influence of parents and other family members decreases, whereas peers play a big role (Nederlands Jeugdinstituut, 2018; Smetana, Campione-Barr & Metzger, 2006; Steinberg & Morris, 2001). Teenagers become friends with people who are similar and are influenced by them because they value the opinion of their peers (Steinberg & Morris, 2001). Besides meeting each other at home and school, social media is important for interaction between peers (Dennen, Choi & Word, 2020; Nederlands Jeugdinstituut, 2018). In the Netherlands, almost 95% of people aged 12-18 use social media (Centraal Bureau voor de Statistiek, 2020b), underlining its importance. In general, teenagers access the internet in various ways, most of them being in the possession of a phone (98,6%), laptop (93,7%), or tablet (78,5%) (Centraal Bureau voor de Statistiek, 2020b). Although the internet makes it easier to come into contact with like-minded people, navigating the world of social media can be complex for teenagers (Dennen et al., 2020; Fitton et al., 2014). When there is competition between peers, the intensive use of social media can increase social comparison and envy (Charoensukmongkol, 2018).

This increase of social comparison combined with the isolating effect social media can have, can result in polarisation (Charoensukmongkol, 2018; Geschke et al., 2019). The Radicalisation Awareness Network (RAN) acknowledges the problem of polarization and radicalization among youth (RAN, 2018). In the Netherlands, tensions at school primarily arise between teenagers with- and without a migration background (Van Wonderen & Van den Berg, 2019). Since more than a quarter of vmbo students have a non-western migration background (Centraal Bureau voor de Statistiek, 2020a), tensions can be more prevalent at these schools. A school needs to offer a democratic environment, where people learn to solve conflicts peacefully, and issues of importance to them are heard and discussed (RAN, 2018).

One of the concrete things RAN (2018) recommends to fight polarization, is to increase media literacy. This involves for example general understanding of social media, but also knowledge on "the technical functions and algorithms that contribute to the visibility of related content" (RAN, 2018, p.14). When we look at youth in the Netherlands, a study of Platform JEP[1] showed that social media can increase the us vs. them mentality for young people (Van Wonderen & Van den Berg, 2019). Besides this, social media acts as a catalyst and hardens differences between groups. Nederlands Jeugdinstituut [2] (2018) emphasizes that the lack of variance of information received through media and the 'information bubbles' contribute to polarization. They recommend, just like RAN, to increase the media literacy (also called digital literacy) of youth, providing them with tools to increase resilience against polarization.

The relevance of teaching media- or digital literacy in schools is underlined by the revision of the curriculum in the Netherlands. The current curriculum dates back to 2006 and is in the process of being updated

[1]Platform JEP (jeugd preventie van extremisme en polarisatie) is a Dutch governmental organization that supports people who work with youth in answering questions regarding polarization, radicalization and extremism.

[2]English: Netherlands Youth Institute

(Curriculum.nu, 2020b). One of the new themes that is suggested to be added is Digital Literacy, consisting of sub-themes like Data & Information, Digital Communication & Collaboration, and Digital Citizenship (Curriculum.nu, 2020a). The goal is to ensure that children can function in a society where technology and (social) media play a big role. The research of this thesis is therefore in line with the (proposed) new curriculum.

2.4 Teen-Computer Interaction

While research on Human-Computer Interaction (HCI) and Child-Computer interaction (CCI) is well represented, there still is a lack of research on Teenager-Computer Interaction (TeenCI) (Fitton et al., 2014; Iversen, Dindler & Hansen, 2013; Omar & Husni, 2019; Poole & Peyton, 2013; Rose, Björling, Kim & Alvarez, 2018). Already in 2011, a meta-study analysing nine years of IDC (Interaction Design for Children) research found that no papers were focusing on teenagers (Yarosh, Radu, Hunter & Rosenbaum, 2011). In the previous section, I already mentioned some characteristics unique to teenagers. Bell and Davis (2016) summarized the aspects of teenagers that are important to consider for TeenCI researchers as follows: teenagers are cognitively further developed than children, but not as developed as adults; they are highly sensitive to social information and primarily self-oriented; teenagers are not a homogeneous group. Since teenagers differ from both children and adults and are such a unique group, this should be taken into account when designing with- and for them (Bell & Davis, 2016).

2.4.1 Guidelines for designing with teenagers

Since TeenCI is still in its infancy, there is not a generally agreed-upon set of guidelines for designing technologies together with- and for teenagers. However, in the book Perspectives on HCI research with teenagers, Little, Fitton, Bell and Toth (2016) collected current research in the field of TeenCI and provided several "pragmatic suggestions for working with teenagers" (Fitton et al., 2016, p.256). These suggestions can be helpful during this research and offer a basis for the methodology. I adapted the original nine pragmatic suggestions (Fitton et al., 2016) to be more concise. Some guidelines which were similar have been combined, and additional resources have been added to strengthen each guideline. This resulted in the five guidelines below.

Consider group dynamics. When working with teenagers in research, it is important to consider group dynamics. The involvement of peers makes teenagers feel more comfortable expressing their opinions (Bhattacharya et al., 2019; Fitton et al., 2016). An additional benefit of working in groups is their ability to reduce the power imbalance between researchers and teenagers (Poole & Peyton, 2013). Fitton et al. state that groups are most effective if they consist of teenagers of approximately the same age and are mixed in gender. Rose et al. (2018) confirm this and suggest using groups with the same interests. The optimal amount of participants for a group that has to collaborate closely together lies between four and seven (Fitton et al., 2016).

Use mixed research media, a range of techniques and make it rewarding. Fitton et al. (2016) found that using different methodologies and techniques ensures that teenagers stay engaged in the research. When an activity is engaging, it is also more rewarding for participating teenagers. Yip, Foss and Guha (2014) noticed that most teenagers wanted to come back for the second part of the research and were intrinsically motivated. Fitton et al. (2016) furthermore showed that both online and offline research can be performed together with teenagers to get meaningful results. Varying in techniques provides more qualitative data, resulting in a better understanding of teenagers. It is advised to use high-quality media during the research because the quality plays a large role in the opinion of teenagers (Rose et al., 2018).

Teenagers are nor children, nor adults, and they differ from each other. As described in Section 2.3, teenagers are a distinct group. This should be remembered when involving them in research. Fitton et al. (2016) describe that teenagers are more independent and critical than younger children, but they are not as mature as adults and sometimes require extra explanation. While teenagers share properties as a group, there can be differences as well, for example between younger and older teenagers, or teenagers who are part of a vulnerable group. In most design research involving teenagers, authors underline not to treat teenagers

as either children or adults (Bell & Davis, 2016; Katterfeldt, Zeising & Schelhowe, 2012; Jimenez Pazmino, Slattery, Lyons & Hunt, 2015; Poole & Peyton, 2013).

Embrace playfulness and seriousness. Fitton et al. (2016) indicate that teenagers can easily switch between serious and playful tasks. It is wise to incorporate both tasks in research. Some teenagers do not like playful activities and prefer serious, more school-like exercises. On the contrary, some are more enthusiastic when conducting playful activities.

Be reflective. Both during and after the research, it is of importance to reflect on the used activities (Fitton et al., 2016). Researchers should do this themselves, but it is also valuable to ask teenagers to reflect and let them express how they feel about participating. Bell and Davis (2016) add that reflection enables teenagers to think on a metacognitive level. Reflecting as a researcher ensures that you can learn from the performed activities and make improvements the next time.

The guidelines above, mainly based on Fitton et al. (2016), are important to consider during the current study. The fact that there is no fixed set of guidelines available for doing research in TeenCI, underlines the importance of this study. It helps to understand working with teenagers, a group of people that are "both child-like and adult-like, both homogenous and different, and both playful and serious" (Fitton et al., 2016, p.235).

2.4.2 UX preferences of teenagers

Past research on usability and user experience has identified preferences specific to teenagers. We have to check whether those preferences are valid for the current target group of teenagers in vmbo schools in the Netherlands, but they can be a good starting point for setting up initial requirements. The Nielsen Norman Group studied over 100 users aged 13 till 17, to find out how to engage teenagers and how to keep them on an app or website (Joyce & Nielsen, 2019). I summarized their findings in four points. First, teenagers are impatient and do not like large amounts of text on screen. When designing a website, the text should be available in chunks to improve information processing, and visually illustrated sites are preferred. The font should not be too small and the writing style not too complicated, as teenagers like to get the message right away. This message should be written in the right tone of voice, and anything childish should be avoided. Teenagers are a distinct group (as also described in Section 2.3) and should not be treated in the same way as younger children. Second, sites or apps should be interesting because teenagers will leave when they are bored. Aesthetics and multimedia solutions can help to make content more engaging, provided they serve a specific purpose. Applying interactive features just for the sake of applying them has the opposite effect. Good features actively involve teenagers, examples are online quizzes and feedback forms. When adding these features, negative effects on the speed of the website should be avoided, since teenagers do not have the patience to stay on a slow website. A third point to consider when designing for teenagers is the control over social or sharing options. Teenagers like to share things with peers, but they want to be in control and have the freedom to choose which platform they use for sharing. This can for example be achieved by adding an option to copy the link, which allows for sharing across platforms. To conclude, websites or apps should be responsive: they should change seamlessly from mobile, to tablet, to laptop. Since teenagers do often use mobile devices and touch-enabled devices in general, the interactions should be adapted to this. Thus, eliminating actions that require precision.

To ensure that teenagers stay engaged, this research should take into account the described usability and user experience preferences. It is necessary to check whether these preferences are in line with those of Dutch teenagers at the vmbo. However, they still offer a good starting point for the design of the application.

2.4.3 Engaging students with educational technologies

Schools play a big role in enhancing the digital literacy of teenagers. The anti-filter bubble project aims to support schools in addressing the topic of filter bubbles, by means of an application. Technology can enrich and support education in various ways and it can serve as a tool to enhance learning (Bower, 2017). One of

the ways technology is used in education is through the use of gamification and games (often called serious- or edutainment games), which can be motivating, engaging, and enhance retention (DiFranzo et al., 2019; Kapp, 2012; Kiryakova, Angelova & Yordanova, 2013; Nah, Zeng, Telaprolu, Ayyappa & Eschenbrenner, 2014). In a serious game, learning can be improved by applying instructional techniques like collaboration, content integration, feedback and reflection (Van Oostendorp & Wouters, 2016). When designing the application for the anti-filter bubble project, applying game elements or gamification might be valuable to increase motivation and engagement.

A recent literature review by Escueta, Nickow, Oreopoulos and Quan (2020) divides educational technologies into four categories: access to technology, computer-assisted learning (CAL), online courses, and technology-enabled behavioural interventions. The research showed that solely giving students access to a computer does not improve learning, it just increases computer skills. Online courses are promising when they use blended learning, i.e. a mix of online and offline learning, but can have negative consequences for learning when in-person contact is lacking completely. Most positive effects are shown for CAL and technology-enabled behavioural interventions. Especially personalizing the learning experience contributed to the engagement of students. Besides this, it is an important finding that technologies should support both the teacher and the learner. Designing educational tools in which teachers do not have a role is undesirable (Bower, 2017; Escueta et al., 2020).

There is a wide range of tools, apps, and games for education available, making it a challenge for schools and teachers to decide which ones to use. Kolb developed the *Triple E Framework*[3] to "define what it looks like to effectively integrate technology tools into a lesson while supporting learning goals" (Kolb, 2017, p.30). The framework consists of three concepts important for educational applications: Engagement, Enhancement and Extension of learning goals. First, the Engagement a tool creates should be active and social engagement. When students interact with a tool, this should be meaningful and related to the learning goals, not just focused on the gimmicks of the tool (such as customizing avatars). The used technology should activate and motivate users to learn. Second, Enhancement considers the added value of a tool. The use of technology should enhance the understanding of a topic and offer guidance for the learning, in ways that would not have been possible without technology. Third, the concept Extension is about the relationship between everyday lives and technology. A strong bridge between the used technology and the lives of users helps them to develop skills that can help them outside the classroom. When designing the anti-filter bubble application, it is useful to consider the concepts of the Triple E Framework to ensure the tool supports learning in the best way possible.

2.5 Summary

Filter bubbles are caused by information personalisation, which can be pre-selected by algorithms and self-selected by the user. Especially on social media, the information personalisation results in users being in their own filter bubble. The decrease in variety of information can isolate groups of people from each other, eventually leading to polarisation. Users, in general, do not take action to defeat the filter bubble, it is therefore important to increase awareness about this phenomenon and its dangers. Little is known about good strategies, tools, or techniques to achieve this goal. This research contributes to this, by developing an application that raises awareness of filter bubbles.

The polarizing effect of social media is prevalent among teenagers in the Netherlands. Teenagers go through various cognitive, biological, and social changes, and are easily influenced by the opinion of their peers at this stage of life. Social comparison can arise and navigating social media is complex in general. It is recommended to increase media or digital literacy, to ensure teenagers can function in a society where technology and (social) media play a big role, and to fight polarization. This research aims to find out what strategies will increase the digital literacy of teenagers.

Research on Teenager-Computer Interaction is still lacking. This unique group has both child-like and adult-like characteristics, is sensitive to group dynamics, and can be serious and playful. Those are all

[3]More information, how to use, and rubrics: www.tripleeframework.com

characteristics to consider when designing with- and for teenagers. For the design of educational technologies, it is important to create engagement, and the use of technology should enhance the understanding of a topic. Keeping the learning goals in mind ensures that technology supports users in the best way possible.

This research is relevant because the polarising effect of social media and its filter bubbles is a threat to our modern society and democracy. Educating teenagers on digital literacy and raising awareness can help to decrease the dangers of filter bubbles. In addition, little is known about Teenager-Computer Interaction. This thesis will address these gaps, by investigating the following research question:

> *What design qualities does an interactive tool for raising awareness need to effectively integrate into secondary education?*

By answering this question, this research will contribute to the field of Teenager-Computer Interaction, by means of design guidelines, a prototype and empirical results of interviews, user studies and focus groups. Therefore, the results of this study can be used in future studies.

3 Background

This thesis is part of the anti-filter bubble project. In order to understand in what environment the development of the application and the writing of this thesis is situated, it is important to learn more about the history of the project, its partners and the goal of the project.

3.1 History

The anti-filter bubble project originates from an initiative of the municipality and primary schools in Utrecht. To develop interventions that prevent polarisation and segregation in education, these parties work together with Utrecht University in a project called UNION (Utrecht Network of Inclusive Education). Within Utrecht University the anti-filter bubble project is embedded in the research hub 'Change your perspective', which is a part of the strategic theme 'Dynamics of Youth'. The project has an interdisciplinary character as researchers from Education Sciences, Human-Computer Interaction, and Information Sciences work together. Over the years, various teams of students contributed to the project. In 2019, student-teams developed initial ideas and prototypes of the application, for the bachelor course Designing Interactive Systems, part of Information Sciences. In 2020, a team of third-year Computer Science students developed the back-end of the anti-filter bubble application for the Software Project course. At the same time, two master students of Youth, Education & Society (YES) studied the effectiveness of the intervention and the attitude of the target group regarding filter bubbles for their master's thesis. From November 2020 till June 2021, two new YES students and two Human-Computer Interaction students (Tim van de Wiel and myself) wrote their master's thesis within the project.

3.2 Partners

Besides Utrecht University, there are various partners involved in the anti-filter bubble project. To start, various schools in Utrecht are involved in the project: Globe college, Trajectum College, X11, Academie TIEN, and Gerrit Rietveld College. These schools will provide teachers and students for participation in the research and they plan to use the application in their curriculum. Another partner in the project is Mira Media[4], a Utrecht-based organisation that aims to increase digital- and media literacy to improve intercultural dialogue. Their expertise covers the media use of youth and discussing sensitive topics like polarisation. Mira Media is in direct contact with teenagers and knows what issues and problems they experience. Furthermore, Bibliotheek Utrecht is involved in the project to ensure the final application is embedded in the curriculum of schools and the library. The many partners, all from different backgrounds and with varying interests, that work together in this project, result in a challenging environment for developing an application.

[4]Mira Media does no longer exist, and is now called Het Mediateam (https://hetmediateam.com/)

3.3 Goal

The goal of the anti-filter bubble project is to develop an application that raises awareness of the filter bubble among teenagers and offers them tools to deal with the dangers a filter bubble brings along. The application should be embedded in the curriculum and be accompanied by lesson plans. At the same time, Utrecht University uses this project and the development of the application to study how anti-bubble software can be used in educational settings, and in what way the design (both didactic and application) is most effective. The project therefore has both a research and practical component.

4 Pre-study 1 - Establishing Requirements

To develop an educational application that raises awareness of filter bubbles among teenagers, it is important to talk to teachers and students. During the first pre-study, several teachers (N=6) were interviewed to establish the context of use and gather requirements. The teachers provided insights into the way technology plays a role in their lessons, how their students behave online, and how to address sensitive topics like polarisation. In the second part of the interview, we learned how teachers would like to use a filter bubble application within the classroom and what role teachers would like to play.

4.1 Method

Semi-structured interviews were performed with teachers, using an interview protocol (Appendix A.1). The interview consisted of open questions, to enable the teachers to tell their own story with little restrictions, and follow-up questions were asked if necessary. The goal of the interviews was on the one hand to gather insights in the context the application will be used in, for example regarding the online behaviour of students, the use of technology in the classroom, and the teaching styles students prefer. On the other hand, questions were asked regarding the use of the application in class, and how teachers would imagine this in their classroom.

The interviews lasted one hour and took place online on Microsoft Teams. After verbal consent was given for participating in the interview and recording it for analysing purposes, the interview was recorded using the built-in functionality of Microsoft Teams.

4.1.1 Participants

Convenience sampling was used to gather participants for this pre-study. All teachers were part of either my network or that of Tim van de Wiel. Participants consisted of 5 teachers and 1 educational technology expert (also a former teacher). Table 1 contains characteristics of the participants. Besides their gender and the course they teach, the years of experience as a teacher are added, and the level of education they teach or have taught. Note that participants T1 and T2 work at the same school, as goes for T4 and T5.

Table 1: Teachers that participated in pre-study 1

ID	Gender	Course / Expertise	Experience	Level of education
T1	F	Levensbeschouwing	9 years	havo, vwo
T2	F	Levensbeschouwing	30 years	mavo, havo, vwo
T3	M	Maatschappijleer	13 years	mavo, havo, vwo
T4	M	Math & Teamleader	27 years	mavo, havo
T5	F	Maatschappijleer	26 years	mavo, havo, vwo
E1	M	Educational software & former teacher Dutch language	25 years	-

4.1.2 Analysis

The recorded interviews were transcribed and the interesting and important aspects were highlighted. Both myself and Tim van de Wiel marked the sentences, after which we discussed similarities and differences, resulting in meaningful quotes from the interviews. These quotes were extracted from the interview and clarified by adding text in square brackets, making it possible to use the quotes outside their original context. Next, Mural was used to group the quotes into categories. This tool contains a digital canvas on which you can move around and group post-its. Each post-it contained a quote, with each participant represented by their own colour. Structuring the quotes using Mural made it easier to get the insights and provided a visual overview of the data. The quotes and insights provided input for the context of use and the requirements of the application.

4.2 Context of Use

The application is targeted at students of the vmbo, aged 12 till 14 years. Since it will be used in classrooms at school, teachers have a good idea of the context of the application. This context has various aspects: the stakeholders involved (teachers and students), the physical context, the organisational context, and the social context. In this section, the context of use of the application is described.

4.2.1 Teachers

Since the application will not be standalone, it is of utmost importance to ensure that teachers trust the application and will be motivated to use it. All teachers used some form of technology in their classes, mostly to add interactivity (using tools like Kahoot or Socarative) or to show presentations, videos, and pictures on the (smart)board. When working with the application, it should be clear to teachers what the goals of the application are, how the application will support their classes, and what is expected from them. The interviewed teachers indicated that the topics that will be addressed in the application are relevant and that they would use it. They prefer the application to be embedded in a lesson and accompanied with clear guidelines for use.

The interviewed teachers disagreed on the question if every teacher is suitable for teaching a class with the application. Some of them mentioned that a teacher needs certain skills and experience with talking about sensitive topics, since the topic of filter bubbles is linked with themes like polarisation. Other teachers indicated that every teacher should be able to address these topics, since they all have didactic skills. There was general agreement that the influence of the teacher is important and that the effectiveness of the application depends to a greater or lesser extent on the teacher.

4.2.2 Students

The application will be used by students, which is the second group of stakeholders. It is hard to describe students in general terms since the individual differences within this group are prevalent. Despite this fact, teachers provided some insights into student behaviour. Vmbo students, who are the target group of this application, prefer class activities that require active participation. They have a short tension span, so listening to a story for too long is not an option. The theory has to be kept to a minimum and they have to interact with the course material to learn. Ensuring a class is diverse and a variety of techniques or activities are used is key for all students, but for vmbo students in particular. Additionally, a strong connection with the teacher is for vmbo students an important factor. Those students are more inclined to participate in class just to please the teacher, something that is less of a topic for havo and vwo students.

Besides the influence teachers have, parents also play a role in the lives of students. Especially in the first two classes of secondary school, how someone is raised is clearly visible in class. When students get older, the influence of parents decreases and gets replaced by the influence of peers.

Students spend a lot of time online, this is something all teachers agree on. They use Social Media (Instagram, Snapchat and TikTok are mentioned a lot), play games, shop online, and watch videos on YouTube,

among others. A lot of their online behaviour is about interacting with peers, sharing things they like with each other. While they know their way around this part of the internet, teachers are concerned about the way students search and use information. They usually stop at the first link on Google and are prone to believe things just *"because it is on the internet"* (T4). Moreover, teachers experience that students are not aware of the news. They do not have objective knowledge about the world, something that would be derived from watching the news or reading a newspaper. These insights about the online behaviour of students are relevant to consider when designing the application.

4.2.3 Physical context

The application will be used in the classroom, both on the smartboard (or projector), and the devices of students. These devices may differ from school to school or even from class to class. At some schools, every student has their own laptop or tablet, either being provided by schools or purchased by students themselves. There are so-called 'Google-schools' and 'Apple-schools', where every student has the same device. When students do not have a laptop or tablet in class, they should be able to use the application on their mobile phones. The use of a projector or digiboard can also differ across schools.

Other physical aspects might be relevant as well. Dutch classes usually consist of around 25 students, who are located in the same room during the lesson. This might result in a lot of noise when everyone is watching a video (with sound) at the same time. This should be taken into account when designing the application.

4.2.4 Organisational context

Teachers indicated that the application should be embedded in a (series of) lesson(s) and detailed information and background should be provided to them. There was also not a unified answer to the question where the app should be located in the curriculum. Multiple options were provided: the courses Maatschappijleer or Informatica, the mentor classes, and as a separate project. While Maatschappijleer is a mandatory course in the Netherlands, this takes place in the higher years of education. Schools have the freedom to offer courses like Digital or Media Literacy, Information Sciences, or Citizenship. The organizational context of the application will differ therefore from school to school, and depending on where it will be placed, the context and people involved will differ.

4.2.5 Social context

In every interview, teachers brought up the importance of a safe environment in class. Even when we did not ask the preconditions for discussing polarisation in class (a question everyone answered by stating the importance of a safe environment), teachers stressed this aspect. The atmosphere within a class and the cohesion among the students, and between students and teacher, differs and a safe environment has to be built over time. In some classes, it can be easy to discuss sensitive topics, while they might be too delicate for other classes. According to teachers, it can do more harm than good when a sensitive topic is addressed in such classes. It is the responsibility of teachers to evaluate the situation in their class and decide what (not) to do. On the other hand, the application is used in this context and should support a safe environment.

4.3 Requirements

During the interviews, teachers provided insights into the way technology plays a role in their lessons, how their students behave online, and how to address sensitive topics like polarisation. Furthermore, we learned how teachers would like to use a filter bubble application within the classroom and what role teachers would like to play. The full list of insights is added in Appendix A.4. These insights resulted in six requirements for the application.

4.3.1 The application should be part of a lesson or project.

Teachers indicated that when an application is used just a single time, its effects will not last long. As T1 said: *"One theme class is fun and you might briefly catch their attention, but it is not going to last".*

Therefore, in order to teach students something, it is important to talk about the topic multiple times, since *"you don't experience it by doing it a single time"* (T3). The repetition can have many forms and teachers do not have a single solution for this. Some teachers mention *"for the impact, it is better to do this in a project"* (T5). Which can be either an interdisciplinary project or a project within a single course, that runs over multiple weeks. Another option is to spread the use of the application over the years: *"something that you start in the first year, but returns in the second, third, and fourth year"*(T1). The choice where to embed the application highly depends on the school. Teachers agreed on the fact that the application should not be the goal, but a tool to achieve a goal: *"You won't be finished with just an app. The app is a tool to address a bigger topic. Like a calculator for Math, a tool to take further steps."*(T4).

4.3.2 Teachers should have a clear overview of what students are doing within the application.

Teachers play an important role when the application is used in class. For teachers to trust and support the application, they want information on the learning goals, the pedagogical background, the risks of using the application, and how to best use it. As T5 summarized it: *"There should be a solid manual. Not just: here is the app, have fun."*. Besides the information teachers wish to receive before using the application, teachers also want to have a clear overview of what their students are doing within the application at any given time. This can be hard to achieve because *"when students work within the app environment, it is not always easy to guide them, because they are submerged in the application"* (T1). Teachers suggested adding a teacher dashboard or multiple checkpoints within the application where students are stopped from proceeding. At these checkpoints, classical moments can be used to figure out *"what do students actually take from the app, you let them explain in their own words"* (T1). The specific role teachers have depends on the design of the application, roles that were mentioned are, for example, initiator and supervisor.

4.3.3 The application should foster a safe environment for students within the classroom.

When teachers are asked about the preconditions for discussing sensitive topics like polarisation in class, they all answer the same: *"a safe environment"*. Students should feel comfortable expressing their opinion, even if this opinion is not conventional. *"When you want them to tell how they think about something, or about experiences they have, you should create a safe environment."* (T1). Students should listen to each other with respect. The application should contribute to this safe environment.

A second factor that is important for a teacher to consider is the atmosphere in each particular class. Because *"sometimes there are separate groups* [within a class]*, and then it will be harder to discuss sensitive topics"* (T4). And it might even be necessary not to discuss a topic in certain classes as T3 indicated: *"sometimes you should not discuss a topic, because the matter is just too delicate"*. The application should therefore not harm the atmosphere that is present in class.

