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Tackling bullying with technology

A literature review of existing bullying prevention solutions

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Abstract

Bullying is a serious problem that affects people all around the world, particularly children. The consequences of bullying are so severe that the issue cannot be set aside. There are multiple ways to tackle bullying, and in recent years technology has been brought up as a possible solution. There are different kinds of technological solutions that have different points-of-view to the issue and on how to solve it.

The research method applied in this thesis was a literature review of the technological solutions that have been developed to battle bullying. The purpose of the study was to examine and describe the existing bullying prevention technologies and their distinctive features. Two databases were used to gain material for this study, and through very strict exclusion criteria and several analyses from over 2000 search results, 15 articles were included in this study.

Bullying and cyberbullying as concepts are explained. The study results pointed out four groups of possible solutions to bullying: Serious Games, anti-bullying apps, bullying detecting algorithms, and solutions that combine more than one type of technology as well as one group for cyberbullying. These groups are presented with suitable examples and their identified distinctive characteristics.

Keywords

Bullying; Cyberbullying; Online harassment; Children; Adolescent; Youth; Teenager

Contents

Abstract	2
1. Introduction	4
2. Research methods	6
3. Prior research	8
3.1 Bullying	8
3.1.1 Serious Games against bullying	9
3.1.2 Apps against bullying	11
3.1.3 Algorithms against bullying	13
3.1.4 Combined solutions against bullying	13
3.2 Cyberbullying	17
3.2.1 Technology against cyberbullying	17
4. Discussion	19
4.1 Existing solutions for tackling bullying with technology and their distinctive characteristics.	20
4.2 Suitable methods for the bullying battle	21
4.3 The perfect solution	22
5. Conclusions	24
References	25
Appendix A. Research plan	27
Appendix B. Literature findings	28

1. Introduction

Bullying is a serious, world-wide problem that affects a multitude of people, especially children and teenagers. It is a phenomenon that increasingly concerns the entire society (Raminhos et al., 2015). Over 50 percent of students around the world are said to be involved in some form of bullying, either as a victims, bullies, or bystanders (Calvo-Morata et al., 2020). School bullying is a very common problem among children and teenagers. It causes many negative consequences and is one of the main reasons for depression among adolescents (Gao & Ye, 2019). Bullying needs to be stopped no matter where or how it happens, and everybody, especially adults, should be taking action to make sure the younger generations can grow up without the fear of being bullied (Hall, Jones, Paiva, & Aylett, 2009; Ivvari et al., 2021).

In Finland, a widely known bullying prevention strategy used at schools is the KiVa antibullying program by Yang and Salmivalli (2015). Research data shows that the program does help reduce bullying cases, and many other studies, such as the one by Neo and others (2018), have even used the KiVa program (Yang & Salmivalli, 2015) as a base for their research because there is concrete data that the program has made a significant difference. Not only has the program reduced bullying incidents, but it has also made a difference in the anxiety and depression levels among Finnish children, which has led to better academic results and higher self-esteem.

One issue that is raised by the KiVa -program (Yang & Salmivalli, 2015) is the lack of cyberbullying prevention—at least there is little mention of it. Children use computers and smartphones even during the school day, so the online aspect of bullying cannot be forgotten any longer. While technology certainly brings a lot of advantages to schools, it also brings many problems, with only one of them being cyberbullying as stated by Cohen and her research group (2014). Although the results of the KiVa program (Yang & Salmivalli, 2015) seem good, bullying has not disappeared from Finnish schools, which means we cannot solely rely on the KiVa program any longer. Other, more technology-focused methods could contribute to a more positive outcome in this situation.

In addition, bullying can be seen as a wicked problem, which means that the problem can eventually be impossible to solve. Wicked problems are issues that are made up of many independent, incomplete factors that are difficult to define and would require a deep understanding of all the stakeholders (Interaction Design Foundation, 2021). That does not mean that attempts should not be made to find ways of dealing with the issue, it just means that the problem of bullying is so inherently difficult that there are no any easy fixes or solutions that would work for every situation and all around the world. There are no definitive answers to wicked problems, and the suitability of solutions differs based on the individuals (Interaction Design Foundation, 2021).

Recently bullying has been much discussed in the Finnish media. There are currently many on-going discussions (f. ex. Kantola, 2021) concerning bullying and how it should be taken into consideration even on the level of legislation. These discussions were brought up once again because of recent incidents where bullying became incontrollable and the consequences were devastating. The court cases currently on the news prove that this issue is not a minor thing and that the current actions are not sufficient anymore (Kantola, 2021).

Technology has become a huge part of our life and it is also widely used in schools. Therefore, technology has also been brought up as a solution to tackle bullying, but none

of the proposed solutions have yet seen much use. There are solutions like Serious Games (e.g., Calvo-Morata et al., 2020) as well as different kinds of apps (e.g., Neo, Teo, & Boon, 2018) and algorithms (e.g., Ye, Shi, Ferdinando, Seppänen, & Alasaarela, 2020) that can be used to deal with bullying.

The aim of this study is to examine and describe the bullying prevention strategies from a technological point of view. The research question of this study is “*What are the existing solutions for tackling bullying with technology in the literature and what are their distinctive characteristics?*” This study is a literature review, and the kinds of solutions found from suitable literature are listed with examples. The prior research starts with the definition of bullying, and after the previously mentioned listed solutions, there is a short narrative on cyberbullying—should cyberbullying be considered as bullying or as an entirely separate thing, and how technology can be used to tackle it. The study ends with a discussion concerning the found solutions and a proposition of what could be the most suitable solution.

I conducted the literature review as part of a bigger project called “Make-a-Difference” at the University of Oulu, INTERACT Research unit. The Make-a-Difference project is a four-year project funded by the Academy of Finland, and the project started in January 2020. The project aims to understand critical design and making identities among children and has focused on designing solutions for tackling school bullying together with the children.

The Make-a-Difference project aims to understand and facilitate the emergence of critical designer and maker identities among children. This will be accomplished by exploring and engaging in critical design and making activities together with children.

The results of this literature review were first published in “CHI Against Bullying: Taking Stock of the Past and Envisioning the Future” by Iivari and her research group (2021). In this candidate thesis, I present different kinds of bullying prevention solutions that I identified from the material gained through literature searches.

2. Research methods

Research material was collected from the ACM digital library and Scopus. ACM Digital library was chosen first because it includes the most important human interaction related journals and conferences. Although bullying has been much studied in many different fields of study, in this research it was decided to limit the material searches only to human interaction related journals and conferences, so that the results would only demonstrate how much this issue has been studied in relation to this field. It would not benefit this study to include papers from a variety of fields since this issue has been greatly studied.

