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Teaching Digital Literacy with the BBC micro:bit in the EFL Classroom

DIPLOMA THESIS

to achieve the university degree of

Magister degree

Teacher Training Programme

English and Computer Science and Computer Science Management

submitted to

Graz University of Technology

Supervisor

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Graz, Mai 2019

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Abstract

In the winter term of 2017/18, the Austrian Ministry of Education introduced the strategic concept of *Digital Literacy* to all schools of Secondary Education I and required them to teach their pupils certain technological competences. For this purpose, a lesson sequence consisting of twelve lessons for the EFL classroom was developed. This lesson sequence is called *New Technologies* and covers a few IT related topics in class to teach both English and Digital Literacy skills in a cross-disciplinary context. In particular, the planned lessons integrate the competence *Computational Thinking*, one of the eight official subareas of Digital Literacy, by allowing students to use the official BBC micro:bit for different projects. Moreover, through the cross-disciplinary approach the students do not only acquire technological competencies but also improve their English skills as well.

Three interviews with English teachers were conducted to gather feedback on the quality of the prepared lesson plans. Much praise was given to the learning materials, the individual lesson plans with regard to didactic purposes, and the carefully prepared content. However, the interviewees identified a few major problems as well: the language level of the planned activities is rather high, and pupils might struggle with the possibly unfamiliar learning environments such as project-based work or the concept of independent learning. Therefore, the interviewees suggested that in some cases the lesson plans might be more suitable for Secondary Education II. Moreover, the interviewees also addressed organisational issues such as the question of how to integrate this lesson sequence into the semester or the high preparation time for English teachers to become familiar with the new content as presented in the lesson plans. In conclusion, the interviews revealed many practical problems for the lesson sequence New Technologies, but also showed that the lesson plans are well-designed and offer numerous opportunities for further development, especially due to the lessons' diverse content and license-free materials.

Kurzfassung

Die vorliegende Diplomarbeit beschreibt eine Unterrichtssequenz bestehend aus 12 Stunden für den Englischunterricht in der 8. Schulstufe, welche das Ziel hat, SchülerInnen diverse digitale Grundkompetenzen zu vermitteln. Diese Kompetenzen beziehen sich auf das Konzept der *Digitalen Grundbildung*, das vom Österreichischen Bundesministerium für Bildung in allen Schulen mit Sekundarstufe I im Schuljahr 2018/19 als verbindliche Übung eingeführt wurde. Diese Unterrichtssequenz heißt *New Technologies* und beinhaltet verschiedene Informatik-Themen, welche für den Englisch-Unterricht aufbereitet worden sind. Der Fokus dieses Unterrichtskonzepts im Rahmen der Digitalen Grundbildung liegt auf dem Kompetenzbereich *Computational Thinking*, welcher mit dem Einsatz des BBC micro:bits zur Gänze gedeckt werden soll. Zugleich werden durch den fächerintegrativen Ansatz nicht nur Lernziele der Digitalen Grundbildung erreicht, sondern auch die Englisch-Kenntnisse der SchülerInnen gezielt gefördert.

Es wurden insgesamt drei Englisch-LehrerInnen interviewt, um Feedback bezüglich der Qualität und der Realisierbarkeit dieser Unterrichtssequenz zu bekommen. Positives Feedback gab es inbesondere für die Lernmaterialen, die vorbereiteten Unterrichtsstunden in didaktischer Hinsicht, und den sorgfältig aufbereiteten Inhalt. Die Interview-PartnerInnen nannten jedoch auch einige negative Aspekte der Unterrichtssequenz: Zum einen ist das Sprachniveau für die 8. Schulstufe sehr hoch angesetzt, und die SchülerInnen könnten mit dem Ansatz von Selbstgesteuerten Lernen und Projektarbeiten eventuell überfordert sein, falls sie diese Lernmethoden noch nicht gewohnt sind. Für manche Klassen wäre dafür die 9. oder sogar 10. Schulstufe besser geeignet. Zum anderen wurden organisatorische Fragen aufgeworfen, wie zum Beispiel die Schwierigkeit, die geplanten Stunden in das Semester zeitlich zu inkludieren, oder der hohe Vorbereitungsaufwand für die Lehrperson, sich über alle Informatik-Themen vor den Unterrichtsstunden im Detail zu informieren. Abschließend lässt sich aus den Interviews schlussfolgern, dass die Unterrichtssequenz New Technologies viele praktische Probleme aufwirft, jedoch didaktisch sehr gut aufbereitet ist und aufgrund des vielseitigen und frei lizensierten Inhalts gute Ansatzpunkte für weitere Stundenpläne und Materialen bietet.

Contents

List of Abbreviations

AHS	„Allgemeinbildende höhere Schule" (Academic Secondary School)
BBC	British Broadcasting Cooperation
BMWFW	Austrian Federal Ministry of Education, Science and Research
CC	Creative Commons
CEFR	Common European Framework of Reference
CT	Computational Thinking
EFL	English as a Foreign Language
IoT	Internet of Things
ISP	Internet Service Provider
NMS	"Neue Mittelschule" (New Secondary School)
OER	Open Educational Resources

1 Introduction

The concept of "Digitale Grundbildung" (*Digital Literacy*) as introduced by the Austrian Ministry of Education in 2018 describes a predefined set of digital skills that pupils between the age of 10 and 14 need to acquire. In Austria, all schools of Secondary Education I – namely the "NMS Neue Mittelschule" (New Secondary School) and the "AHS-Unterstufe" (Academic Secondary School Lower Cycle) – need to teach these digital skills either in the form of special lessons or integrate them into other school subjects (cross-disciplinary). Many schools opt for the latter since they are less inclined to organise additional IT lessons in the lower secondary level and rather take advantage of the potential learning benefits resulting from teaching multiple disciplines at the same time.

One of the eight official competence areas of Digital Literacy is called *Computational Thinking*. This competence area involves a fundamental understanding of how programming languages and algorithms work. Since pupils in the lower secondary level are still fairly young, teaching Computational Thinking to them might be particularly challenging. However, nowadays many online platforms and tools are available that aim to teach young learners how to program in a very creative and simple way.

One of these tools to learn programming is called BBC micro:bit. This device is a pocket-sized computer (often referred to as a *single-board microcontroller*) with different input sensors and LED lights that can be used to create fun applications or games. Users can create a micro:bit program on the official BBC website, download this program to their computer, and with a USB cable copy it onto their device as though it were a USB drive. The device executes the program and gives the user immediate feedback depending on the instructions the user defined for their program. For example, it is possible to create a program that shows a smiley face on the device's LED display when the micro:bit is being shaken. Since the device has a motion sensor, it knows exactly when it is being moved and can then execute whatever instructions (such as an output on the LED display in this case) the programmer defined for this event.

Using microcontrollers such as the BBC micro:bit in the classroom has proven to be an efficient and exciting way for young learners to acquire programming skills (Videnovik, 2018). The micro:bit can be used for a variety of different projects, ranging from simple applications such as a digital compass or a step counter to interactives games and advanced programs involving additional equipment. Students are particularly excited about the hands-on experience the micro:bit offers, and are usually motivated to get creative and create their own programs to see the immediate feedback on their devices (Hodges et al., 2013). The close relationship between software and hardware is part of the reason why microcontrollers are very positively received in the education sector. Moreover, using the micro:bit in class adds variety to traditional lessons and promises for new and interesting learning experiences. Therefore, the BBC micro:bit seems to serve as an appropriate tool to teach young learners Computational Thinking in the lower secondary level.

The choice to include the BBC micro:bit in the classroom is also supported by the Austrian Ministry. Originally, the BBC micro:bit was designed and produced in England in 2015 for the BBC initiative *Make It Digital*, which aimed to encourage young pupils in the UK to acquire programming skills and learn more about digital technologies (Sentence, Waite, Hodges, Mac-Leod, & Yeomans, 2018). However, in recent years the use of single-board microcontrollers such as the micro:bit to teach programming sparked a lot of interest in different countries of Europe. For example, Germany created and uses the *Calliope Mini*, a microcontroller inspired by the BBC micro:bit, to introduce pupils of primary schools to programming (Calliope, n.d.). Likewise, Switzerland produced a microcontroller called *Oxocard* for the same purpose (Oxocard, n.d.). In Austria, the government seemed to choose the BBC micro:bit for teaching Digital Literacy in schools: for example, at the request of the Ministry, in 2018 a schoolbook containing 22 micro:bit projects to be used for a variety of different school subjects was published (Bachinger & Teufel, 2018). Furthermore, AustroTec (n.d.), the publisher of this schoolbook, states that Austrian schools also get financial support when purchasing BBC micro:bits for their pupils since the device has officially been added to the list of "Unterrichtsmittel eigener Wahl" (optional teaching tools).

Since the BBC micro:bit offers many opportunities to create programs relating to different subjects (e.g. a compass for Geography, or creating electrical circuits for Physics lessons), it is particularly effective for cross-disciplinary teaching (Zellacher, 2018). Although many micro:bit projects for different school subjects are already available online (such as the official

schoolbook), there still seems to be a lack of concrete ideas how to integrate the micro:bit into the EFL classroom, for example. Moreover, most online platforms only provide ideas for micro:bit projects and do not offer structured lesson plans that incorporate the micro:bit purposefully into the curriculum. Since (English) teachers working in secondary education often do not have a lot of resources to devise such lesson plans but are now asked to teach Computational Thinking to their students as well, there is an urgent need for more free teaching materials in the context of Digital Literacy to relieve the workload of all teachers.

This diploma thesis serves the purpose of providing English teachers with a comprehensive lesson sequence that incorporates the BBC micro:bit into the EFL classroom. This lesson sequence was designed in accordance with modern language teaching approaches such as *Communicative Language Teaching*, which aims to produce greater learning successes for the pupils by focusing on meaningful communication tasks in class. Before introducing the theoretical framework for the created lesson sequence, more motivation behind this thesis is given since previous attempts of creating micro:bit projects for the EFL classroom revealed some valuable insights into the difficulty of this task.

2 Motivation

The initial purpose of the thesis was to create BBC micro:bit projects that could be used in the EFL classroom of Secondary Education I to teach students *Computational Thinking* and improve their English skills at the same time. However, this proved to be very difficult as hardly any project ideas could be found that combined language learning with the aspect of Computational Thinking meaningfully. For example, one approach was to create micro:bit programs that showed specific grammar aspects on the device's LED display, but this idea was eventually discarded as the micro:bit's LED display is very small and does not seem to be suited for showing lots of text on its display.

Another approach to combine language learning with the BBC micro:bit was to let students create an adapted version of the popular German game "Stadt-Land-Fluss" (Town-Country-River). In this game, the micro:bit device shows a random letter on its display, and the players would have to find, for example, a noun, verb, and adjective starting with the corresponding letter as soon as possible before time runs out and the players get a new letter.

Although incorporating such a game in the EFL classroom seems quite reasonable, there are several issues to consider: first of all, writing such a program would require the students to have some micro:bit programming experiences already. Beginners would need a lot of guidance and support to develop a game like that. Secondly, playing this game hardly follows the CLT approach. Students do not use language meaningfully, but only practice their abstract knowledge of vocabulary. And most importantly, the pupils could just as well use an app or website on their smartphones to play the same game, making the micro:bit seem somewhat redundant. This is in fact the root problem: using the BBC micro:bit purposefully, and not just for the sake of using it. In the context of mobile learning, Correia & Santos (2017) also agree that teachers should "avoid the use of technology by technology" and for every lesson carefully evaluate whether the use of specific technological devices does have indeed a positive influence on the intended learning outcomes.

2.1 Pilot Test at the GIBS Graz

Nevertheless, an attempt was made to introduce students of the "6. Schulstufe" (2nd form) to the BBC micro:bit in the English classroom at the Graz International Bilingual School (GIBS) in order to receive immediate feedback and evaluate how effective this device can be used for language learning. Due to a project day, the school was able to provide three consecutive English lessons for a particular group of students. These three lessons were used to introduce the 18 learners to the BBC micro:bit in order to let them create small micro:bit programs afterwards. At the end of the session, the learners played the "Stadt-Land-Fluss" game and briefly discussed how the game was programmed. One has to keep in mind that these students, due to the type of school, already had very good English skills considering their age. All three lessons were conducted in English, but there were hardly any misunderstandings. After the end of the last lesson, the pupils completed a questionnaire asking them what they have learned from working with the BBC micro:bit.

As it turned out, over 80% of the learners indicated that they did not improve their English skills. The "Stadt-Land-Fluss" game did not seem to make a major impact on the pupils' vocabulary either – only a third of them claimed that they learned new words. Although the majority of learners liked working with the BBC micro:bit, and even showed some interest in buying a device for their own private use, the lessons suffered from a serious lack of language learning.