The third aspect to consider for a safe environment and a good discussion is the role of factual information. When topics are delicate and opinions might differ a lot, *"sometimes it can help* [...] *to add science, add statistics, add numbers, which will result in a less emotional layer in a conversation about polarisation"* (T3). Focusing on knowledge is important, and teachers mentioned specifically asking their students about the source of their statements: *"you say this now, but what do you base that on?"* (T2). An application can offer information from various sources on certain topics and thereby contribute to building knowledge and a respectful discussion.

4.3.4 Students should work together with the application.

Sharing experiences and discussing increases curiosity. All teachers agreed on the fact that the application should not be used individually. Especially because this topic is about the bubbles groups of people are in, it would not make sense to convey this topic through a single-player application. When working in groups, students can share things with each other. Talking about the differences between members of the group increases curiosity. Teachers described the importance of working with groups: *"in a group it might be even more powerful, because you can share experiences"* (T3), *"because there is an element of competition, it suddenly works"* (T1), and *"when they exchange within a group, I think this is most effective"* (T2).

This does not mean that students should work in groups only. Teachers expressed the wish to have *"a kind of variety between* [working] *by themselves and then again a classical moment. That is surprisingly fun."* (T1). The application should be designed to foster both group work and classical discussions or assignments. One teacher summarizes it as follows:

> *"I would never do it solely individually* [...] *but rather that they could compare something with each other. Like: hey, we are doing the same, but both get a different answer. I can imagine this makes them curious."* (T4)

4.3.5 The application should use meaningful examples and experiences that are relevant for students.

When you want to convey a topic or message to a student, teachers stress the necessity to make it relevant and meaningful for a student: *"It should really be close to their world"* (T1). This also determines the success of the application: *"a student or teenager first has to realize the importance of something, before they want to do something with it"* (T4). When the application fails to do this, it will not be successful for students. There are various ways to make the application relatable for students. Teachers mention that students like the Dutch tv-show Zondag met Lubach and the Netflix movie The Social Dilemma, they are both able to successfully explain topics like the filter bubble. One teacher also described using recent news events:

> *"I think it's important to make sure that a student gets the feeling: 'I am looking forward to learn more about this'. I believe you can achieve this by using meaningful, relatable contexts, by for example connecting it to news events"* (T3)

Talking to students is necessary to provide more insights into what they would like to see in the application. However, all teachers agree that the application is most motivating and effective when the connection with the lives of students is in order:

> *"I think it's really important to make it meaningful for the students. That is motivating. That you use recognizable examples from their own lives. That students feel like the things they learn in class, in the classroom, that those things can be relevant for society."* (T3)

4.3.6 The application should cater to all students, from those with low or high interest/knowledge in the topics to those with certain disabilities.

According to literature, it is hard to talk about teenagers (or students) in general terms, considering the big differences within this group. Teachers confirmed this: *"You can not talk about 'the students' and just paint a picture. That is impossible."* (T2). Differences between students exist on all levels. Some examples provided during the interviews: students receive more or less information from the news at home, they use different social media or use it in a different way, they know what the filter bubble is or haven't heard from it. Besides these topic-related differences, there are many more. This poses a challenge that is described by one of the teachers:

> *"That is often the trick. How do you make it attractive* [for students]*, while also dealing with a huge number of target groups, with all kinds of personalities, from introvert to extrovert, to autistic, ADHD, and dyslexic"* (T4)

Catering to all students is an important challenge and requirement for the application. We should even *"always be aware that there are students who don't care at all* [about this topic]*"* (T4). Talking to students will provide more insights into their differences and preferences.

5 Pre-Study 2 - Storyboards

Based on the interviews with teachers from Pre-Study 1, two storyboards were developed. Both show a potential activity that could be implemented within the application. The storyboards were evaluated with teachers, to find out how the activities could be improved. The input from those teachers resulted in a first lo-fi prototype.

5.1 Storyboard

Both storyboards were drawn by hand and digitalized. The input for these storyboards came from different sources. First, the input from the teachers provided during the interviews. Their wishes and ideas for an application about filter bubbles provided a starting point. Second, the documentation of earlier stages of this project, where several activities were developed (Berkhout, personal communication, 2019). Storyboard 2 is directly based upon one of the activities invented at an earlier stage. Third, the various conversations within the project team about filter bubbles, teenagers, polarisation, and how to address these issues. Although these were not formal conversations or interviews, the ongoing discussion served as inspiration for the storyboards. All three aspects were used, resulting in the two activities and storyboards explained in the subsections below.

5.1.1 Storyboard 1

Figure 1 shows Storyboard 1. The class is divided into groups of three students and the teacher shows the start of the activity on the smartboard (box 1). The activity is called 'Volgende video?' and the students are asked to open the application on their phones. In the application, students can see the explanation of the activity (box 2). First, they have to select a video from the four videos that are provided in the application. These videos all link to a YouTube video. Second, they have to look at the recommended videos, those will be different for each student. Third, they discuss within the group what the differences are between the recommended videos. Last, they return to the application to answer what stood out. Once the students have chosen a video for this activity, they open the video on the YouTube application on their phones. There, each student can see which videos are recommended to them by YouTube (box 3). They discuss the differences, decide what stood out, go back to the application, and answer the question presented there (box 4). Every group of students goes through this activity at their own pace. The answers provided by the different groups are presented on the smartboard (box 5). The answers will be the input of a class discussion, guided by the teacher.

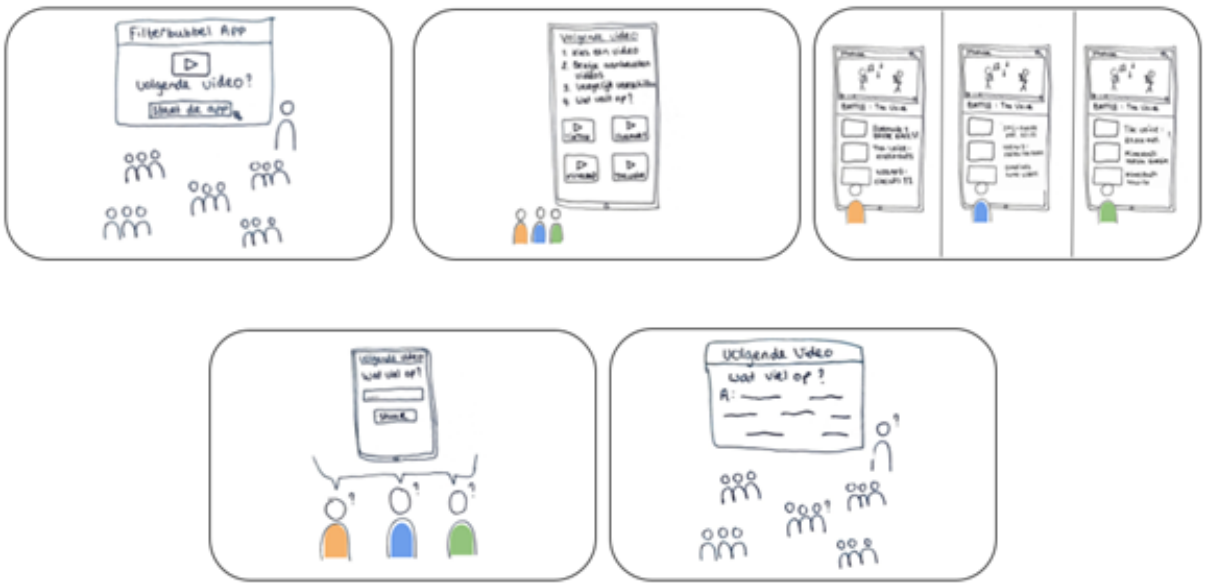


Figure 1: Storyboard 1

5.1.2 Storyboard 2

Figure 2 shows Storyboard 2. The class is divided into groups and the activity 'Algoritme Activiteit' is displayed on the smartboard. On the screen, students see a person that is watching a YouTube video (the viewer) (box 1). In this case, the video is about a red square. This is just an abstract example. During this activity, students will pretend they are the algorithm of YouTube. They have to choose which video to recommend to the viewer, in order to keep him engaged. Students open the application on their phones and are presented with two options for the next video: a video about two red squares and a video about a yellow triangle (box 2). They discuss within the small group which video would be best suitable for the viewer (box 3). After discussing, they choose the video about the yellow triangle and select that one in the application. It turns out that the viewer is not happy with this video, he would have preferred the video about the two red squares. The viewer and the video are presented on the smartboard, together with the interest-score of the viewer, which has decreased (box 4). During the entire activity, the interest-scores of the different groups are visible on the smartboard (box 5). This adds an element of competition since everyone tries to keep the viewer as interested as possible. The activity consists of multiple rounds, where the groups have to decide on the next video for the viewer to watch. At the end of the activity, there is a class discussion about the different strategies the groups used.

Figure 2: Storyboard 2

5.2 Method

Semi-structured interviews were performed to gather feedback on the created storyboards. The protocol used for these interviews (Appendix B.1) was based on the protocol from Pre-Study 1. Questions that needed more in-depth answers or clarification were kept and extra time was added to show the storyboards. Since the interviews took place online on Microsoft Teams, the storyboards were shown box by box using a PowerPoint, while the activities in the storyboard were explained. After each storyboard, teachers could comment on what they saw and follow-up questions were asked.

5.2.1 Participants

Convenience sampling was used to gather participants for this pre-study. Table 2 contains characteristics of the three participants that took part. Besides their gender and the course they teach, the years of experience as a teacher are added, and the classes on different levels they teach or have taught. Note that participant T6 works at the same school as T4 and T5 from Pre-Study 1.

Table 2: Teachers that participated in Pre-Study 2

ID	Gender	Course / Expertise	Experience	Level of education
T6	F	Maatschappijleer	3 years	mavo, havo
T7	M	Computer Science & Head of Havo 4/5	16 years	mavo, havo, vwo
T8	M	History & Computer Science	6 years	havo

5.2.2 Analysis

The same method as in Pre-Study 1 was used, where the recorded interviews were transcribed and the interesting and important aspects were highlighted and exported to Mural. The categories that resulted from Pre-Study 1 were used to group the highlighted quotes, and new categories were added for the comments on the storyboards. The quotes in those categories were especially important for the evaluation of the storyboards and the development of the first lo-fi prototype. Once all quotes were grouped in the categories, they were combined into a list of insights.

5.3 Results

Teachers commented on the storyboards, which resulted in both tips and suggestions, and things they already liked in the current storyboards. They are combined in 29 insights, which are added in Appendix B.2. Below the improvements are described for both storyboards.

5.3.1 Storyboard 1

Teachers indicated that working in groups is effective for the activity in Storyboard 1 since students can discuss their recommended videos within the group. In general, using a phone in class and watching videos is a fun thing to do for students, according to some of the teachers. Another positive aspect of the activity that they mentioned, is the various steps the activity consists of. Talking in small groups, collecting all information from the groups on the smartboard, and discussing the final results together is a logical way to go in class. T7 mentioned: *"It is good to use multiple steps* [...] *the many layers are nice."*

Teachers expressed concerns about the introduction and explanation at the start since this could make or break the activity. It should be clear what the goal of the activity is and what students need to do should be as specific and concrete as possible. This also goes for the questions at the end of the activity, when the question is vague, the answers will be vague as well. Teachers concluded that improving the clarity of the explanations and the questions would improve the learning of students. T6 explained one of the reasons why this is important: *"If* [at the start] *questions remain unanswered, you will notice this later on, because students will just start doing something, since they don't completely understand what to do."*.

Teachers mentioned to be aware of the privacy of students. Some of them might not be willing to show their YouTube account and the recommended videos to others. As T8 described: *"it depends of course, but for some kids, it is confronting* [to share their personal YouTube account]*"*. This is something to consider since within the current design it is only possible to participate using your own YouTube app.

5.3.2 Storyboard 2

In general, the teachers were more enthusiastic and positive regarding this activity. They for example deemed the shock or surprise effect more clear compared with the first storyboard. The activity was found to be more interactive, which teachers expected to be more engaging for the students. They expected that when the activity was used in class, this would be a good start of a discussion. When asked about the lack of technical details in the activity, T7 commented:

> *"It's about them being aware of it* [how algorithms work] *and thus becoming more resilient. And how the technology exactly works does not really matter. That might distract from the rest of the message."* (T7)

This comment is in line with the intended goal of the activity and supports the lack of technical details in the activity.

Besides these positive comments, teachers also expressed some concerns. For example, one of them wondered whether students would find it difficult to place themselves in the shoes of someone else. It was suggested to add a profile picture, to make it easier for them to empathize with the character in the activity.

When asked about the preference for doing this activity within a group or individually, the opinions of teachers varied. Two of them preferred to do the activity in groups, and one of them preferred to do it individually. T6 said: *"But groups are better, because then they can discuss things with each other."*.

5.3.3 General remarks

Besides the comments on Storyboards 1 and 2, teachers commented on how the application would be used in class. Something that was mentioned across all interviews was the importance of a manual or guidelines for teachers. This document should provide teachers with background knowledge on algorithms, how to work with the application, and guidelines for the class discussion after the activity. This document should be flexible, since some teachers have a lot of knowledge on the topic, while it is new for others. As T8 said:

> *"Some teachers will only want the app, but others would also like to have a bit more information about it, because they themselves are not quite into the topic."* (T8)

The value and importance of the class discussion after the activity was also underlined by all teachers. This has also practical implications, as T7 points out:

> *"So, for example, if a lesson lasts 50 minutes, make sure you spend no more than 20 minutes on that app. To ensure you have sufficient time before and after to discuss and reflect."*. (T7)

5.4 Summary

The comments of the teachers serve as input for the development of the lo-fi prototypes. To summarize, it is important to improve the clarity of the two activities, so the goal of the explanations and the questions are clear for students. For the first storyboard, the activity might need to be changed to be playable for students without a YouTube account or students who do not want to share their personal YouTube recommendations. For the second prototype, it might be beneficial to make the character more relatable for students. Other remarks regarding the general use of the application in class do not have direct implications for the lo-fi prototype (e.g. the development of a teacher manual).

6 Design

This section describes the design process of the activities in the application and the design choices made. Following an iterative design process, several prototypes were created. During this process, which lasted approximately two months, we (Tim van de Wiel and myself) talked to both teachers and students, and gradually changed the design based on their input. This section is structured based on the four elements

that have been designed: the first activity, the second activity, the third activity, and the overall idea for the application. Within each section, the changes will be mentioned in chronological order. Before I present the design choices per element, I will discuss the general methodology and the participants that took part in the entire process.

6.1 Method

During the entire design process, we talked with teachers and students. The interviews with the teachers took place online using Microsoft Teams and were both individually and in groups of two or three. During these interviews, we showed one or more prototypes to the teacher(s), walked through them, and asked questions afterwards. In Table 3 you can see which prototypes were shown during which interviews, and which participants took part. The interviews slightly differed in set-up, I1 and I4 lasted approximately 50 minutes, and were exclusively for showing the prototypes. I2 and I3 were interviewed together with pedagogy students, meaning that only half of the time (approximately 20 minutes) was available for showing a prototype.

Table 3: Interviews with teachers during the design process

ID	Participants	Prototype 1	Prototype 2	Prototype 3	Overall idea
I1	D9 + D10	1	2A		
I2	D11		2A		
I3	D12 + D13				V1
I4	D13 + D14 + D15		2D	3	V2

The goal of the interviews was to get input from the teachers, in order to improve the design of the activities and validate the design choices made. After we showed the prototypes to the teachers, we asked general questions about the design, whether students would like the activity, and how they would use the application in their classes, among others. The interview protocols can be found in Appendix C.

Besides interviewing teachers, we showed the prototypes to students during various focus groups. The focus groups were held both online using Microsoft Teams and at the schools, and varied in size from two to five students. They lasted on average 45 minutes, and we showed various versions of the prototypes to the students, at different stages in the design process. Depending on the versions, we walked through the prototypes together with the students, or they were able to play the activities themselves. Table 4 shows an overview of the focus groups and the version of the prototypes participants interacted with.

Table 4: Focus groups with students during the design process

ID	Participants	Prototype 1	Prototype 2	Prototype 3	How
PL1	PL1 + PL2 + PL3 + PL4	1	2A		Alone
F1	S1+ S2 + S3		2A		Together
F2	S4 + S5 + S6 + S7		2C		Together
F3	S8 + S9 + S10 + S11 + S12		2D		Together
F4	S1+ S2 + S3		*brainstorm*		
F5	S13 + S14 + S15		2D		Together
F6	S16 + S17 + S18			3	Alone
F7	S19 + S20			3	Alone

After interacting with the prototypes (either together or alone), we asked questions to find out how students felt about the prototypes: both specific questions about the elements of the activity, and general questions about the interaction with the prototypes. Questions were for example about whether they would like to do this activity in class, whether they like working in groups, whether the level of difficulty was in order, and whether the app was fun. The answers provided by the students were used to improve the prototype for the next focus group. The protocols for the focus groups can be found in Appendix C.2.

6.1.1 Participants

Convenience sampling was used to select teachers for the interviews. Besides T9 and T10, who were recruited via a pedagogy student within the project, every teacher worked at a school enrolled in the anti-filter bubble project. All teachers had experience with teaching vmbo students. Table 5 contains the teachers who participated, accompanied by information on their gender, the course they teach, and the experience they have in education.

Table 5: Teachers who participated in the design process

ID	Gender	Course / Expertise	Experience
T9	F	Economics & Mentor & Dean	13 years
T10	M	Geography	12 years
T11	F	Maatschappijleer & Maatschappijkunde	3 years
T12	F	Mens & Maatschappij	7 years
T13	F	Various Maatschappij courses	14 years
T14	M	Various Maatschappij courses & History	21 years
T15	F	History (intern)	1 year

To select the students for the focus groups, convenience sampling was used as well. Half of the students were from schools in Utrecht that participate in the anti-filter bubble project, the other half was from various schools in Amsterdam, recruited via a pedagogy student within the project. The age of the participants ranged from 12 till 14 years old and they all received education on the vmbo level. In total 20 students (M=8, F=12) took part in the focus groups, and 4 students took part in a pilot. The full list of participants can be found in Appendix C.3.

6.1.2 Analysis

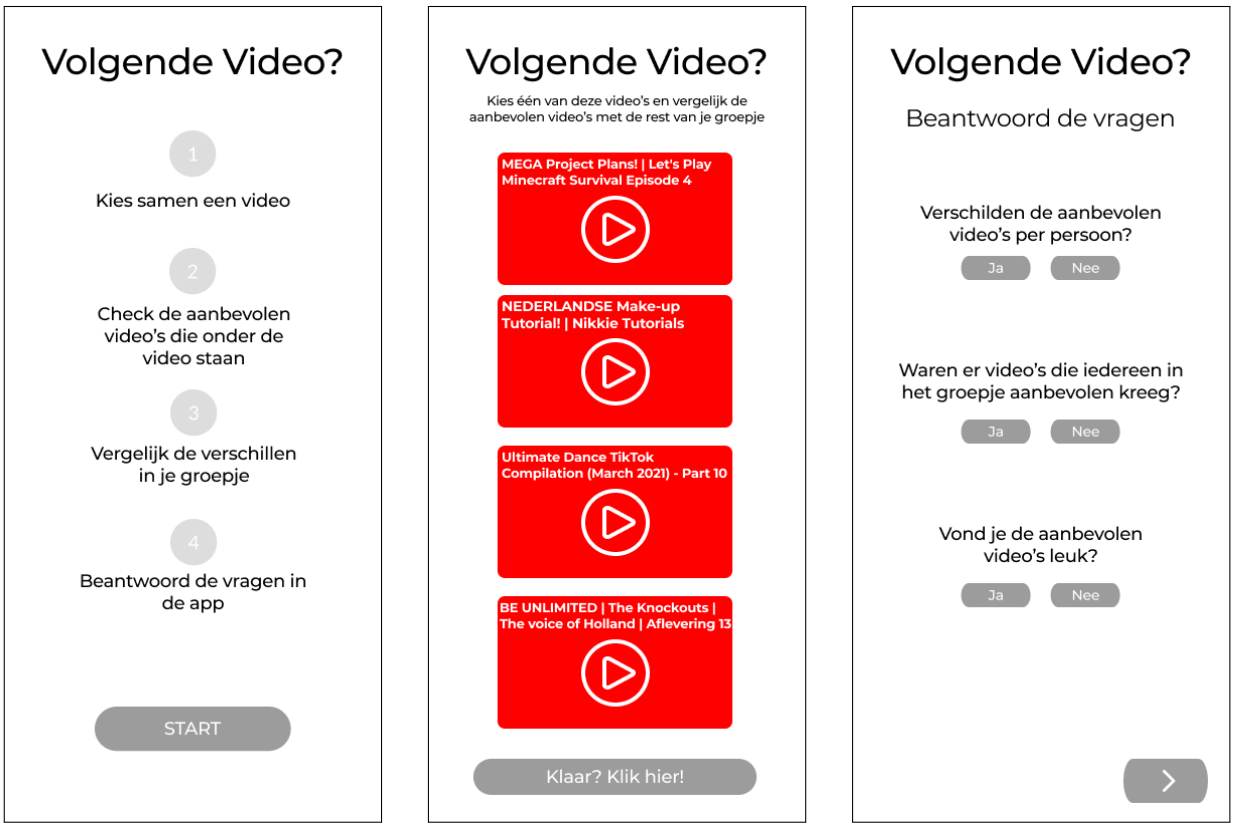
The interviews with teachers were analysed in the same manner as the interviews in pre-study 1 and 2. First, they were transcribed, after which both Tim van de Wiel and myself marked the interesting aspects in the text. We discussed differences and similarities in de markings and added the quotes in Mural. Here, we categorized the quotes to get a good overview of the various topics teachers gave their opinion about.

The focus groups with students were transcribed as well and imported into Nvivo. They were coded using open coding, which resulted in the following ten codes for Prototype 2: argumentation algorithm, collaboration, competition, difficulty, clarity, knowledge algorithms, positive remarks, negative remarks, duration, and other. For Prototype 3 the following ten codes were present: chat, difficulty, clarity, interaction, choice/influence, duration, negative remarks, positive remarks, topic, and other remarks. Using these codes made it easy to find the remarks students made about the different parts of the prototypes, and see commonalities across focus groups.

6.2 Activity 1

The first prototype evolved from the first storyboard, of which the activity is explained in Section 5.3.1. In Figure 3 you can see the explanation of the activity on the left screen, and the choice between four videos on the middle screen. When you click on a video, the prototype directs you to the corresponding YouTube video, using the YouTube app on your phone or the website. When on YouTube, students can look at the recommended videos and discuss differences and similarities. After this, they return to the prototype, in which some questions are asked about the recommendations they just saw (Figure 3c). This prototype was designed to be used on a mobile phone since students are most likely to use their YouTube app (which is preferred for this activity) with an account.

Since this is a lo-fi prototype, no final choices were made on the design. For example, a standardized font was used and the colour grey. However, the colour red was used for the video thumbnails, since this is the colour of YouTube (Figure 3b).



(a) Explanation of the activity (b) Different videos to choose from (c) Questions after the activity

Figure 3: Lo-fi prototype of Activity 1

6.2.1 Evaluation with teachers

Prototype 1 was shown to teachers T9 and T10 during an interview (I1). They liked the activity and found it positive that there were multiple videos to choose from, in that way *"there is something for everyone, so that's nice"* (T9). They found the questions after the activity good, because they were not too difficult, which would demotivate students to answer. There was some discussion about how the open questions should be answered. Both teachers stressed the need for anonymity, so students feel safe to answer the questions, and do not have to worry about feeling ashamed or embarrassed. D10 suggested *"to set up some forbidden words, for example, the following words may not be used in the open question"*, in order to force students into writing longer answers and prevent nonsense answers. The general reaction to this activity was positive, but the teachers reacted way more enthusiastically to Prototype 2. Compared to Prototype 2, Prototype 1 does not contain a game element, and the added value of the app itself is less clear.

This prototype was also shown to the students and the pedagogues in the project team. They liked the activity and were interested in how much the recommended videos would differ between students. However, the activity could also be performed without the application, by letting students watch the same video on YouTube and discussing the results. This makes that this activity would be less suitable to be added in the application, compared to e.g. Prototype 2.

6.2.2 Evaluation with students

During a pilot focus group (PL1), four students interacted with Prototype 1. They used their mobile phones and worked in groups of two. It was not quite clear to them what they needed to do when they opened a YouTube video. Although the instructions were added to the prototype, they asked the researcher what they

had to do. Once I explained that they had to compare the recommended videos, it remained quite silent, no conversation started. I had to directly ask the students about the differences they noticed. They indicated that there were not that many differences between the videos. The questions at the end of the activity were clear to the students, most of them found the questions easy. They did not have a problem with their answers being displayed on the smartboard, for the entire class to see. This might have been because they really don't care, or because they could not see the implications of publicly showing their answers.

6.2.3 Conclusion

Although both teachers and students did not have anything against this activity, they were not very enthusiastic either. The added value of performing this activity in the app was not that clear and the activity did not help students to talk about the differences in recommended videos. The responses to Prototype 2 were significantly more positive, therefore we decided to stop developing Activity 1. A variation of this activity might still be used in the project since it is still valuable to find out what YouTube recommends to its users. However, Prototype 2 has more potential, because the experience includes game elements and teachers expect students to be more engaged.