The first searches were made in ACM to find what has generally already been done when it comes to combining bullying with technology. The keywords used in these first searches were bullying, technology, school bullying, children, adolescent, teenager, young people, prevention, and cyberbullying. The literature searches were limited to papers written in English and published between the years 2005 and 2021. The searches were made with the advanced search function, and the keywords needed to be found in the article title, the abstract, or in the keywords. The data retrieval yielded 1599 results, which were sorted by relevance and skimmed through. The reasons for excluding most of the papers included the main group of participants in the mentioned study not being children or minors, the article referred to some other sort of bullying or violence rather than school-related bullying, and technology was not used as a prevention tool. At this point the literature Excel sheet included 25 articles. The keywords used were found useful and offered some insight into what existing solutions and tactics are already in use. However, the number of papers was deemed too low.

Scopus was used to perform more searches with the same keywords and exclusion criteria. The data retrieval from Scopus yielded 1815 results. In addition, based on the results of the first searches, more suitable articles were found by using the snowball method. The reasons for excluding some papers were the same as listed above, but also if the article did not have any relation to the field of computer science and IT. All the relevant articles were added to one Excel sheet, and in the end the Excel sheet included 146 articles. Out of the 146 articles, 76 are from computing disciplines and 70 from other suitable disciplines. The research workflow is presented in figure 1 below.

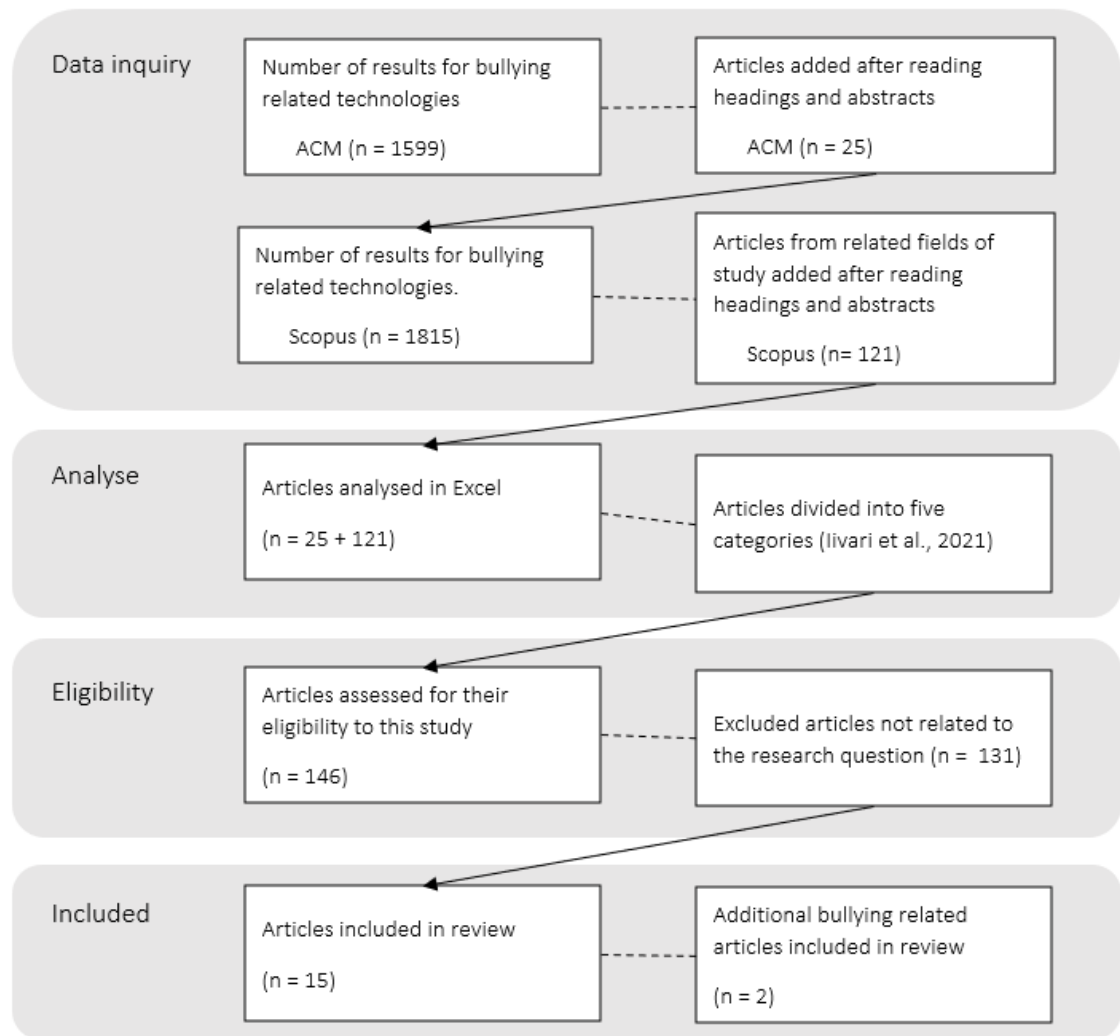


Figure 1. Research material workflow

The articles were divided into five categories: bullying in general, technology, cyberbullying, methods, and bullying prevention/intervention strategies (Iivari et al., 2021). The categories were then analysed again based on the research questions in this literature review, and based on the analysis, in total 15 articles were selected to this study. The 15 articles that were chosen present clear possible solutions against bullying. At this point most of the articles were excluded since they did not provide any concrete solutions to bullying, as the technology presented in these articles was used as a data-collecting method instead of as a solution or the solutions were presented by someone else and only evaluated in the article. However, the solutions presented in this study are only examples of possible solutions and there are countless numbers of articles that could have been included as well. The technologies recognized by this study are later divided into groups to help identify their distinctive characteristics. The articles used in this study are listed in Appendix B.

Additional searches were made in Scopus to gain more information about bullying in general. These searches were not limited to any special journal, conference or field and the main goal was to find how to define bullying as a concept. Two articles were included and used for that purpose.

3. Prior research

The prior research chapter starts with the important definition of bullying. The chapter details how bullying is described in the literature and how the problem is currently being dealt with in Finland. The main part of the chapter focuses on the technological solutions against bullying. Cyberbullying is addressed separately from traditional bullying, and the possible solutions against cyberbullying are also separately presented.

3.1 Bullying

A widely used definition of bullying by Dan Olweus (2013) defines bullying as a form of aggressive behaviour against those who cannot for some reason defend themselves. Bullying is making other people feel less of themselves by, for example, calling them names or even physical violence. According to Olweus (2013), bullying is a type of aggressive behaviour that includes intentionality to hurt, repetition over a period of time, and imbalance of power between the bully and the victim.