2.2 Revaluation of Thesis

The result was more or less expected, and constituted the main reason why the direction of the thesis had to be slightly changed. Instead of forcing language tasks onto BBC micro:bit projects, the idea was to create English lessons that link thematically to different programs that can be written with the BBC micro:bit. A variety of IT related topics had to be identified and didactically prepared to create lesson plans suitable for the "8. Schulstufe" (4th form). This approach led to the lesson sequence *New Technologies*: a collection of different topics related to modern technologies, all of which include specific BBC micro:bit projects that link to these specific topics.

The English unit New Technologies involves 12 lessons in total. Its target group is a 4th form since the original goal of teaching Computational Thinking to pupils of Secondary Education did not change after revaluating the thesis. However, since the topics and the language tasks contained in New Technologies can be quite difficult for young learners, it is not recommended to use this lesson sequence for 3rd forms or lower (though bilingual schools, for example, might be an exception).

During the development of the lesson plans for this English unit, particular emphasis was placed on following the principles of *Communicative Language Teaching* and the *4 C's of Education*, as explained in the next chapter. However, due to the challenging task of devising such a comprehensive teaching concept from scratch and a lack of practical testing, the created lesson plans might not be ideal or could potentially use slight adjustments, especially for different teaching styles. Luckily, since New Technologies is licensed under CC BY and therefore an OER concept, any teacher is allowed to change the lesson sequence and is further encouraged to republish their modified lesson plans, given the original authors are mentioned.

The next section will provide an overall educational framework for the lesson sequence New Technologies and introduce concepts such as CLT or OER. This is then followed by a detailed description of all the created lesson plans for the unit New Technologies. Afterwards, important feedback by three experienced English teachers that were interviewed to evaluate this teaching concept will be shared. Since the interviewees' insights mostly relate to practical concerns of using New Technologies in class, it is highly recommended for anyone considering to include this English unit into their teaching to read through this chapter as well.

3 Educational Setting and Objectives

The lesson sequence *New Technologies* uses the method of cross-disciplinary teaching, which means that more than one subject is taught in a single lesson at the same time – in this case, English skills and IT related competences. Therefore, the curricula of both subjects are briefly introduced in this chapter. This is followed by a discussion of CLT and the *4 C's of Education*, both of which refer to modern teaching principles that should lead to promising learning opportunities in the classroom and were therefore carefully considered when creating the lesson plans. Lastly, the movement of *Open Educational Resources* is presented and discussed as well since all the materials of this lesson sequence are licensed under CC BY and therefore contribute to the OER movement.

3.1 English Curriculum

Since the official English curricula of 2019 in Austria for NMS and Secondary Education I of AHS are almost identical, only the curriculum of the latter will be cited in this chapter.

The English curriculum involves educational goals characterised by a strong focus on teaching competences: pupils should not only develop their communicative, social, and intercultural abilities and acquire new learning strategies, but also improve their reading, writing, listening, and speaking skills to understand everyday language and successfully communicate with other people in both spoken and written form (BMBWF, 2019a). In particular, by the end of the "8. Schulstufe" (4th form), the BMBWF states that pupils are expected to finish the school year with an English language proficiency level of A2/B1 in reading, writing, and listening, whereas for speaking skills, pupils only need to reach the level A2 before beginning with Secondary Education II.

The terms A2 and B1 refer to the *Common European Framework of Reference* (CEFR), and serve as reference levels for the students' language abilities (Council of Europe, 2001). In the English curriculum, the BMBWF (2019a) claims that pupils with A2/B1 should be able to:

- "Texte verstehen, in denen vor allem sehr gebräuchliche Alltags- oder Berufssprache vorkommt" (read and understand texts containing everyday language),
- "über Themen, die ihnen vertraut sind oder sie persönlich interessieren, einfache zusammenhängende Texte schreiben" (write simple, coherent texts about topics they are interested in or familiar with),
- „Hauptpunkte verstehen, wenn klare Standardsprache verwendet wird und wenn es um vertraute Dinge aus Arbeit, Schule, Freizeit usw. geht" (understand the main points in spoken language when the topic is already familiar), and
- "sich in einfachen, routinemäßigen Situationen verständigen, in denen es um einen einfachen, direkten Austausch von Informationen und um vertraute Themen und Tätigkeiten geht" (communicate in simple and routine tasks requiring a simple and direct exchange of information on familiar topics).

Aside from defining the pupils' expected language level for Secondary Education I, the English curriculum also lists a number of educational areas and didactic principles that the EFL classroom has to incorporate. According to the BMBWF (2019a), English classes need to contribute to the general areas of Language & Communication, Society, Nature & Technology, and Health & Fitness. Some of the didactic principles include: developing the students' communicative competences and using the target language as much as possible, contextualisation of vocabulary and grammar, differentiation, a balanced approach to integrate all four key competences in the lesson plans (e.g. reading, writing, etc.), and providing relevant and meaningful conversation situations (BMBWF, 2019a). Moreover, the BMBWF also declares "Ganzheitlich-kreatives Lernen" (creative and holistic learning) and "Fächerübergreifende Aktivitäten" (interdisciplinary activities) to be important didactic elements of the EFL classroom.

All the lesson plans of New Technologies aim to incorporate the aforementioned teaching goals and didactic principles. The lessons will make a positive contribution to every educational area by including, for example, reflection tasks that ask pupils to evaluate how technology influences our environment and society in general. Moreover, since New Technologies combines the subjects English and Computer Science, the lesson sequence provides ideal opportunities for communicative activities in the context of cross-disciplinary learning.

3.2 Digital Literacy

Before the BMBWF introduced the compulsory subject *Digital Literacy* in Austria to Secondary Education I in 2018/2019, there had been no obligation for schools to include a subject in their curricula that was solely concerned with teaching technological competencies. Some schools offered optional units such as Media Design that students could take if they wanted, but those were not compulsory either. In the winter term of 2017/2018, the subject Digital Literacy was then finally presented, but only as a pilot project, before it became compulsory for all Austrian schools in the following year (BMBWF, 2019b).

The concept of Digital Literacy as presented by the BMBWF (2018b) encompasses eight competence areas:

- Social Aspects of Media Change and Digitalisation,
- Information, Data and Media Competency,
- Operating Systems and Standard Applications,
- Media Design,
- Digital Communication and Social Media,
- Information Security,
- Solving Technical Problems,
- and Computational Thinking.

The BMBWF (2018b) states that every school can decide autonomously how they want to implement the subject Digital Literacy into their curriculum as long as all eight competence areas between the "5. Schulstufe" (1st form) and the "8. Schulstufe" (4th form) are covered. The BMBWF only requires schools to organise between 64 and 128 lessons for this subject in total, either in the form of special lessons, or integrated in other subjects (a combination of both is also possible). These lessons can be split over a longer period of time, which would then naturally result into fewer Digital Literacy lessons per week.

The unit New Technologies is tailored to the competence area Computational Thinking. According to Wing (2006), Computational Thinking (CT) comprises "solving problems, designing systems, and understanding human behaviour, by drawing on the concepts fundamental to

computer science" (p. 33). Wing particular stresses that CT is not limited to technological competencies – for example, retracing lost items such as keys or a wallet requires humans to perform *backtracking*, which refers to a computer concept involving algorithms to retrace one's steps. In this sense, humans sometimes think much like a computer – hence the term *Computational Thinking*. Wing gives many more examples of how CT is integrated in our everyday lives without us even knowing, and therefore argues that it is crucial, especially in the age of technology, that "we should add computational thinking to every child's analytical ability" (p. 33). Since this viewpoint has been widely accepted by educational researchers, the BMBWF regarded CT as a key element for their concept of Digital Literacy.

In the Digital Literacy curriculum, the BMBWF defines Computational Thinking as consisting of two parts: "Mit Algorithmen arbeiten" (working with algorithms), and "Kreative Nutzung von Programmiersprachen" (using programming languages creatively). The specific learning objectives in both areas essentially focus on understanding fundamental programming concepts and how algorithms work. Moreover, they also involve the ability to reflect on the potential and the limits that computers as machines have. All these learning objectives are evidently based on key principles of CT, and can be realised by, for example, working with the BBC micro:bit.

The lesson sequence New Technologies incorporates Computational Thinking to the full extent. Other competence areas are also included during the course of this lesson sequence, but not to the same degree. For example, in one double period pupils will learn about how to stay safe on the internet (Security), or in another discuss the role of social media in today's society (Digital Communication and Social Media). The focus of New Technologies will lie, however, on covering the competence area Computational Thinking.

3.3 Communicative Language Teaching (CLT)

When creating the lesson plans for the unit New Technologies, special emphasis was placed on designing communicative tasks that foster communication between the students.

The idea of Communicative Language Teaching has been around for decades, but it took quite some time for CLT to find its way into the EFL classroom. Although much research on CLT is available nowadays, the core ideas are still the same: in the classroom, "meaning must be at

the centre of all communicative exchanges", and the foreign language needs to be "presented in contexts that are linguistically accurate and culturally appropriate" (Hendrickson, 1991, p. 197). Hendrickson also claims that in CLT teaching, instructors should be aware of the students' "communicative needs, their personal interests, their individual learning styles, and their levels of proficiency in the foreign language" (p. 197). Hendrickson further stresses the importance of pair and group work with the pupils as the central role of the classroom (p. 197). All these ideas are embedded in the English curriculum, which underscores the impact the CLT approach has had on the education sector and its importance in language learning.

In the lesson sequence New Technologies, most activities require the students to work with partners or in small groups. Moreover, since all the topics covered in this unit relate to the students' personal lives (some more than others), the learners will engage in meaningful conversation and discuss issues they should be personally interested in. For example, the pupils may be particularly interested in evaluating the effect of social media on their generation since the majority of young learners use social media quite frequently already. The BBC micro:bit projects also ask the pupils to work together and communicate effectively to solve a specific problem, which also encourages communication in the classroom, following the principle of CLT.

3.4 4 C's of Education

The unit New Technologies was also designed according to the *4 C's of Education*. This principle refers to four key skills particularly relevant in the 21st century (referred to as the *21st century skills*): Critical Thinking, Creativity, Collaboration, and Communication (Levin-Goldberg, 2012). Similar to CLT, different sets of such skills have been identified, evaluated, and compared in contemporary research (Yengin, 2014). Since the aforementioned definition has found wide application in the education sector, the 4C model was integrated into the lesson sequence New Technologies.

The key skills Collaboration and Communication are both referred to and embedded in the curriculum and the CLT approach. However, the skill Creativity is only partly addressed, whereas Critical Thinking skills are not mentioned at all in the English curriculum for pupils

of Secondary Education I. Although students between the age of 10 and 14 might be over-whelmed with tasks that require them to reflect critically upon various topics, the severe lack of a didactic principle involving any kind of Critical Thinking skills seems rather strange, especially in a subject where the focus lies on language and communication. In this respect, the 4 C's of Education and the English curriculum do not seem to fully correspond with each other.

One reason why the English curriculum and the 4 C's of Education emphasise different skills might be the fact that the latter is often associated with the role of new technologies in the 21st century and its effects on our world. The skill of Critical Thinking in the 4C model often refers to the way that "technology has changed the critical thinking platform", and therefore asks students to always question technological changes and evaluate their potential consequences for society (Pakizer, 2016). Since young learners are becoming more and more exposed to technological advances, they should not only need to learn how to use new technology properly, but also become aware of and question technology's influence on their personal lives and their environment. Levin-Goldberg (2012) further emphasises the importance of including the 4C model into the curriculum as early as possible as it prepares students for their future career: "The global market is driven by creativity and innovation. It is dominated by critical thinkers and problems solvers communicating and collaborating" (p. 63).

As it turns out, the subject Digital Literacy seems to compensate for the lack of Critical Thinking skills concerning technological aspects in the (English) curriculum. This is why cross-disciplinary teaching with the BBC micro:bit is especially useful in this context, and in fact explains why Digital Literacy was introduced to Secondary Education I in Austria in the first place. Additionally, Resnick (2019) claims that students also get the chance "to develop the confidence and capacity to express themselves creatively with new technologies" when using such programming tools. Working on different BBC micro:bit projects in the EFL classroom sharpens the students' Creativity skills, making the 4 C's of Education a central part of the unit New Technologies.

3.5 Open Educational Resources (OER)

The previous chapters aimed to provide an educational setting of New Technologies. Finally, before describing the lesson sequence in detail, the idea behind Open Educational Resources (OER) is addressed as well since all the materials created for this lesson sequence are in fact OER materials.