6.3 Activity 2

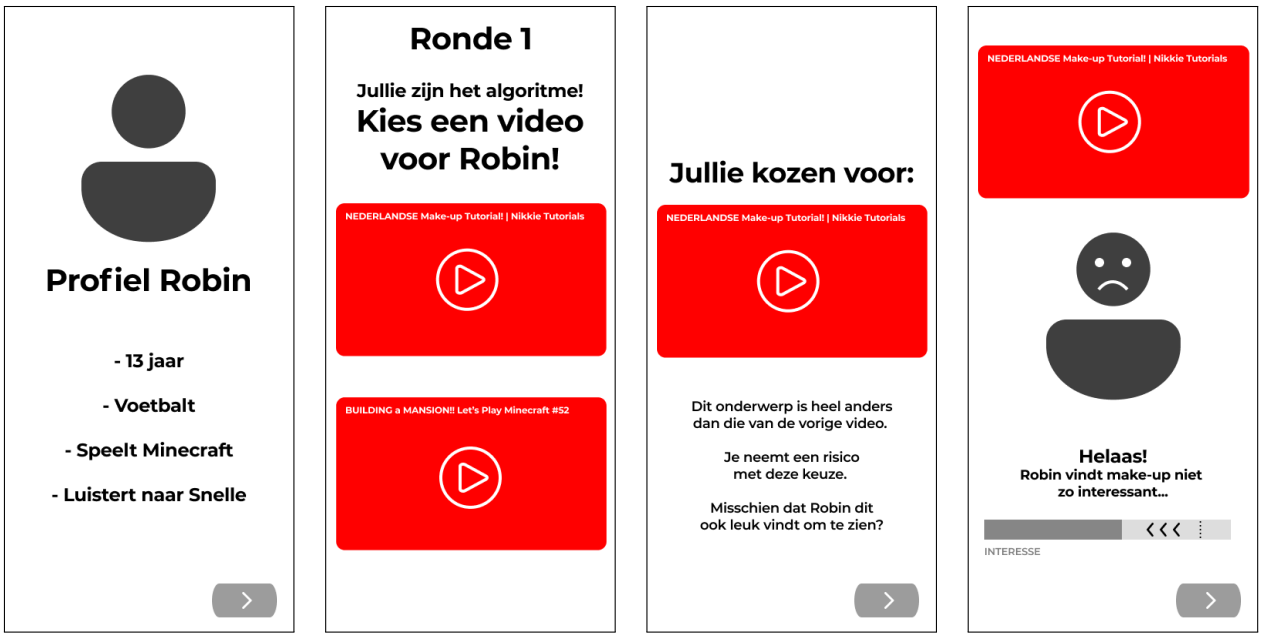
The second activity and prototype is the one that went through the most iterations. Based on the storyboard and the feedback from the teachers, we developed a first version of the prototype (Prototype 2.A). In the end, we developed five versions of this activity with the input of both students and teachers. The final version (Prototype 2.E) was used in the final evaluation. In this section, I present each version of the prototype, accompanied by the opinion of both students and teachers. In that way, I am able to show the design process and the versions that led to the final prototype.

6.3.1 Prototype 2.A

This prototype was created in Figma, and designed for mobile use. Students first see a profile of Robin, a person that watches videos on YouTube (Figure 4a), and the first video Robin watches. Students have the task to recommend videos to Robin, with the goal to keep him as interested as possible. They get to choose between 2 videos, of which the titles are shown (Figure 4b). After choosing a video, there is some feedback on the choice (Figure 4c), for example whether the chosen video is similar to the previous video. This is followed by the interest score of Robin, which goes up or down depending on whether he liked the video or not (Figure 4d). The activity consists of only two rounds in this version, to test whether the activity makes sense. When the activity would be done in groups, there could be a list of scores on the smartboard, as displayed in Figure 5. In this way, there is a competition between the groups, to keep Robin as interested as possible.
During one interview (I1) and two focus groups (PL1, F1), teachers and students commented on this prototype. I will discuss their feedback regarding various topics.

Enjoyment & Interactivity Both students and teachers liked this activity. S2 for example commented: *"I really like that it is interactive* [...] *that you can do something yourself."*. During the focus group students recommended videos to watch, they understood the activity and were happy when the interest of Robin went up. This was mentioned by T10 as well: *"You have a kind of competition element.* [...] *you become a bit eager to make sure that the other person keeps watching as long as possible"*. The teachers brought up that students are most excited when they can actively participate in an activity, which is the case for this prototype. Furthermore, they preferred activities that were close to the perception and world of the students, which was the case for this activity.

Difficulty All students agreed on the fact that the activity was too easy. They had no trouble choosing the next video to recommend and there was often no discussion about it because the choice was so obvious. Teachers shared this opinion, T9 commented: *"vmbo-t can use a bit more of a challenge, because at a certain point they will get the trick"*. While they wanted the activity and interaction to be more challenging, teachers did mention that the general level was in order for vmbo students, the text was for example not too difficult.



(a) Profile of Robins interests

(b) Two videos to choose from

(c) Feedback on the chosen video

(d) Interest score based on the chosen video

Figure 4: Prototype 2.A

Students also expressed that the activity was understandable and they knew what to do. However, to make the activity more difficult and challenging, students suggested having more than two videos to choose from, for example four videos. Another suggestion was to expand the profile of Robin, for example by adding more interests or by *"giving that boy a little more personality too"* (S1). In this way, it would be harder to suggest the next video, since you have to make a tradeoff between his different interests. The teachers suggested playing the activity multiple times, where the second time the videos would contain more sensitive or extreme topics, in order to address that you can end up in a trap on YouTube.

Duration Students indicated that if the activity stayed this easy, they would only want to play it for 5 minutes. They would like to play it for more rounds, most of them suggest four rounds, although one student suggested making it eight rounds. When the activity would become more challenging, students would like to play it for a longer time. The teachers did not really comment on the duration of the activity, but they did suggest playing it multiple times, with different content in the videos.

Collaboration & Competition Students of PL1 interacted with the prototype independently on their phones during the focus group. They indicated that they would prefer to work together in a group because this would create more of a competition within the class. The element of competition was compared with Kahoot, something that is regularly used in class. Students from F1 also mentioned that they would like to see how other classmates are doing, during the activity. They also mentioned that working in teams would be more fun and added that this would help to prevent students from guessing: *"if you are in a team, you have to discuss it together, and I think if you work individually and you don't feel like it, you will be more likely to just guess something"* (S2). While students indicated they would prefer to work in a group, teachers T9 and T10 prefered doing this activity individually. They thought this would make it more fun, and saw some disadvantages of working in groups. T10 explained: *"within a group, there are usually one or two dominating* [students]*, and they just make that choice. You just miss the opinions of two or three in the group."*.

Other remarks According to the students of the pilot (PL1), the content of the videos in the activities was a bit too similar, they would like to see more diverse videos, not only videos about games. Another important

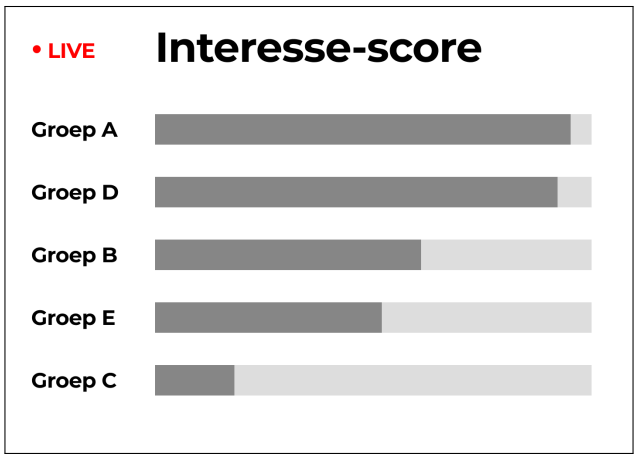
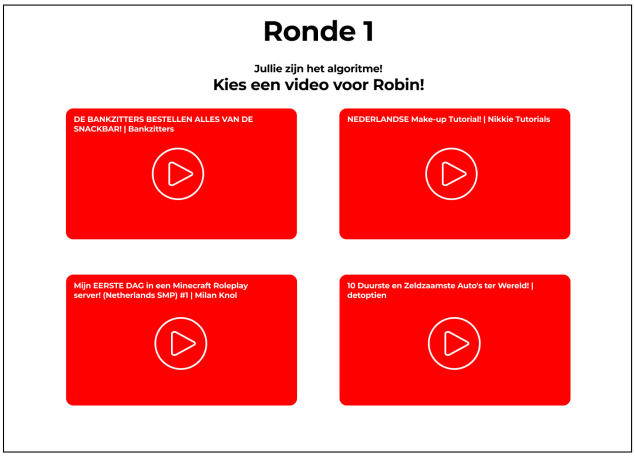


Figure 5: Prototype 2.A, competition displayed on the smartboard

comment they made was to include thumbnails of the videos, not only the title. This would appeal more to them and make the activity more fun. Another remark came from the teachers who commented on the importance of a safe environment in the class before sensitive topics can be discussed. This remark is in line with what teachers indicated in the pre-studies.

6.3.2 Prototype 2.B

The comments students and teachers gave on Prototype 2.A served as input for Prototype 2.B. The limited version 2.A was updated to become more challenging and more extensive, which is a result of the comments made by the students. The changes are described below.



(a) Four videos to choose from

(b) Interest score based on the chosen video

Figure 6: Two screens of prototype 2.B

Mobile to desktop To start, the prototype was changed from mobile to laptop. Playing the activity on a laptop makes it possible to work together on a device when students have to work in a group. Working with multiple students on a single phone would not have been possible. Second, there is more room on the screen to add videos to choose from, something that was suggested by the students.

Increasing difficulty To make the activity more difficult, students could now choose between four videos instead of two (Figure 6a). The number of rounds was extended from two to four, which also enabled us to make the storyline more extensive and challenging. Robin is in this version subscribed to Milan Knol, Supergaande and Touzani, this information is added to his profile. In every round, there is a video with Milan Knol in it. However, these are not all game videos, so students do have to figure out that Robin likes Milan Knol in general and not just his Minecraft videos. Since the other videos include game videos as well, students have to take into account the channels Robin is subscribed to.

More general interest score Since this prototype includes four rounds of four videos each, it was no longer manageable to make a total interest-score that is dependent on the previous answers. There would be too many options, and Figma does not offer an easy way to handle this. Therefore we decided to make the interest-score more general. While there was an interest-bar in the previous version, currently the avatar of Robin is shown with a happy or sad face, combined with arrows and the text 'interest up' or 'interest down' (Figure 6b). This choice is made for prototyping purposes, we still would like the final version to have an actual score in the end, and not just interest going up or down as displayed here.

Improved feedback text To improve the playability and scalability of the prototype, the feedback texts provided after a choice were changed to be stand-alone. In this way, it does not matter which choice was made in the previous rounds, the feedback text does not refer to that. The texts were also enriched with more information, to start the actions Robin performs were added. Examples of actions are: subscribing to a channel, liking or disliking a video, leaving a comment, and sharing the video with friends. Second, it was added how long and in which way Robin watches the video, for example clicking away within seconds, or watching the video till the end.

This version of the prototype served as a step in the design process between Prototype 2.A and 2.C and was not evaluated by students or teachers. It was discussed with the team of pedagogues, after which some more changes were made before it was shown to students again.

6.3.3 Prototype 2.C

The prototype was adapted, with the main difference being the addition of thumbnails for the videos. Furthermore, some changes were made in the feedback texts and the algorithm table was added as a new element. These changes are described below.

Adding thumbnails The biggest change in this prototype is the addition of thumbnails for the videos (Figure7a). The students of the pilot focus group already provided this suggestion, and the pedagogues stressed the importance of thumbnails to make the prototype appeal to teenagers and get valuable feedback. It was always the intention to add thumbnails in this activity, but they were left out to study the interaction and playability of the activity. The danger of adding thumbnails is that students could get distracted by the content of the videos, and will like or dislike the activity depending on whether they like or dislike the content. However, if students find the design too boring or ugly, they are also not able to comment on the interaction. Therefore, we opted to use thumbnails, with the remark that the content of the activity can be changed.

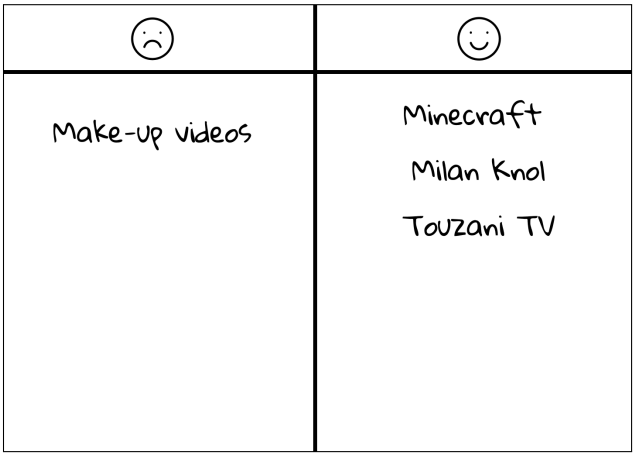
Objective feedback texts After giving it some more thought, we figured that the feedback texts contained information that actual algorithms do not have. For example the opinion of Robin in statements like 'Robin likes games and enjoyed watching the video.'. An algorithm would not know specifically whether or not Robin enjoyed the video, only whether he gave the video a like and whether he watched the video till the end. Therefore, all information that an algorithm could not know was removed from the feedback texts (see for example Figure 7b).

Algorithm table To support the students in remembering Robin's interests, we added a new element to the activity: the algorithm table (Figure 7c). Students can write down the things Robin did and did not like in any way they like, for example the titles of the videos, the channels, or the topics of the videos. After

each round students are asked to add the knowledge they gained as an algorithm in the table. Because of the limitations of Figma the table is currently on paper, but it is intended to be included in the application.

(a) Four videos to choose from, with thumbnails

(b) Interest score based on the chosen video



(c) Algorithm table, currently on paper

Figure 7: Prototype 2.C

This prototype was evaluated during a focus group (F2) with four students. The prototype was shown on the smartboard, and we asked the students which video they would recommend next and why. In between rounds we asked questions about different aspects of the activity.

Enjoyment & Interactivity When students saw the videos they immediately recognized most of them, and reacted enthusiastically to the thumbnails. They liked the activity and would prefer this over a teacher who is explaining things about algorithms, because *"you do it yourself"* (S4) and *"you can hear everyone else's opinion"* (S5).

Difficulty The students did not find the activity difficult. When asked if they would prefer the activity to be more difficult, S6 answered: *"Yes, I think that will be more fun, a challenge."*. The others agreed and S6 even had an explanation why it was too easy:

> *"The first video, in the first round, you had Minecraft and Milan Knol together. If you would not have done that, it would be a bit more difficult.* [...] *Look, if the start is easy, then the rest is super obvious and easy."*

There were various suggestions to increase the difficulty, S5 for example suggested to include four videos with topics that were not part of Robin's profile. That forces you to think about which video will best suit Robin. S6 stressed that the first video should not be too obvious, as can be read in the quote above. The students were positive about the four videos and the four rounds of the activity.

Collaboration & Competition All four students would prefer to do this activity in groups and not individually, because *"in groups is more fun than by yourself"* (S4). They liked the idea that there is a competition between the groups in class, as S6 said: *"Winning is always fun."*. They even expect competition to make the activity more fun *"because then you will try harder. Then you really play against other people."* (S7).

Algorithm table During the focus group the algorithm table was drawn on the board and filled in after each round. The principle of the table worked, students added the channels of the videos Robin watched, but also categories and topics like 'humor' and 'games'. The students understood the purpose of the table and it helped them to remember everything they had learned as an algorithm. They mentioned that they felt like they learned more about algorithms and how they work after the activity.

6.3.4 Prototype 2.D

Based on the feedback on Prototype 2.C, the prototype was adapted, with the main goal to make it more challenging. The storyline was made more difficult, the profile of Robin was changed and icons were added for feedback.

More difficult storyline Students still found the storyline too easy, since every video with Milan Knol in it was the correct one. Therefore different videos were added in this prototype, to increase the challenge. For example, as suggested by the students, some rounds do not contain videos from the channels Robin is subscribed to. In Appendix D.1 ther is an overview of the different videos per prototype. I will describe the updated storyline, but note that other topics, content or storylines can be used in this activity as well in the future. The current storyline starts with the first round, where a video of Milan Knol playing Minecraft is the correct one, since this is one of the channels Robin is subscribed to. In round 2 all videos are about games (Fortnite, Fifa, Among Us and GTA), but one of them is from Touzani TV, again a channel Robin is subscribed to. In the third round the videos are diverse and no video is part of Robins subscribed channels. The video about football from DylanHaegens is the correct one, since this topic is related to the content of Touzani's videos. In the last round, there are two random videos and two videos of StukTV, starring Touzani and Milan Knol. Since Robin is subscribed to them, those are the videos he prefers, even though they are from a different channel.

In addition to this update storyline, the first video Robin watches, before the rounds start, is removed in this prototype. Students indicated that this also made the activity too easy.

Less information in the profile The profile of Robin is updated, and does now contain less information, only his age and the subscribed channels. This ensures that students have to make decisions by themselves about what Robin likes and is intended to make the activity more difficult.

YouTube actions added The actions Robin performs on YouTube were already added in text, but it was suggested by the experts from MiraMedia to make them more visible, by using visual elements as well. Therefore we added icons for liking, disliking, commenting, and sharing, next to the video. The actions performed by Robin are visible, while the others stay grayed out.

Feedback from students and teachers

This prototype was played by students during two focus groups (F3 and F4) and shown to three teachers during an interview (I4). They commented on various topics, which I will discuss below.

Enjoyment & Interactivity Students liked to do this activity, again they knew most of the videos and they understood the concept of the activity immediately. One student expressed why she liked the activity: *"because you have to pay attention and think about it. Now you can not just be on your phone, because then you don't know all this."* (S15). They could provide clear arguments for the choices they made, which shows that they understood the 'story' that is behind the videos, for example: *"I think we will go for Touzani, because he already watched his video about football, and then he watched another video about football, and again he liked that"* (S13).

Teachers liked the concept of the activity and saw the value of this activity in explaining algorithms to students. They figured that this activity would help to make students aware of the fact that they can end up in a bubble if they keep watching more of the same videos. One teacher said:

> *"There are students who are not on Instagram or TikTok at all, so this will also help students who are not aware what this is* [algorithms]*, or students who are on those platforms, but are not aware of it. Then it becomes really clear: this is what happens."* (T13)

Difficulty Again, the activity was found to be too easy by the students. They suggested removing the subscribed channels from the profile of Robin, and just state some things he likes: *"You don't have to know which channels he is subscribed to. You really don't want to know that, because then it becomes a bit more challenging"* (S11). This is contrary to the comments made by the previous focus group, where they wanted to remove the things Robin liked and keep the subscribed channels. It can be concluded that students want to have less information, but what information exactly can be discussed.

While we try to make the activity more challenging with each iteration, students still have the video correct most of the time. Teacher T13 explained that this does not have to be a problem: *" I think it makes sense that they have it correct. It is quite easy, rather simplistic, this is what you* [as Robin] *do and do not like."* Having the videos correct does not make the activity less valuable.

Collaboration & Competition When asked how they would feel about a competition between groups in class, students generally were positive. Someone said *"I think it is more fun when you play against each other"* (S14) and someone else expressed that he would do better when he saw that his group had a bad score. However, some students did not like it when this activity became a competition, because then you would primarily be focused on winning the game, not on the activity itself.

Teachers did see the benefits of working in groups, because there is more discussion about the topics and the choices you make when working together. Even so, the risk of working in groups was expressed again: *"if there is one person in charge of the laptop, what will the others do?"* (T14).

6.3.5 Prototype 2.E

Small changes were made in the final prototype, mainly in the content, to make it possible for students who gave feedback in the design process to participate in the final evaluation as well. The storyline was kept the same, but we changed most of the thumbnails to videos who were similar. In this way, the activity would be 'new' to the students, since they did not know which videos were the correct ones. The videos used in this prototype, and the ones before it, are stated in Appendix D.1.

6.4 Activity 3

In the middle of the design process, at a time when we had already decided to drop Activity 1, and were primarily focussing on Activity 2, we came up with an idea for another activity. During a brainstorm about

how we could discuss filter bubbles with students, this activity was born. We were inspired by one of the activities that the pedagogues used during their focus groups with students. In this section I will describe the brainstorm process that led to the idea, explain the prototype, and discuss the opinions of students and teachers.

6.4.1 Brainstorm process

The anti-filter bubble project is going to consist of seven lessons, each with a different theme related to the topic of filter bubbles: filter bubbles itself (2x), algorithms, taking perspectives, opinions online, digital citizenship and ethics, and future of the internet. We wanted to come up with another activity that could be used in one of the lessons, besides Activity 2. With this goal in mind we started a brainstorm. The insights we gained during the interviews with teachers, conversations with pedagogues and first focus groups with students served as valuable input. This was complemented with the outline of the seven lessons, created by the project team.

During the brainstorm we tried to come up with activities, with the following questions in mind:

1. How can we design an activity that engages students?
2. How can we design an activity that has educational value?
3. How can we design an activity that teachers trust?
4. How can we ensure the activity is not a single-use gimmick?

We used Mural for this brainstorm and started with writing down everything that came to our minds. There was a limited time of 20 minutes and we could not see the post-it notes of the other until time was up. After this first round we discussed the idea's and used dot voting to select the best ideas, the ones we saw potential in. After discussion, this resulted in six ideas that went through to the next round. In this second round we applied the same method and tried to come up with as many ideas for the activity as possible, within a time-limit of 8 minutes. We presented the ideas to each other and added post-its if new ideas arose during this conversation. This process was repeated for each of the six ideas.

In the end we combined 2 of the ideas into one idea for a filter bubble activity (Activity 3). In short the idea was to let students experience different storylines, using an interactive story where they can make choices. Students would experience that the opinion you have (and the bubble you are in) can depend on your behaviour online, the videos you see, and the information you come across. By letting every student play with a different character in the activity, different bubbles will develop in class, which can be the start of a discussion.

To develop a prototype for this activity, we needed a specific topic for the storylines. This should be a topic people have different opinions about. In that way, the different characters in the activity can each develop their own bubble, which is distinct from the others. We came up with various topics, for example violence in video games, being vegetarian, or gender diversity. Most topics were very general and not specific to teenagers, that's why we tried to look for a topic in the focus groups we had with students. We noticed that some of them had a strong opinion about family vloggers and the role of children in the vlogs. Because this topic can be seen from multiple perspectives and resulted from the focus groups, we opted to develop the storyline around this topic.

We came up with two characters who each develop a different (opposing) opinion about the fictional vlog family 'Baaij'. The storylines and the choices the characters come across are summarized in a flowchart for each character (Figure 8). Those storylines were implemented in the prototype. Since time was limited, we only made some quick drawings and directly started creating the prototype in Figma.

6.4.2 Prototype 3

Students can choose four characters to play with during this activity: Jayden, Younes, Kyra, and Sophie (Figure 9a). For this prototype only Jayden and Sophie are available . There is some information available for each character: the age, hobbies, family situation and job of the person, and the social media channels the person is active on. Jayden discovers the Baaij family online, reads more about them, watches a video,

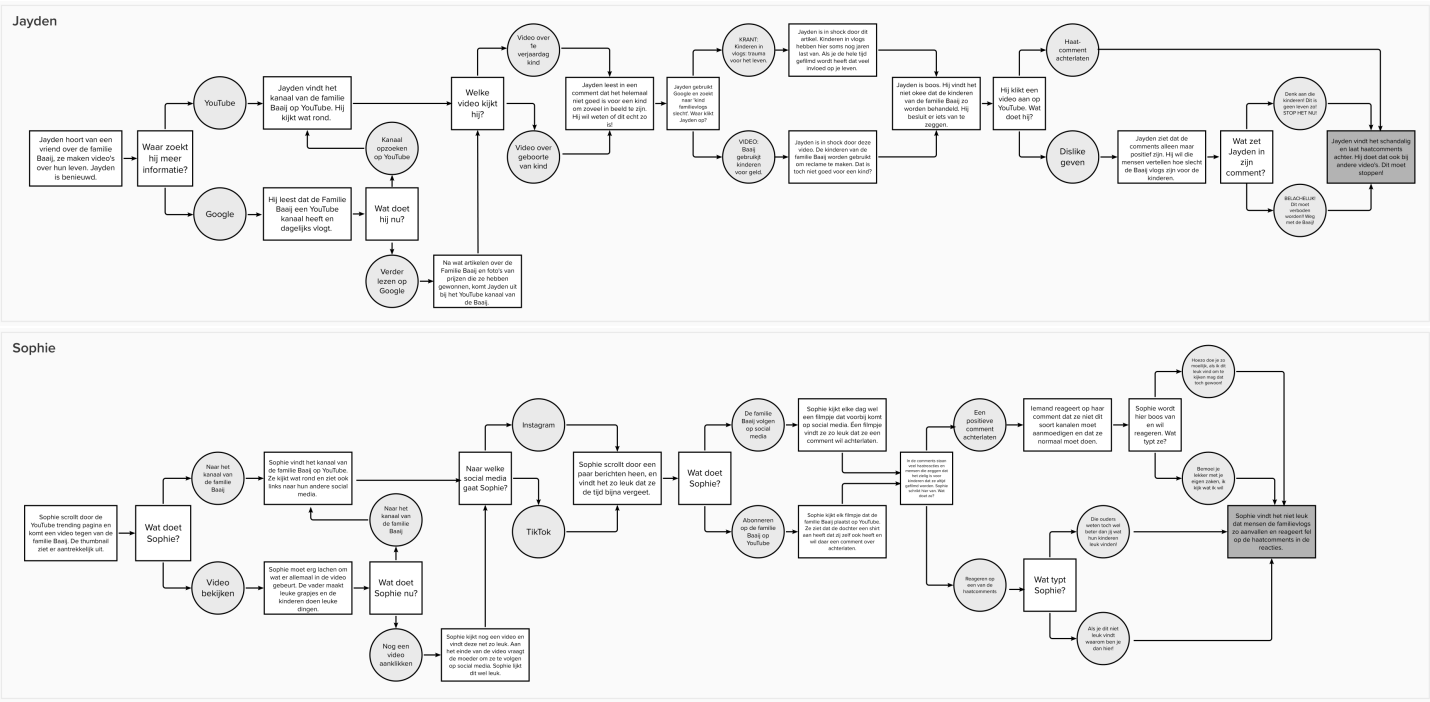


Figure 8: Flowcharts of the storylines of Jayden and Sophie. Text is represented in squares and rectangles, choices in grey circles, and the end in dark gray

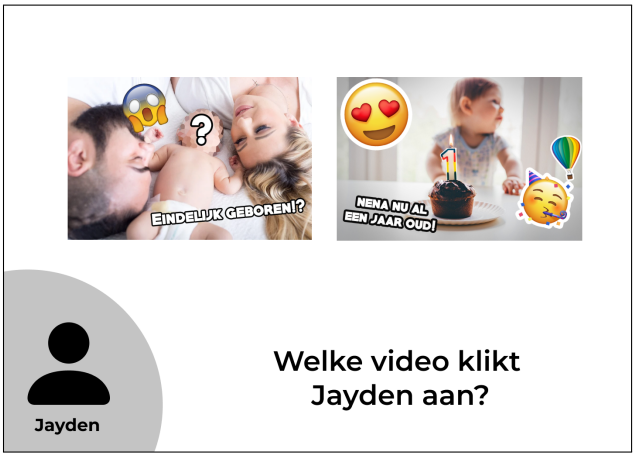
and finds out that being in front of the camera can be damaging for children. He decides to comment on the videos of the Baaij family to make others aware of their troubling behaviour. In the end Jayden gets angry and leaves hate comments on multiple videos. The story of Sophie is the opposite of Jayden. She comes across the Baaij family online, watches a video and decides to follow the family on social media. She likes them very much and becomes a fan of the videos and the family. When she reads the hate comments on the video, Sophie stands up for the family. In the end she defends the family and reacts to hate comments that people should go elsewhere if they are against these videos. The complete storylines of Jayden and Sophie, and the choices they face, are presented in Appendix E.2.