As stated in the introduction, the KiVa anti-bullying program (Yang & Salmivalli, 2015) is currently highly used in Finnish schools (Yang & Salmivalli, 2015). The program aims to reduce bullying by not only focusing on bullies and victims but also by providing the bystanders with means to intervene (Neo et al., 2018). The KiVa program (Yang & Salmivalli, 2015) emphasizes the role of bystanders in the bullying process by trying to encourage them to support their victimized classmates and friends rather than staying silent or supporting the bullies.

The KiVa program (Yang & Salmivalli, 2015) consists of two parts: the *universal actions* and *indicated actions*. The universal actions are targeted to the entire school through lessons and anti-bullying computer games. The indicated actions are means to tackle the bullying incidents that have already happened. These include, for example, discussions and steps for the school administrators and students to take.

Like the games in the universal actions of KiVa (Yang & Salmivalli, 2015), there are many that are similar, and those games are one of the ways bullying can be tackled by technology. Different technological solutions against bullying exist, and the ways in which they are designed to have an effect also varies. Some of the solutions focus on raising awareness among children and teaching them how it feels like to be bullied or to be the bully. Some of the solutions want to provide children with strategies on how to act or tools for what to do when a bullying situation occurs.

Through material searches four groups of digital prevention solutions against traditional bullying were identified: Serious Games, anti-bullying apps, bullying detecting algorithms, and solutions that combine more than one type of technology. Cyberbullying and how to deal with it are discussed in chapter 3.2.

3.1.1 Serious Games against bullying

Serious Games against bullying are interactive applications that combine the technology of entertaining videogames with a higher purpose (Raminhos et al., 2015). In this case, the higher purpose is preventing bullying. According to Marsh (2011), as referred to by Kolić-Vehovec and others (2020), Serious Games are digital games, virtual environments, or media that use stories and gameplay to affect the players' actions and well-being.

Conectado is a Serious Game made to increase awareness on bullying and cyberbullying, developed by Calvo-Morata and others (2020) in Spain. Unlike in some other games, in *Conectado* the children play only in the role of a victim. It focuses on helping the children to better understand the actual feelings the victims have in bullying situations. Knowledge and information concerning bullying is not seen as important as the feelings the developers want the players to understand. Creating empathy towards the victim is the main goal of the game. (Calvo-Morata et al., 2020.)

The *Conectado* game is said to be a classic "adventure videogame" (Calvo-Morata et al., 2020). In the game, the students live a day in the life of a high-school student. The story proceeds through the choices made in dialogue options, and different choices lead to different outcomes. *Conectado* is targeted to 12–17-year-old students. (Calvo-Morata et al., 2020.)

Kriglstein with her research group (2020) developed **two prototypes of Serious Games** to grow awareness among children about the consequences of bullying. The games were tested by 29 Austrian students aged 11–15 years. In these games the players are put in the role of a bystander in order to see how they themselves could make a difference in those situations. The role of the bystanders can be easily forgotten, but the reactions of bystanders can have a major impact on the situation as well. (Kriglstein et al., 2020.)

The two prototypes had different terms of gameplay (Kriglstein et al., 2020). In one game the players were guided quite strictly from one situation to another, and in the other the players could freely move around in the game world, but the idea of the games was still the same. They wanted to point out how the bystanders can affect a bullying situation with their actions by either accepting the bully's behaviour by not interfering or by helping the victim. (Kriglstein et al., 2020.)

School of Empathy is a Serious Game developed by Instituto Tecnológico de Castilla y León Burgos in Spain as a part of an EU-funded *eConfidence* (2020) project. The *eConfidence* (2020) project started in November 2016 and aims to answer whether Serious Games are an effective instrument of behaviour change in children.

The *School of Empathy* -game consists of minigames that present various situations that happen at school, and the players need to choose a reaction from a list of alternatives in each situation. The situations are presented in three different perspectives: the victim, the bully, and the bystander. The idea behind the game is to provide the children with knowledge about what is an appropriate reaction in a bullying situation and how they can make a difference with their behaviour. (Kolić-Vehovec, Smojver-Ažić, Martinac Dorčić & Rončević Zubković, 2020.)

FearNot! is a virtual learning environment aimed at the battle against bullying (Hall et al., 2006). The idea behind of *FearNot!* is to help children come up with suitable coping strategies by placing them into virtual bullying situations. In *FearNot!*'s virtual

environment, the children can safely go through bullying scenarios that might occur in everyday school life. The bullying situations include physical bullying, verbal bullying, and social exclusion. The FearNot! -software has been tested by over 800 8–12-year-old children in the United Kingdom and Germany. (Hall et al., 2006, Hall et al., 2009.)

In the virtual environment, the children view different situations and then act as an “invisible friend” to the victimized character (Hall et al., 2009). The decisions that the children make in the game act as advice to the victim, who then morphs his/her behaviour in response to the children’s choices. The scenario and the choices combined create a believable drama scene that helps the children develop empathy towards the victims and helps them see how it feels like to be the victim and what they should do if those kinds of situations occur. (Hall et al., 2006, Hall et al., 2009.) The presented Serious Games are summarized in table 1.

Table 1. List of Serious Games

Solution name	Authors	Means of tackling the issue
<i>Conectado</i>	Calvo-Morata et al. (2020)	Developing empathy among children
(No official name, “Game A”)	Kriglstein et al. (2020)	Giving bystanders more knowledge on how to help in the situation
(No official name, “Game B”)	Kriglstein et al. (2020)	Giving bystanders more knowledge on how to help in the situation
<i>School Of Empathy</i>	Kolić-Vehovec et al. (2020)	Developing empathy among children and knowledge on how to help others
<i>FearNot!</i>	Hall et al. (2006)	Providing the children with coping strategies and gaining awareness on bullying

As can be seen from table 1, a common goal of all the Serious Games is that by going through the situations, the children learn more about bullying: what does it mean, how does it feel, and what are the consequences. By playing the games they learn how to help by giving useful advice and know how to take responsibility. The idea behind the games is to affect the behaviour of the children and use that to decrease the amount of bullying incidents in schools.

In terms of user interface, a common aspect of all the presented Serious Games is that they follow the same pattern of style, where the user interface and characters are created in a cartoon-style for it to be less serious for the players to play. When the bullying scenarios are presented with visual and verbal cues, different, even difficult, situations are simpler for the children to go through and understand in depth compared to just text (Kriglstein et al., 2020).

3.1.2 Apps against bullying

An example of an **anti-bullying app** is *#StopBully*. *#StopBully* is an Android-based app aimed at anti-bullying education developed by Neo and others (2018) in Malaysia, and it is meant for raising awareness among teenagers in order to stop bullying. The *#StopBully* (Neo et al., 2018) app has six different features. The first four features are videos, games, quizzes, and comics that were designed to teach the users about bullying and its consequences. The games that the app includes are similar to the previously mentioned Serious Games, where fun and interactive technology is combined with bullying prevention education.