Although the OER movement has already started in the early 2000s, the majority of society is still unaware of its existence, which is often attributed to a generally low understanding of open licenses needed for OER (Mishra & Abeywardena, 2016). However, in the age of the Internet, where materials can be uploaded and shared all over the world with a simple mouse click, the question of copyright is becoming increasingly important. This is why people working in the education sector, for example, are reluctant to upload and share their materials as they often use content in their lesson plans that is actually copyright protected (Caeiro, Míguez, & Blanco, 2015). Teachers would benefit greatly from exchanging lesson plans and learning materials online without having to worry about copyright problems and potential legal consequences.

Open Educational Resources provide a solution for distributing license-free materials. According to the UNESCO website, OER refer to "materials in any medium – digital or otherwise – that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions" (UNESCO, n.d.). This means that all kinds of materials on the internet (or in the offline world) can be shared worldwide and used for a variety of purposes as long as they are either in the public domain or have an open license. In other words, OER materials are materials that use certain licenses permitting people to freely use and share the licensed content.

One of these open licenses to produce OER materials is called the Common Creative (CC) license. Content creators using the CC license can "retain copyright while allowing others to copy, distribute, and make some uses of their work" (Creative Commons, n.d.). Different CC licenses are available to limit the extent to which other people can use the licensed work (for example, the author can decide whether others are allowed to use their work in only a non-commercial context). Every type of license requires specific information that needs to be shared along with the licensed materials, which is explained in detail on the official Creative Commons website. It is important to note that CC licenses do not replace the copyright of the original work, but only incorporate it to make redistribution possible without legal consequences.

The unit New Technologies uses the CC BY license, which means that if the author's name is indicated on the shared resources, all lesson plans and materials described and included in this paper can be used by anyone without further restrictions, even commercially (more information how to use the CC BY license properly is given on the Creative Commons website). The idea behind creating OER teaching materials for the subject Digital Literacy was to provide teachers with free resources that they can use for their lessons without worrying about copyright issues. Moreover, teachers are also encouraged to change, develop, and distribute these teaching materials to further contribute to the OER movement.

4 Lesson Sequence *New Technologies*

4.1 General Information

This lesson sequence describes a self-contained teaching unit for the subject English in the 4th form ("8. Schulstufe") of Secondary Education I in Austria. This unit is called *New Technologies* and is tailored to the Austrian curriculum of 2018/19. The unit comprises various topics about IT and modern technologies, and integrates different competence areas of the "Digitale Grundbildung" (Digital Literacy).

One of the main goals of the unit New Technologies is to teach students Computational Thinking (one of the eight subareas of Digital Literacy), which is achieved by using the BBC micro:bit (see Figure 1) for various activities during the lessons. The BBC micro:bit – a small programmable board originally used for the subject Computing in the UK – was particularly designed for young children to program small applications with an easy-to-use graphical interface. Students can use the BBC website on the computer (or use the BBC app on their smartphones) to create a program, copy it onto their micro:bit devices (as if it were a USB drive) and see how their devices execute their program. For the unit New Technologies, students are expected to use the computers at school to write several different micro:bit programs.
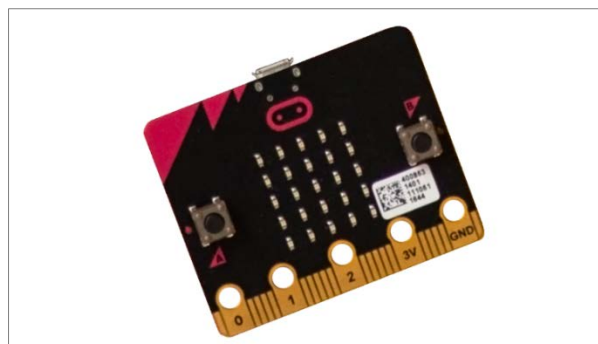

Figure 1: The BBC micro:bit

As recent studies in Europe have shown, using the BBC micro:bit in class has positive effects on the students' motivation for learning which is due to the tangibility of the device and opportunities for collaboration and creativity the use of the BBC micro:bit in the classroom can offer (Videnovik, 2018). The increased motivation for learning and the shared interest among learners to work together may facilitate communication in the English classroom and encourage learners to engage with the lesson content more deeply.

Aside from Computational Thinking, other subareas of Digital Literacy are also covered during the course of this lesson sequence. For example, the unit comprises a topic called "Information Security" which explains how to stay safe on the internet. This session integrates competences as described in the Digital Literacy subcategory "Sicherheit" (Security). The detailed lesson plans of all sessions will involve specific references to the covered areas of Digital Literacy to provide a more concise overview of the learning objectives of the single lessons. Further references to English language skills are included in the lesson plans as well.

As the Austrian curriculum requires 4th form students to finish the school year with an A2/B1 level in English (referring to the CEFR), the unit New Technologies should be used towards the end of the school year as the activities described therein are very close to B1. New Technologies may also be used in higher forms ("AHS-Oberstufe"), especially if the English level of the intended target group (4th form) is far below B1. However, integrating Digital Literacy as early as possible in the syllabus does not only develop the pupils' 21st century skills, but also prepares them for the topic "Moderne Technologien" (Modern Technologies), which represents an official subject area for English exams in both B1 and the Matura level B2 according to the current Austrian curriculum.

4.2 Course Structure

The unit New Technologies consists of 12 lessons á 50 minutes and involves the IT topics "The Internet of Things", "Digital Communication", "Information Security" and "Green Technology", concluded by an "Independent Project". Teaching ideas for an extra session about "Robotics" are also provided, but would require additional equipment (aside from the BBC micro:bit). All IT topics are to some degree simplified to account for the corresponding age and English level of the target group (A2/B1). It would be advisable to organise double lessons for

all sessions (except the "Independent Project") to let the students engage with both the content and the programming process more effectively – however, single lessons are also possible. For the last session '4.7.7 Independent Project', it is recommended to hold the lessons on two different days since the students are asked to work on and finish a micro:bit project in between.

Since the students need to use computers to create micro:bit programs, the English teacher needs to organise computer rooms for all the programming sessions. The first lesson of a double period (such as "The Internet of Things", for example) can always be held in a traditional classroom (with a computer and a projector for the teacher), whereas the second lesson of a double period will always involve a micro:bit programming task, and therefore require a computer room. However, the very first two lessons of New Technologies ("Introduction to New Technologies" and "Early Programming: Crash Course") need to be held in computer rooms as well as these aim to make the students familiar with the micro:bit interface and basic programming concepts.

4.3 Student Booklet

A separate booklet for the students containing all the new content and the BBC micro:bit projects was also designed for this course. Unlike the activity descriptions in the teacher guide, the booklet is tailored towards the learners and explains the tasks they have to do in a more engaging and pleasant way. The booklet should be used in class so that both the students and the teacher will have an easier time getting started with the lessons and not waste too much time on organisational matters. Furthermore, a collection of all the micro:bit projects in an attractive design will be more useful for the learners since they not only get a better overview of the programs they will write, but they can also reflect on or go back to past project or topics easier and take notes whenever they want. The booklet gives the learners the chance to finish the lesson sequence with a compact representation of what they have learned and achieved during the past weeks.

It is recommended to provide the students with a digital copy of the student booklet as printing these booklets can be quite expensive (in total, the student booklet consists of 63 A5 pages). A few tasks in the booklet require the students to fill in some gaps – if they are working with digital copies, the learners may either write their answers into their exercise books, or use a pdf

reader's Sticky Note or Comment function (of which the latter is quite advanced, however, and may delay the lesson unnecessarily).

4.4 Notes on Teacher Guide

All the topics covered in this lesson sequence include BBC micro:bit projects to incorporate different areas of Digital Literacy. Since the teacher needs to guide the students through different micro:bit projects and be able to help the learners in case they encounter any technical difficulties, it is necessary for the teacher to get informed about the BBC micro:bit and the programming interface beforehand.

It is highly recommended to visit the official BBC micro:bit website ("micro:bit Educational Foundation", n.d.) and watch a short micro:bit introduction video created by the same company who produces the micro:bits (BBC, 2015) to get a first idea of how the device works. The German iMooX course "Computational Thinking mit BBC micro:bit - der MOOC zum freien Schulbuch" (n.d.) provides an excellent step-by-step introduction to the BBC micro:bit and its potential use in the classroom. Additionally, Hackster.io (2017) also offers two good instruction videos on their YouTube channel for the BBC micro:bit – the first one describing the physical features of the device, and the second one explaining the programming interface. Further resources and helpful information concerning the micro:bit and the specific IT related topics will be given in the lesson plans whenever appropriate.

Since the teacher guide includes all materials and solutions for the lesson sequence New Technologies, the teacher does not need to code anything for the BBC micro:bit projects described therein or manually prepare any files beforehand (except providing the students with the micro:bit devices and printing master copies for some in-class activities, of course). However, it is recommended to analyse the micro:bit projects in detail and perhaps take a little time to try and find alternative solutions for the programming challenges since some students will find different ways to solve the same problem and the teacher needs to be ready to answer any questions that may arise in this respect.

Lastly, aside from working with the BCC micro:bit, the teacher also needs to be able to use online platforms such as *Kahoot*. Kahoot is a classroom response system that allows the teacher

to create an online quiz that students can take simultaneously with their mobile devices (Kahoot, n.d.). The teacher gets live results of the students' answers on his or her computer and can use the projector to show the class a chart visualising the amount of correct and wrong answers (see Figure 2).

Figure 2: Example of a teacher using Kahoot in class (note: this picture is also licensed under CC0 – see https://pixabay.com/photos/teacher-property-plant-and-teaching-3765909/)

Kahoot is a very popular website among students to take quizzes since it relies on gamification, which is proven to be more effective and engaging than traditional learning methods (Chaiyo & Nokham, 2017). In a Kahoot quiz, the student who is the first to guess the correct answer of a question receives the most points, whereas the others get less points the longer it takes them to select an answer. Students are usually motivated to collect as many points as possible as a ranking of the players with the most points is also shown after each question. In New Technologies, Kahoot is effectively used in the last session to revise content from the previous weeks.

Another online platform that is used in New Technologies is Quizlet. On this website, people can create study sets to revise, for example, vocabulary (Quizlet, n.d.). A study set is a list of terms paired with their matching definitions (or questions with answers), and Quizlet provides different study modes to study these sets.

Figure 3: Interface for creating a Quizlet study set

In this lesson sequence, only the Quizlet function *Flashcards* is used in class, which basically gives the user digital flashcards. The students will play this study mode to learn new vocabulary. Quizlet is a particularly useful tool since the pupils can simply use the Flashcards function without creating an account, and the teacher can easily adapt their study sets whenever needed. Moreover, digital flashcards are usually easier to manage and prepare than printed cards.

4.5 Lesson Plan Structure

The detailed lesson plans in the teacher guide, which is presented in the next chapter, will guide the teacher through the entire lesson sequence and explain every activity and its rationale behind it. Aside from the first two sessions introducing the students to the BBC micro:bit and programming basics, the subsequent sessions dealing with IT related topics are organised as double lessons. All lesson plans included in this paper are structured into:

- *Short Introduction*

  A short paragraph about the main objectives and the content of the lesson

- *Overall Objectives*

  A small list of 'can do'-statements that describe the desired students' learning outcomes

- *Preparation Steps for the Teacher*

  The necessary steps the teacher has to take before holding the lesson, such as printing teaching materials or informing themselves about a specific topic relevant for class

- *Short Overview of Planned Activities (Reference to Materials)*

  A compact overview of all activities planned for the lesson; if the activity does not refer to the learning materials (see section 4.9) or a related task in the accompanying student booklet of this lesson sequence, it is either a simple speaking task or a collaborative activity such as watching a video together

- *Description / Rationale of Activity A, B, C...*

  A description of all the tasks and their rationale behind them, according to their chronological sequence in the lesson; each task is identified and referenced with a distinct capital letter from the *Short Overview of Planned Activities (Reference to Materials)*

4.6 Overview of Sessions

Unit New Technologies (12 sessions à 50')		
Session	**Content**	**Goals** *The students know…*
1	Introduction to New Technologies and the BBC micro:bit	• … what programming means and why it is necessary in our society. • … how to create and run programs with the BBC micro:bit.
2	Early Programming: Crash Course	• … basic programming concepts. • … understand how the micro:bit integrates these basics.
3 & 4	The Internet of Things	• … what The Internet of Things means and how the BBC micro:bit is related to this concept. • … how to create programs with the micro:bit to solve simple problems.
5 & 6	Digital Communication	• … various forms of digital communication and how they are embedded in everyday life.
7 & 8	Information Security	• … about the principles of information security and understand simple forms of cryptography.
9 & 10	Green Technology	• … how technology can be used to save energy and achieve a positive impact on the environment.
11 & 12	Independent Project	• … how to use the BBC micro:bit to create their own video games.
Extra Session: Robotics		

Table 1: Overview of the topics and goals of the teaching unit *New Technologies*

4.7 Lesson Plans (Teacher Guide)

4.7.1 Introduction to New Technologies

The first session of this lesson sequence aims to introduce the overall topic. The students get an idea of what *New Technologies* and programming means, and understand how to run their own programs on the BBC micro:bit.