Choices At given moments in the story, students can decide what the next step of their character is going to be. For example, do they dislike the video or do they leave a hate comment? There are always two options to choose from, sometimes an image is added, sometimes it is just text (Figure 9c). Students can click on one of the two boxes to make the choice, after which the story continues with text. While students have the idea that the choice they make determines the direction of the story this is not the case. The story of a certain character will always have the same ending, there are only minor differences in the way this ending is reached. This clearly shows from the flowchart (Figure 8). The way the choices are represented is kept simple for prototyping purposes, but can be more elaborate in the final design, for example by adding animations or custom drawn pictures of the choices.

Bubble When a choice is made, students can place the choice in the bubble of the character. In this way they can keep track of everything they came across during the story. It shows what elements are inside the bubble, and thereby contribute to the opinion of the character. The bubble was implemented in two ways: digital in the prototype, with draggable elements, and physical on paper, with pictures that could be placed on a paper with the bubble. The digital bubble is reached by clicking on the avatar of the character. During the focus groups the paper version was used.

(a) Four profiles to choose from

(b) Text of the story, with Jaydens bubble



(c) Choice between two options

(d) Chat between Jayden and Sophie, after the story

Figure 9: Lo-fi prototype of Activity 3

Chat After completing the story of either Jayden or Sophie, students can chat with a classmate that has played with an opposing character. They are not able to type, just select one of the options presented in the chat (Figure 9d). During the chat session they can use the elements from their bubble to motivate their opinion. In the chat they will talk about family vlogs and how they feel about this topic. The goal of this conversation is to make students aware that someone else can have a different opinion, depending on the things they came across online. Since Figma is limited, the working of the chat is simulated. In this way the idea of the chat can be shown to teachers and students, however they can not interact with the chat themselves.

6.4.3 Feedback from students and teachers

This prototype was shown to students and teachers during two focus groups (F6 and F7) and one interview (I4). During the focus group the students played the prototype by themselves, where at least one person was playing Jayden, and one Sophie. The chat at the end was shown by the researcher and discussed with the students. Since this prototype was developed quite late in the process, there was only one version that got evaluated. I will discuss the topics they liked and did not like.

Choices & interactivity When students heard they were able to make their own choices, they got excited to play this activity. They got the activity straight away and interacted with the prototype without any

problems. Most students got the feeling that their choices determined the story, S17 for example said: *"I like that when you click on a choice, you do not get the same story. The option you choose makes for a different story."*. The same student got really excited to figure out the other characters and their endings: *"Wait, can I play again but with different choices? Because I want to see what happens. What happens to other endings? I want to know this. Is there another ending?"*. Although playing the same activity multiple times with different characters is not part of the idea at the moment, this could be something to look into. One of the teachers supported this, stating that students probably will be curious about the other characters as well.

When asked about the amount of choice and the duration of the activity, we got various answers. That teachers would not add much more choices to the current activity, but suggested to replay the activity or add a different storyline (besides family vlogs). All students would like to see more endings, more details, and more choices. For their preferred duration of the activity answers varied from 5 till 20 minutes. However, they agreed on the fact that adding choices would make the activity a bit more challenging, more fun, and also longer. By adding choices, they do not mean changing the number of choices per question, as S19 explained: *"Two choices per question is enough. Just more questions, and also more endings, that it will spread, branch out."*.

Regarding the choice element in this activity, the teachers had some additional remarks. For example, that students will understand when their choices are limited: *"If you as a developer start limiting the choices, then you will soon be steering in a certain direction. And I think they will feel that very quickly."* (T14). Additionally they mentioned that some students will click through the story rather quickly, something to keep in mind. They were curious how realistic this story and the scenarios would be for students, and how they would translate it to their own lives and online behaviour. Nevertheless, they did believe in the activity, stating things like *"this will give input for a good conversation"* (T13) and *"If you can emphasize that* [different choices will lead to different outcomes]*, they will understand it. And they will become more aware of their own click behaviour because of it."* (T14).

Story & content The topic of family vlogs received mixed reactions from the students. Some of them prefered another topic, some were okay with the topic for this activity, others liked it. One student had the idea to make a wheel with different topics that you can spin before playing, to determine what the story will be about. This would make it random, and add an element of surprise at the start of the activity. Interestingly, he did not like the topic of family vlogs, but would be okay with it if this was the result of spinning a wheel. During the focus groups we noticed that students did recognize the topic from real life and had opinions about it. This could be concluded from quotes like: *"sometimes family vlogs are not a good idea. I saw a vlog from a family, but then a man screamed to his wife* [...] *it became a big chaos on YouTube"* (S20), and *"This topic we are talking about is also present in real life. Those moms, teenmoms, they will use their children like celebrities, children of 2, 3 years old. That is a topic people actually talk about."* (S16).

Teachers liked the topic and suggested making the connection to existing families in publicity, like the 'Familie Meiland' (a famous Dutch family starring in a real-life soap), to emphasize that this topic is present in real life. They saw a lot of potential in the current activity, with many themes to talk about in class: *"You can really talk about freedom of speech, about censorship, about twitter trolls, and why people do this, what is the effect when I type something, what is the effect when I discuss things. So valuable!"* (T13). An issue that was noted by the teachers is keeping the content up-to-date. This would require some work from the development team.

Keeping track of the bubble Students worked with the bubble on paper, and most of them used it consistently throughout the activity, placing in new pictures after each choice. Two students forgot about the bubble, but placed the items after they finished the activity. When talking about Jayden and Sophies opinion regarding filter bubbles they looked at the bubble, as a reminder of the story they had just followed and the things they chose.

It was interesting to notice that the students really were involved with the character they played with.

They pretended to be the character or imagined what the character would do or say in a certain situation. Some quotes to illustrate the involvement of the students: *"I pretended to be Sophie, just a girl in puberty who watches a lot of YouTube and TikTok"* (S19), and *"Jayden would say: stop it, it is not right for the children"* (S16).

Chat After playing the activity individually, the chat was shown by the researchers. Students got excited by the chat, S16 said: *"this is not a normal quiz, it is just a conversation between two people. Yes, I just like it. Because I have never seen something like this before!"*. They saw this as an additional activity, one that seemed really fun to do. We asked them whether they would prefer the current way the chat is designed, with two fixed answers to choose from, or would like to be free to type whatever they want. This resulted in very clear, honest answers: *"that* [free text] *would make no sense, because we can just talk about some other topic"* (S16), and the rhetorical question of S19 *"What do you think this would look like if every word could be used?"*. As expected, students indicated that they will get distracted and the chat function will probably be abused if it has no limitations. Therefore, they preferred the chat in its current form, with two options to choose from. Teachers confirmed the disadvantage of free typing: *"yes, there will be weird things in it"* (T14).

6.5 Overall idea for the application

While we had designed two activities that could be played in class, there still was no idea how all seven lessons (and activities) could be connected to each other. During the brainstorm for the third activity, we came up with an idea for a structure for the application. This overall idea was developed quite late in the process, and remained in an early stage of development. However, it was shown to the project team and some teachers to get initial feedback and find out if this idea would be suitable for the anti-filter bubble application.

During the interviews with teachers, it became clear that students like to work on a big project that runs for multiple weeks. This keeps them motivated, since students like to work towards a goal, or a product they have to deliver at the end of a project. Additionally, for vmbo students it is important to know why they need to do a certain assignment, according to several teachers. Providing them with a structure and a general goal for the project will help them, because the individual activities contribute to the bigger picture. With this input from the teachers, we developed a first version of the idea.

6.5.1 Version 1

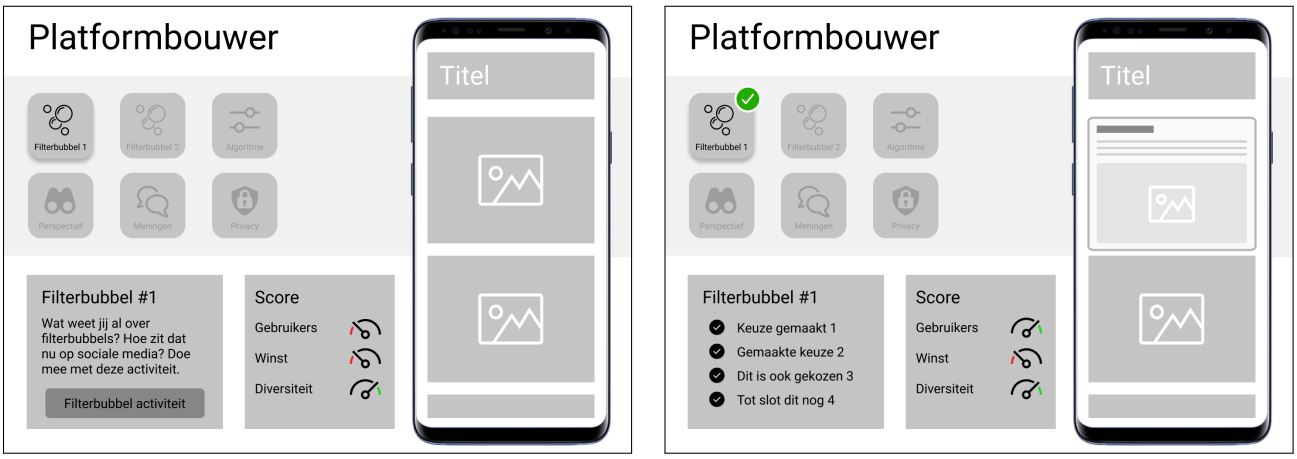
The overall idea of the application is that students can build their own social media platform over the course of seven lessons. They have to make various choices about the different aspects of their platform. To do this, and make an educated choice, students first learn about the current situation on platforms (as-is) with the help of an activity. After this, they get to make a decision about their future platform, and how they want it to be. Students start with a platform that is empty, and fill in a new part of the platform bit by bit. Each lesson has the same structure:

1. There is an introduction about the theme of this lesson, provided by the teacher.
2. Students do an activity, to get to know more about a certain topic of their platform. This can for example be Activity 2 or 3, as described above.
3. There is a class discussion about the activity and the topic the activity addresses.
4. Students make a choice for their platform. For example about the algorithm they use, or how they handle hate comments. Depending on the choice made, a new part of the platform is revealed or 'filled in'.
5. There is a discussion about the choices students made for their platform.

The choices that are made also have an effect on three meters, representing the amount of users on the platform, the profit the platform makes, and the diversity of the messages on the platform. In this way,

students get direct feedback on the choices they make for their platform. For example, when they would decide to remove all advertisements from their platform, the users would go up (happy to have an add-free platform), but the profit would go down. The consequences of the choices students make, easily seen by the stand of the meters, can be used in the class discussion (point 5). In addition, the meters add a competition element, since students can compare how their platform scores on the different meters. Both teachers and students previously indicated this to be motivating.

To illustrate this idea, a lo-fi prototype was created, which just consisted of two screens (Figure 10). Each lesson is represented by an icon, where the future lessons are grayed-out. On the first screen (Figure 10a) you can see and start the activity of the current lesson (grey box, bottom left), and see the score on the meters. The platform is represented as a phone, with no content yet, it is empty since this is the first lesson. The second screen (Figure 10b) would be visible after doing an activity and making a platform choice. A list of choices is displayed, the meters have changed depending on the choices, and a new part of the platform is now visible.



(a) Before the activity

(b) After the activity

Figure 10: Visual representation of the idea for the application

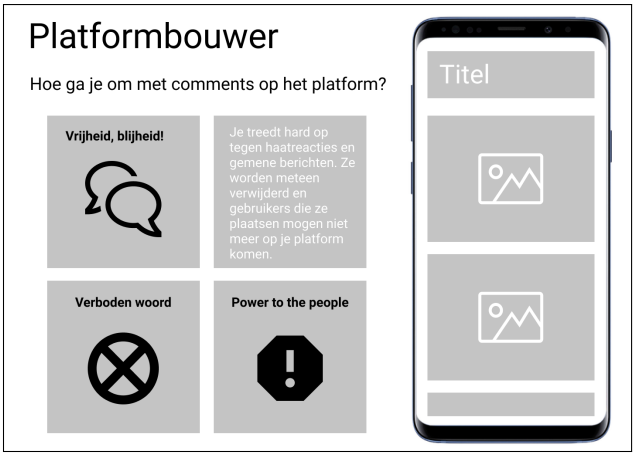
These two screens primarily served as a visual to support us in explaining the overall idea of the application. We showed it to the pedagogues in the project team, two experts from Mira Media, and two teachers (T12, T13). The initial reactions of the pedagogues was positive, since coming up with something that would tie everything together was much needed. Experts from Mira Media liked the idea as well, they emphasized that it really helps students to work towards an end goal. Teachers saw the potential of this idea: *"didactically, this is a form that suits our school* [...] *they really get to work with it themselves"* (T13). They liked it as a tool, because students get triggered to think about the choices they make. Especially the meters elicited responses from the teachers, although more details would be needed, in particular for the diversity meter:

> *"That parameter diversity, as teachers we feel that it should be very green, because that is important. But that's a part of the context you should pay attention to. Because why is it important to have diversity? That might be a bit abstract for them."* (T12)

Within the project team, the meters were also cause for discussion. According to them, using a term as 'diversity' for a meter would not work, because it is just too broad. They even questioned the use of meters in general, because it would require such a simplification of the situation. On the contrary, Mira Media liked the diversity meter a lot, because this would clearly show the impact of students' choices on diversity. After this, the consequences of less or more diversity should be discussed by the teacher. They were less fond of the other two meters, because the number of users and profit might not be that relevant or relatable for students.

6.5.2 Version 2

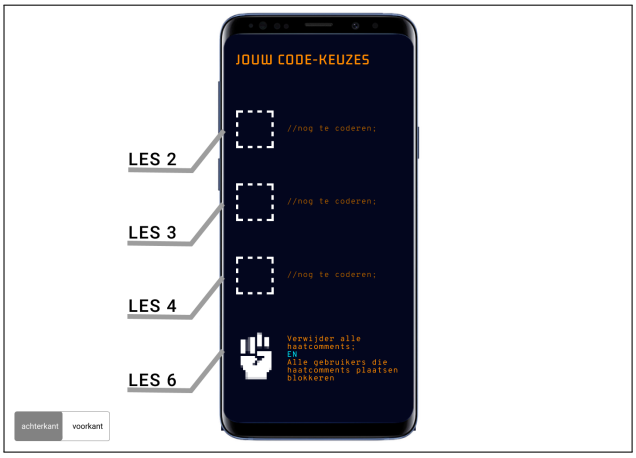
With the input we received on version 1 of the idea, we made some improvements and added screens to create a lo-fi prototype. In agreement with the project team, we decided to remove the meters for now, and focus on the platform choices. More time would be needed to figure out which meters are suitable to include and how they would correspond to the real world. The home screen was updated, to include the outline of the lesson, as described in the previous section. After the activity is done, students can make a choice for their platform. In this example, students have to decide how they will handle the comments on their platform, and they are provided with four options. When you hover over the icons, more information about the option is (Figure 21c). If one of the options is chosen, students get information on the consequences of their choice (Figure 21d). After this, they can see what their platform looks like, by clicking on the phone. The front- and back-end of the platform have both changed, showing respectively what the platform looks like (Figure 21e, and what rules are used to guide the platform (Figure 21f).



(a) Additional information when hovering over an option

(b) Consequences of the choice made

(c) Front-end of the platform, after the choice is made to block comments



(d) Back-end of the platform, after a choice is made in lesson 6

Figure 11: Lo-fi prototype of the framework of the application

This prototype was shown to the project team and to three teachers (T13, T14, T15). The pedagogues liked the improvements and were positive about the way the four choices were represented. The different ways to handle a problem (comments in the example), clearly showed, and the feedback students would get after

making a choice would serve as good input for a class discussion. The teachers were enthusiastic about the platform choices, and how they make you think: *"Of course those buttons make you think about: Who am I? Who do I want to be? What do I think about censorship?"* (T13). Again, the value of the conversation was stressed: *"The conversations about this are very valuable. Because it makes them realise: 'ok, that means I am not able to see some part of it myself'."* (T14). They expected that this tool would cause students to reflect about various topics, and that they would make the connection to their own lives.

It was advised by both the teachers and the pedagogues to make it possible for students to change their choices later in the project. If they would have gained knowledge, coming back to previous decisions should be an option, since students would not be happy if they were forced to stick with a platform that they no longer support. Another comment made by the teachers was to include an overview for the teacher: *"So I would have a central logg-in, where I can see that I created a class, and I see student A is building that platform, and has looked at these buttons."* (T14). This comment is in line with what we heard in previous interviews. Teachers prefer to have an overview of what each student is doing.

6.5.3 Conclusion

The idea for an overarching idea that ties all seven activities and lessons together was received with enthusiasm. Making students build their own platform would help to motivate them to participate in the project, and see the individual activities as part of a bigger whole. Enabling students to make choices for their own platform gives them a sense of ownership, and the choices made are good input for class discussions. Besides the positive reactions, there were various concerns, tips, and suggestions for the overall idea. For example, a decision has to be made on whether to include the meters, and if so in which form. Since this is only an initial idea, there is a lot more work to do, to fill in all details and make educated choices. This will be done by the project team, which will use this idea and the lo-fi prototype as a starting point for further development.

6.6 Summary

The iterative design process has resulted in three activities and one overall idea for the application. A total of 20 students and 7 teachers saw the prototypes and provided valuable feedback to make improvements. Additionally, the project team and the pedagogues in it provided us with feedback, as goes for the experts at MiraMedia.

In the first activity, students have to compare the videos YouTube recommends to them. This activity was discontinued, because it was not that interactive and received less enthusiasm than the others.

In the second activity, students play as the algorithm of YouTube, where they have to recommend video's to keep a user as interested as possible. This activity went through the most iterations. Students quickly understood the activity, liked recommending the videos, and got excited by the videos they saw. They offered various suggestions to improve the prototype and make it more challenging, which resulted in the final Prototype 2.E.

The third activity was designed later in the process after a brainstorm, and has only one version. In this activity, students take part in an interactive story, in which they make choices about the online behaviour of a character. Depending on the chosen character, the story will have a different ending, and the character will end up in a different bubble. In the end, students will chat with another student that played the opposing character, to find out how their opinions and their bubbles differ. Although this activity was not seen by that many students, initial reactions were positive. They liked how they could influence the story, but wanted the activity to be longer, with more choices, and multiple endings.

To tie all activities together, we came up with an overall idea for the application. Students will build their own social media platform, by making various choices that will determine how their platform will work and what it will look like. Every lesson students will play an activity to learn about various aspects of platforms, for example about the filter bubbles that can arise by using them (Activity 3), or how algorithms determine what you see (Activity 2). Implementing this idea for the application will motivate students, because they

work towards an end goal, and every activity will help them to create their platform.

In general, teachers received the activities with enthusiasm, and saw the potential of using them in class. They appreciated the interactivity of the activities and liked the element of choice. Teachers saw the activities as tools to start a discussion, and an easy way to convey the topic of filter bubbles and algorithms to students. Some aspects of the activities require more thought or research, to optimize the educational value of the application. However, the importance and urgency of the topic was shared by most teachers, which is nicely summarized by T11 :

> *"I find the filter bubble and them knowing what an algorithm is very important, that they have information about it, or at least that they are aware of it. And I really hope that eventually they can apply this in their own lives."* (T11)

7 Evaluation

Although several aspects of the different prototypes need to be evaluated, this evaluation focused on whether Activity 2 should be performed in groups or individually. Another evaluation was performed by Tim van de Wiel, who studied whether the filter bubble in Activity 3 should be included into the activity (digitally) or be present on paper (physically). I refer to his thesis for the results of this evaluation. In this section I will describe the goal of the evaluation, the method for both students and teachers, after which I describe the results of the evaluation.

During the interviews with teachers, both in the pre-studies and the design process, it became clear that they did not agree on the way Activity 2 should be used in class. Some opted for working with the application in groups of around four people, while others preferred students to work individually. The motivation for collaboration was sometimes practical: it is easier to classically discuss the outcomes of 7 groups than the outcomes of 30 individuals. At the same time, teachers mentioned the benefits of discussing answers and talking to peers. Students also did not agree on their preference for working in groups or working individually. Therefore the question arose whether collaboration would be beneficial for this activity or not.

On the one hand collaborative learning can support critical thinking and engagement (Johnson, 2008; Yu et al., 2020), and improve motivation and learning (Van Der Meij, Albers & Leemkuil, 2011). Students might enjoy the social aspect of the activity, since they are working together towards a mutual goal (Kapp, 2012). On the other hand, research on the positive effects of collaborative play (compared to solitary play) is ambiguous and yields contradictory results(Qian & Clark, 2016; Wouters, Van Nimwegen, Van Oostendorp & Van Der Spek, 2013). For example when we look at computer-supported collaborative learning (CSCL), benefits include higher levels of learning, equal participation in conversations, and more complex discussions, and disadvantages include less productivity, more time needed to come to a mutual agreement and added confusion during discussions (Mostmans, Vleugels & Bannier, 2012). In a study where collaborative and solitary play in education were compared, it was found that the students primarily benefited from the discussion they had after playing the game (Van Der Meij et al., 2011). In general it can be concluded that when compared to traditional teaching methods, "both single users and groups showed higher cognitive gains" while playing games (Wouters et al., 2013, p.251).

Since the ambiguity in literature could not provide a clear answer to the question whether collaboration is beneficial in playing this activity, this evaluation aimed to find out whether collaboration would improve the game experience and knowledge of students who play Activity 2. The following research questions were investigated:

1. Does collaboration improve the game experience of Activity 2?
2. Does collaboration improve the understanding and knowledge of algorithms?

In the first instance, the evaluation was planned with students only. However, the number of participants remained quite low due to unforeseen circumstances and the COVID-19 crisis. That is why I interviewed

two teachers to give additional input for the evaluation. Below, the methods of both parts of this study are described in two separate sections.

7.1 Method: Students

This evaluation had a between-subjects design, where multiple groups of students took part part across different secondary schools. In the first condition students played the activity collaboratively, with a group of three or four participants, this number of students was mentioned by teachers during the design process. In the second condition, students played the activity individually.

In order to test whether participants' understanding and knowledge of algorithms was different for each condition, I composed four questions about the algorithm of YouTube. In the remainder of this research I will refer to this short questionnaire as the 'Algorithm Knowledge Questionnaire'. Since the activity is about YouTube, I opted to make the questions specific for this platform, and not about algorithms in general. The first question (Q1) aimed to find out to what degree participants think they know what an algorithm is. In the second question (Q2) participants had to explain in their own words what the algorithm of YouTube does. The third question (Q3) asked in a more indirect way to explain what algorithms do, students had to explain why YouTube recommends different videos to different people. The final question (Q4) was about the degree in which watched videos, likes/dislikes, comments, and subscriptions play a role in recommending videos on YouTube. The full questionnaire is added in Appendix G.2. This questionnaire was filled in both at the beginning and end of the evaluation, to find out if participants' knowledge increased after playing the activity. For practical reasons it was unfortunately not possible to do the pre-activity questionnaire a week in advance.

Secondly, to test whether the game experience differed across conditions, participants answered the ingame Game Experience Questionnaire (iGEQ) after playing the activity (Ijsselsteijn, De Kort & Poels, 2013). This questionnaire measures the game experience, based on seven constructs: Competence, Sensory and imaginative immersion, Flow, Tension, Challenge, Negative affect, and Positive affect. If the scores of the constructs would be higher in the collaboration condition, this would indicate that the game experience is better when students work in groups.

After playing the activity there was a short discussion, facilitated by the researcher. This discussion provided additional insights into participants' understanding of algorithms and their game experience. In this discussion the following questions were asked to the participants:

1. What information do you think YouTube uses to recommend videos to people?
2. What do you notice when looking at your own YouTube recommendations?
3. How did you determine which video to select in the activity?

The audio of the session was recorded, and observations were made while participants used the prototype. This resulted in additional qualitative data.

We conducted a pilot study (PL2) in which four participants took part in the collaboration condition. Questionnaires on paper were used in this pilot, but for practical reasons this was changed to digital questionnaires for the actual evaluation. We made a change in the order of the questionnaires, since students commented that they had to answer the same questions twice. Therefore, the post-activity questionnaires were moved to the end of the evaluation, instead of directly after the activity. This ensured that the time between pre- and post-test was as long as possible.

7.1.1 Participants

Although it was the intention to recruit 10 participants for each condition, due to the COVID-19 crisis and unforeseen circumstances at the participating schools, this goal was not met. One group of participants performed a pilot for the evaluation in the collaboration condition, four participants took part (M=2, F=2). The actual evaluation was performed by three groups of students, two for the individual condition, (6 students, M=3, F=3), and one for the collaboration condition (3 students, F=3). All groups and the participants who

took part are presented in Table 6 and additional information of the participants can be found in Appendix G.1. Note that the students from F8 and F9 did participate in the design process. However, the content of the activity was changed for this evaluation.

Table 6: Groups of students who took part in the evaluation

ID	ID	Condition
PL2	S21, S22, S23, S24	Collaboration
F8	S8, S9, S10, S11	Individual
F9	S13, S15	Individual
F10	S25, S26, S27	Collaboration

7.1.2 Procedure, materials & apparatus

Table 7 shows the timeline and procedure of the evaluation, and the materials needed. During the session, both Tim van de Wiel and myself did our evaluation. This means that half of the time available was used for my evaluation, and the other half for the other evaluation.

Table 7: Timeline and procedure of the evaluation

Phase	What's happening	Materials	Time
Preparation	Participants will be informed about the experiment and its structure. Collection of demographic data	Recording device	2 min
Pre-activity	Participants individually fill in the Algorithm Knowledge Questionnaire	Algorithm Knowledge Questionnaire	3 min
Activity	Participants participate in the algorithm activity, either in a group or individually.	Prototype, Worksheet like/dislike, Laptop/Computer	5 min
Discussion	Participants talk about the discussion points with the researcher	Talking points	5 min
Post-activity	Participants fill in the iGEQ and Algorithm Knowledge Questionnaire.	iGEQ, Algorithm Knowledge Questionnaire	4 min
Closing	Participants are thanked for their participation	-	-

The following materials and apparatus were used during the evaluation:

- As many laptops/computers as there are participants
- Prototype of Activity 2, accessible via a link
- Phone to record audio
- Pen or pencil
- Worksheet to fill in liked/disliked videos (Algorithm Table)
- Questionnaires accessible via a link (Algorithm knowledge pre-test, Ingame Game Experience Questionnaire (iGEQ), and Algorithm knowledge post-test)

7.1.3 Analysis

Giving the number of participants, doing a statistical analysis would not have been meaningful. I intended to use a non-parametric test, the MannWhitney U test, to compare the game experience (resulting from the iGEQ) across the two conditions. However, using this test to compare 3 against 6 participants, would not yield any valid results. The sample is too small and the number of participants was not balanced across the two conditions. Therefore no statistical tests were performed. In the remainder of this section, I will discuss how I analysed the different elements of this evaluation.