A big part of the *#StopBully* app (Neo, et al., 2018) are the educational games that it contains, but where it differs from the other solutions are the extra features. The two other features are an information page about *Befrienders*, which is an international support centre for suicide prevention. The other feature is an emergency button, which connects the app user directly to suitable authorities. These features can be used in actual bullying situations or while suffering from the negative consequences of being bullied and this way the app is not only for prevention but also for support during and after a situation occurs. (Neo, et al., 2018.)

In their study, Ferreira and others (2020) compared **ten different mobile apps** that can be used against school bullying. They benchmarked the different features of the apps and determined the most relevant features. The study included 10 apps: *School without bullying*; *Bullying no more!*; *Enough of bullying*; *Beat bullying with confidence*; *School bullying*; *School bullying—stop bullying*; *SOS. save our students*; *Stop bullying*; *Bully prevention*; and *No bullying and bullying*. (Ferreira et al., 2020.)

One of the features that can be found in the apps benchmarked by Ferreira and others (2020) is the identification of school bullying incidents, and similar to Serious Games, some of the apps provide the children with coping strategies, give the children information on bullying and present informational videos and articles on the subject. Some of the apps include links to websites that offer means of obtaining help when needed or include news on bullying-related issues. (Ferreira et al., 2020.) All these features can also be identified in the app by Neo and others (2018).

Some of the apps listed by Ferreira and her research group (2020) provide a possibility for the student to virtually connect with teachers or school counsellors, similar to the emergency button in the solution by Neo and others (et al., 2018). Some apps allow the reporting of bullying incidents by messages, videos, photos, or by sound, and some even include violence identification questionnaires (Ferreira et al., 2020). All the previously mentioned apps and features are summarized in table 2 below.

Table 2. List of Apps against bullying

App name	Authors	Primary means of tackling the issue
<i>#StopBully</i>	Neo et al. (2018)	Teaching the users about bullying and its consequences, information pages and emergency button.
<i>School without bullying</i>	Ferreira et al. (2020)	School professional help
<i>Bullying no more!</i>	Ferreira et al. (2020)	List of articles and sites about bullying
<i>Enough of bullying</i>	Ferreira et al. (2020)	Informational videos, list of articles and sites about bullying
<i>Beat bullying with confidence</i>	Ferreira et al. (2020)	Complaint of school violence, informational videos about bullying
<i>School bullying</i>	Ferreira et al. (2020)	School professional help, informational videos about bullying, complaint of school violence, violence identification
<i>School bullying—stop bullying</i>	Ferreira et al. (2020)	Informational videos and list of articles and sites about bullying
<i>SOS. save our students.</i>	Ferreira et al. (2020)	Informational videos about bullying, complaint of school violence
<i>Stop bullying</i>	Ferreira et al. (2020)	Only partially meets the desired features
<i>Bullyprevention</i>	Ferreira et al. (2020)	Violence identification, list of articles and sites and news related to bullying
<i>No bullying and bullying</i>	Ferreira et al. (2020)	Informational videos, list of articles and sites and news related to bullying

As can be seen from table 2, some of the anti-bullying apps offer the students tools to deal with bullying situations on-time or to help identify those situations as well as means of obtaining help when bullying happens. These features can be seen in the #StopBully app (Neo et al., 2018) and also in several of the apps benchmarked by Ferreira and her research group (2020). Some of the apps only work as a means to provide important information to children by, for example, showing videos and related news (Ferreira et al., 2020).

As table 2 further points out, the apps have various means of dealing with the issue, both before and after the bullying incident, but what separates the apps from the other groups of solutions is the on-time aspect and the ability to obtain help during the situation.

3.1.3 Algorithms against bullying

Gao and Ye (2019) as well as Ye and others (2020) have presented **algorithms against bullying**. They have proposed school violence detecting methods that use sensors and algorithms to automatically detect bullying situations in schools. Ye and the other authors (2020) point out that traditional anti-bullying methods, such as the previously mentioned games and apps, rely on the user to operate them. But if the user is in the middle of a bullying situation, they might not be able to operate the system. This is where the different kinds of detection sensors can help because the detection of bullying would happen automatically. (Ye et al., 2020.)

In the study by Gao and Ye done in Finland in 2019, data was collected by movement sensors and sound recordings by monitoring 8 elementary school students. They combined *Activity Recognition* by accelerometers and gyroscopes with *Speech Emotion Recognition*. In the study by Ye and others (2020), also done in Finland, they only focused on motion data and used multi-sensor fusion and improved Relief-F algorithms.

In both studies (Gao & Ye, 2019; Ye et al., 2020), they gathered data by having children act out situations that might happen during their school day, whilst having sensors attached to their legs and arms. The situations acted out by children included school violence activities, such as beating and pushing, as well as daily life activities, such as walking and sitting down. In both cases the motion data was first captured with the sensors attached to the children's legs and arms, and then the motion data was paired up with video recordings from the sessions. As such, the authors were able to adjust the algorithms and allow them to automatically create an alert when a bullying situation happens. (Gao & Ye, 2019; Ye et al., 2020.)

The authors first gathered data, then extracted time domain features and frequency domain features of the activities to describe the characteristics of bullying events (Gao & Ye, 2019; Ye et al., 2020). In the study by Gao and Ye (2019), they also extracted the feature parameters from the sound recordings. Gao and Ye (2019) used an algorithm called *the k-Nearest Neighbor* (k-NN) to classify the features, and Ye and others (2020) used a two-level classifier called the DT-RBF.

3.1.4 Combined solutions against bullying

Combined solutions mean in the context of this study technological bullying detection solutions that combine more than one kind of technology in the system. These systems have a variety of different technologies that might not be meant to tackle bullying separately or on their own, but combining all the parts might still form one suitable solution.

One of the proposed solutions against bullying is *StopBully*, which was developed by Raminhos and others (2015) in Portugal. *StopBully* (Raminhos et al., 2015) includes both a Serious Game that was created to cause attitude changes among children as well as a back office application. The back office application makes the *StopBully* different from the others Serious Games.

A back office application (BOA) is a software that assists the researchers, therapists, and psychologists with data management features that allow them to evaluate the levels of involvement in bullying (Raminhos et al., 2015). The BOA does not interact with the children directly, but was developed to support the research work or therapy that happens

whilst the children play the Serious Game. While the children play, game statistics are sent to the BOA and can be queried by the researcher or psychologist for different data analyses. Raminhos and her research group (2015) state that all the clinical psychologists and psychology researchers in their study said that they would use this kind of Serious Game and back office application in their real work contexts because they really saw the positive value of using the combined solution. This would suggest that the back office application makes the StopBully (Raminhos et al., 2015) a more useful tool than the regular Serious Games.