Overall Objectives:

- The students can explain what programming means.
- They can justify the need for programming languages.
- They can explain what the BBC micro:bit is and describe a few physical features of the device (such as the USB port, or the input buttons A and B).
- They can list a few simple functions of the micro:bit (such as showing a message on the LED display, or measuring the current movement of the device).
- They can connect the micro:bit to the PC in order to transfer a program to the device.
- They can create their own program on the BBC website and present it on their device.

Digital Literacy reference	"Betriebssysteme und Standard-Anwendungen" → "Grundlagen des Betriebssystems" (Operating Systems and Standard Applications → The Fundamentals of Operating Systems)
Micro:bit focus	First Steps with the device (creating/downloading/copying a program)
Language focus	• Expressing wishes / Expressing likes and preferences (D. Newby: Conditional – the imagined present: 'would') • Understanding English instructions in the context of operating systems and programming

Table 2: Didactic functions of the session Introduction to New Technologies

Preparation Steps:

- Good background knowledge about the BBC micro:bit, and how to connect the device to the computer to run custom programs
- If needed, sufficient amount of copies of the New Technologies BBC micro:bit booklet for all students – otherwise provided as an online resource for the pupils

Planned Activities:

5min	**A. Speaking Activity (Find Out…)**
10min	**B. Teacher's Introduction to Programming and the BBC micro:bit**
35min	**C. Getting Started with the BBC micro:bit**

A. Speaking Activity (Find Out…)

Description

In New Technologies, many lessons start with a short speaking activity: "**Find out** from your partner what kind of technological devices they would like to have". Before the students start talking, the teacher should give an example of how to answer this question properly. The teacher encourages one of the students to ask her/him to reveal how she/he uses technological devices in everyday life: "**Ask me** what kind of devices I…". The teacher gives a long and reasonable answer, including as many examples as possible (e.g. I would like to have a super fancy computer because… phone, tablet, Kindle, TV, headphones, camera, robot etc). The teacher should make extra efforts to include a specific grammar aspect as well when providing an answer for the students so the pupils are likely to copy the teacher and use the same grammar aspect as well when talking to their partners. In this particular example, the focus lies on 'would' constructions. When the students finish talking, the teacher picks a few students to share what their partners have said.

However, depending on the class, the task could also be used to practice Type 2 Conditionals, for example: "If I had a gaming laptop, I would play videos games all day… If I had a tablet, I would use it to read books and also draw some pictures with it". The simplest task would be to let the students find out from their partners what kind of technological devices they generally use (focus on Present Tense). Whichever option the teacher opts for, they must ensure that they give many examples with the respective grammar so that the students can do the task properly.

Rationale

This activity is based on the approach of communicative language teaching: as an ice-breaker, it activates the students' English and gets them talking about the subject they are about to learn more of. The task creates an *information gap* (the students need to find out something from their partners) and therefore initiates meaningful communication. A focus on a particular grammar aspect is recommended, but not required.

The creation of an information gap is particularly important because students will communicate purposefully and improve their listening and speaking skills. Also, the teacher needs to make sure the students follow three rules when answering a question: they are not allowed to say 'nothing', 'cannot remember', and 'I do not know' as these are known as conversations stoppers. After the students have finished talking, the teacher asks a few pupils to share in class what their partners have said ("**What did your partner say?**").

If this activity is done more often, students will have an easier time remembering facts during a conversation due to plenty of practice. Since the students know that they will be asked by the teacher to talk about what their partner has said, they will try harder to listen to their conversation partners.

B. Teacher's Introduction to Programming and the BBC micro:bit

The teacher explains that every technological device needs to be programmed and that everyone can write their own programs for everyday devices. A short overview of the overall lesson sequence is given, and the BBC micro:bit is introduced.

C. Getting Started with the BBC micro:bit

The teacher uses the projector to explain how to connect the BBC micro:bit to the computer, and how to run a custom program with the micro:bit. Also, the teacher should refer to the accompanying booklet that includes all the necessary information as well. The remaining minutes of the lesson may be used to allow the students to tinker with the micro:bit interface as this enables the learners to stimulate "curiosity that might arise as they are introduced to new technology, platforms or concepts" (Tyrén, Carlborg, Heath, & Eriksson, 2018, p. 85).

4.7.2 Early Programming: Crash Course

In the previous lesson, the students learned how to connect the BBC micro:bit to the computer and how to transfer a custom program onto the micro:bit drive. Before they start developing micro:bit programs, it is essential to introduce the students to basic programming concepts so they will be able to write more complex micro:bit programs in the subsequent sessions.

Overall Objectives:

- The students can identify different key elements of programming and demonstrate how to write very simple programs with the BBC micro:bit.
- They can explain what an *algorithm* is and give examples for algorithms based on everyday tasks.
- They can demonstrate what *loops* are and how they work in micro:bit programming.
- They can create *conditional statements* and express which role these statements have in micro:bit programming.
- They can explain what *variables* are and how they are used in micro:bit programming.
- They can create variables and use them as counters for various purposes (e.g. high score counters in a game, or a step counter).

Digital Literacy reference	"Computational Thinking" → "Mit Algorithmen arbeiten" (Computational Thinking → Working with Algorithms)
Micro:bit focus	Application of basic programming concepts (loops, conditions, variables)
Language focus	• Giving instructions (D. Newby: Neutral Attitude – the 'will' future) • Understanding and explaining fundamental programming concepts in English

Table 3: Didactic functions of the session Early Programming: Crash Course

Preparation Steps:

- Introductory Program either ready on a shared drive for the students to copy or transferred to all the students' devices beforehand (https://makecode.microbit.org/_JAY4JvP2WJAb)
- Adequate knowledge about basic programming concepts (see Booklet pp. 5 – 12)

Planned Activities:

15min   **A. Analysis and Discussion of a Simple Program** (Booklet Task 2.1)

30min   **B. Independent Learning** (Booklet Task 2.2 – 2.6)

5min   **C. Class Discussion**

-        **D. Homework** (Booklet Task 2.7)

A. Analysis and Discussion of a Simple Program (Booklet Task 2.1)

Description

At the beginning of the lesson the students run a program and describe how it behaves (see Figure 4). The teacher should place the according .hex file – a .hex file is the type of file one gets when downloading a created program from the BBC micro:bit programming interface – on a shared drive beforehand so the students can copy it quickly to their personal computers and to their micro:bit drive. The students should only run the program on their devices and not analyse any code.

The program incorporates the four programming concepts that represent the main learning objectives of this lesson: algorithms, loops, variables, and if statements. The teacher should not only ask the students to describe the program but also rephrase their answers in a way that corresponds to the code of the program, highlighting the single programming concepts by referring to the program's behaviour and the students' answers.
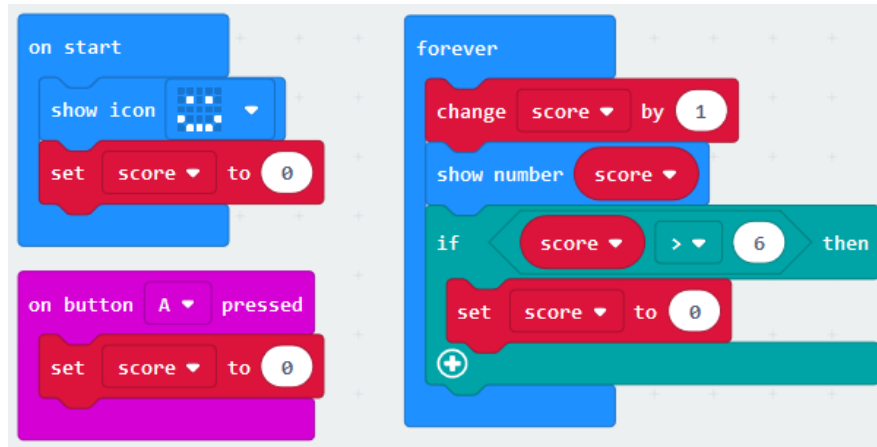
Figure 4: Source code of the Introductory Program for the session Early Programming: Crash Course lesson (https://makecode.microbit.org/_JAY4JvP2WJAb)

- **Loops:** For example, the students might say 'The program shows a smiley and then counts from 1 to 7 and then starts all over again'. The teacher may ask questions such as 'How often does the program count from 1 to 7?' (Expected answers: 'always, *forever'*) and 'How often does it show a smiley?' (Expected answers: 'only at the beginning of the program, once'), which should highlight the difference between instructions only executed once or repeatedly/infinitely.

- **Conditions:** Then, the teacher may ask 'Why does the program never show the number 8?' (Expected answer: 'Because *if* the number is 7, it always becomes 1 afterwards') and 'What happens if you press button A?' (Expected answer: 'the number is 1 again' – rephrase to 'so *if* you press button A, the number is set to 1'). Both questions aim to convey the concept of if statements and input events to the students.

- **Variables:** the teacher may rather just explain how the number that the students see on the LED display of the micro:bit is actually just one value that is being changed all the time, and this value can be manipulated in a number of ways (for example, set the value to 1 if you press button A). This explanation is enough to start with – the students will learn more about variables later on.

Rationale

As the students need to learn the concepts of algorithms, loops, conditions, and variables to be able to write meaningful programs, this introduction will facilitate their understanding of these programming concepts. By just thinking about what the program does, they naturally develop

an understanding for the programming concepts taught in this lesson. This may be more effective than explaining the abstract notions separately as the students are actively engaged in this task and already understand the practical purposes behind these concepts.

B. Independent Learning (Booklet Tasks 2.2 – 2.6)

Description

In pairs, students work on the first chapter of their New Technologies BBC micro:bit booklet. This chapter explains the programming concepts (algorithms, if statements, variables, and loops) in detail and serves as useful reference material for future micro:bit projects. The three fill-in tasks (Booklet Tasks 2.2 & 2.3 & 2.5) the students have to do are fairly easy, and can be checked by the teacher during the lesson or compared in the last activity of this session if needed (see Figure 5).

Students further get to apply their theoretical knowledge about the programming concepts they have just learned by writing simple programs with the BBC micro:bit (see Booklet Tasks 2.4 & 2.6). The students will create two different programs – the first program is fairly simple and only tests the students' ability to use loops and basic output blocks (see Figure 6), whereas the latter one involves a variable and conditional statements (see Figure 8).

Rationale

Ideally, most of the learners are able to read the chapter and write both programs in time whereas advanced students may develop and implement their own ideas for the second program. If time is short, it is recommended to finish the lesson by only discussing the first program in more detail and not force the students to begin with the second program. Students may leave the classroom discouraged if they did not have enough time to finish their programs, which, in turn, leaves them with a negative impression on micro:bit programming altogether (Tyrén, Carlborg, Heath, & Eriksson, 2018, p. 85). It would be advisable to let the students do the second program as homework or develop it at the start of the next lesson, since by skipping it the learners may face difficulties with later micro:bit projects as a basic understanding of how to use variables in micro:bit programming will be required.

Since the learners might be quite challenged with the micro:bit interface and programming tasks, they will have a lot of questions during the lesson. The teacher should encourage the

students to carefully read the first two chapters of the booklet and only ask questions if something is very unclear or not mentioned at all in the materials. While designing the booklet, particular focus was put on making it self-instructing as this "allows students to work at their own pace and given that the students are ready for the exercises it can work as an offload for the teacher" (Tyrén, Carlborg, Heath, & Eriksson, 2018, p. 85).

Finish this algorithm consisting of 5 instructions describing how you get ready for school:

1.) *Wake up*
2.)
3.)
4.)
5.)

Create an **if/else statement** for this situation: *You have an important test next week. What needs to happen now so you will pass the test? What will happen otherwise?*

if

then

else

Can you come up with more examples for variables in real life?

- video game score
- age
- _____

- _____
- _____
- _____

Figure 5: The three fill-in tasks in the students' course booklet (Booklet Tasks 2.2 & 2.3 & 2.5)

Program #1: Let's Get It Started

Your first BBC micro:bit program! Let's make it a good one, but keep it short and sweet.

- When the program starts, it should say "Hey" on the LED display.