The data was cleaned and prepared using Excel. Both Tim van de Wiel and I performed our evaluations

during the same session, therefore I first removed all data that was not part of my own evaluation. Second, all Likert scale answers were changed to numerical values, to make it possible to calculate mean values.

Understanding and knowledge of algorithms
The open questions of the algorithm questionnaire (Q2 and Q3) were analysed and given a score according to the guidelines presented in Table 8 and 9. To ensure validity, both Tim van de Wiel and myself scored the answers of the participants. We discussed the differences in scores, explained why a certain score was given, and came to an agreement over the score. The weighted Cohen's Kappa was calculated to comment on the inter rater reliability. I compared the scores of the pre- and post-test for each condition, to see if any differences stood out.

Table 8: Guidelines for analysing the answers of Q2

Guideline Q2	**Score**
Answer is not about algorithms, or is about algorithms but completely wrong	1 point
Answer partly explains the algorithm, but also has incorrect elements	2 points
Answer consists of correct elements of how an algorithm works, but is incomplete	3 points
Answer clearly explains what an algorithm is and is complete	4 points

Table 9: Guidelines for analysing the answers of Q3

Guideline Q3	**Score**
Answer does not explain why YouTube recommends different videos, or is completely wrong	1 point
Answer partly explains why YouTube recommends different videos, but also has incorrect elements	2 points
Answer consists of correct elements of why YouTube recommends different videos, but is incomplete	3 points
Answer clearly explains why YouTube recommends different videos and is complete	4 points

The audio recordings of the evaluation were transcribed and analyzed, and the quotes served as additional findings besides the findings from the iGEQ and algorithm questionnaire.

iGEQ
The ingame version of the GEQ consists of seven different constructs, all corresponding to two items in the questionnaire (See Appendix G.3 for the full iGEQ). The constructs are:

- Competence (items 2 + 9)
- Sensory and Imaginative Immersion (items 1 + 4)
- Flow (items 5 + 10)
- Tension (items 6 + 8)
- Challenge (items 12 + 13)
- Negative affect (items 3 + 7)
- Positive affect (items 11 + 14)

The construct scores per person were calculated by averaging the values of the two items, which were answered on a five-point Likert scale. Next, the average per construct was calculated for each condition. This could provide insights into whether or not collaboration had affected the constructs.

Discussion & Observations
The audio of each of the sessions was transcribed and imported into Nvivo. To analyse the short discussion after playing the activity, I used open coding. This resulted in the following codes: Collaboration (individual condition), Collaboration (group condition), Play, Duration, Characters, Algorithm experience, Algorithm

knowledge. The comments students made during the activity were also coded.

I collected the like/dislike table that students filled in, to see what videos they selected and to get more insights into their thought process. During the evaluation I wrote down observations if they stood out.

7.2 Method: Teachers

Since the number of students that participated in the evaluation was rather low, I interviewed two more teachers, to ask specific questions about the topic of collaboration versus individual play. During a semi-structured interview, I first asked general questions about working collaboratively or individually in class. After this, I walked through the prototype of Activity 2 while explaining how the activity works and what students do, followed by some questions specific about the activity and in what way it would be most effective and fun to do in class. To conclude the interview, teachers could react to a few quotes students gave during the evaluation. The interview protocol is added in Appendix G.4.

7.2.1 Participants

The two teachers that took part in the evaluation were interviewed before during Pre-Study 1 and Pre-Study 2, therefore the same ID is used (Table 10). They were recruited for this evaluation because of their extensive answers in the previous interviews, their experience in teaching, and because they expressed before that they use collaboration in class.

Table 10: Teachers who participated in the evaluation

ID	Gender	Course	Experience	Level of education
T1	F	Levensbeschouwing	9 years	havo, vwo
T7	M	Computer Science, Biology & Head of department havo 4/5	16 years	vmbo, havo, vwo

7.2.2 Analysis

Both interviews were transcribed and imported into Nvivo. I used open coding, which resulted in two categories and 12 codes in total. Comments about general topics received the following codes: When, Student preference, Importance, Benefits collaboration, Benefits individual, Making groups, and Practical. Comments about the prototype received the following codes: Student preference, Collaboration, Individual, Practical, and Competition. Based on these codes, it was easier to see commonalities between the two interviews, and describe the themes that showed up.

7.3 Results

The results of the evaluation with students can be divided into four parts: the algorithm knowledge, the game experience, interaction with the prototype, and collaboration. All results of the interviews with teachers are reported in one section.

7.3.1 Algorithm knowledge

Table 11 and 12 show the results from Q1, Q2 and Q3 of the Algorithm Knowledge Questionnaire. The scores of Q2 and Q3 are the result of marking the answers according to the guidelines. The interrater reliability between the two raters was $\kappa = 0.85$ (95% CI 0.74 - 0.95), indicating near perfect agreement.

The self reported knowledge of algorithms increases in the collaboration condition with 2 or more points, for the individual condition this remains more or less the same. For all participants in the collaboration condition, there is no difference in the knowledge of the algorithm of YouTube before and after the activity. In the individual condition, two of the six participants improve their knowledge after playing the activity. In

both conditions, most participants can explain better why YouTube recommends different videos to different people, after playing the activity. S26 is an exception, since the post-activity answer *"because we see different things"* was not correct, while the pre-activity answer was.

Table 11: Results of algorithm knowledge questionnaire, for the individual condition.

	Q1: Self reported knowledge of algorithms			**Q2: Knowledge of the algorithm of YouTube**			**Q3: Knowledge of recommending videos**		
	pre	**post**	**diff.**	**pre**	**post**	**diff.**	**pre**	**post**	**diff.**
S5	1	1	-	1	1	-	2	2	-
S8	3	4	+1	3	3	-	2	3	+1
S9	2	3	+1	1	3	+2	3	4	+1
S10	2	2	-	1	2	+1	3	2	+1
S13	4	4	-	4	4	-	2	2	-
S15	4	4	-	3	3	-	1	2	+1

Table 12: Results of algorithm knowledge questionnaire, for the collaboration condition.

	Q1: Self reported knowledge of algorithms			**Q2: Knowledge of the algorithm of YouTube**			**Q3: Knowledge of recommending videos**		
	pre	**post**	**diff.**	**pre**	**post**	**diff.**	**pre**	**post**	**diff.**
S25	2	4	+2	1	1	-	3	4	+1
S26	2	4	+2	1	1	-	3	1	-2
S27	1	4	+3	1	1	-	3	4	+1

This is how students for example explained the algorithm of YouTube:

> *"The algorithm searches videos that would be interesting for you, so for example videos of channels you are subscribed to"* (S25. post-activity)

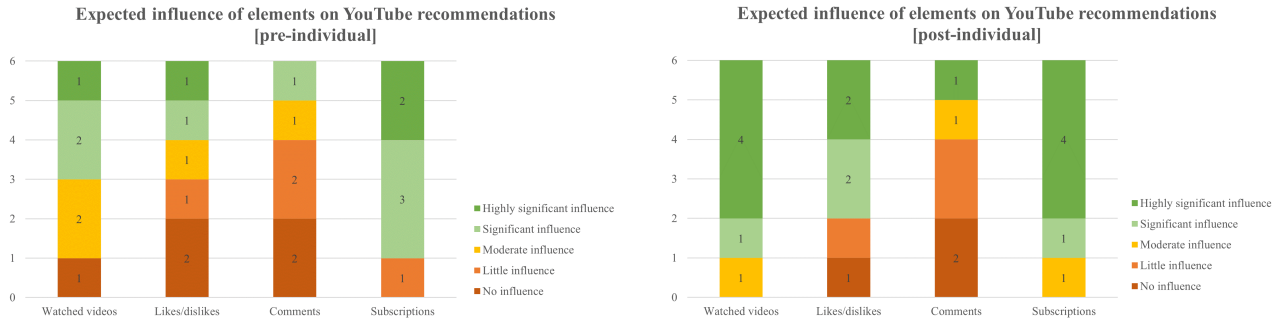
> *"It keeps track of various things like which videos you watch, which videos you like and not like, and who you follow, and based on this they know what you would like to see and they offer you this, to keep things fun interesting"* (S13, pre-activity)

> *"Something you watch a lot, shows up more often"* (S15, pre-activity)

In Q4 of the algorithm questionnaire, students indicated to what extent they think certain aspects play a role in the recommendation of videos. Figure 12 shows the answers students provided to this question in the individual condition. After playing the activity in the individual condition, there are more students who think that the four elements are used to recommend videos, primarily the watched videos and subscriptions increase. In the collaboration condition there are minor differences, but no clear shift is visible (Appendix G.5).

7.3.2 Game Experience

Figure 13 shows the mean construct scores of the iGEQ for both the collaboration condition (n=3) and the individual condition (n=6). For every construct, except Tension, the construct score is higher in the individual condition. Note that the Negative affect is lower in the individual condition, but the activity has a better experience if negative affect is less.



(a) Pre-activity

(b) Post-activity

Figure 12: Results of Q4 of the algorithm knowledge questionnaire, in the individual condition

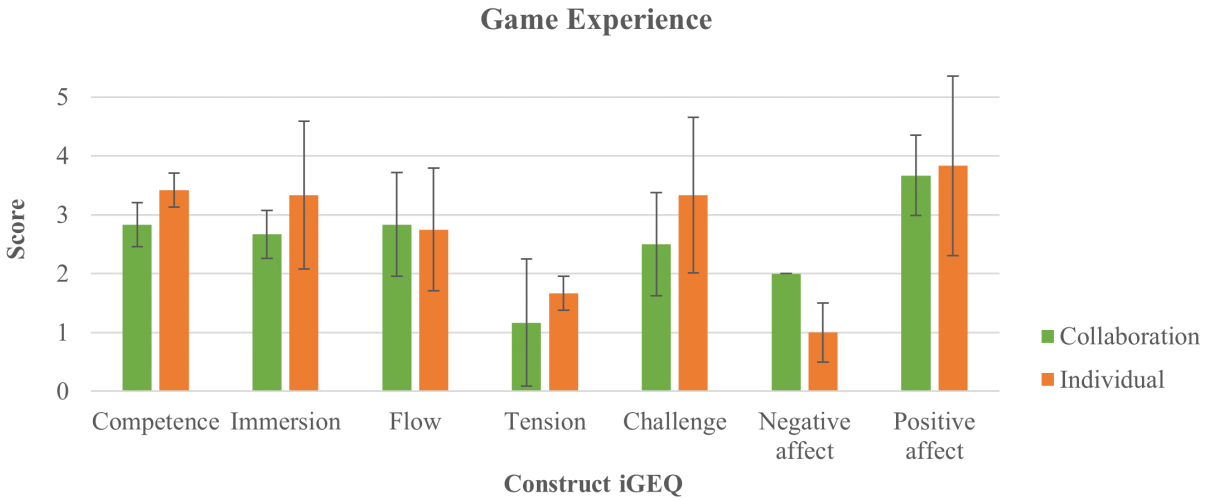


Figure 13: Construct scores of the iGEQ, for the individual and collaboration condition

7.3.3 Interaction with the prototype

In general, all students understood the activity and were able to interact with the prototype. A few students used the arrow keys to move forward, which resulted in skipping to the next screen, which was not the screen they were supposed to be on. Once I intervened to get the prototype back to the right screen, and mentioned that students should not use the arrow keys, no further problems occurred. Students used pen and paper to fill in the like/dislike table and did this during the activity.

Students looked at various things to determine which video to recommend. The channels Robin is subscribed to, and the titles and thumbnails of the video were mentioned the most. Some students also mentioned the categories or topics the video was about. As an example of the steps in the activity, the choices a student makes, and the things they write down, this is what S13 explains:

> *"First I wrote down that he was subscribed to Milan Knol, Supergaande and Touzani, and then I chose the video of Milan Knol playing Minecraft, and then I also wrote down Minecraft, because he probably likes it. After that [I chose] the one of Touzani, so I also wrote down football, since he probably likes football too. After that Dylan Haegens, why, I really have no idea. But it turned out he also liked that one, and then I also wrote down FIFA because it was about FIFA. And then I clicked on the one from StukTV, because Touzani was in it."* (S13)

7.3.4 Students about collaboration

The students who collaborated (F10) divided the tasks: one student used the laptop and clicked, someone else was in charge of filling in the table, and the third student had no specific task. A few times during the activity they discussed what the person should write on the paper, for example:

S26: *"This one, Milan Knol"* [selects a video]
S25: *"Okay, what should I write down?"*
S26: *"Just Milan Knol"*

Students sometimes briefly discussed the choices they made, but most of the time one student suggested a video to choose, and the others agreed. There was a moment during the activity where S25 mentioned: *"You click too fast"*, she could not keep up with the pace of the others. After the activity, S26 (who was in charge of the laptop) also said: *"I just clicked [...] we did not discuss much"*. When asked how they collaborated during the activity, students said the following:

S26: *"No, sometimes we worked together."*
S25: *"She did it herself."*
S26: *"At the beginning we did it together, at the end I just did it."*

When I asked the students from F10 if they would prefer to do this activity by themselves, they unanimously agreed. They said that they would be able to focus better if they work by themselves, and like that they can make their own choice without consulting others. S27 said about doing this activity in groups: *"It is fun, but it is just more convenient if you do it by yourself"*.

The students in the individual condition (F8 and F9) were also asked how they would feel about doing this activity together as a group. Most of them would like to do the activity in a group, because it would be more fun to hear what other people think, and to discuss the answers. It could also help to be in a group where everyone watches different videos, because then students who know certain videos, can help the ones who don't know them. Some disadvantages of working in groups were also mentioned. S9 pointed out that the activity probably would last longer if it was performed in a group, because people are going to have different opinions. There was some hesitation by S13: *"It can go both ways. It can be better, or it can be inconvenient, because you both watch different videos."*.

7.3.5 Teachers about collaboration

During the interviews, teachers first gave general comments about collaboration, after which they commented on collaboration in Activity 2. Both topics are discussed in this section.

General opinion about collaboration
Collaboration is one of the most effective and important methods to use in class, according to both teachers. When asked how he feels about collaboration, T7 answers: *"I think that it is one of the efficient, effective ways for students to engage with study material, learn things, try things out, and achieve learning goals."*. Working together helps students, because they can learn from each other. Teachers see it as a task for schools and for them as educators, to teach children how to work together in a group, because collaboration is part of our society.

> *"But yes, eventually, in whatever working environment, you are going to have to work together. So I think it is one of the most important goals of school to learn to work together. Also in this kind of small tasks, but also in big things."* (T1)

The teachers slightly differed in opinion about when to apply collaboration. While T7 said that it could be used for almost anything, T1 made a more clear distinction:

> *"... when it's really about knowledge processing they do it individually, and when it's more about applying something, or researching something, or in the case of my course opinion forming, then of course group work becomes more interesting"* (T1)

T7 did agree on the fact that working in groups makes it harder to assess the individual performance of a student:

> *"Well, with group work or collaboration you always have to be very careful, because if you really want to know about the individual how things are going, how the progress is, then you have to set up your group assignments very specifically for that."* (T7)

According to both teachers, most students enjoy working in a group, because this adds a social element to the lessons. Although both teachers recognize that there are always students who prefer to work by themselves. A reason for this can be that a student is perfectionistic and does not like to be dependent on others. For students with autism spectrum disorder, collaboration can also be more difficult. Teachers indicate that they sometimes create a smaller group for those students, or pay extra attention to those groups.

Collaboration in Activity 2
After seeing the prototype, both teachers prefered to do the activity in groups. This would be more fun, and students could discuss with each other which videos to recommend. Some things they said about collaboration were:

> *"Because otherwise everyone does it individually and then you might see who has done it best in class, but you have not discussed with each other. And that is precisely what is important. In my opinion, this should be a tool to gain insights, but also to discuss it with each other, then and only then it really comes to life."* (T7)

> *"Yes, I think that it works well, because then they can also give an argument about why this, why that. There is also discussion within such a group. And competition arises between groups. Yes, that seems fun."* (T1)

Although I did not mention the competition element of the activity, both teachers suggested adding competition. T7 said: *"And I think it could also be fun, in a class context, if it would be a sort of battle. A kind of final result of which group in the class was ultimately able to generate the most interest."*. This idea was in line with the live score per group that would be on the smartboard. I showed this screen to them and it matched their expectations. Teachers expected students to prefer to do this activity in groups, especially when there is a competition between the groups in class, because *"It's just fun to puzzle and discuss things with each other. Plus, being able to win as a group also gives a boost I think."* (T7). Another reason was provided by T1: *"This also makes it a social activity. And that is what they are waiting for."* (T1).

Both teachers did not see any practical disadvantages of working in groups for this activity. Groups of three or four students working together on one laptop will not be an issue. T1 did mention: *"It will involve a lot of noise, you can count on that."*, but that was not an issue. T7 suggested adding a time limit to each round, to ensure that all groups spend approximately the same time on the activity: *"That they can discuss for a maximum of 2 minutes. They will probably finish within 1 minute, but at least you will have some pressure for the groups that find it difficult to choose"*.

I asked whether the teachers would prefer a hybrid form of this activity, with both individual and collaborative play as options. T1 saw this as an option for classes that do not work well in groups:

> *"I can imagine that you might want to keep some room for differentiation. Suppose you have a class that is totally out of control, of which you know in advance that it is going to be pure chaos and in the end no one has done it, then perhaps you are happy as a teacher if you have the option of doing it individually."* (T1)

T7 gave a more pragmatic answer:

> *"We don't have to bend over backwards to serve every student who only likes to work 100% individually. If you have to discuss with each other in 4 rounds of 2 minutes maximum, well, they'll survive that."* (T7)

8 Discussion

The polarising effect of social media and filter bubbles is a threat to our modern society and democracy (Geschke et al., 2019). Teenagers in the Netherlands use social media a lot, but their knowledge on filter bubbles and the dangers they bring along is still lacking (Nederlands Jeugdinstituut, 2018; RAN, 2018). When the digital literacy of teenagers increases, they can cope better in a society filled with (social) media, information personalisation, and algorithms (RAN, 2018). The anti-filter bubble project develops a series of lessons and an application for secondary schools, to teach students about the filter bubble and its dangers. During this research, we designed two activities that will be used in that application, accompanied by an overall concept for the application. Both teachers and students were part of the iterative design process, and their comments served as input for the prototypes. In the final evaluation, I aimed to find out whether collaboration would increase the educational value and improve the game experience of Activity 2. The following research question will be answered in this section: What design qualities does an interactive tool for raising awareness need to effectively integrate into secondary education?

In this section, I will first discuss the results and implications of the final evaluation. After this, I will present general recommendations for the application. Although the recommendations are specific for this application and its activities, a lot of them can be applied to other applications or educational technologies as well. Some general recommendations are in line with previous research on this topic. Therefore, this study contributes to the field by offering recommendations to integrate an application into secondary education. After the recommendations, I will discuss the limitations of this research.

8.1 Collaboration in Activity 2

In the evaluation, I investigated whether Activity 2 has a better game experience if it is played in groups, and if collaboration improved the knowledge and understanding of algorithms. Due to the low number of participants in this study, I can not draw real conclusions from the quantitative data. In the limited data available, the game experience of students was slightly better for the individual condition, and for both conditions the algorithm knowledge increased for most students after playing the activity. The qualitative data showed that students who did the activity by themselves would like to work together, and vice versa. Both teachers believe that the activity has the most educational value if it is played in groups, since the discussion during the activity will help students understand what algorithms are, and the competition between groups in class will keep them motivated.

The results of the algorithm knowledge questionnaire show that students can not explain better what the algorithm of YouTube does after playing the activity. There is however some improvement in their explanations of why YouTube recommends different videos to different people. With this number of participants, no meaningful differences between the conditions can be seen. The iGEQ did show that the game experience was better in the individual condition, but only minor differences can be noted. However, in both conditions the tension was rather low and the positive affect quite high, indicating that students were not frustrated and felt good while playing the activity. So, whilst I cannot make firm conclusions given the small sample size, the trend is positive. It makes sense that the quantitative data of the students does not clearly show which condition would be better, given the low number of participants. Furthermore, this activity would be part of a class, and not stand-alone. An introduction by the teacher and a class discussion afterwards will give students the opportunity to learn more and to ask questions if they have any.

While the quantitative data was not conclusive, both teachers were quite clear during the interviews: collaboration is the way to go for this activity. Students will learn more if they discuss the options together, they will hear multiple opinions, can help each other, and the competition between groups increases motivation and makes the activity more fun. These findings are in line with literature, Van Der Meij et al. (2011) for example found that students benefited the most from the discussion after playing the game, and that collaboration improves motivation and learning. Kapp (2012) found that students like the social aspect of collaboration, something that was confirmed by the teachers. It should be noted that this is based on interviews with only two teachers, I recommend conducting more interviews to strengthen the findings.

Where teachers clearly have a preference, not all students are convinced of collaboration. They mention various disadvantages of working in groups, for example that the activity will last longer because opinions will differ and there is a lot of discussion. This is in line with the findings of Mostmans et al. (2012). Teachers did acknowledge that the activity would last longer but did not find that this outweighs the benefits of collaboration. Some students also preferred to work alone, because they can focus better and can make their own choices without consulting others. Teachers recognized that some students always like to work alone, but collaboration is a skill that they need to develop nevertheless, and the activity will teach students more if they work together. Some students do want to work together, for the same reasons teachers and literature provide: they want to learn from each other and are interested in the opinion of others.

Due to the low number of participants and the uneven distribution across the two conditions, I can not draw conclusions from the quantitative data. Despite this, the qualitative data of both students and teachers provides insights into the value of collaboration for this activity. Teachers indicated that working in groups and discussing a topic improves learning, and that the competition between the groups will increase motivation. This is in line with literature, where the discussion is also mentioned as an important aspect of collaborative learning (Van Der Meij et al., 2011), and working together towards a goal helps to increase motivation (Kapp, 2012). Since the goal of Activity 2 is to make students aware of algorithms on YouTube and to serve as a starting point for discussion, I would advise to do this activity in groups. When students would do the activity by themselves, they do not share their motivation behind recommending a certain video. According to the teachers, literature, and some of the students, the value of this activity is in the discussion. Some students would prefer to work alone, but I still recommend playing Activity 2 collaboratively, to ensure that the full potential of the activity is used. Although it can not be concluded from the data that collaboration will improve the game experience (RQ1), the knowledge of algorithms seems to improve when students talk about this topic together as a group (RQ2).

8.2 Recommendations for educational applications

In order to design an application that effectively integrates into secondary education, there are various things to take into account. During this research, we talked with 27 students (10 of them took part two times), 15 teachers (3 of them took part two times), and regularly discussed the ideas with the project team consisting of two pedagogues and two pedagogy students. Based on their input and opinions, I will discuss a few recommendations, both general and specific for the two activities. Although these recommendations are specific for the current application, most of them can be used for the design of educational applications in general.

Ensure a safe environment in class. In every interview with teachers, they mentioned the importance of a safe environment in class. This already showed up in PreSstudy 1, and was therefore added as a requirement for the application. In the design process teachers kept addressing this point, so it is important that the application does not cause any harm and contributes to a safe environment in class. The anti-filter bubble project already aims to keep teachers involved during the entire process, and I would advise to keep doing this to keep the safe environment in the picture.

Take differences into account. During the focus groups we noticed that the differences between schools, and between students can be significant. Some schools already had courses or classes about social media and digital literacy, while others did not. The individual differences between students were also striking. Some of them for example use YouTube and TikTok a lot and subsequently have a better idea of how those platforms work. Others do not use social media at all or have no idea how the platforms actually work. Additionally, students have different opinions about certain topics and have personal preferences when it comes to the content they watch online. These findings are in line with literature, where it is often addressed that teenagers are a diverse target group (Bell & Davis, 2016; Katterfeldt et al., 2012; Jimenez Pazmino et al., 2015; Poole & Peyton, 2013). Teachers also said that it is hard to talk about 'students' in general. Therefore, it is recommended to offer a wide range of topics in the activities, to cater to as many students

as possible. Offering choice to students might also be a way to accommodate the differences in the target group.

Offer a manual for teachers. When the application will be further developed, it is crucial for its success to develop a manual for teachers. As described in literature, technology (in this case the application) should support both students and teachers (Bower, 2017; Escueta et al., 2020). Almost every teacher indicated that a manual would not only help them but is also important to ensure that the educational value of the application is as big as possible. This manual should include at least background knowledge on algorithms and filter bubbles, instructions on how to work with the application, and guidelines for the discussion after the activity.

Invest in an attractive design. When we came up with the activities, we primarily focused on the interaction and the idea of the activities in general. For the current prototypes, we did not spend time on the design, so fonts, colours, and other visual elements are still quite basic. When the application and the activities are further developed, it is necessary to make decisions about the design. Some students already commented on the (lack of) colours. On the other hand, the addition of thumbnails in Activity 2 elicited enthusiastic responses. In line with this, Joyce and Nielsen (2019) stress the importance of aesthetics and multimedia solutions to make the content more engaging for teenagers. I would recommend the project team, and developers of applications for teenagers in general, to hire a designer who will be responsible for the overall design of the application. This also ensures that everything is tied together with the same style.

Improve the usability. During the design process we mainly focused on the interaction of the activities, how students responded to them, what could be improved, and if it was fun to do. The usability of the activity and the prototype was not evaluated or addressed. Although some usability issues showed up (described in the design section), it is advisable to test the usability of the application and the individual activities. Besides the overall usability, there must be attention for colour blindness, dyslexia, and other disabilities. The usability preferences of teenagers, as studied by Joyce and Nielsen (2019), should be taken into account, examples are that the amount of text should be limited, and that the application should be responsive.

Connect to the lives of students. Kolb described in the Triple E Framework that there should be a strong relationship between the technology that is used and the everyday lives of the user (Kolb, 2017). It came up frequently during the interviews with teachers that the application and the activities in it should be relatable for students, otherwise it would not be meaningful to them. Therefore, the content in the activities should be familiar to students, which will help them to apply the things they learn during the activities to their own lives. During the focus groups we already noticed that the thumbnails in Activity 2 elicited enthusiastic responses when students recognized the YouTubers, channels or videos.