EmotoTent is an interactive socio-emotional learning system developed by Antle and her research group (2019). The EmotoTent includes four components: biosensing stick-on tattoos, imagery projection headsets, a robotic dog agent, and an interactive 3D holographic tent environment. The EmotoTent was designed to help children regulate their own emotions and teach them how to interact with others with empathy. EmotoTent concept is seen in figure 1 below.



Figure 1. The EmotoTent system concept picture by Antle et al. (2019) including the different components.

As can be seen from figure 1, the EmotoTent (Antle et al., 2019) includes various kinds of components: a 3D holographic tent, robotic dog agent, headsets, and biosensing tattoos. While using the EmotoTent (Antle et al., 2019), each child wears a biosensing stick-on tattoo, which measures brain, heart, and muscle tissue activities. Those activities are translated into emotion data for the other components to use. The imagery projection headsets reconstruct the children's mental imagery according to the emotion data and projects it into interactive holograms inside the tent. The tent then processes the gestures by the children. The robot dog agent is inside the tent with the children mainly for support during the situation, but it can also teach the children about bullying, and the children can play with it. (Antle et al., 2019.)

The EmotoTent (Antle et al., 2019) does not directly tackle bullying, but it helps make the school environment better for everyone by teaching the children how they should deal with others. In their study Antle and others (2019) state that his has been proven to

decrease the amount of bullying and violence but also racism, gender inequality, and other possible discrimination.

Brahnam and others (2015) propose a **bullying detection system** that combines wearable technology with heartrate monitors and surveillance cameras, different mobile devices, cloud computing, and machine learning. The bullying detection system automatically alerts teachers when bullying is detected in its area (Brahnam, Roberts, Nanni, Starr, & Bailey, 2015). The bullying detection system is presented in figure 2.

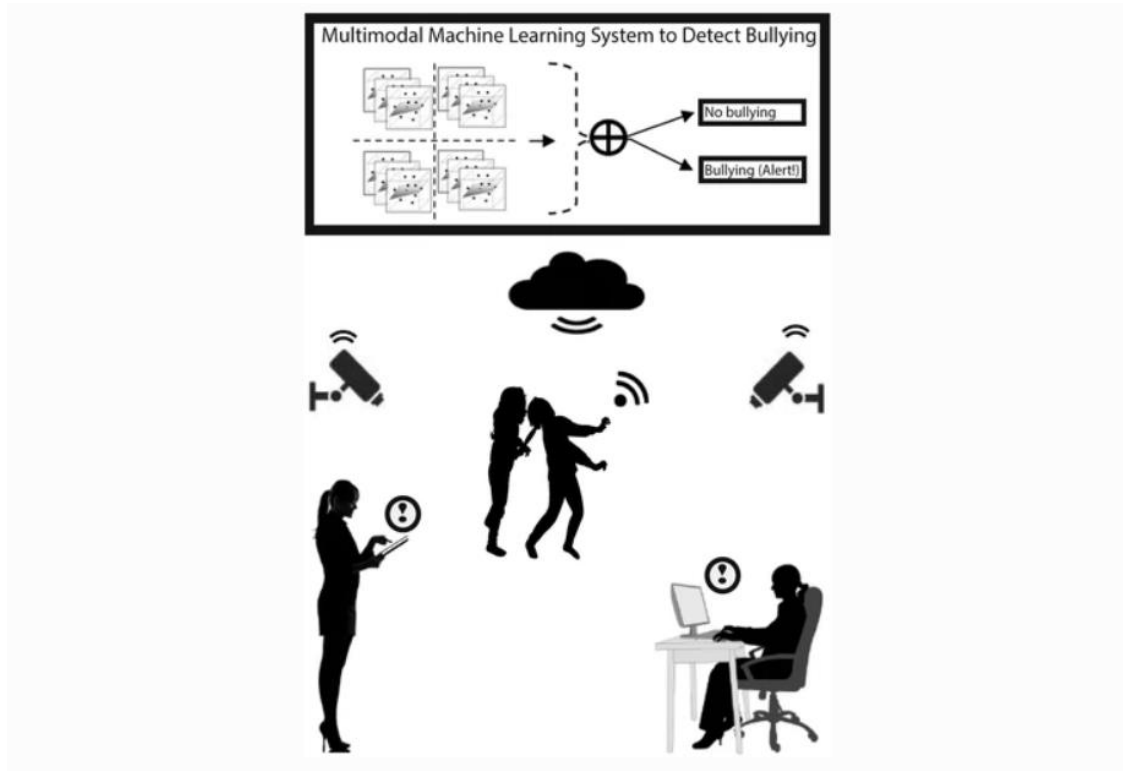


Figure 2. The bullying detection system by Brahnam et al. (2015) including the different components.

As can be seen from figure 2, the bullying detection system uses three ways to detect bullying. Firstly, the system tracks the students' locations, as in how close the known bullies are to the students who are at risk of being bullied. Secondly, the system monitors the stress levels of the students by the wearable heartrate monitors, and thirdly, it recognizes different emotions, actions, and even crowd formations the children might form.

Based on the three ways of detecting incidents, the system creates alerts that can be logged. Previous logged alerts can be reviewed and sorted to review the incidents and to gain information on the overall situation regarding bullying at the school. The system includes the locations, causes, and actors involved in the incidents. This allows the teachers and other school staff to intervene with bullying after the occurred incidents, but it also allows them to review their own methods on how they try to tackle the issue of bullying. The combination of technologies proposed by Brahnam and her research group (2015) has not been tested yet according to their study. All the previously mentioned combined solutions are summarized in table 3.

Table 3. List of combined solutions

Solution name	Developed by	Used technology	Means of tackling the issue
<i>StopBully</i>	Raminhos et al. (2015)	A Serious Game and a back office application.	Developing empathy among children and knowledge on how to help others. Support for research or therapy.
<i>EmotoTent</i>	Antle et al. (2019)	Biosensing stick-on tattoos, projection headsets, a robotic dog agent, a 3D tent environment.	Develop empathy and compassion towards others.
(No name)	Brahnam et al. (2015)	Wearable technology, surveillance cameras, cloud computing, machine learning.	Track the situations and decrease the number of bullying incidents.

As can be seen from table 3, making an anti-bullying solution can include various kinds of technologies combined into one functioning system and even the means of tackling the issue can differ greatly between the systems.

Similarly, as with Serious Games (listed earlier in table 1), the main goal of the *StopBully* combined solution is to develop empathy among children (Raminhos et al., 2015). But in this case, additional tools are included to facilitate possible research and psychological work, which is quite a unique way of dealing with this issue compared to the other proposed solutions.

The *EmotoTent* by Antle and her research group (2019) is also attempting to teach children about empathy, but as can be seen from the table, the used technology is very different. The *EmotoTent* by Antle and others (2019) and the solution by Brahnam and her research group (2015) are both great examples of what kinds of technologies can be used in the battle against bullying.