- Afterwards, the program should **always** show the following four symbols:
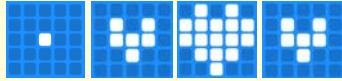
  If you've programmed the sequence correctly, your micro:bit's heart will always pump for you!

Bonus Task: if you **shake** the BBC micro:bit (have a look at the ▮ ⊙ Input category), it should show your name on the display. After your name was displayed, the hearts should appear again automatically!

Figure 6: Task description of the first program the students will write in the *New Technologies* unit (Booklet Task 2.4)
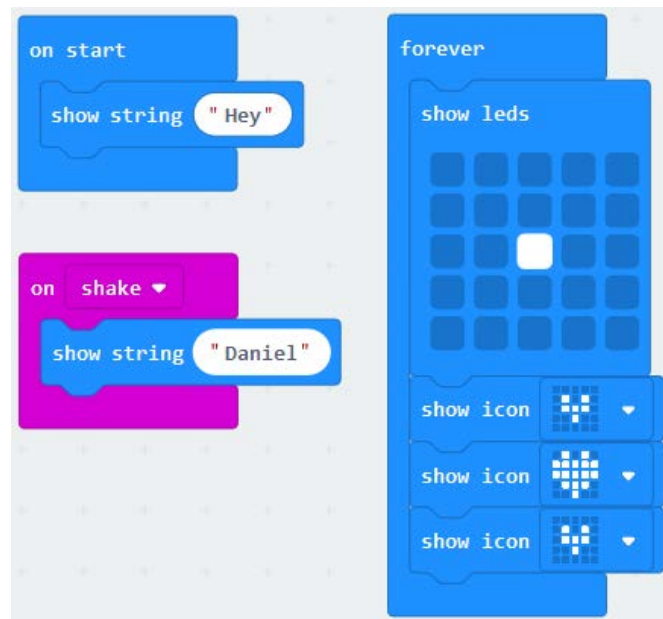

Figure 7: Solution for Program 1: Let's get it started (makecode.microbit.org/_J7t5WULM24dE)

Program #2: The Limit Does Not Exist

Counters can be found everywhere nowadays – high scores in video games, a visitor counter for popular clubs or events, or even the last few minutes of a long and exhausting school day. So why not program something we can actually use as well?

Create a program that helps you to count up or down by pressing the buttons A or B!

- Starting the program, the counter should be 0 and is shown on the display.

- Pressing button B means you add 1 to the counter.

- Conversely, pressing button A means you subtract 1 from the counter.

- Example: Pressing B two times and A four times would show the final result –2!

- Pressing both buttons at the same time should reset the counter to zero.

Do you have any ideas to develop your program even further? How about an upper limit so you can only count to a specific value? What happens then? Or maybe let your program count automatically up or down every second? You decide!

Figure 8: Task description of the second program the students will write in the *New Technologies* unit (Booklet Task 2.6)
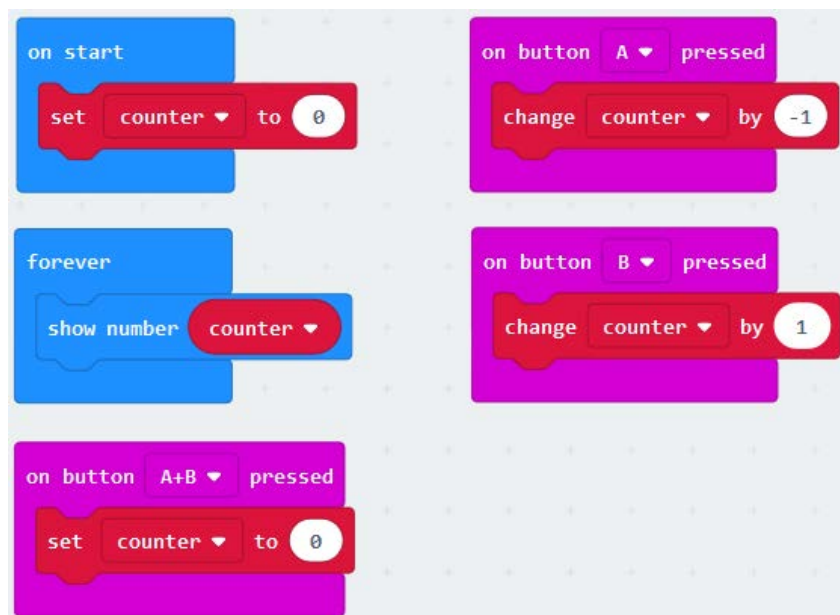

Figure 9: Solution for Program 2: The limit does not exist... (makecode.microbit.org/_RHj4tFdVxKiK)

C. Class Discussion

A final discussion of the lesson concludes the introduction to the BBC micro:bit as the learners are expected to know now how to create small programs with this device. The students should reflect on the introductory chapter to programming and give the teacher feedback regarding the lesson and the difficulty of the two programming challenges. This will help setting up future micro:bit projects to perhaps adjust the difficulty level or adapt various tasks.

D. Homework (Booklet Task 2.7)

As mentioned earlier, if the students could not write both programs in this lesson, they should do the rest of them at home. Otherwise, the students shall read the chapter 'Loops' in their booklets and do a task that requires them to draw a flow chart – which is a visualisation of the logical sequence of steps in a program – for 'Program 1: Let's get it started' (a short explanation for flow charts is provided in the booklet, of course). The solution for this task is illustrated in Figure 10.
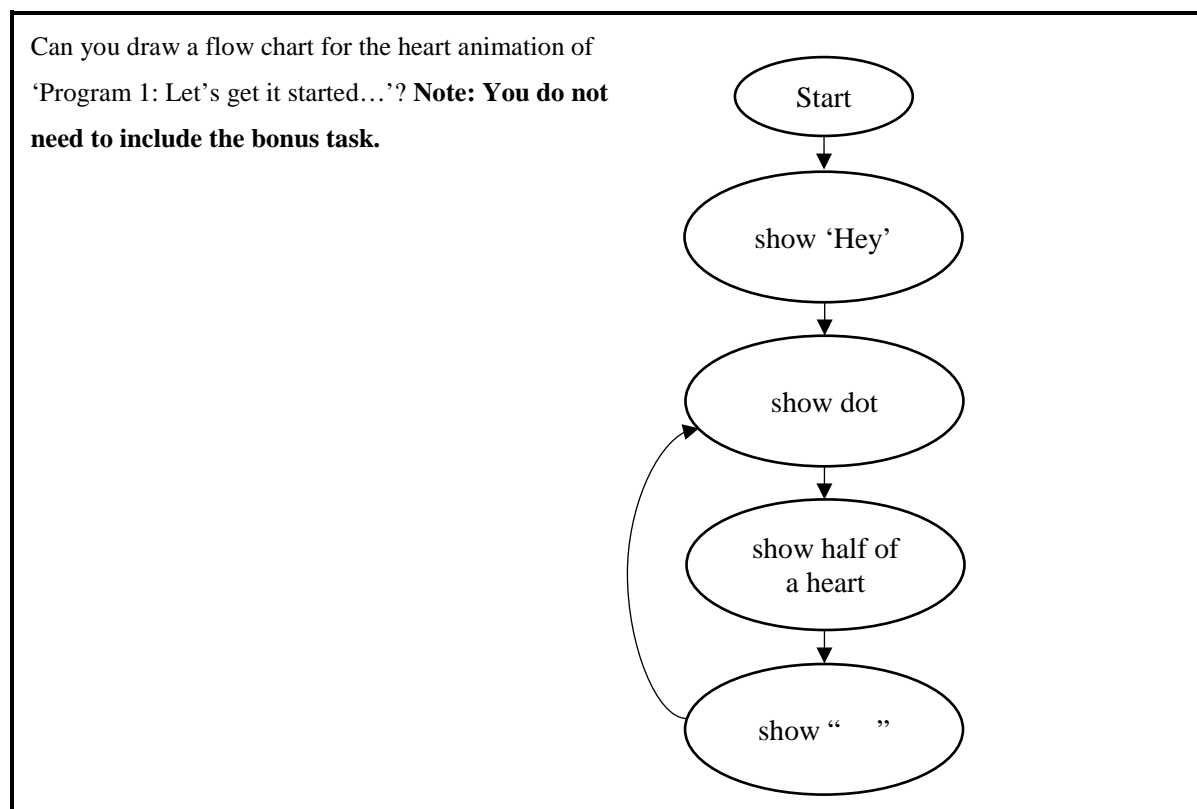

Can you draw a flow chart for the heart animation of 'Program 1: Let's get it started…'? **Note: You do not need to include the bonus task.**

Start → show 'Hey' → show dot → show half of a heart → show " " (loops back to show dot)

Figure 10: The homework task for the Early Programming session – drawing a flowchart (Booklet Task 2.7)

4.7.3 The Internet of Things

The first topic the students will work on is called The Internet of Things. The students will learn how the BBC micro:bit and everyday objects may be related to this concept, and improve their English skills at the same time. In the second lesson of this session, the focus will lie on developing the students' micro:bit programming skills.

Overall Objectives:

- The students can explain what the Internet of Things (IoT) means.
- They can list two to three benefits and drawbacks of IoT.
- They can name practical examples for IoT devices.
- They can give examples how regular devices such as the BBC micro:bit could be used as IoT devices.
- They can use the micro:bit's built-in compass to create a navigation program.
- They can use conditional statements and logical operators together meaningfully.

Digital Literacy reference	"Gesellschaftliche Aspekte von Medienwandel und Digitalisierung" → "Digitalisierung im Alltag" und „Gesundheit und Wohlbefinden" (Social Aspects of Media Change and Digitalisation → Digitalisation in Everyday Life and Health and Well-being) "Computational Thinking" → "Kreative Nutzung von Programmiersprachen" (Computational Thinking → Creative Use of Programming Languages)
Micro:bit focus	Using conditional statements and logical operators
Language focus	Acquiring and using new B1 vocabulary (e.g. benefits, to identify, issues, etc.)

Table 4: Didactic functions of the session The Internet of Things

Preparation Steps:

- Sufficient knowledge about how IoT and Quizlet work – the following YouTube videos give a good introduction to this topic:
    - "Internet of Things (IoT) | What is IoT…" (Edureka, 2018a)
    - "Internet of Things (IoT) Applications…" (Edureka, 2018b)
    - "How Students Study Using Quizlet" (Quizlet, 2018)

- Access to Quizlet study set used in the lesson: quizlet.com/_692a5d (contains vocabulary with additional German definitions and accompanying pictures)

- At least one smartphone for two students as the learners will need to use Quizlet on their mobile phones (alternatively, the teacher may allow pupils to use computers)

- Sufficient amount of copies of the two versions of the text "IoT: The Internet of Things"

- Sets of pictures printed out and cut to size for the activity Match the Pictures (the exact number of sets depends on the class size – one set for three students)

Planned Activities:

10min   **A. Speaking Activity (Find Out…) & Class Discussion**

20min   **B. Quizlet Study Set: New Vocabulary** (Booklet Task 3.1)

10min   **C. Listening Comprehension: IoT Text** (Learning Materials)

10min   **D. Match the Pictures** (Learning Materials)

10min   **E. Revision Task: The BBC micro:bit & IoT** (Booklet Task 3.3)

35min   **F. Micro:bit Programming: Using Sensors** (Booklet Task 3.4)

5min   **G. Project Discussion**

-       **H. Homework** (Booklet Tasks 3.2 & 3.5)

A. Speaking Activity (Find Out…) & Class Discussion

Description

In pairs, the students find out from their partners how often they use the internet and what for (refer to 4.7.1 Introduction to New Technologies for further information about this activity). The teacher should prolong this activity a little to discuss the impact of the Internet on the students' everyday lives and the way they interact with technologies. Some example questions

for leading a short class discussion could be: What could be the benefits if everyday objects were connected to the internet (e.g. cars, coffee machine, light bulbs, etc.)? What are the drawbacks of this approach? Do you know what a Smart Home is and would you like to live in one? Has anyone of you ever heard of the cloud? What is your opinion on virtual digital assistants such as Alexa or Siri?

Rationale

Aside from the general benefits of doing a speaking activity at the beginning of the lesson, talking about the influence of the Internet on society fits perfectly to the topic and is usually a popular subject among pupils as well. This time, no specific grammar aspect may be involved during the speaking activity as it is quite a general topic and the learners' English skills will be particularly challenged later on. The teacher may take more time choosing students to reveal what their partners said and elaborate on how the Internet is embedded almost everywhere in everyday life, which allows for a smooth transition to the text the students are about to read.