Increase difficulty of activities. When the two activities are further developed, it is important to increase the difficulty and elaborate the storyline. For Activity 2, adding more rounds (e.g. 6 instead of 4) will make it possible to add extra videos and make it harder for students to recommend the videos. Students indicated that they would prefer a bigger challenge. They suggested for example to add videos with topics or from channels that were not mentioned in the profile. This would trigger them to think about which videos would be in line with the previous ones. For Activity 3, the element of choice should be elaborated to make the activity more challenging. The storylines of the different characters could have multiple endings and the story can be longer by adding extra choices, as suggested by the students. During the design process and the evaluation, we constantly adapted the activity to figure out the appropriate level of difficulty. I would recommend checking in with the students to ensure the level of the activity is appropriate.

Use competition to keep students engaged. In the prototype of Activity 2 we did not focus on the competition element, since it was hard to show actual scores within the prototype software. Therefore, students only saw whether the video they selected increased or decreased the interest of the viewer, and not their score throughout the activity. It is the idea that this score is live on the smartboard, so the groups in class can see who has the highest interest score. Teachers were enthusiastic about this form of competition,

and most students stated that they like activities where they can win. This is also in line with tools like Kahoot, which are often used in class.

8.3 Limitations

The students who participated in this research were all going to schools in Utrecht and Amsterdam, which makes it harder to generalize the results to schools that are located in smaller cities or rural areas. Besides this limitation on the location of the schools, the students were also specifically selected by their teachers to participate in the focus groups. They picked students who were motivated and talkative, to ensure that they could give good feedback to the prototypes. Although those students might not be representative of the entire vmbo student population, this did result in focus groups where students shared a lot and provided meaningful insights.

Most of the teachers who took part in this research are teaching a civics course. Those teachers have a lot of experience with class discussions, differing opinions, and sensitive topics in class, therefore they could comment extensively on those topics. This might make it harder to generalize the results to all teachers, and it could be valuable to talk to a more diverse pool of teachers.

Due to the COVID-19 pandemic, secondary schools in the Netherlands were closed for four months, after which they reopened with a part-time schedule, and eventually reopened completely. This caused a lot of organisational difficulties and stress by the participating schools and schools in general, which made it harder to arrange the focus groups and interviews. For this reason, all interviews with teachers, and three of the focus groups with students took place online. For teachers, this was not a problem, but for students this impacted the quality of the focus groups. It was harder to see what each student was doing at each time, and conversations and discussions were more difficult, because everyone had to wait for their turn to speak.

The target group for the application is currently vmbo students aged 12-14, and during this research we only interviewed students in that group. In the end, the application should be used by students of all ages and educational levels. However, the findings of this study can not be generalized to all students, given the differences within this population. Further research is needed, for example to check whether the activities would have the right level of difficulty.

8.3.1 Limitations in the evaluation

The low number of participants and the uneven distribution across conditions is the biggest limitation of the evaluation. Because of this, I could not do any statistical tests, and therefore I could not show whether the differences across conditions were significant. Since only three participants did the activity as a group, it is impossible to generalize the findings from the evaluation. Additionally, some of the students already participated in the design process and were therefore familiar with the activity. The content of the activity was changed, but it might still have impacted the results of the evaluation.

Another limitation is the setting of the evaluation. Since the sessions with students took place in a quiet environment, with only one group present, this can not be compared with a regular classroom setting. When this activity is played in a class with 30 students, this would result in 8 groups who play against each other. The group dynamics and the interaction in class were not accounted for in this study. Therefore, I would advise to evaluate the activity in a natural classroom setting, with more students, and a teacher who can introduce the activity and lead a discussion afterwards.

The composition of the group of students might also influence the results, as different personalities could result in different group dynamics. Same goes for the size of the groups, when the activity would be played with groups of two students, this might yield different results. It is also important to note that whether students like collaboration might be a personal preference. In that case, repeating the evaluation with a bigger sample size still might not give conclusive results.

Finally, it should be noted that it is possible that students do not learn from Activity 2, because they

already have pre-knowledge about algorithms. In that case, the activity might not improve their knowledge of algorithms, but it can still serve as a tool to talk about this topic. When everyone in class has the same experience after playing the activity, this helps the discussion.

9 Conclusion

This research aimed to design activities for an educational application that raises awareness of filter bubbles among students in secondary education. Based on interviews with teachers, we came up with requirements for the application and storyboards. They served as input for the iterative design process, in which both students and teachers shared their opinion about various prototypes. This resulted in two activities and an overall idea for the application. Additionally, by conducting this research, I aimed to find out what design qualities an interactive tool for raising awareness needs, to effectively integrate into secondary education.

The two activities that were designed, focus on algorithms and filter bubbles respectively. Activity 2 aims to teach students how the algorithm of YouTube works, and what elements an algorithm takes into account to recommend videos to a user. In the activity, students have the goal to keep a person as interested as possible, by recommending videos that this person would like. Both students and teachers were enthusiastic about this activity because it has an element of competition, the used videos are familiar to students, and it is an interactive, fun way to learn about algorithms.

In the other activity, Activity 3, students learn how their online behaviour affects the opinion they have and the filter bubble in which they end up. Students walk through an interactive story with a character, in which they can determine what actions the character performs. The stories of all four characters will have a different ending, and at the end of the activity, students will chat with an opposing character to see how and why opinions differ. This activity served as a tool for a discussion about filter bubbles afterwards, and teachers deemed it very suitable for this goal. Students liked the choice element and felt in control, but would like to have even more choices and a more elaborate storyline.

Besides the contribution of two activities that can be implemented in the anti-filter bubble application, I also evaluated whether Activity 2 is best played collaboratively or individually. Although quantitative results were not valid due to a small sample size, qualitative results show that collaboration increases the educational value of this activity. Additionally, I composed a set of recommendations for the future development of the application. These resulted from both the interviews with teachers and the focus groups with students. Examples of these recommendations are to ensure a safe environment in class, pay attention to differences between students, make sure to connect to the lives of students, and provide a manual for teachers. Most of the recommendations can serve as guidelines for the development of other educational applications.

To ensure that students can cope in a society where social media, algorithms, and filter bubbles are omnipresent, increasing their digital literacy is of utmost importance. The activities designed in this research and the anti-filter bubble application in general, try to raise awareness of these topics in an interactive manner. During the design process, teachers stressed the importance of this topic, and students were excited to learn about this topic in an active and interactive way. With the recommendations in mind and the activities at hand, everything is in place to take the next steps in developing the application and to test it in a classroom setting.

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A Pre-Study 1

A.1 Interview protocol Pre-Study 1

Introductie
Heel fijn dat je mee wil werken met dit interview. Wij zijn Tim en Anneleen en we studeren Human-Computer Interaction aan de Universiteit Utrecht. Voor onze masterscripties doen we onderzoek naar jongeren en filterbubbels. Hiervoor interviewen we docenten en leerlingen van de middelbare school. Jij bent als docent expert op het gebied van lesgeven en jongeren, daarom kunnen jouw kennis en ervaring ons goed helpen.

We zouden dit gesprek graag willen opnemen. De antwoorden die je geeft zullen anoniem verwerkt worden in onze scripties. Je kan op ieder moment stoppen met dit interview, zonder daarvoor een reden te geven. Daarnaast zullen we altijd je gegevens verwijderen als je daarom vraagt. Geef je toestemming voor het opnemen van dit interview?

Een filterbubbel ontstaat als social media, zoekmachines of andere websites hun inhoud aanpassen op jouw persoonlijke voorkeuren. Daardoor krijg je meer van hetzelfde te zien en worden andere perspectieven, meningen of kritieken weggefilterd. Je kan zelf ook bijdragen aan je filterbubbel, bijvoorbeeld als je altijd dezelfde soort websites bezoekt of alleen bepaalde berichten liket.

Vragen

1. Kan je ons eerst wat vertellen over jezelf: welk vak geef je op welk niveau en hoe lang doe je dat al? Welke opleiding heb je gedaan?
2. Kan je ons vertellen wat de rol van technologie is in jouw lessen?
3. Wat is jouw beeld van het online gedrag van leerlingen?
4. Hoe gaan leerlingen om met de informatie die zij online vinden?
5. Welke vorm van lesgeven wekt het meeste enthousiasme op bij leerlingen?
6. Jij bent ervaringsdeskundige op het gebied van lesgeven en jongeren. Op welke manier zou jij een onderwerp als polarisatie bespreken of behandelen in de klas?
   (a) Kan je omschrijven waar je op let? Wat de randvoorwaarden zijn van een gesprek of discussie?
7. Hoe zou technologie je hierbij kunnen ondersteunen?

Voor onze scripties maken we een educatieve app over filterbubbels. Het doel van de app is leerlingen bewust maken van het feit dat ze in een filterbubbel zitten en welke consequenties dit heeft. De filter bubbel is een redelijk abstract concept, maar ligt ook dicht bij de belevingswereld van jongeren.

8. Op wat voor manier zou je zo'n soort concept overbrengen in de les
   (a) Wat werkt er voor jongeren volgens jou beter: een verhalende aanpak of een meer directe aanpak?
9. Hoe zie je voor je dat een app gebruikt kan worden in de les? (aantal leerlingen, groepjes, gezamenlijk/alleen)
   (a) Hoe vaak zou je de applicatie willen gebruiken? (1 les, meerdere weken)
10. Op wat voor manier zou jij als docent een rol willen spelen tijdens een les met de applicatie?
11. Heb je nog vragen of opmerkingen? Wil je nog terugkomen op eerdere vragen of antwoorden?

A.2 Adapted questions for T4

Since this teacher was also the head of vmbo 2, questions 6 was altered to be better suitable. One question was added.

6. Komt het wel eens voor dat je een gevoelig onderwerp als polarisatie bespreekt of behandeld in de klas?

a. Kan je omschrijven waar je op let? Wat de randvoorwaarden zijn van een gesprek of discussie?
b. Weet je van andere docenten hoe zij zulke thema's in de klas aanpakken?

NEW. Op wat voor manier wordt er bij jullie op school aandacht besteed aan thema's als burgerschap, digitale geletterdheid, en mediawijsheid?

A.3 Topic list interview E1

Heel fijn dat je met ons wil praten vandaag. Voor onze masterscripties Human-Computer Interaction ontwikkelen we een app die jongeren meer bewust moet maken van filter bubbels en de gevaren hiervan. We horen graag de ervaringen en tips die jij hebt met betrekking tot technologie in het onderwijs.

We zouden dit gesprek graag willen opnemen. De antwoorden die je geeft zullen anoniem verwerkt worden in onze scripties. We zullen altijd je gegevens verwijderen als je daarom vraagt. Geef je toestemming voor het opnemen van dit gesprek?

Vragen vooraf
1. Kan je iets over jezelf vertellen? Wat doe je precies? Hoe lang al?
2. Met wat voor scholen werk je meestal samen, bijvoorbeeld qua niveau?

Topic list
1. Technologie en onderwijs
Kansen, uitdagingen, problemen
Apps in de klas

2. Docenten
Waar lopen ze tegenaan?
Wat vinden ze leuk?
Houding t.o.v. technologie

3. Samenwerken in grote projecten
Hoe houd je iedereen tevreden?
Hoe let je op alle belangen?

4. Kinderen
Heb je ervaring met kinderen betrekken tijdens project?

5. Algemeen
Do's en don'ts, tips & tricks

A.4 Insights from Pre-Study 1

These 40 insights were generated from the interviews with five teachers and one expert, as described in chapter 4. These interviews generated 397 phrases that we categorized in 14 different groups, from which we distilled the following 40 insights.

What do students do online?

- Students want to keep social media to themselves and don't often like to share it with parents and/or teachers.
- Students are strongly connected to each other online.
- Whether a teacher knows what their students are doing online heavily depends on the teacher.

How do students handle online information?

- People often think that students/teenagers can easily handle information and/or technology. This assumption is wrong.
- Students really do struggle with searching and finding information online, and often just trust everything they find.
- Students do not have a lot of knowledge of current events. This has decreased over the years. Students are not up to date. Even some big news events aren't always properly followed.

Students in general

- The term 'students' is too broad, because there are too many individual differences.
- Vmbo-students rather have 'something to do', are distracted more easily, and will work less for themselves but more for the teacher.
- Students should first recognise the importance of something (for themselves) before they'll want to do something with it.

Teaching in general

- Use a lot of variation, especially at vmbo.
- Competition always works well.
- Lessons should be meaningful for the students, by for example using examples directly from their personal lives.
- It helps for students to work towards a bigger goal; that could be something like developing a product.
- Students become enthusiastic if they notice they are learning something and they can do something they couldn't do before.

Role of technology in class

- If students have access to devices (such as Chromebooks), using technology in class becomes a lot easier.
- Quizzes like Kahoot, Mentimeter and Socrative are often used, either to measure prior knowledge or to gather viewpoints and opinions.
- Technology isn't often used as a means of interaction, but as a way to gather knowledge.

Talking about polarisation

- Activating prior knowledge is important.
- A safe environment in class is fundamental when talking about sensitive topics.
- Focussing on knowledge and formulating opinions based on facts and numbers can help during discussions.
- It may help to gather individual opinions and viewpoints beforehand and then discuss those points. Otherwise, the loud minority might define the entire discussion.
- It needs to be made sure that the discussion does not increase the differences in a class and it does not strengthen people in their own opinion. That is the exact opposite of what should be achieved.

Technology and polarisation

- When discussing polarisation, the teacher can make relevant online sources available for students through technology (for example with QR codes in assignments).
- Adaptive forms of learning, that adapt to the student, can be useful in this context.

Conveying the concept of a filter bubble

- Items such as Zondag met Lubach or The Social Dilemma (Netflix) are popular among students. However, these items are often only about the extremes, so they need to be 'translated' to something more relatable for students.
- Whether a direct or a narrative approach works best heavily depends on the type of student.
- Students should experience something in different, realistic contexts with appealing examples. That will make it more meaningful for a student ('context-concept approach').

The application in class

- The application should allow students to experience something, and not just convey knowledge.
- Students should be able to share things with each other, which means working in (small) groups is preferable. Working individually is not as effective. Differences between group members can elicit curiosity.
- Differentiating between students is important: some students might be interested, some won't be, some already know about filter bubbles and some not at all. They should all benefit from the application. Letting students make choices themselves can also be helpful.
- In terms of usability, the application should be able to be understood at first glance, for both students and teachers.

Curriculum/place of the application in teaching

- The application should return multiple times, using it once is not going to help at all.
- The application should not be stand-alone; a guide for teachers, a course package or lesson plans are a necessity.
- In general, media/digital literacy should get a structural/more prominent place in education.
- Teachers mention different possibilities regarding where to use the application. It could be used in weeklong projects, in the mentor programme or in courses like civics, philosophy of life, or computer science.

Role of the teacher

- Teachers have a very important role in leading discussions and maintaining a safe atmosphere. Teachers should be able to intervene and should also have the capabilities to do that.
- For teachers, it is sometimes difficult to keep an overview of what all students are doing within an application. Teachers could be supported by providing for example a dashboard or partitioning the application into smaller parts.
- Teachers do not have to stay neutral in discussions and can certainly show their opinion on some sensitive topics, but should make clear that their opinion isn't the only opinion around and that students aren't expected to have the same opinion.
- Teachers mention different roles they expect teachers to have when working with the application: initiator, supervisor or just having the application as a teacher (implying they themselves do not have to do anything). Their role will entirely depend on the format of the application itself.
- Especially on vmbo, the social relationship of the teacher with students is very important.

B Pre-Study 2

B.1 Interview protocol Pre-Study 2

Introductie
Heel fijn dat je mee wil werken met dit interview. Wij zijn Tim en Anneleen en we studeren Human-Computer Interaction aan de Universiteit Utrecht. Voor onze masterscripties doen we onderzoek naar jongeren en filterbubbels. Hiervoor interviewen we docenten en leerlingen van de middelbare school. Jij bent als docent expert op het gebied van lesgeven en jongeren, daarom kunnen jouw kennis en ervaring ons goed helpen.

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Vragen algemeen
1. Kan je ons eerst wat vertellen over jezelf: welk vak geef je op welk niveau en hoe lang doe je dat al?
2. Kan je ons vertellen wat de rol van technologie is in jouw lessen?
3.Wat is jouw beeld van het online gedrag van leerlingen?
4.Hoe gaan leerlingen om met de informatie die zij online vinden?
5.Welke vorm van lesgeven wekt het meeste enthousiasme op (bij VMBO leerlingen)?
6. Jij bent ervaringsdeskundige op het gebied van lesgeven en jongeren. Op welke manier zou jij een onderwerp als polarisatie bespreken of behandelen in de klas? Kan je omschrijven waar je op let? Wat de randvoorwaarden zijn van een gesprek of discussie?

Storyboard
Voor onze scripties maken we een educatieve app over filterbubbels. Het doel van de app is leerlingen bewust maken van het feit dat ze in een filterbubbel zitten en welke consequenties dit heeft. De filter bubbel is een redelijk abstract concept, maar ligt ook dicht bij de belevingswereld van jongeren.

Op basis van de interviews die we met docenten hebben gedaan, hebben we een eerste idee voor de app. Dit hebben we weergegeven in een storyboard, je ziet op verschillende schermen hoe de app in de klas gebruikt wordt. De 2 storyboards die we hebben gemaakt laten beide een mogelijke activiteit/opdracht zien die in de app zit.

We laten je nu graag het storyboard zien. Houdt er rekening mee dat dit nog een concept is en het simpele ontwerpen zijn. We vertellen hoe de opdracht werkt, stop ons vooral als je vragen hebt of denkt: dit gaat niet werken.

Storyboard A uitleggen en laten zien
7. Wat vind je van dit idee? Zou het werken?
8. Op wat voor manier zou jij als docent een rol willen spelen tijdens een les met de applicatie?

Storyboard B uitleggen en laten zien
9. Wat vind je van dit idee? Zou het werken?
10. Op wat voor manier zou jij als docent een rol willen spelen tijdens een les met de applicatie?

Afsluiting
11. Heb je nog vragen of opmerkingen? Wil je nog terugkomen op eerdere vragen of antwoorden?

B.2 Insights from Pre-Study 2

Students
Pygmalion effect: if you expect that mavo students work less independently, they will work less independently.

Lessons
Setting learning goals is important, and benefits students. Surprising elements or a shock-effect are effective in delivering information.

Role of technology
Teachers have different opinions about whether to provide students with prepared online sources, or let them search the internet themselves.

Discussing polarisation
Anonymity can be a tool to discuss sensitive topics in class, to gather opinions without people feeling threatened, embarrassed or ashamed.

App in class
Both before and after the use of the application, there should be plenty of room for discussion.

Role of the teacher
Aside from being able to handle discussions about sensitive topics, teachers should also have sufficient knowledge on the topic. This is not always the case right now.

Storyboard 1 - Positive

- Working in groups is an effective way to do this activity, since you get results from each group and they can discuss the results within their group.
- Using a phone and watching videos is attractive for students.
- The activity being tiered (small groups -¿ all groups -¿ in-class discussion) is good.

Storyboard 1 - Notes and observations

- The way an activity is introduced is very important (activate prior knowledge)
- It might be the case that not all students will want to share their YouTube recommendations, because they might feel that what videos they watch is private information.
- The final in-class discussion with the teacher contains the most important step: there, students should realize what a difference in recommended videos could cause.

Storyboard 1 - Suggestions and tips

- Include a clear instruction for the questions students have to answer after watching the different recommending pages. Concrete is always better.
- The negative side of filter bubbles should not be too underlined; students will take it less seriously if its only negatives.
- Include videos that appeal to students
- The videos should last 3 or 4 minutes
- Teachers should have the possibility to see the answers (of open questions) before they are presented on the board. Otherwise they will be scared by the possibility of students who give weird, funny or provocative answers.

Storyboard 2- Positive

- The shock/surprise effect is more clear in this storyboard.
- Teachers feel this is a nice interactive activity to engage students.
- This activity results in students asking follow-up questions, which is good.

Storyboard 2 - Notes and observations

- Students might find it hard to place themselves in someone else's shoes, especially when this is a fictive character. Using a profile might help students to let go of their own interests.
- If the goal is to empower students by learning how algorithms work, it is not important to teach them the technical details.

Storyboard 2 - Suggestions and tips

- One teacher thinks that this activity is better suited for individual work rather than group work, another thinks group work is better.
- The scores, steps, and explanations in between the moments of choice are important. Students should have a clear idea about the impact of their choice.
- The topic of the videos could be political, but could also be 'polarizing' on topics close to them.
- Be careful that students do not get to see extreme content on YouTube.
- Suggestion to add another game modus where the goal is to show videos that are as diverse as possible.

Manual for teachers

All teachers mention the need for a 'manual' or at least guidelines, tips or advice for when using the application in class. Both on a knowledge level (what are algorithms, what are filter bubbles) and on a meta level (how to manage discussions).

C Design Process

This appendix contains the interview protocol for teachers in the design process, the protocol for the focus groups, and the students who participated in the design process.

C.1 Interview protocol teachers

Introduction
We zouden dit gesprek graag willen opnemen. De antwoorden die je geeft zullen anoniem verwerkt worden in onze scripties. Je kan op ieder moment stoppen met dit interview, zonder daarvoor een reden te geven. Daarnaast zullen we altijd je gegevens verwijderen als je daarom vraagt. Geef je toestemming voor het opnemen van dit interview?

Wij zijn Tim en Anneleen en we studeren Human-Computer Interaction aan de Universiteit Utrecht. Binnen het project zijn wij verantwoordelijk voor het ontwerpen van een educatieve app over filterbubbels. Het doel van de app is leerlingen bewust maken van het feit dat ze in een filterbubbel zitten en welke consequenties dit heeft.

We hebben al verschillende docenten van middelbare scholen geïnterviewd en op basis van deze gesprekken hebben we een eerste prototype van de applicatie gemaakt. In het prototype zie je hoe de app in de klas gebruikt wordt. Er zijn op dit moment twee mogelijke activiteiten/opdrachten uitgewerkt die in de app kunnen komen.

We laten je nu graag het prototype zien. Houdt er rekening mee dat dit nog een concept is en het simpele ontwerpen zijn. We vertellen hoe de opdracht werkt, stop ons vooral als je vragen hebt of denkt: dit gaat niet werken.

Prototype algemeen
1.Wat vind je van dit idee? Zou het werken?
2. Denk je dat leerlingen dit leuk vinden om in de klas te doen?
3. Wat vind je van het niveau van de app?

Prototype A
4. Wat vind je ervan dat leerlingen hun eigen YouTube account gebruiken?
5. Hoe voorkom je dat leerlingen filmpjes gaan kijken op YouTube, terwijl dat niet bij de opdracht hoort?
6. Welke vragen zouden we op het einde moeten stellen?
7. Wat vind je ervan dat de antwoorden van leerlingen op het bord terecht komen?

Prototype B
8. Wat vind je van de profielschets vooraf?
9. Wat vind je van de tekstjes tussendoor?
10. Wat voor type video's moeten gebruikt worden? Polariserend of niet?
11. Iets waar ze neutraal in staan of juist waar ze al een mening over hebben?
12. Hoeveel rondes zouden er moeten zijn?
13. Wat vind je van de live meters op het bord? (en competitie)

Les eromheen
14. Wat vind je van het werken in groepjes met de app?
15. Hoe vaak zou je de app willen gebruiken in de les? Hoeveel lessen?
16. Hoe zou je een les voor je zien met de app?
17. Op wat voor manier zou jij als docent een rol willen spelen tijdens een les met de app?

Afsluiting
Heb je nog vragen of opmerkingen? Wil je nog terugkomen op eerdere vragen of antwoorden?

Extra vragen bij tijd over
Merk je ook iets van bubbels in de klas?
Wat is de invloed van een docent bij het bespreken van een gevoelig thema?
Wat zijn VMBO-specifieke eigenschappen, wat werkt, wat zijn de valkuilen?
Waar kan de app geplaatst worden in het curriculum?
Op wat voor manier zou je zo'n (bubbel) soort concept overbrengen in de les?

C.2 Protocol for focus groups with students

A. Prototype filterbubbels
Leerlingen kiezen of ze spelen met Jayden/Sophie
Lopen zelfstandig het verhaal door tot EINDE

B. Vragen

- Vond je dit leuk om te doen?
- was het duidelijk? begreep je het?
- Vond je het moeilijk?
- Had je het gevoel dat je keuzes het verhaal bepaalden?
- Heb je alle tekstjes gelezen? Was het teveel tekst? Denk je dat klasgenoten dit zouden lezen?
- Zou je meer keuzes willen? Of minder? Hoe lang is dit leuk om te doen?
- Herken je dit verhaal zelf ook?
- Heb je ook wel eens meegemaakt dat je haatcomments zag onder een video? Of dat je in een bubbel kwam? Meer van hetzelfde zag?

C. Eindgesprek
Stelling: Familievlogs zijn slecht voor kinderen

- Jij was Jayden/Sophie. Wat zouden die er van vinden?
- Denk je dat Jayden/Sophie hetzelfde vindt?
- Waarom komt dit?
- Herken je dit/is dit in het echt ook wel eens gebeurd?
- Vind je het erg dat zoiets kan gebeuren?

D. Prototype filterbubbels, eindgesprek

- Zou je zelf willen typen of is zo een keuze aanklikken fijner?
- Hebben jullie een idee voor andere profielen invulling?
- Is dit een leuk onderwerp/Welke andere onderwerpen zou je willen zien?
- Hebben jullie ideeën hoe we dit leuker/spannender/moeilijker maken?

E. Prototype algoritme spelen
Op beamer, Spelen app met de leerlingen samen
Op papier/bord alvast profielschets invullen in de twee categorieën (leuk/niet leuk)
Leerlingen keuzes laten maken over video's
Na iedere stap, op het bord (of groot papier) bijhouden met denkstappen
Vragen kunnen gaandeweg gesteld worden, of na de app

Vragen tijdens:

- Waarom kiezen jullie voor deze video?
- Waarom kies je niet voor de andere video's?
- Ken je deze video's?
- Kijk je deze video's zelf ook?
- Vind je de video's die YouTube aan jou aanraad leuk?

- Bij welke categorie zou deze video horen?

Doorvragen

- Waarom?
- Wat vind jij daarvan?
- Kan je dat uitleggen?
- Hoe gaat het nu in de klas?
- Denk je dat andere leerlingen daar hetzelfde over denken?
- Kan je hier een voorbeeld van geven?
- Maak je dat zelf ook mee?