3.2 Cyberbullying

Since technology has become a huge part of our lives, so have the problems that come with it. Bullying is not presently only physical abuse because it can also happen on the internet or via different kinds of social media platforms (Cohen et al., 2014). At first the aim in this study was to focus solely on the physical aspect of bullying, but while making the literature searches, it became clear that cyberbullying can no longer be excluded when addressing the issue of bullying.

There are a few different views on cyberbullying. It can be considered as a form of bullying, but some researchers (such as Law, Shapka, Hymel, Olson, & Waterhouse, 2012 and Cohen et al., 2014) suggest that it should be considered as an entirely different issue with its own tackling methods. Cohen and others (2014) have defined cyberbullying as oppressing others using internet-based technology, such as the social media sites Facebook and Twitter, emails, and text messages. Cyberbullying is harassment that is performed by, for example, hacking into someone else's social media accounts, blackmailing, sending hateful and abusive messages, or any way trying to invade the victim's personal zone and cause harm. What separates cyberbullying from physical bullying or "normal" bullying is that it can easily reach bigger audiences and even include people from around the world. (Cohen et al., 2014.)

Law and others (2012) made a comparison between traditional bullying and cyberbullying where they wanted to find out if cyberbullying and bullying could be measured with the same items. Both Law and others (2012) and Cohen and her research group (2014) agreed that bullying that happens via internet cannot be tamed with the same methods as bullying that occurs on school playgrounds because the features that comprise cyberbullying are so distinctive.

3.2.1 Technology against cyberbullying

When it comes to tackling cyberbullying with technology, Cohen and others (2014) state that cyberbullying prevention starts with examining messages that are sent from one user to another. They propose two different approaches which both focus on incoming messages from the user's point of view. The first approach labels the messages as a likely instance of bullying and the second removes all the messages that seem to be related to bullying or are in any other way harmful for the user to see. (Cohen et al., 2014.)

Cohen and her research group (2014) also state that as important as it is to prevent the users from seeing malicious messages, it is also important to provide support for the reporting of bullying instances. The second thing Cohen and others (2014) propose is a reporting system with third party assistance called a *Cyberbully Reporting page* which can be used to record bullying events or instances. The recordings can later be sent to the suitable authorities to investigate so that the situation can be resolved properly, and if needed, more actions can be taken afterwards (Cohen et al., 2014).

Ashktorab and Vitak (2016) worked with teenagers in the United States and had multiple participatory design sessions where the goal was to find solutions for cyberbullying. In the design sessions, they produced nine prototypes that are presented as solutions for mitigating and preventing cyberbullying. The prototypes were divided into different themes that describe how the solutions make a difference or affect the cyberbullying situation. The themes that Ashktorab and Vitak (2016) used were first defined by Bowler, Mattern and Knobel (2014). The themes that the prototypes teenagers were assigned to

are *designing for control*, *designing for reflection*, *designing for consequence*, and *designing for support* (Ashktorab & Vitak, 2016).

Designing for control includes prototypes that control the messages that are sent to the social media platform. These prototypes are similar to the solution proposed by Cohen and her research group (2014). The messages sent from one user to another is checked, and possibly removed, before the message will be available for the receiver to see. The *Design for reflection* -theme includes prototypes that make the users think twice before they send their messages. This means that the solution forces the users to think before sending the message and hopefully make them change their minds before sending anything malicious. (Ashktorab & Vitak, 2016.)

Prototypes that are designed for consequence include the prototypes that help the situation become better once it has occurred (Ashktorab & Vitak, 2016). Bullying has already happened, and the design is meant for damage control. This is similar to the reporting system that Cohen and her research group (2014) proposed. The last theme of prototypes pointed out by Ashktorab and Vitak (2016) is designing for support. Support is an important phase of bullying which can potentially alter the effects that a bullying situation that has already happened might normally have (Ashktorab and Vitak, 2016). The presented technologies against cyberbullying are summarized in table 4.

Table 4. List of technologies against cyberbullying

Author	Means of tackling the issue
Cohen et al. (2014)	Label the messages as a likely instance of bullying
Cohen et al. (2014)	Remove all harmful messages
Ashktorab & Vitak (2016)	The messages sent from one user to another are checked and possibly removed
Ashktorab & Vitak (2016)	Make the users think twice before they send their messages
Ashktorab & Vitak (2016)	Help the situation become better once it has occurred—damage control
Ashktorab & Vitak (2016)	Provide support after the incident

Whether one considers cyberbullying as a type of bullying or as an entirely different thing, there is no arguing about the fact that the prevention tactics of cyberbullying rely on different aspects than preventing traditional bullying, as can be seen from table 4.

Cyberbullying prevention relies greatly on text recognition which can happen by, for example, analysing messages between users, as in the solution by Cohen and her research group (2014). Other means of text recognition include, for example, blocking harmful messages so the bullying incident does not happen like in the prototypes suggested by Ashktorab and Vitak's research (2016).

4. Discussion

The goal of this study was to find out what kind of technological solutions to bullying previous literature recognizes and what the solutions do in the fight against bullying. The research question for this study was “*What are the existing solutions for tackling bullying with technology in the literature and what are their distinctive characteristics?*”

Literature searches were performed in two different databases with over 2000 results in total. The results were limited to only computer science or IT related papers, written in English, and published after 2005. By skimming through the titles, abstracts, and keywords of the articles, the final number of articles was cut down to 146. All the articles were divided into five categories (Iivari et al., 2021), which were then analysed based on the research question. Most of the articles were excluded at this point since they did not present a clear solution against bullying or the solution was only analysed in the paper and not developed by its authors. In total 17 articles were selected for this study, out of which 15 papers present some kind of a solution and two are general bullying-related articles.

Literature searches pointed out that there are various kinds of technological solutions that can be used in the constant battle against bullying. The literature also identified the question of cyberbullying. Out of the 15 articles, five groups of solutions emerged: Serious Games, apps, algorithms, combined solutions, and technologies against cyberbullying. All the findings and their distinctive features are listed in table 5.

Table 5. All findings combined

Group	Distinctive feature
Serious Games	Prevent the situations by developing empathy and teaching means of dealing with bullying.
Apps	Allows obtaining help while the situation is happening (on-time aspect) and contacting the authorities.
Algorithms	Detecting bullying automatically and preventing it from happening.
Combined solutions	Combining various technologies into one solution, various ways of affecting.
Cyberbullying prevention	Based greatly on text recognition.

As can be seen from table 5, there are various kinds of existing solutions that can be used to tackle both bullying and cyberbullying with technology. The groups of technologies presented in this study do have many common features, but the groups also have distinctive characteristics that vary greatly from one group to another.