B. Quizlet Study Set: New Vocabulary (Booklet Task 3.1)

Description

In this lesson, the students use a Quizlet study set containing explanations of difficult words and phrases that occur in the text they will read in the next activity (see Figure 11). They will use the Quizlet 'Flashcards' function to learn the new terms and phrases (for more information about Quizlet, refer to 4.4 Notes on Teacher Guide).

The students get together in pairs. Every pair needs to have at least one smartphone. Student A starts by reading the term on the first flashcard aloud. Then student B has to say whether they know the word and guess (in English) what it could mean. Student A then flips the flashcard and reads the answer (English definition + example sentence) aloud. Now the students take turns, and student A gets to guess the definition of the second term. This continues until all (or most) flashcards were discussed.

Alternatively, the flashcards may also be printed out, if, for example, the smartphone policy is very strict at the school, or it is known that the students do not work efficiently when working on their mobile phones. However, this can get very time-consuming for the teacher in terms of preparation as they have to prepare printed sets of cards for all groups.

automation — a technique that is used to make a process automatic

Example: Self checkouts are becoming more and more popular. This automation is a reason why saleclerks are slowly losing their jobs.

benefit — [Vorteil, Nutzen] to gain or receive good results from something; an advantage

Examples: Using technology in class has a lot of benefits for the environment. For example, you save a lot of paper if students use their computers to read a text.

embedded — [eingebettet, eingeschlossen] to insert something as part of a whole

The YouTube videos are embedded in her website.

Figure 11: 3 of the 28 entries in the Quizlet vocabulary study set – https://quizlet.com/_692a5d
(Booklet Task 3.1)

Rationale

Before the students receive a text about IoT, it is essential to introduce them to unfamiliar vocabulary used in the text so they will be able to understand the main points. Quizlet is an excellent tool to let the students learn new words as this platform not only offers a stable and easy-to-use interface, but it also opens many opportunities regarding lesson planning. In this activity, the students need to talk to each other to discuss the new vocabulary. Moreover, this task ensures that advanced students who might know most of the vocabulary already will not get bored as they get to show their partners that they have a good range of vocabulary, whereas other students are given the chance to learn new words without much pressure. For some terms, pictures or German definitions were provided as well to cater to students who might get lost with English explanations only.

C. Listening Comprehension: IoT Text (Learning Materials)

Description

The students get a text with gaps in it and have to listen to an audio recording to fill these gaps (see section 4.9). There are two versions of the text that have gaps at different places, and the teacher should hand out the versions alternatively so all students who sit together have different versions. The learners get one to two minutes to skim the text before starting with the listening comprehension.

The audio recording is actually a YouTube video (and the text a transcript) but for the first round of the listening comprehension, the projector should be turned off. Afterwards, the video should be shown so the students also receive visual input for the text at hand.

Rationale

Since the text may be quite challenging for students, a listening comprehension and a video will facilitate the understanding of the main points. Students who struggle with the listening comprehension may understand one or the other missing word by paying attention to the visual input of the video. Additionally, the missing words can be found listed in a random order at the bottom of the worksheet for students who find the listening activity particularly difficult.

After watching the video, the pupils can check with their partners' texts and fill in the missing words. In practice, sometimes learners tend to complete the gaps by looking at their partners' texts, which cannot be completely avoided. However, if the teacher, for example, walks around the classroom while the audio is playing, most students will do the task properly.

D. Match the Pictures (Learning Materials)

Description

Students form groups of three. Every group gets the same set of pictures from the teacher (see section 4.9). Each picture relates to one word or phrase in the text. The learners need to sort the pictures according to the chronological order of their corresponding words occurring in the text. For example, for an image depicting an air conditioner the students would have to find the first occurrence of this word in the text and position the image in the final order accordingly. Finally, when the learners have agreed on the image order, they need to give all the word and picture pairs a unique number (starting from 1) so it will be easier to compare the final results of all groups at the end of this activity.

In total, there are 14 pictures in one set. Eight images are straightforward in terms of the words they refer to (for example, an image of a barcode for the word 'barcode', or a moneybag with a dollar sign on it for 'revenue'). The other six pictures are more difficult, especially because they represent general concepts and therefore there might be more than one correct interpretation of a single image (see Figure 12).
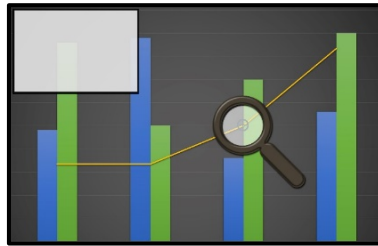

Figure 12*: An image that may relate to the word 'analytics' or the phrase 'track data' in the source text (see section 4.9 for all pictures)*

Rationale

This post-reading activity requires the students to scan the text and try to match the pictures to the words in the text. Since the learners will try to get the chronological order of the images right and not every picture clearly refers to one word or phrase, the students will discuss and decide in their groups what they think might be the best word order, which not only encourages communication between the students, but also facilitates their understanding of the topic altogether. Moreover, the pupils improve their ability to interpret every day pictures and memorise the new vocabulary better by closely analysing the text. The students should be allowed to view the Quizlet study set to check terms or phrases they do not remember anymore.

E. Revision Task: The BBC micro:bit & IoT (Booklet Task 3.3)

Description

The students take their booklets and read the first page of the chapter The Internet of Things, which includes a short summary of what IoT means and an example of communication between IoT devices. Then, the students have to discuss in pairs how they could use the BBC micro:bit's sensors to create a program that could be useful in everyday life. Also, the students should talk about the micro:bit's potential if it were an IoT device as well (see Figure 13). Afterwards some students should share their ideas in class.

Rationale

By reading the text about IoT in the booklet, the students get the chance to revise the topic. Also, some vocabulary from the previous lesson was also incorporated in this chapter so that the learners get more examples how these new words can be used.

The main rationale behind this activity are that the students acquire a fundamental understanding of how IoT is realised and that they comprehend how the BBC micro:bit relates to this concept. Moreover, by thinking of IoT scenarios with the micro:bit on their own, the pupils can further recognise the practical purpose behind both the micro:bit and the Internet of Things. As a teacher, it is important to stress both the potential and the limitations of the micro:bit as a mini computer when commenting on the students' answers, especially with regard to IoT.

> The BBC micro:bit cannot connect to the Internet, but it does provide you with a compass and a light, temperature, and motion sensor – this means that it can measure how dark or bright the environment (= Umwelt) is, how warm or cold it is and whether the device is being moved (for example, if you shake it) or not.
>
> With a partner, can you come up with one or two examples how to use the micro:bit's sensors to make life easier for you (or achieve something positive for the environment)? And what if you could connect your micro:bit to your smartphone (or the Internet in general) – what new opportunities would it bring?

**Figure 13**: The IoT discussion task in the student's booklet (Booklet Task 3.3)

F. Micro:bit Programming: Using Sensors (Booklet Task 3.4)

Description

The students need to create a BBC micro:bit program that uses the device's sensors meaningfully. They need to program a compass with the built-in compass sensor to display the correct letter of the direction the micro:bit is currently pointing to, even if the device is being moved (see Figure 14). Students who finish early may add features to the program or change parts of it to achieve a different result (such as showing an arrow on the display that always points to North).

Program #3: Never Eat Shredded Wheat

North, East, Sou–, … ummm… if you ever get lost, a compass may come in quite handy. Create a program that always shows the first letter of the direction (N, E, S, or W) on the LED display that the BBC micro:bit is currently pointing to.
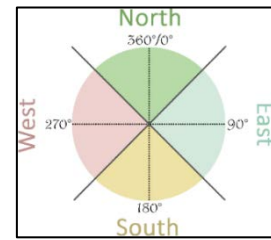
- Create your own variable and make sure it is **always** updated to the `compass heading (°)`.

- Don't forget that you want to **show** your variable too. Also, you need to `calibrate compass` by pressing, for example, the button A, so the micro:bit can always be calibrated and is aware of its current position. Otherwise, the compass sensor will not work!

- Try and run your program on your micro:bit. It might say "TILT TO FILL SCREEN" before showing the value – this is normal! You need to calibrate the device before using it. Just move your device around when you see a single centred dot in the LED display!

- If you see a value updating all the time while moving the device, you're on the right track!

- Example: if the value is between 45° and 135°, it should show the letter E (for East) on the display. You will probably need to use a few **conditional statements** 😉

- **Remember: the shorter your algorithm, the better!**

Figure 14: Task description of the overall third program the students will write in this lesson sequence (Booklet Task 3.4)

Rationale

By developing a compass, the students realise how sensors are used. They will mostly experiment around with conditional statements, which will facilitate their understanding of algorithms and prepare them for more difficult projects in subsequent lessons.

In theory, the learners could also implement their own ideas from the previous activity (see Figure 13), However, at this point they probably lack the knowledge and programming skills to develop their ideas on their own and would ask too many questions during the lesson due to inexperience with micro:bit programming. If the teacher still wants to give the learners the chance to develop their own ideas and explore their creativity, it is recommended to organise a co-teacher who also knows how to program with the micro:bit and is therefore able to help the students individually with their programming questions. However, as mentioned before, this is not recommended at this stage of the unit.
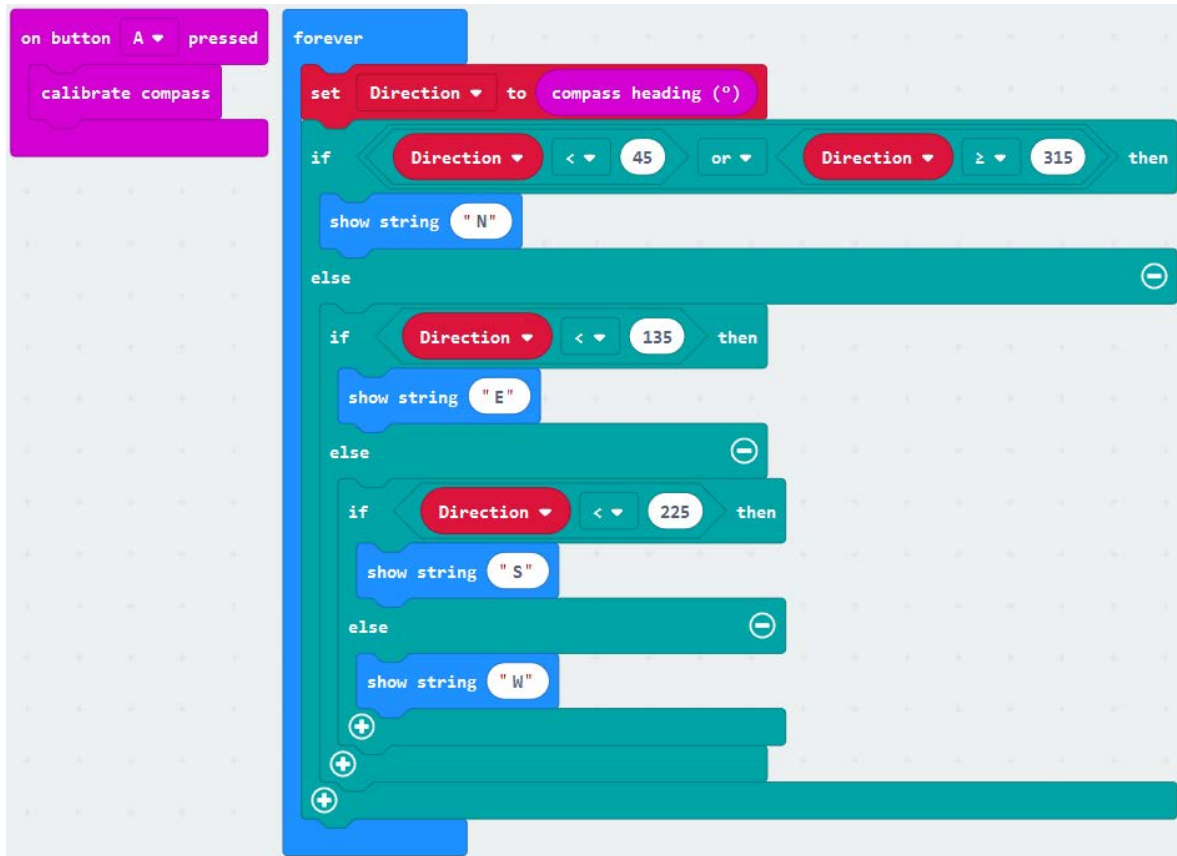
Figure 15: Solution for Program 3: Never Eat Shredded Wheat
(https://makecode.microbit.org/_EY8dq7fTYeYq)

G. Project Discussion

The teacher should reserve at least five minutes for a short class discussion on the Independent Project before the lesson ends. The students should give the teacher feedback on the program they worked on: how difficult was the programming process? What did they particularly like about it? Did they find different solutions than their classmates? Whose algorithm for the BBC micro:bit compass is the shortest? Discussing these questions aims to round off the lesson and encourages the students to reflect on programming with the BBC micro:bit.