F. Vragen na spelen

- Wil je de uitleg van deze activiteit zelf lezen/bekijken in een video of wil je liever dat de docent het uitlegt?
- Had je genoeg informatie over Robin na het lezen van dit profiel?
  - Wil je meer informatie? Zo ja, wat voor informatie?
  - Zouden we het profiel ook weg kunnen laten?
- Vond je het moeilijk om te kiezen tussen de 4 video's?
  - Hoe zou je dit moeilijker maken?
- We hebben nu 4 rondes gespeeld. Zou je nog meer rondes willen spelen? Hoeveel?
- Wil je dit liever samen spelen in een groepje (zoals nu net), of alleen op je eigen laptop of telefoon?
- Wij zijn nu een groepje met z'n allen. En wij hebben dit spel gespeeld. Als we dit met de hele klas spelen, zijn er natuurlijk meer groepjes. Stel je voor dat iedereen een score krijgt aan het einde van het spel. Dus wij krijgen best een hoge score, want we hebben heel veel video's gekozen waar Robin blij van werd. Ieder groepje heeft zo z'n eigen score.
  - Zou je nog meer je best doen als er scores van verschillende groepjes op het bord staan?
  - Zou je nog meer je best doen als je kan winnen?
- Zou je dit leuk vinden om in de klas te doen?
- Hebben jullie nog ideeën hoe we dit spel nog leuker kunnen maken? Jullie spelen misschien zelf ook wel eens spelletjes, of misschien heb je in de les ook wel eens een leuke app of website gebruikt? Is er iets waarvan je denkt, het zou echt cool zijn als dit ook in het spel zat?

C.3 Participants in the design process

Table 13: Students that participated in the design process

ID	Gender	Grade	Project school
PL1	M	2	No
PL2	M	2	No
PL3	M	2	No
PL4	M	2	No
S1	F	3	Yes
S2	F	3	Yes
S3	F	3	Yes
S4	F	1	Yes
S5	M	1	Yes
S6	M	1	Yes
S7	F	1	Yes
S8	M	Kopklas	No
S9	M	Kopklas	No
S10	M	Kopklas	No
S11	F	Kopklas	No
S12	F	Kopklas	No
S13	F	1	Yes
S14	F	1	Yes
S15	F	1	Yes
S16	M	Kopklas	No
S17	M	Kopklas	No
S18	F	Kopklas	No
S19	M	Kopklas	No
S20	F	Kopklas	No

D Activity 2

This appendix contains the videos used in Activity 2 and the screens from Prototype 2.E

D.1 Videos used in Activity 2

For each version of the prototype the profile of Robin is described, the first video, and the videos used in each round. The correct video is made bold.

Prototype 2.A

Profile Robin:
13 years old
Play soccer
Plays Minecraft
Listens to music of Snelle

Startvideo: MINECRAFT Let's Play Aflevering #11

Round 1
NEDERLANDSE Make-up Tutorial! — Nikkie Tutorials
BUILDING a MANSION!! Let's Play Minecraft #52

Round 2
Vaccinatiepaspoort — Zondag met Lubach (S14)
Playing Fortnite with you guys — PewDiePie

Prototype 2.B

Profile Robin:
13 years old
Play soccer
Plays Minecraft
Listens to music of Snelle
Subscribed to: Milan Knol, Supergaande en Touzani

Startvideo: MINECRAFT Let's Play Aflevering #11

Round 1
DE BANKZITTERS BESTELLEN ALLES VAN DE SNACKBAR!— Bankzitters
NEDERLANDSE Make-up Tutorial! — Nikkie Tutorials
Mijn EERSTE DAG in een Minecraft Roleplay server! (Netherlands SMP) #1 — Milan Knol
10 Duurste en Zeldzaamste Auto's ter Wereld! — detoptien

Round 2
RANDOM *ZELDZAME* SKIN CHALLENGE In Fortnite!— Knijn
MALINO DE HOND IN MINECRAFT BUILDOFF! #2 — Milan Knol
Mijn grootste blunder als Imposter in Among Us — GameMeneer
Playing GTA 5 Without BREAKING LAWS For 24 Hours! — Kwebbelkop

Round 3
24 UUR OVERLEVEN IN DE DIERENTUIN (SLAPEN IN HET OLIFANTEN VERBLIJF!)— Milan Knol
Achtervolging motorscooter door politie Utrecht Noord. — Politievlogger Jan-Willem
The Weeknd - Save Your Tears (Official Music Video) — The Weeknd

Stealing SIREN HEAD CARS In GTA 5 RP! — Kwebbelkop

Round 4
IK ZETTE DURE SPULLEN GRATIS OP MARKTPLAATS, EN DIT GEBEURDE ER... — Kalvijn
EEN LEUK CADEAU VAN JADE & HANWE ZIJN HUIS IS AF! — Gio
Gaby Blaaser op de Vlucht - Jachtseizoen'20 #6 — StukTV
Milan Knol op de Vlucht - Jachtseizoen'20 #7 — StukTV

Prototype 2.C

Profile Robin:
13 years old
Play soccer
Plays Minecraft
Listens to music of Snelle
Subscribed to: Milan Knol, Supergaande en Touzani

Startvideo: Minecraft Challenges #14 - HOE IS DIT MOGELIJK?! — Milan Knol

Round 1
DE BANKZITTERS BESTELLEN ALLES VAN DE SNACKBAR!— Bankzitters
NEDERLANDSE Make-up Tutorial! — Nikkie Tutorials
Mijn EERSTE DAG in een Minecraft Roleplay server! (Netherlands SMP) #1 — Milan Knol
10 Duurste en Zeldzaamste Auto's ter Wereld! — detoptien

Round 2
RANDOM *ZELDZAME* SKIN CHALLENGE In Fortnite!— Knijn
MALINO DE HOND IN MINECRAFT BUILDOFF! #2 — Milan Knol
Mijn grootste blunder als Imposter in Among Us — GameMeneer
Playing GTA 5 Without BREAKING LAWS For 24 Hours! — Kwebbelkop

Round 3
24 UUR OVERLEVEN IN DE DIERENTUIN (SLAPEN IN HET OLIFANTEN VERBLIJF!)— Milan Knol
Achtervolging motorscooter door politie Utrecht Noord. — Politievlogger Jan-Willem
The Weeknd - Save Your Tears (Official Music Video) — The Weeknd
Stealing SIREN HEAD CARS In GTA 5 RP! — Kwebbelkop

Round 4
IK ZETTE DURE SPULLEN GRATIS OP MARKTPLAATS, EN DIT GEBEURDE ER... — Kalvijn
EEN LEUK CADEAU VAN JADE & HANWE ZIJN HUIS IS AF! —Gio
Bram Krikke op de Vlucht - Jachtseizoen'19 #1 — StukTV
Milan Knol op de Vlucht - Jachtseizoen'20 #7 — StukTV

Prototype 2.D

Profile Robin:
13 years old
Subscribed to: Milan Knol, Supergaande en Touzani

Round 1
DE BANKZITTERS BESTELLEN ALLES VAN DE SNACKBAR!— Bankzitters
NEDERLANDSE Make-up Tutorial! — Nikkie Tutorials
Mijn EERSTE DAG in een Minecraft Roleplay server! (Netherlands SMP) #1 — Milan Knol

10 Duurste en Zeldzaamste Auto's ter Wereld! — detoptien

Round 2
RANDOM *ZELDZAME* SKIN CHALLENGE In Fortnite!— Knijn
FIFA BATTLE CHAMPIONS LEAGUE PSG-BARCE — TOUZANI TV
Mijn grootste blunder als Imposter in Among Us — GameMeneer
Playing GTA 5 Without BREAKING LAWS For 24 Hours! — Kwebbelkop

Round 3
10 IRRITATIES TIJDENS VOETBAL! — Dylanhaegens
Achtervolging motorscooter door politie Utrecht Noord. — Politievlogger Jan-Willem
The Weeknd - Save Your Tears (Official Music Video) — The Weeknd
Stealing SIREN HEAD CARS In GTA 5 RP! — Kwebbelkop

Round 4
IK ZETTE DURE SPULLEN GRATIS OP MARKTPLAATS, EN DIT GEBEURDE ER... — Kalvijn
EEN LEUK CADEAU VAN JADE & HANWE ZIJN HUIS IS AF! — Gio
Touzani op de Vlucht - Jachtseizoen'19 #6 — StukTV
Milan Knol op de Vlucht - Jachtseizoen'20 #7 — StukTV

Prototype 2.E

Profile Robin:
13 years old
Subscribed to: Milan Knol, Supergaande en Touzani

Round 1
TOP 10 DUURSTE AUTO'S VAN NEDERLANDSE YOUTUBERS — TOP LIJSTJES
MAKE-UP doen met SQUISHIES?! — OnneDi
MIJN DROOMHUIS BOUWEN MET JEREMY FRIESER! — Milan Knol
DE BANKZITTERS BESTELLEN ALLES VAN DE SNACKBAR!— Bankzitters

Round 2
JE MAG NIET LACHEN! (Fortnite) — Alex Klein 2
HET GEHEIM van de VRIJE TRAP VAN WESLEY SNEIJDER — TOUZANI TV
Mijn grootste blunder als Imposter in Among Us — GameMeneer
Playing GTA 5 Without BREAKING LAWS For 24 Hours! — Kwebbelkop

Round 3
FIFA TOERNOOI BEPAALT BESTEMMING! - Bestemming Onbekend #4 — Dylanhaegens
NEW ELEMENTAL SUPERCARS in GTA 5 RP! — Kwebbelkop
Billie Eilish - Your Power (Official Music Video) — Billie Eilish
Achtervolging motorscooter door politie Utrecht Noord. — Politievlogger Jan-Willem

Round 4
IK GAF WILDVREEMDE MENSEN 1000,- OM CADEAU'S VOOR ME TE KOPEN — Kalvijn
Touzani op de Vlucht - Jachtseizoen'19 #6 — StukTV
EEN LEUK CADEAU VAN JADE & HANWE ZIJN HUIS IS AF! — Gio
De Kluis'19 #1 — Milan Knol, Jayjay Boske & GameMeneer — StukTV

D.2 Screens of prototype 2.E

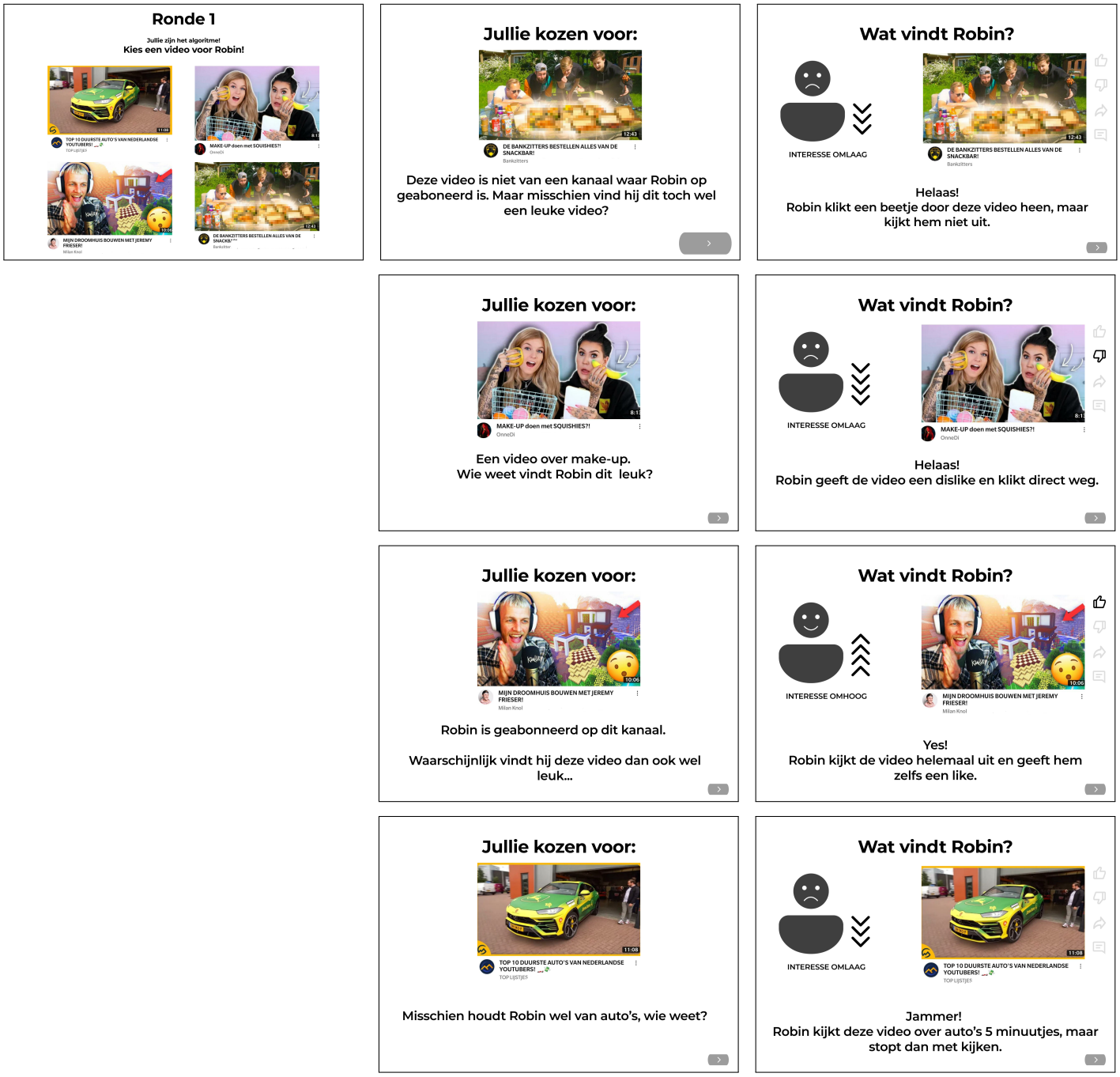


Figure 14: Screens of the first round of Prototype 2E

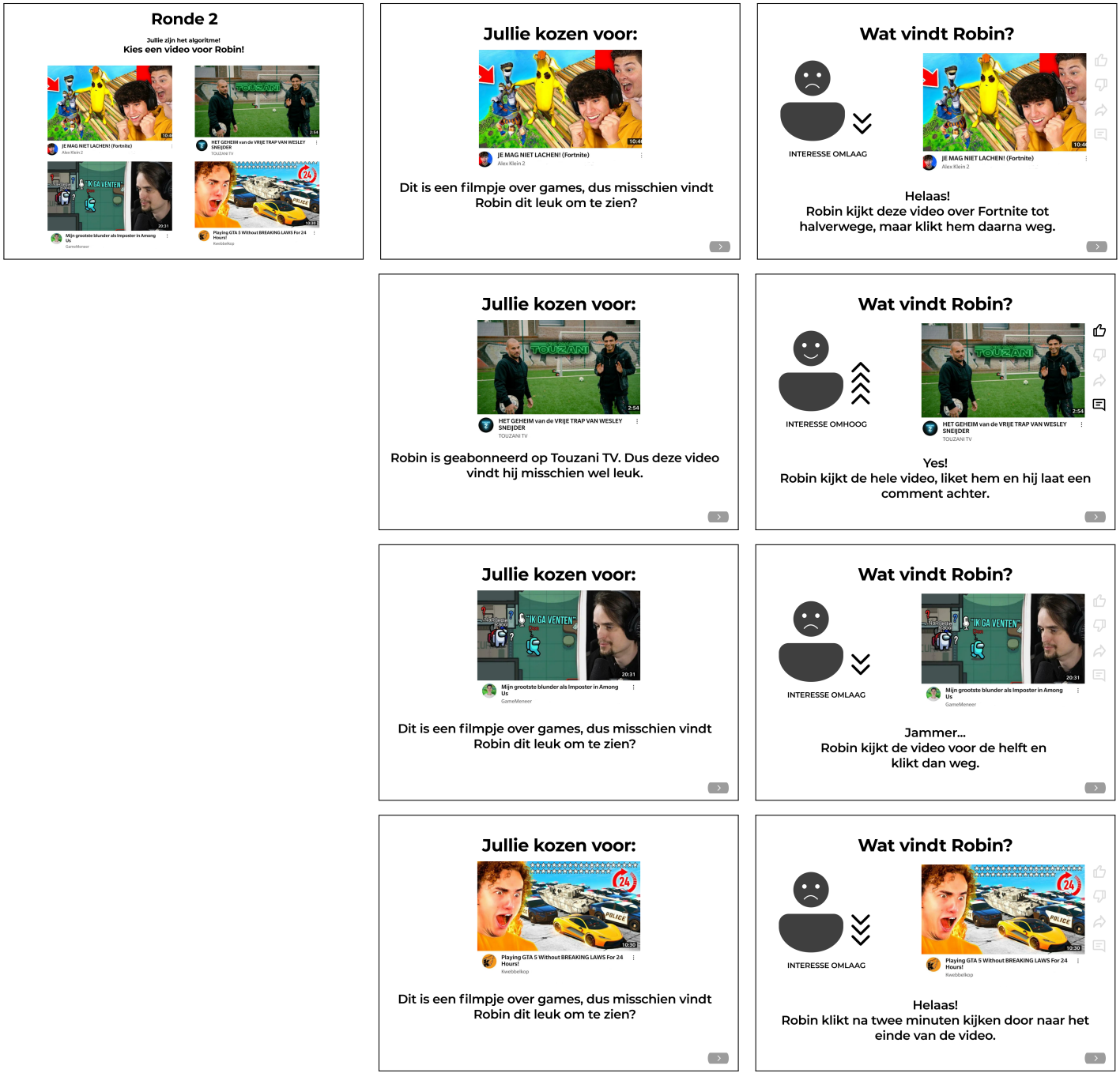


Figure 15: Screens of the second round of Prototype 2E

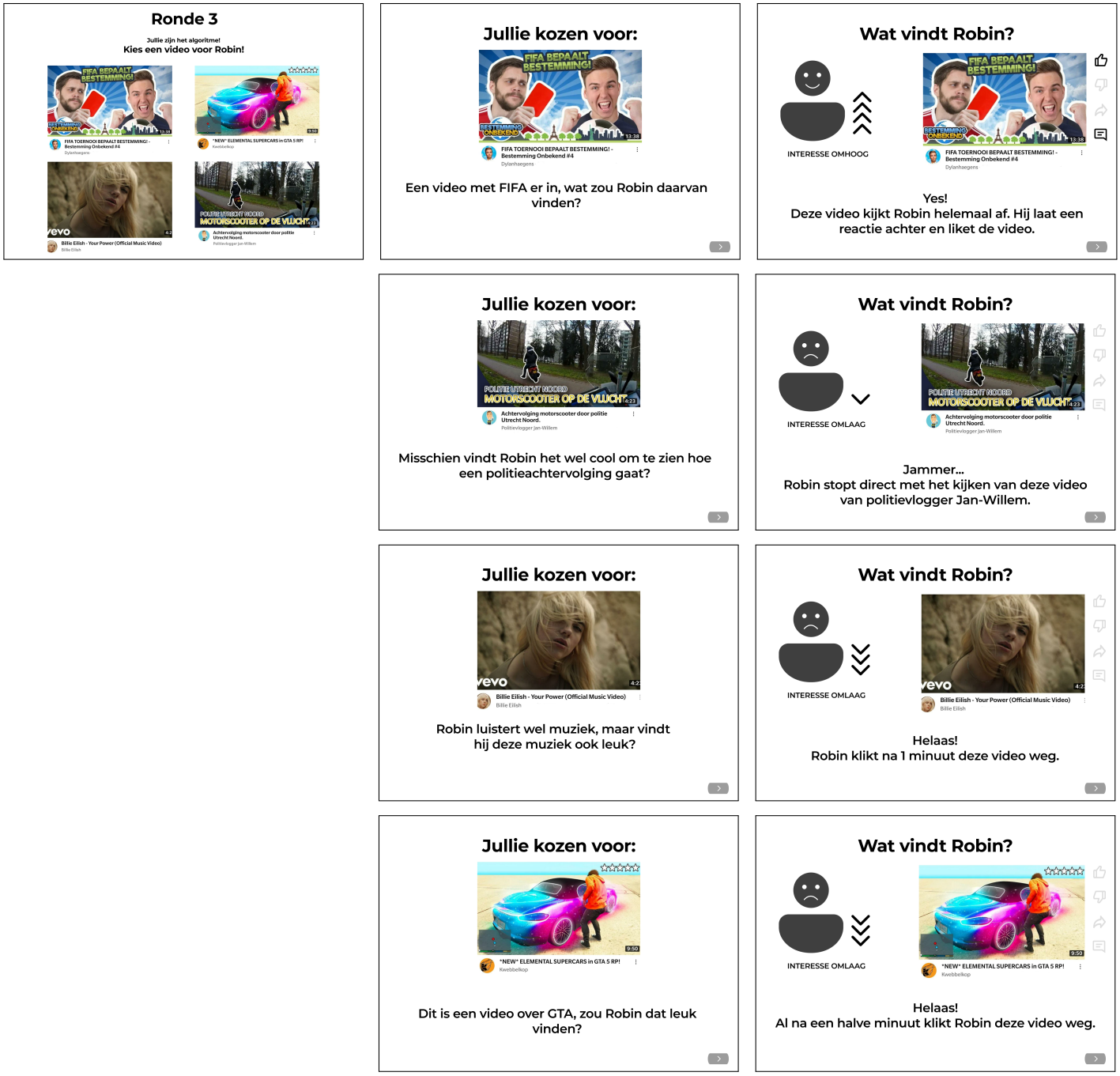


Figure 16: Screens of the third round of Prototype 2E

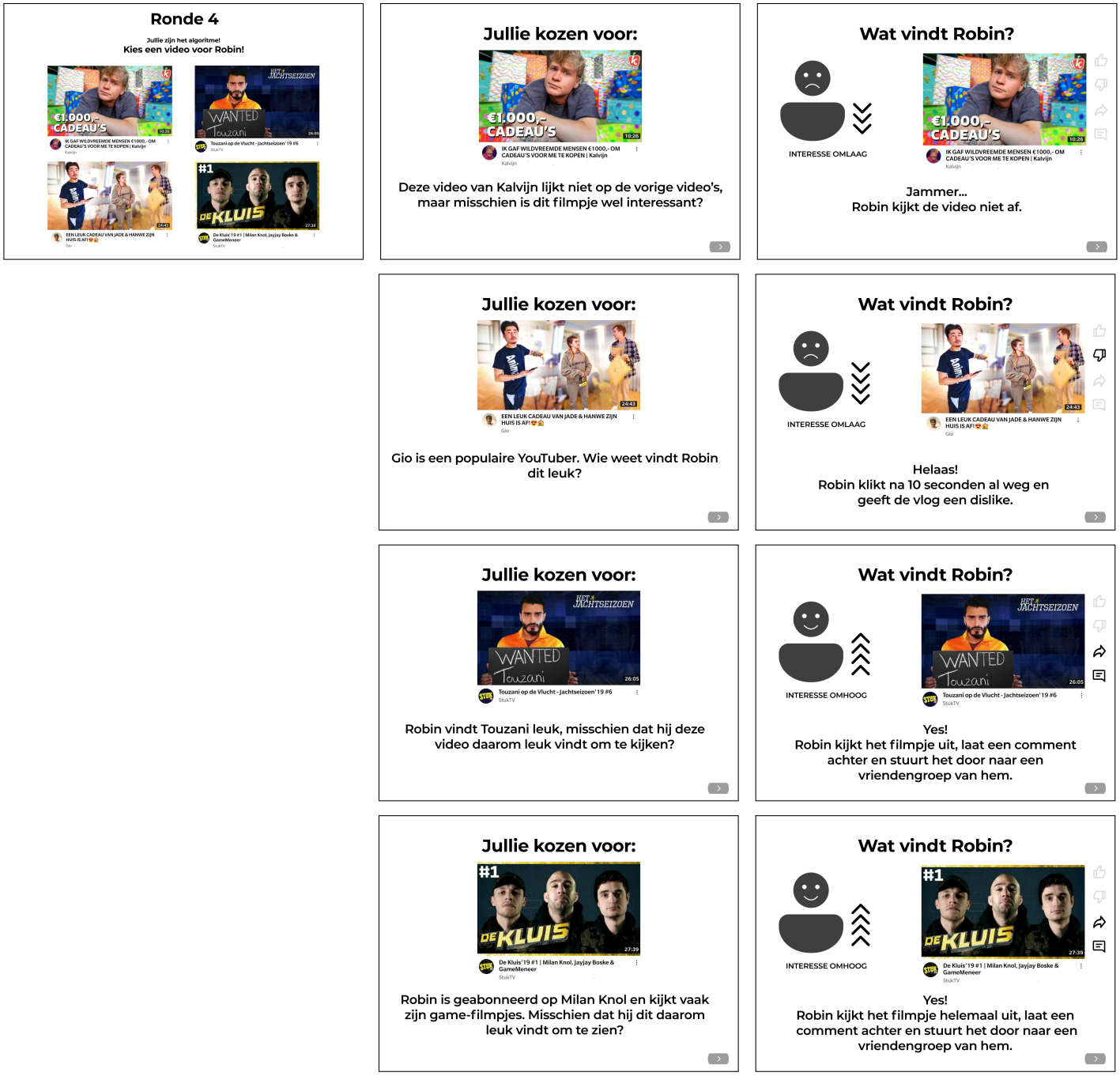


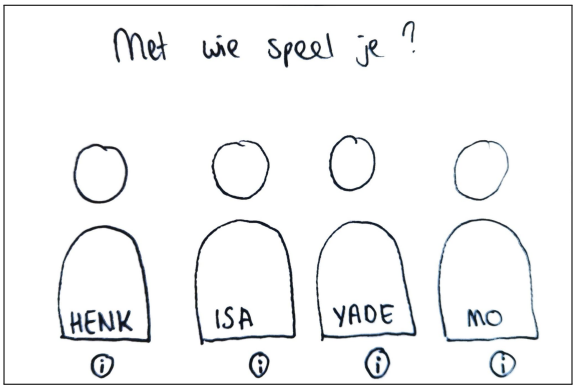
Figure 17: Screens of the fourth round of Prototype 2E

E Activity 3

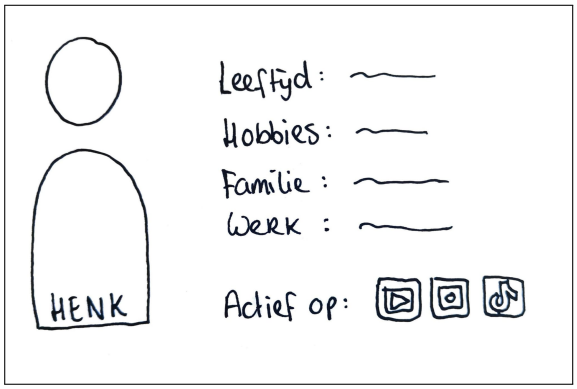
This appendix contains the initial sketches of Activity 3, the storylines of Jayden and Sophie, and the screens of Jaydens in the prototype.