4.1 Existing solutions for tackling bullying with technology and their distinctive characteristics

Based on the literature searches, four groups of bullying tackling solutions were found as well as one group for dealing with cyberbullying. The groups are *Serious Games*, *Apps*, *Algorithms*, *Combined solutions*, and *Technology against cyberbullying*. The different groups clearly point out the distinctive characteristics of the different solutions.

Serious Games deal with bullying by teaching the children about empathy towards other people (e.g., Calvo-Morata et al., 2020) by teaching the children how to deal with the situations as a bystander (e.g., Kriglstein et al., 2020) and providing them with strategies on how to cope with the issue (Hall et al., 2006). The distinctive feature of the Serious Games -group is trying to prevent the situations from happening or teaching the children how to deal with the situation after a bullying incident has happened.

The second group, apps, have several features in common with Serious Games, such as providing the children with coping strategies (Ferreira et al., 2020). However, what makes the apps differ from the Serious Games and what can be considered as their distinctive characteristic is the on-time aspect. The functionalities, such as an emergency button (Neo et al., 2018), help the children during the bullying situation and allow the children to contact the correct authorities directly, whether it is the teachers or even the police department.

Algorithms such as the *k-Nearest Neighbor* (k-NN) by Gao and Ye (2019) provide a means of dealing with bullying on-time. The idea is that by creating algorithms that automatically identify bullying incidents in the school area, there is no need for the students to, for example, push an emergency button or for the teachers to see anything, and thus the bullying situations can be solved more easily or even prevented. The automatic detection of bullying is the distinctive characteristic of the algorithms.

The fourth group is the combined solutions. They are combinations of more than one technological aspect, which is the distinctive characteristic of this group. These technological solutions are, for example, biosensing stick-on tattoos (Antle et al., 2019), a back office application for therapy purposes (Raminhos et al., 2015), and wearable technology (Brahnam et al., 2015). These combined solutions have various means of affecting the issue. Like the Serious Games, the combined solutions also attempt to deal with the matter by encouraging the children to develop empathy (e.g., Antle et al., 2019), or, for example, keeping track of the situations and thus decreasing the number of incidents (Brahnam et al., 2015).

As stated in chapter 3.2., cyberbullying differs from traditional bullying and therefore so do the means of dealing with it. Cyberbullying can be detected and prevented by, for example, examining the message exchanged between users (Cohen et al., 2014), making the users think twice before sending a message, or providing support after incidents (Ashktorab & Vitak, 2016). Cyberbullying relies greatly on text recognition, which is its distinctive characteristic.

4.2 Suitable methods for the bullying battle

Serious Games like the one in the KiVa program (Yang & Salmivalli, 2015), are a highly proposed solution against bullying. As Hall and others (2009) point out in their study, results indicate these kinds of software do have a positive impact on bullying. The Serious Games and similar kinds of software help raise awareness concerning bullying among children, and they provide useful information in a way that the children can understand it and learn from it.

The research groups by Raminhos (et al., 2015), Calvo-Morata (et al., 2020), Krigstein (et al., 2020) and Hall (et al., 2006, 2009) present a wide group of solutions that should work in the battle against bullying. Because there seems to be many similar kinds of games, the question is why these games are still not more often implemented in schools and why are the Serious Games that the KiVa -program also included not enough any longer?

Kolić-Vehovec and others (2020) evaluated the effectiveness of the *School of Empathy* -game in the behaviours of bystanders in bullying situations. The authors state that their study results indicate only a weak positive effect on students' behavioural choices after playing the game. They also mention that although the Serious Games might be powerful tools for learning, there are still not enough empirical studies that really prove their effectiveness. This could indicate that it is probable that the Serious Games are not the best choice after all, and the games might not work as an independent tool. It needs to be considered that the articles written concerning these games are very likely written by the developers, so the results might be a little controversial and it is possible that the studies that do not prove any positive results are not even published.

When it comes to Serious Games in general, much of the responsibility lies on the children. Do they want to change their behaviour or take action when they recognize bullying? If the answer is no, the positive effects of the games are frankly non-existent. The Serious Games do have a good idea behind them, but they still need something more or other technologies on the side to be effective.

The anti-bullying apps bring their own input to the discussion. A feature that the apps have, which other methods do not, is a way for the children to connect with the authorities when bullying happens, whether it happens to them or they witness it happening to someone else. Whilst the Serious Games and algorithms may provide means of preventing and detecting, only the apps give the children a way to do something concrete themselves. Apps give the children the chance to affect the situation directly and empower them to take action.

When using smartphones and their apps to stop bullying and for it to work as intended, the victim or the one witnessing it needs to take out a smartphone, run the application, and send an alarm by, for example, pressing a button. Sometimes getting help requires writing a message or taking pictures as a proof for authorities to later examine. As stated by Gao and Ye (2019), from the eyes of the victim or witness, this is not convenient at all. If the user cannot reach the application, it does not provide any help during the situation if after it.

The solutions including algorithms have a very different view on bullying, but the results of the studies do suggest their value to the issue. The final recognition accuracy of the method by Ye and others (2019) is 84.4 % in situations of violence. If the algorithm could be used in every school and the actual percentage of bullying incidents recognized would

be even close to what was reported, it might affect the occurrence of these situations. The main question concerning the algorithms and solutions that combine multiple technologies, such as The EmotoTent by Antle and her research group (2019), is the price of the technological equipment and how well could this solution be implemented in an actual school environment. The same questions about the implementation arise with the other combined solutions as well.

The solution by Brahnam and her research group (2015) raises two quite significant issues. One is the dividing children or students into known bullies and students that are in danger to be bullied. In the study by Brahnam her research group (2015), they do not take this into consideration at all. What if the known bully has nothing but good intentions? Does the system still alert that the “known bully” is getting closer to the other students? Does the system take into consideration if the children marked as in danger to be bullied turn into bullies themselves? This division of students might work as a concept, but it raises a lot of ethical issues that cannot be set aside.

Another issue that arises regarding the solution by Brahnam and others (2015) is security and privacy. The solution is quite wide-scale since it monitors the students through many parameters, and with heartrate monitors and surveillance cameras combined to cloud computing, the amount of data collected from each student is massive. Although it might work well in bullying prevention, it does raise some safety and privacy issues since the monitoring is so extensive. The same goes for the algorithms by Gao and Ye (2019) and Ye and his research group (2020) that require constant monitoring of the children to function the way they are planned. Privacy issues also arise with the cyberbullying solutions that monitor the messages that the users send to each other.

Constant surveillance, monitoring, and tracking raises a lot of questions. Is it okay to track the students’ movements in such an invasive way and leave no privacy during the school day? Who can say that something said or written is bullying or just a joke? Do these methods only affect the time the children spend in school and move all bullying to after-school hours? These are the questions that need to be answered.