H. Homework (Booklet Tasks 3.2 & 3.5)

Description

As a homework assignment, the students shall answer five questions about IoT (see Figure 16). These questions will challenge the learners to evaluate the effects of IoT on society. Although these questions can be found in the students' booklets as well, the teacher may hand out a

separate sheet with these questions if he or she wants to collect the homework and has enough time to look at all the students' answers. Otherwise, they should be at least checked at the beginning of next lesson. Additionally, the students should again revise the Quizlet study set (Booklet Task 3.2).

Question 1:	How do you think compasses can operate as IoT devices in real life?
Question 2:	IoT has had a huge influence on the way people use technology. Give at least three benefits of using IoT devices.
Question 3:	Can you identify any issues of living, for example, in a Smart Home where almost all appliances are connected to the Internet?
Question 4:	In your opinion, does IoT have a positive influence on one's fitness and health? Why / why not?
Question 5:	With IoT, more and more manufacturing companies are able to use Automation to produce their products. Give at least three advantages of Automation for companies.

Figure 16: As a homework assignment, the students have to answer four IoT related questions
(Booklet Task 3.5)

Rationale

The homework task gives students the opportunity to reflect on IoT and revise some of the new vocabulary. The questions are quite advanced for 4th form learners, and depending on the class, the questions may be rephrased or simplified to some extent. However, letting the students work on these questions will definitely improve their English skills and give the teacher important feedback on their learning progress.

4.7.4 Digital Communication

In the chapter Internet of Things, the students learned that everyday devices are also able to connect to the Internet and interact with each other. In this lesson, the focus lies on digital communication altogether. This topic not only involves a general introduction to the Internet and different forms of communication between computers (such as Bluetooth or Wi-Fi), but

also a discussion on the effects of human interaction with digital media technologies (social media in particular).

Overall Objectives:

- The students can explain what digital communication is and which role it has in everyday life.
- They can analyse the benefits and drawbacks of digital communication for society.
- They can criticise the effect of social media on the individual.
- They can list different ways to communicate with a computer or mobile devices.
- They can explain what servers, clients, and internet service providers (ISPs) do.
- They can explain the key differences between the Internet and Wi-Fi.
- They can demonstrate how Bluetooth works using the BBC micro:bit.

Digital Literacy reference	"Digitale Kommunikation und Social Media" → "Interagieren und kommunizieren" und „Gesundheit und Wohlbefinden" (Social Aspects of Media Change and Digitalisation → Digitalisation in Everyday Life and Health and Well-being) "Computational Thinking" → "Kreative Nutzung von Programmiersprachen" (Computational Thinking → Creative Use of Programming Languages)
Micro:bit focus	Using Bluetooth
Language focus	• Ability to evaluate and reflect on topics like social media • Acquiring vocabulary relating to digital communication in a technical context (e.g. server, client, modem, radio waves, etc.)

Table 5: Didactic functions of the session Digital Communication

Preparation Steps:

- Sufficient knowledge about the Internet – the following YouTube videos give a good introduction to this topic:
    - "How the Internet Works in 5 Minutes" (Aaron, 2009)
    - "The Internet: Wires, Cables & Wifi" (Code.org, 2015)
    - "Modem vs Router - What's the difference?" (PowerCert Animated Videos, 2018)

- Sufficient amount of copies of the Evaluation Sheet for the debate (see Booklet p. 23)

Planned Activities:

5min **A. Speaking Activity – Parent Child Discussion**

17min **B. Poem – Internal Monologue** (Booklet Task 4.1)

8min **C. Getting Things Ready: How to Hold a Debate** (Booklet Task 4.2)

20min **D. Debate on Social Media** (Booklet Task 4.2)

20min **E. Input: Digital Communication and Bluetooth** (Booklet Tasks 4.3 – 4.5)

25min **F. Micro:bit Project: Bluetooth** (Booklet Task 4.7)

5min **G. Project Discussion**

- **H. Homework** (Booklet Task 4.6)

A. Speaking Activity – Parent Child Discussion

Description

The students get together in pairs. One has to act like a parent, and the other one as a child. The child has to pick their favourite social media app (e.g. Instagram, Snapchat, or YouTube) and explain this app to the parent. After two minutes, the students switch roles and the new child explains a different app to their partner.

At the start of the activity, the teacher may use a projector to show a list of different apps in case the students lack inspiration or ideas which social media apps they could pick. If a student does not know any apps, or does not even use mobile phones, they may explain to their partners what the BBC micro:bit is or what the term *The Internet of Things* means.

Rationale

This activity introduces the students to the topic of social media, which is one of the two main aspects of this session. Instead of telling the learners just to talk about their favourite apps, they need to play the role of a child explaining something to their parent. It is important that the students switch roles after a while so that everyone gets to play both roles.

B. Poem – Internal Monologue (Booklet Task 4.1)

Description

The students open the chapter Digital Communication in their booklets and look at the pages 19 – 20. They will find five different short poems. They get about five minutes to write down silently what they think about one specific poem. However, once they have started writing down their thoughts, they are not allowed to stop writing. The teacher should emphasise that the learners must not put down their pens in these five minutes. Then, the students talk to their partners about what they wrote. They do not have to show their texts to their classmates, but just summarise their thoughts and give their opinion on the poem. Finally, the teacher discusses every poem and asks a few students to share their thoughts on the text that is currently addressed.

Rationale

This activity aims to make the students reflect on social media and/or the idea of using the internet to talk with other people. The writing task asks them to immerse themselves into a specific poem and think about different aspects of online communication. Usually this task makes the students realise that they have a lot more to say about a text than they originally thought. In the subsequent discussions the students get to know different viewpoints on social media, which will help them for the upcoming debate activity.

C. Getting Things Ready: How to Hold a Debate (Booklet Task 4.2)

The students read the 'Rules of the Debate' and look at the 'Evaluation Sheet' in their booklets. Then, the teacher starts to divide the class into groups and explains the activity again.

D. Debate on Social Media (Booklet Task 4.2)

Description

Students form groups of three. Two students will hold a debate whereas the third one will evaluate their arguments. The debate topics are about the two different aspects of social media (see Figure 17). The debaters play Rock, Paper, Scissors to decide who will support the statement and who will be against it. They get three minutes to prepare themselves for the debate. Meanwhile, the evaluators think about which pro and contra arguments the debaters might present. It is important that the teacher pays particular attention to time management in order to do two rounds of debates.

Statement 1: Popular social media apps such as Instagram and Snapchat should change the age limit for creating an account from the age of 13 to 16.

Statement 2: Social media is making us more anti-social.

Figure 17: The two topics for the debate (included in the booklet)

The debate itself should last about four minutes. Finally, the evaluator has to decide which student performed better in the debate and therefore wins the round (see Table 6). Then, the students switch roles and hold a new debate. The winner may decide whether they want to be the evaluator this time or hold another debate. In the latter case, the student who lost the debate will switch with the evaluator.

Rationale

Social media is a great topic for debates since young learners are usually very interested in applications such as Instagram or Snapchat and should therefore be encouraged to give their opinion on this matter. If the class size cannot be divided into three, one or two students may join different groups so that there are two debaters and two evaluators in one group. In this case, the debaters and the evaluators simply switch after the first debate, regardless of who won before.

Give the debaters a ✓ for something they did right. If you end up with the same amount of ✓, you have two winners!		
Debater A	Debater B	Criteria
		… stayed *objective* & did not attack the opponent personally
		… did not *interrupt* their opponent when he or she was speaking
		… used full sentences and spoke clearly
		… was able to *convince* the opponent with one of their arguments
		… answered the opponent's questions and did not *distract* from the topic
		… provided arguments that were logical and easy to follow
Note: For words written in *italics* German translations are provided in the booklet.		

Table 6: The list of criteria the evaluators will use for the debate (included in the booklet)

The evaluation sheet helps learners to make a fair judgement when evaluating the debaters. Sometimes both debaters may end up with the same amount of checks, which means that both debaters win. More specific rules and introductory notes to debates were not given since preparing for debates is not the focus of this lesson. Moreover, 4th form learners may be already quite overwhelmed trying to talk about a specific topic in this setting and develop their own arguments. This activity only intends to make the learners aware which effects social media can have on the individual. Moreover, they can critically examine online communication by debating on different aspects of social media.

E. Input: Digital Communication and Bluetooth (Booklet Tasks 4.3 – 4.5)

Description

The students read through the second part of the chapter Digital Communication in their booklets ('B. The Internet') and do the three booklet tasks (see Figure 18). The first two tasks require the pupils to give examples of offline and wireless communication, whereas for the third task they have to complete a diagram where a few elements are missing. After ten minutes, the teacher discusses these tasks with the class. Particular attention should be paid to the diagram

visualising how the Internet is realised from a technical perspective. Before the teacher summarises the diagram, they should ask if one of the students wants to explain it in their own words first.

Rationale

This lesson focuses on the technical part of digital communication, which is why the students need clear and accurate information to understand how the Internet works. This chapter is arguably the most difficult one in the booklet since the students need to grasp the concept of the Internet in a foreign language. However, if the learners understand the diagram and can explain the differences between wired and wireless communication, the main objectives of this lesson are already met.

F. Micro:bit Project: Bluetooth (Booklet Task 4.7)

In pairs, the students will do a programming task to communicate with their BBC micro:bits via Bluetooth (see Figure 19). Since they only have 25 minutes to do the micro:bit project, fewer rules and instructions were given so that the learners have more freedom regarding the programming process. The solution to send messages from one micro:bit to the other is fairly simple (see Figure 20), but it usually takes students quite some time to figure out how to set up their devices properly.

Task 1: Can you name other forms of communication that do **not** require the internet?

[Solutions already provided]

- fax machine
- radio
- television
- newspaper
- letters
- telephone / call phone

Task 2: Wi-Fi does not need a wire because it uses **radio waves** to transmit and receive information. Yes – just like the radio that was invented over 100 years ago! Which other devices or technologies do you think use radio waves to communicate wirelessly?

[Solutions already provided]

- Television
- Remote Controls
- Smartphones to call someone
- Bluetooth
- Car Navigation System
- Car Radio
- Radar

Task 3: Complete this diagram.

[Missing elements already added – this is the final solution]
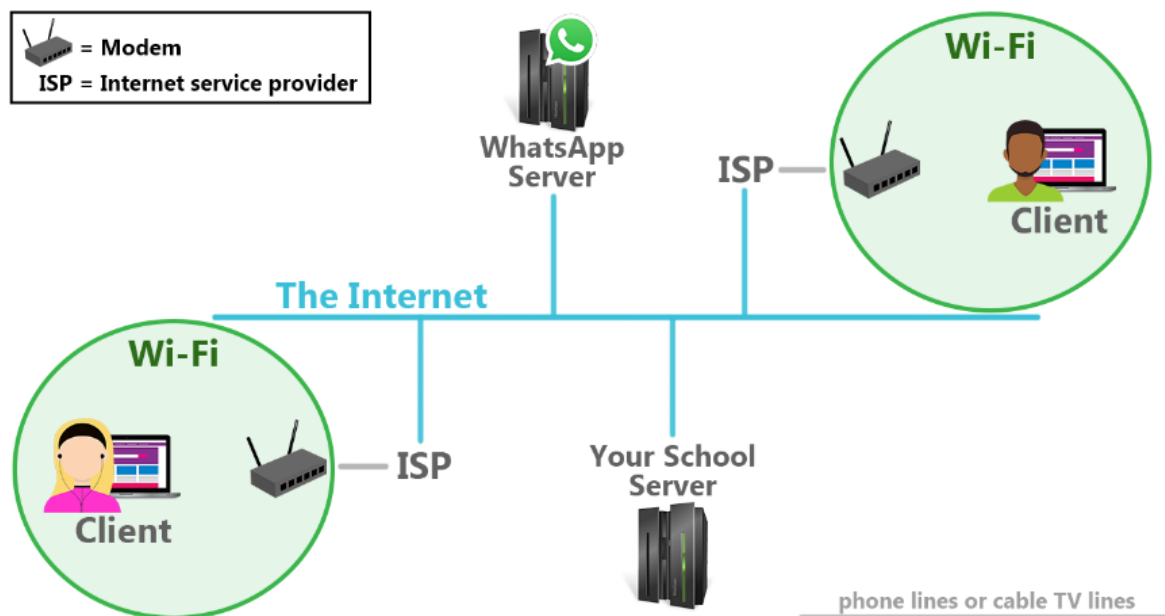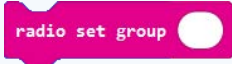
Figure 18: Task descriptions and solutions for the reading comprehension tasks in the chapter Digital Communication (Booklet Tasks 4.3 – 4.5)

G. Project Discussion

After writing their programs, the students should again reflect on the programming session. In addition to general questions about the project, the teacher may ask: Can you think of any real-life scenarios where you could use the BBC micro:bit's Bluetooth function? Do you now think differently about digital communication? In your opinion, how does the Internet of today influence social media?