E.1 Sketches for Activity 3

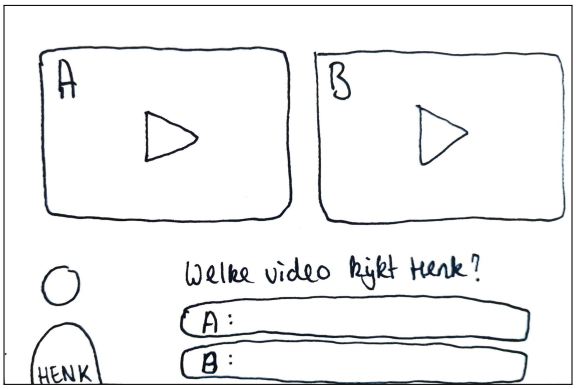
Below you can see the initial sketches of Activity 3, that were made after the brainstorm.



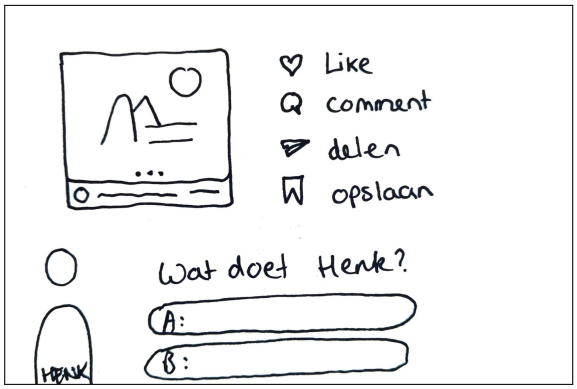
(a) Choosing a character to play with



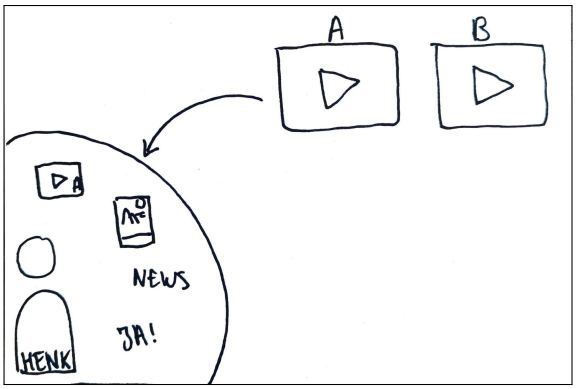
(b) Profile of a character



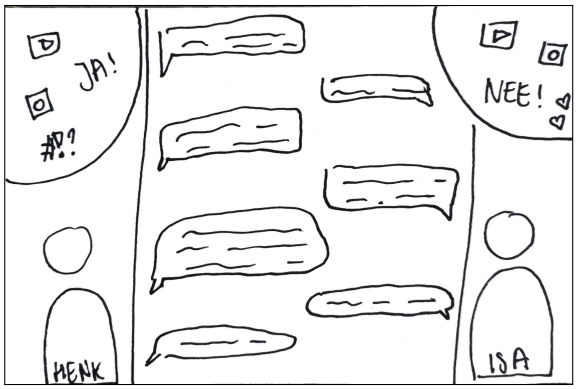
(c) Example of the choice between two options



(d) Example of the choice between two options



(e) Options are placed in the bubble



(f) Chat with a different character

Figure 18: Initial sketches of Activity 3

E.2 Activity 3 - Storylines

The storylines used in the prototype are described below. When there are two options to choose from, the note between brackets tells you where the next part of the story is located.

E.2.1 Jayden

T1 Jayden hoort van een vriend over de familie Baaij, ze maken video's over hun leven. Jayden is benieuwd. (C1)

C1 Waar zoekt hij meer informatie?
- C1.A YouTube (T3)
- C1.B Google (T2)

T2 Hij leest dat de Familie Baaij een YouTube kanaal heeft en dagelijks vlogt. (C2)

C2 Wat doet hij nu?
- C2.A Kanaal opzoeken op YouTube (T3)
- C2.B Verder lezen op Google (T4)

T3 Jayden vindt het kanaal van de familie Baaij op YouTube. Hij kijkt wat rond. (C3)

T4 Na wat artikelen over de Familie Baaij en foto's van prijzen die ze hebben gewonnen, komt Jayden uit bij het YouTube kanaal van de Baaij. (C3)

C3 Welke video kijkt hij?
- C3.A Video over de eerste verjaardag van kind (T5)
- C3.B Video over de geboorte van kind (T5)

T5 Jayden leest in een comment dat het helemaal niet goed is voor een kind om zoveel in beeld te zijn. Hij wil weten of dit echt zo is! (C4)

C4 Jayden gebruikt Google en zoekt naar 'kind familievlogs slecht'. Waar klikt Jayden op?
- C4.A Krantenartikel: 'Kinderen in vlogs: trauma voor het leven' (T6)
- C4.B Video: Baaij gebruikt kinderen voor geld (T7)

T6 Jayden is in shock door dit artikel. Kinderen in vlogs hebben hier soms nog jaren last van. Als je de hele tijd gefilmd wordt heeft dat veel invloed op je leven. (T8)

T7 Jayden is in shock door deze video. De kinderen van de familie Baaij worden gebruikt om reclame te maken. Dat is toch niet goed voor een kind? (T8)

T8 Jayden is boos. Hij vindt het niet oké dat de kinderen van de familie Baaij zo worden behandeld. Hij besluit er iets van te zeggen. (C5)

C5 Hij klikt een video aan op YouTube. Wat doet hij?
- C5.A Dislike geven (T9)
- C5.B Haatcomment achterlaten (E)

T9 Jayden ziet dat de comments alleen maar positief zijn. Hij wil die mensen vertellen hoe slecht de Baaij vlogs zijn voor de kinderen. (C6)

C6 Wat zet Jayden in zijn comment?
- C6.A 'Denk aan die kinderen! Dit is geen leven zo! STOP HET NU!' (E)

C6.B ‘BELACHELIJK! Dit moet verboden worden!! Weg met de Baaij!’ (E)

E Jayden vindt het schandalig en laat haatcomments achter. Hij doet dat ook bij andere video’s. Dit moet stoppen!

E.2.2 Sophie

T1 Sophie scrollt door de YouTube trending pagina en komt een video tegen van de familie Baaij. De thumbnail ziet er aantrekkelijk uit. (C1)

C1 Wat doet Sophie?
- C1.A Video bekijken (T2)
- C1.B Naar het kanaal van de familie Baaij (T3)

T2 Sophie moet erg lachen om wat er allemaal in de video gebeurt. De vader maakt leuke grapjes en de kinderen doen leuke dingen. (C2)

C2 Wat doet Sophie nu?
- C2.A Nog een video aanklikken (T4)
- C2.B Naar het kanaal van de familie Baaij (T3)

T3 Sophie vindt het kanaal van de familie Baaij op YouTube. Ze kijkt wat rond en ziet ook links naar hun andere social media. (C3)

T4 Sophie kijkt nog een video en vindt deze net zo leuk. Aan het einde van de video vraagt de moeder om ze te volgen op social media. Sophie lijkt dit wel leuk. (C3)

C3 Naar welke social media gaat Sophie?
- C3.A Instagram (T5)
- C3.B TikTok (T5)

T5 Sophie scrollt door een paar berichten heen, en vindt het zo leuk dat ze de tijd bijna vergeet. (C4)

C4 Wat doet Sophie?
- C4.A De familie Baaij volgen op social media (T6)
- C4.B Abonneren op de familie Baaij op YouTube (T7)

T6 Sophie kijkt elke dag wel een filmpje dat voorbij komt op social media. Één filmpje vindt ze zo leuk dat ze een comment wil achterlaten. (C5)

T7 Sophie kijkt elk filmpje dat de familie Baaij plaatst op YouTube. Ze ziet dat de dochter een shirt aan heeft dat zij zelf ook heeft en wil daar een comment over achterlaten. (C5)

C5 In de comments staan veel haatreacties en mensen die zeggen dat het zielig is voor kinderen dat ze altijd gefilmd worden. Sophie schrikt hier van. Wat doet ze?
- C5.A Een positieve comment achterlaten (T8)
- C5.B Reageren op een van de haatcomments (C7)

T8 Iemand reageert op haar comment dat ze niet dit soort kanalen moet aanmoedigen en dat ze normaal moet doen. (C6)

C6 Sophie wordt hier boos van en wil reageren. Wat typt ze?
- C6.A ‘Hoezo doe je zo moeilijk, als ik dit leuk vind om te kijken mag dat toch gewoon!’ (E)
- C6.B ‘Bemoei je lekker met je eigen zaken, ik kijk wat ik wil’ (E)

C7 Wat typt Sophie?

C7.A ‘Die ouders weten toch wel beter dan jij wat hun kinderen leuk vinden!’ (E)

C7.B ‘Als je dit niet leuk vindt waarom ben je dan hier!’ (E)

E Sophie vindt het niet leuk dat mensen de familievlogs zo aanvallen en reageert fel op de haatcomments in de reacties.

E.3 Screens of Prototype 3 - Jayden

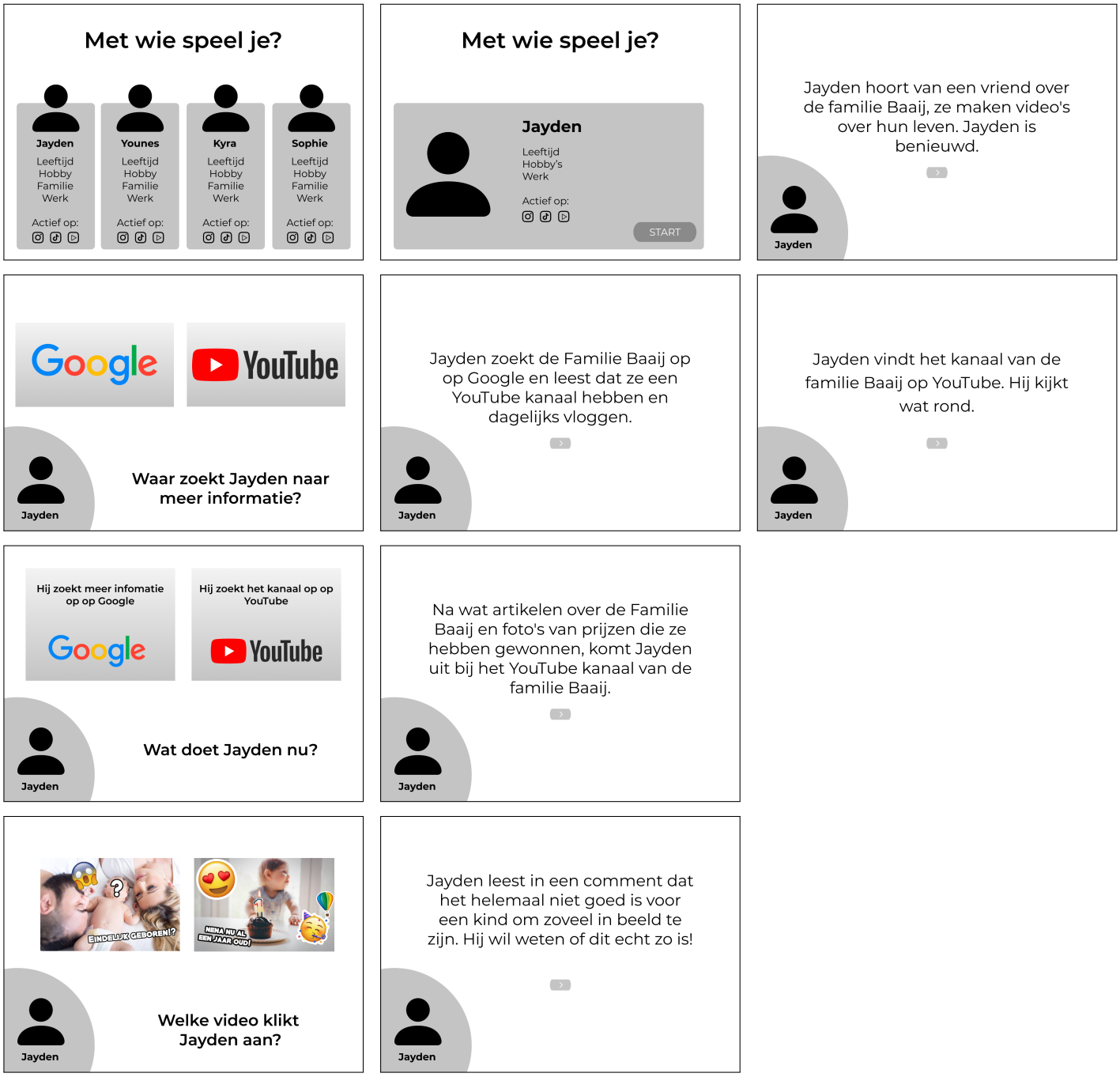


Figure 19: Screens of Prototype 3, for the story of Jayden

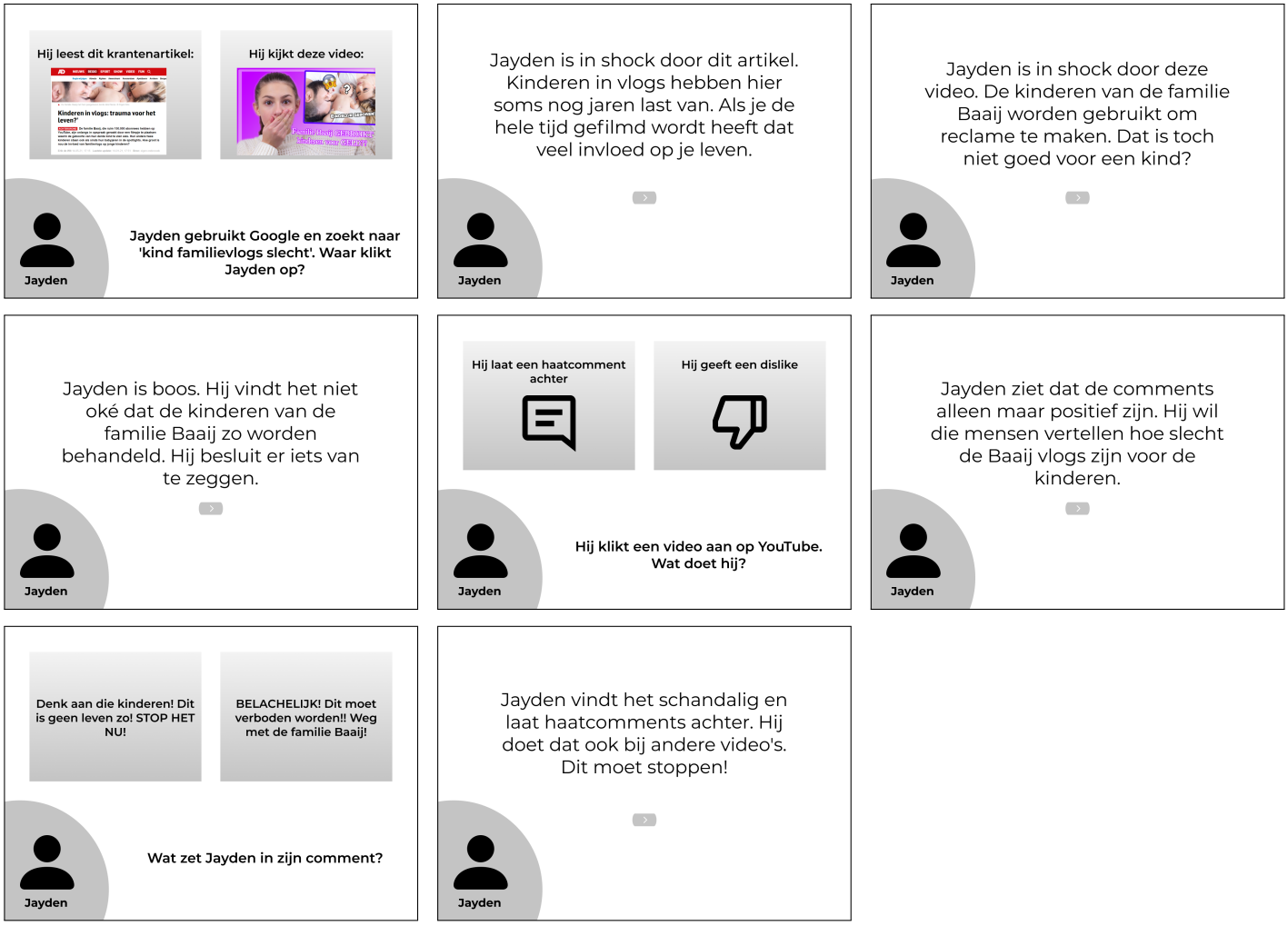
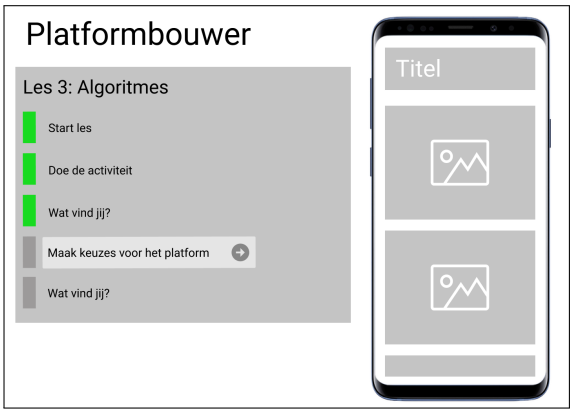
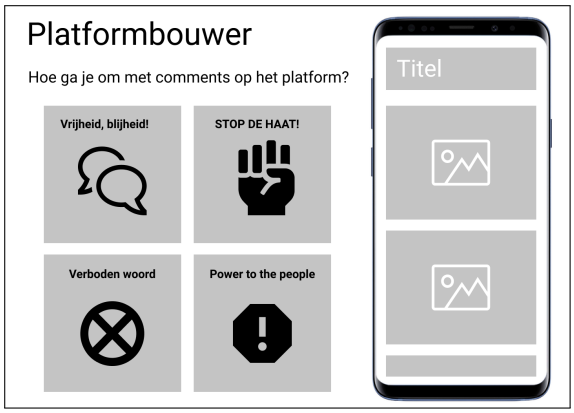


Figure 20: Screens of Prototype 3, for the story of Jayden

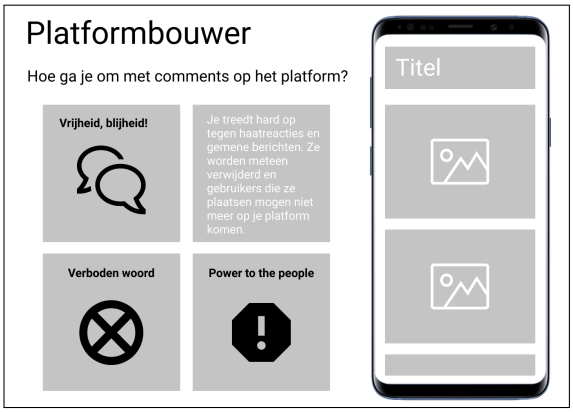
F Overall idea for the application - Version 2



(a) Updated home screen, after activity is done



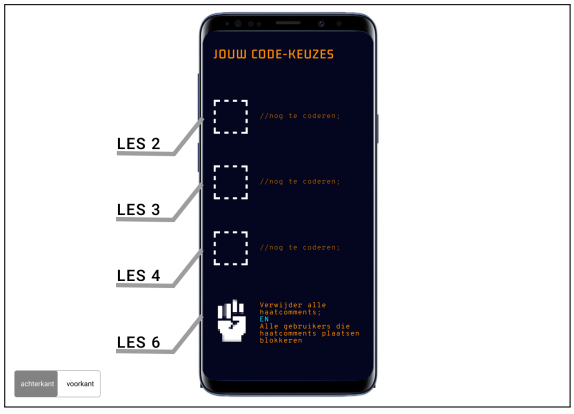
(b) Choice for the platform



(c) Information when hovering over an option

(d) Consequences of the choice made

(e) Front-end of the platform, after the choice is made to block comments



(f) Back-end of the platform, after a choice is made in lesson 6

Figure 21: Lo-fi prototype of the framework of the application

G Evaluation

This appendix contains the participants of the evaluation, the questionnaires used, the interview protocol for the teachers, and some additional results.

G.1 Student participants in the evaluation

Table 14: Students who participated in the evaluation. An asterisks (*) indicates that the student also participated in the design process

ID	Age	Gender	Project school
S8*	13	M	No
S9*	12	M	No
S10*	13	M	No
S11*	12	F	No
S13*	14	F	Yes
S15*	13	F	Yes
S21	12	M	Yes
S22	13	M	Yes
S23	13	M	Yes
S24	12	F	Yes
S25	13	F	Yes
S26	12	F	Yes
S27	12	F	Yes

G.2 Algorithm Knowledge Questionnaire

1. Weet je wat een algoritme is?
   (a) Ja en ik kan ook uitleggen wat het (ongeveer) is
   (b) Ja, maar ik vind het lastig om het precies uit te leggen
   (c) Nee, maar ik heb er wel ooit van gehoord
   (d) Nee en ik heb er ook nog nooit van gehoord
2. Kan je in je eigen woorden uitleggen wat het algoritme van YouTube doet? Als je niet weet wat het is, schrijf je op: ik weet het niet. *[open vraag]*
3. Stel je voor, jij en een klasgenoot bekijken dezelfde video op YouTube, allebei op je eigen telefoon. Jullie zien dat de video's die worden aanbevolen verschillend zijn. Kan je uitleggen waarom YouTube andere video's aanbeveelt? *[open vraag]*
4. Als iemand een video kijkt op YouTube worden er daarna altijd verschillende video's aanbevolen aan de kijker. Die staan aan de rechterkant als je YouTube gebruikt op een computer/laptop/tablet en onder de video als je YouTube gebruikt op een telefoon. Hoeveel invloed hebben de volgende dingen op de video's die YouTube uitkiest:
   (a) De video's die iemand bekijkt
   (b) De video's die iemand liket of disliket
   (c) De reacties die iemand achterlaat onder een video
   (d) De kanalen waarop iemand geabonneerd is

   [5-punt Likert scale: helemaal geen invloed - bijna geen invloed - een beetje invloed - best veel invloed - heel veel invloed]

G.3 IGEQ - Ingame Game Experience Questionnaire

1. Ik was geboeid door het verhaal van het spel
2. Ik voelde me succesvol
3. Ik voelde me verveeld
4. Ik vond het indrukwekkend
5. Ik vergat alles om me heen
6. Ik was gefrustreerd
7. Ik vond het saai
8. Ik was prikkelbaar (ik was snel geïrriteerd)
9. Ik was er goed in
10. Ik ging helemaal op in de game
11. Ik voelde me tevreden
12. Ik voelde me uitgedaagd
13. Ik had het gevoel dat ik aan het leren was
14. Ik voelde me goed

[Antwoorden op een 5-punt Likert scale: Helemaal niet - Een beetje - Gemiddeld - Best wel - Heel erg]

G.4 Interview protocol teachers

Introductie
We hebben al een keer eerder gesproken, inmiddels zijn we bijna aan het einde van dit project. Er zijn prototypes ontwikkeld voor 2 activiteiten en zijn die nu aan het evalueren. We horen graag wat je ervan vindt, alles wat je zegt is nuttig. Als docent ben je expert in het lesgeven en werken met jongeren, dus je input is heel waardevol.

Algemene vragen

1. Wat vind je van samenwerken in groepjes in de klas?
2. Wanneer pas je samenwerken toe in de les en wanneer juist niet? Bij wat voor type opdrachten/lessen/doelen?
3. Waar leren leerlingen het meest van, samenwerken of individueel werken? Waardoor komt dit?

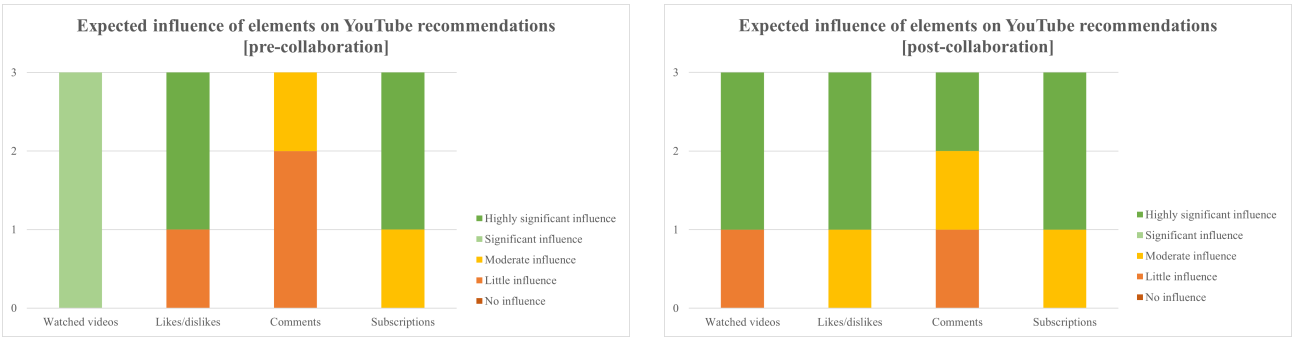
Vragen over het prototype
[Activiteit laten zien, uitleggen in context van de les en de verschillen tussen samen/alleen spelen]

4. Wat zou je ervan vinden als deze activiteit in groepjes gedaan werd?
5. Wat zou je ervan vinden als deze activiteit alleen gedaan werd?
6. Waar leren leerlingen het meest van, de activiteit doen in groepjes of alleen?
7. Wat zou jij als docent het liefst zien, samenwerken of individueel werken?
8. Wat zouden leerlingen het liefst doen, samenwerken of individueel werken?
9. Zijn er praktische tips waar we op moeten letten als dit in de klas gespeeld wordt?

Praktijkvoorbeelden van leerlingen

- "Het wordt wel heel leuk en je gaat wel veel leren van anderen, want ze gaan ook hun mening zeggen [...] dus je gaat veel overleggen."
- "Het duurt wel langer als het in een groepje is"
- "Alleen is fijner, want dan kan je zelf keuzes maken"

G.5 Results - Algorithm questionnaire Q4



(a) Pre-activity

(b) Post-activity

Figure 22: Results of Q4 of the algorithm knowledge questionnaire, in the collaboration condition