4.3 The perfect solution

The perfect solution should have the means to both prevent and tackle bullying, but it should also include a means of support after incidents, which was pointed out by Ashktorab and Vitak (2016). Support is an important phase of dealing with bullying, one that can possibly decrease the negative effects of bullying after the incident has occurred, even if there were some prevention tactics in use. It is quite surprising that support was not pointed out by the other current solutions. The themes and examples that Ashktorab and Vitak (2016) have in their study could be useful whilst creating new and bigger solutions because the themes *designing for control, reflection, consequence, and support* all are aspects that deeply affect the situation and need to be considered. The themes could be possibly modified into some sort of checklist that could be used to form new solutions.

Bullying itself has many forms, including cyberbullying, but also verbal and physical bullying, and a widely working anti-bullying solution needs to cover all forms of bullying. As cyberbullying prevention has its own methods, so does the prevention of verbal and physical bullying, which must not be forgotten. The solution must combine aspects that tackle all kinds of bullying since it cannot and should not be defined which kind of bullying is the most harmful or has the most harmful effect on people.

The perfect solution needs to work during school hours, but on some levels, it must also extend beyond those. Most of the solutions do not cover this aspect at all. Bullying might start at school, but it can also happen before and after it, so solutions that only cover the school hours are not be good enough. The solution needs to bring the children an overall feeling of safety, but simultaneously respect the children's privacy. The usage of some of the solutions themselves raise safety concerns, such as the violation the children's privacy, which is something that should also be taken into consideration when building the perfect solution.

All the presented technology solutions bring something new to the battle against bullying. Creating the perfect solution by considering all the aspects, both negative and positive, and answering all questions raised, makes the perfect solution maybe even impossible to create.

5. Conclusions

There are a variety of different options on how to use technology as a bullying prevention method. The literature review pointed out four different groups: Serious Games, anti-bullying apps, bullying detecting algorithms, and solutions that combine more than one type of technology. Cyberbullying was also included as its own group with some of its own prevention tactics, which differ from the other bullying prevention methods.

By going through the possible solutions, it was clear that different kinds of technologies can be used in the battle against bullying. Developing empathy is a very common denominator for the presented solutions, but there are also tools and detectors that have a direct effect on the possible bullying situations. The technology solutions affect the number of bullying incidents that occur, and by decreasing the amount of bullying, the solutions would also decrease the more serious problems that are caused by bullying.

All the groups of possible solutions have their distinctive characteristics and their own negative and positive parts which should be considered. The meaning behind the solutions is good, but the negative outcomes, such as the invasion of privacy, need to be taken into consideration when using them separately or as part of a bigger combination of technologies. The limitations for this study are in the number of articles used because there might be many more kinds of solutions or even groups of solutions that could have been included and would have brought more variety to the solutions. Making the literature searches only in two databases might also have limited the number of suitable papers found because there are also other suitable databases. There is also the possibility that by limiting the searches to only English language papers, there might be many more local technologies that are used but cannot be included in this study due language barriers.

The perfect combination of solutions is something that could be studied more later. Also, the users', in this case the children's, own views on bullying prevention, combining bullying with technology, and what solutions the children might come up with are interesting questions for later studies. These questions are already part of the University of Oulu INTERACT -unit's Make-a-Difference project. However, there is still a need for more research and for many more questions to be answered.

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Appendix A. Research plan

Introduction

Bullying is a serious, world-wide issue that affects many people. Especially when it comes to children and teenagers, bullying can cause severe problems, and therefore it needs to be stopped as soon as possible. Even recently bullying has been brought up by the media, but there still do not seem to be any valid solutions that could be used when bullying occurs.

Since technology has become a part of our everyday life, it has also been suggested as an option for solving the bullying issue. The question is, how can technology be used to tackle bullying?

Research problem and research methods

The goal of this research is to present the means in which technology can be used to fight bullying. The issue is finding out what technological solutions already exist to deal with the problem and in what ways can technology be used to find out if bullying happens. This research is a literature review, which focuses on obtaining a general view of what has been achieved in the bullying-related issues in the field of computer science and human computer interaction.

Limitations

The limitation of this study is the number of articles used. There might be several kinds of solutions or even groups of solutions that could have been included.

Preliminary earlier research

In Finland a widely known bullying prevention strategy is the KiVa antibullying program. The program aims to reduce bullying by providing the bystanders with means to intervene in the bullying situations. (Yang & Salmivalli, 2015)

List of main prior literature in relation to the background theory

Yang, A. & Salmivalli, C. (2015). Effectiveness of the KiVa antibullying programme on bully-victims, bullies, and victims. *Educational Research (Windsor)*, 57(1), 80–90. <https://doi.org/10.1080/00131881.2014.983724>

Timetable

The literary research was performed during summer 2020, the main structure of the candidate thesis was written in spring 2021, and the final edits are performed during March and April of 2022. The final version of the candidate thesis will be ready by the end of April 2022.

Preliminary structure of contents

Prior research, discussion, conclusions

Appendix B. Literature findings

Authors	Year	Proposed solution	Used methods	Participants	data	Study location
Antle et al.	2019	Combined solution	Information not available (NA)	Children, not specified	Information not available (NA)	Information not available (NA)
Ashktorab and Vitak	2016	Against cyberbullying	Multiple ways of collecting data	21 students, 14–17-year-olds	Qualitative	USA
Brahnam et al.	2015	Combined solution	No data collecting	Children, not specified	NA	NA
Calvo-Morata et al.	2020	Serious Games	Literature review	Children, not specified	NA	NA
Cohen et al.	2014	Against cyberbullying	NA	Children, not specified	NA	Canada
Ferreira et al.	2020	Apps	An integrative review	Children, not specified	NA	NA
Gao and Ye	2019	Algorithms	Data gathered with movement sensors and a camera	8 students	Quantitative	Finland
Hall et al.	2006	Serious Games	The Classroom Discussion Forum technique and discussions	345 children, 8–12-year-olds	Qualitative	UK & Germany
Hall et al.	2009	Serious Games	Questionnaires	Over 800 8–12-year-old	Quantitative	UK & Germany
Kolić-Vehovec et al.	2020	Serious Games	Questionnaire and video recordings	345 students, 12–14-year-old	Quantitative	Spain, Malta, UK, and Ireland
Kriglstein et al.	2020	Serious Games	Questionnaires and discussions	29 students, 11–15-year-old	Both	Austria
Law et al.	2012	Against cyberbullying	Questionnaire and a survey	18284 students, 11–18-year-olds	Quantitative	Canada
Neo et al.	2018	Apps	Questionnaires	30 undergraduate students	Quantitative	Malaysia
Raminhos et al.	2015	Combined solution	Multiple questionnaires and discussions	27 students, 9–14-year-olds	Both	Portugal
Ye et al.	2020	Algorithms	Data gathered with movement sensors and a camera	Children, not specified	Quantitative	Finland