Program #4: Blue Teeth

Your BBC micro:bit supports Bluetooth! Find a partner and develop programs that use Bluetooth to send each other (nice!) messages. Keep in mind that both of you have to create a program for yourself.

- **At the start of both of your programs**, you need to make sure that you use the same channel to communicate. Pick a different value than 1, or otherwise other students may read your messages! 😱   `radio set group ⚪`

- By pressing a button, one of you **radio sends** a message. This message can be seen as a variable: it could be 1.) a number, 2.) a string (= word) with a number, or 3.) just a string. Your partner, the receiver, needs to check if he or she receives the variable. If yes, they should **show** the variable/message on their LED display.

  If you managed to send your partner a couple of messages, find another group to work with. Can you figure out how several micro:bits can send messages to one single micro:bit? Try it out!

  Also, can you think of a scenario in real life where multiple micro:bits sending signals to one micro:bit could be useful? Think about counting!

Figure 19: Task description of the overall fourth program the students will write in this lesson sequence (Booklet Task 4.7)
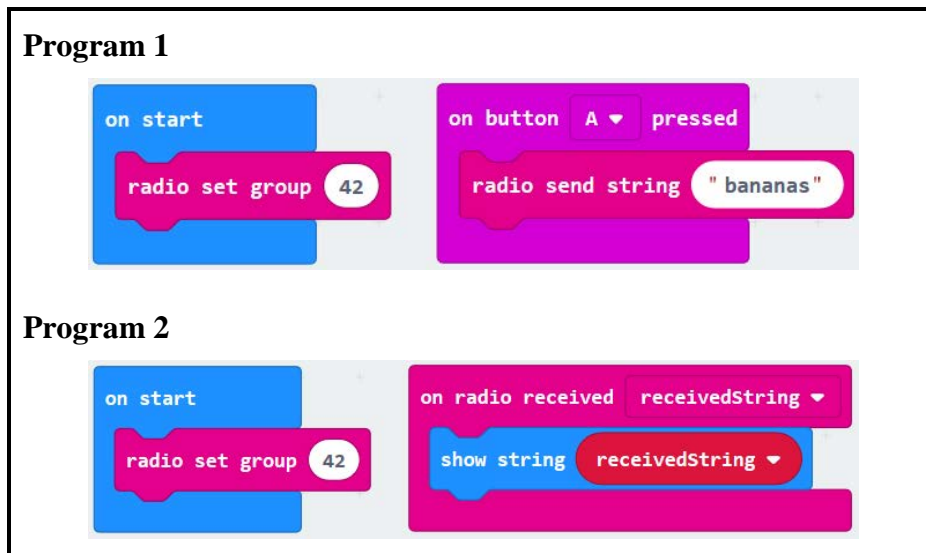
Program 1

Program 2

Figure 20: Solution for Program 4: Blue Teeth (https://makecode.microbit.org/_dhWgzU7PU7rA and https://makecode.microbit.org/_KEyD9eXEMXKu)

H. Homework (Booklet Task 4.6)

The students should write a text about one of the debate topics they discussed in class. Since they have already worked on these topics, they should have some ideas what to write about. The teacher should collect the learners' texts since it will take students a lot of time and effort to write them. In the next lesson, students will revise what they still know about the Internet from a technical point of view.

Write a short text (~150 words) about one of the debate topics you discussed in class. Give your **personal opinion** on the topic and make sure to have **three separate sections**:

- Introduction: what are you writing about / what is your general opinion?
- Arguments: explain in detail why you are either for or against this idea
- Ending: summarise your arguments in one or two sentences

Debate Topic 1: Popular social media apps such as Instagram and Snapchat should change the age limit for creating an account from the age of 13 to 16.

Debate Topic 2: Social media makes people anti-social.

Figure 21: Homework of this lesson – a prompt for writing a short text about one of the two debate topics (Booklet Task 4.6)

> **Homework Example text:**
>
> *In class we talked about how social media makes people anti-social. I am against this idea because I think that the opposite is true.*
>
> *If we feel lonely and there is no one nearby, we can use social media to talk to other people. This makes us more social because we actually chat with another person instead of talking to no one. Also, social media gives us the opportunity to talk to people who live far away. For example, when I feel lonely, I call my best friend who lives in a different city, and we often talk on the phone for hours. Lastly, we can use social media to see what our friends are doing and maybe meet up with them.*
>
> *Social media allows us to talk to other people, chat with friends who live far away, and makes it easier to meet friends. This is why I think that social media makes us more social.*

Figure 22: Fictitious example of a text written for the Digital Communication homework

4.7.5 Information Security

The session Information Security aims to make the students aware that with the increasing interconnectivity, security measures need to be taken to protect our personal data and privacy. They will learn how to stay safe on the Internet, and also get some insight into relevant aspects of information security (e.g. necessity of encryption in networks, strong passwords).

Overall Objectives:

- The students can argue why information security is important nowadays.
- They can demonstrate how to stay safe on the Internet and recognise possible dangers of sharing personal data online.
- They can examine emails and websites to identify whether they might be suspicious.
- They can explain what Social Engineering means and give examples for phishing.

- They can explain what cryptography is and use the Caesar method to encrypt and decrypt messages.
- They can create a simple micro:bit program that contributes to their personal safety.

Digital Literacy reference	"Sicherheit" → "Geräte und Inhalte schützen" und „Persönliche Daten und Privatsphäre schützen" (Security → Protecting Devices and Content and Protecting Personal Data and Privacy) "Computational Thinking" → "Mit Algorithmen arbeiten" (Computational Thinking → Working with Algorithms)
Micro:bit focus	• Programming different tones to create an audio alarm • Connecting piezo speakers with the micro:bit to play music
Language focus	• Acquiring vocabulary relating to information security (e.g. phishing, scams, suspicious websites, malware, ads, etc.)

Table 7: Didactic functions of the session Information Security

Preparation Steps:

- Sufficient amount of cables with crocodile clips and piezo speakers for at least one pair of students (this equipment can be purchased online relatively cheap – for example, 30 crocodile clips on Amazon cost around 10€)
- Sufficient amount of copies of the texts for the 4 Minutes Research activity
- Access to YouTube video about phishing: youtube.com/watch?v=R12_y2BhKbE (Google for Education, 2017)
- Taboo cards printed out

Planned Activities:

10min   **A. Reading/Speaking Activity – 4 Minute Research** (Learning Materials)

20min   **B. Booklet Input** (Booklet Tasks 5.1 – 5.4)

12min   **C. Guiding Comprehension Activity for the Video** (Booklet Tasks 5.5 & 5.6)

8min   **D. YouTube Video: Stay Safe from Phishing and Scams** (Booklet Task 5.7)

30min   **E. Micro:bit Project: Audio Alarm** (Booklet Task 5.8)

5min   **F. Project Discussion**

15min   **G. Game: Taboo** (Learning Materials)

\-   **H. Homework** (Booklet Task 5.9/6.1)

A. Reading/Speaking Activity – 4 Minute Research (Learning Materials)

Description

The students need to read a text to find out as much as possible about a specific topic. One group of students get a text about 'Biometrics' whereas the other get an article explaining what 'Malware' is (see section 4.9). The students get four minutes to read the texts. Then, they get together in pairs, turn the sheet over so they cannot read it anymore and tell each other what they can remember. Afterwards, the teacher tries to reconstruct all the points in the text with the class without looking at the texts.

Rationale

This speaking activity introduces the topic Information Security to the students. Moreover, the task challenges the learners to quickly inform themselves about a complex topic they are most-likely completely unfamiliar with. They practice how to retrieve and remember the most relevant information in a limited period of time and explain it again in their own words.

The texts contain some unknown vocabulary, but the goal of this activity is not to fully understand all sentences or vocabulary in any given article, but rather to figure out the main points of the text. However, a few German translations for relevant words that convey the main points in the texts were added.

B. Booklet Input (Booklet Tasks 5.1 – 5.4)

Description

The teacher guides the students through the chapter Information Security in their booklets. Although the students could read the chapter and do the tasks independently, the teacher should take the opportunity to introduce and discuss the different subtopics and make sure the learners understand the new content.

Two tasks require the students to analyse micro:bit programs: one about how safe communication via Bluetooth really is (see Figure 24) and the other one depicting a brute-force attack programmed with the micro:bit (see Figure 25). The third task involves a decryption activity (see Figure 23), whereas for the last task the students should visit a website that dynamically calculates and displays the seconds how fast a computer may crack a specific password.

Rationale

The tasks relate to the theoretical input in the booklet and give the students a practical perspective on Information Security. The students also learn how to understand and analyse simple programs. All the tasks should be done in pairs so the students can practice their English as well.

Task Description

Look at this encrypted text:

<div align="center">G JGIC RFC ZZA KGAPMZGR</div>

Can you guess what the original text means? Hint: you do not need to change the position of the letters, but you *may* want to change the letters to different ones…

Solution

If you shift every letter 2 positions to the right in the alphabet, you get the message "I LOVE THE BBC MICROBIT". This type of encryption is called the **Caesar cipher**, named after Julius Caesar who actually used this method to send encrypted letters to his allies. There are many different ciphers nowadays, and obviously the Caesar cipher can be easily cracked. One of the most popular ciphers today are called AES and RSA.

Figure 23: Decryption task: the students need to figure out the original text (Booklet Task 5.2)

Task Description

Look at the two BBC micro:bit programs below. Discuss with a partner: How do Alice and Bob communicate? Do you think their conversation is safe? Why / why not?
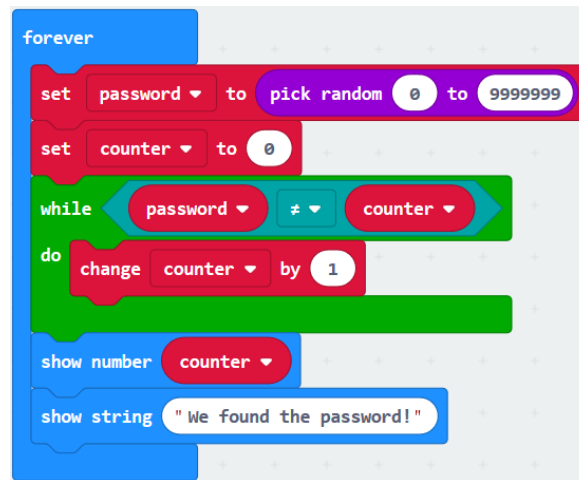

Solution

Alice and Bob use the BBC micro:bit to communicate via Bluetooth. Both of their programs use the radio channel 163473. Their conversation is not safe because anyone on the same channel could also receive the message from Alice. Note that **Bluetooth messages with the micro:bit are not encrypted** – the messages can be read by external parties. However, in real life data sent via Bluetooth is encrypted as well.

Figure 24: Discussion Task: how safe is this communication via Bluetooth? (Booklet Task 5.1)

Task Description

Look at the micro:bit program below. What does it do, and how? How long do you think this program will execute?

Solution

This micro:bit program describes a brute-force attack. A brute-force attack means that you try every combination until you find the correct one. If you have a powerful computer and the password consists only of a few digits, the computer will be able to crack it in a matter of milliseconds.

Firstly, a random password between 0 to 9999999 is set. This is not part of the attack yet, and would not be found in any program since the user specifies the password. Computer store password somewhere (also in encrypted form!) so they can check if the user's input matches the actual password.

The green 'while do' block demonstrates the attack: it compares the real password with a variable called 'counter'. The counter was set to 0 before, and if the password is not 0, the computer increases the variable by 1. The computer checks again if the password is 1, and if it is not, it increases the variable by 1 again. This continues until all values between 0 and 9999999 are checked. Even the micro:bit, a mini computer, can run this program in a **few seconds**. This is why brute-force attacks can be quite powerful for short and easy passwords.

Figure 25: A brute-force attack exemplified in micro:bit programming (Booklet Task 5.3)

C. Guiding Comprehension Activity for the Video (Booklet Tasks 5.5 & 5.6)

Description

The students get a worksheet containing a sentence matching activity (see Figure 26) and some discussion questions relating to online scams and suspicious websites. The students should do the first task individually whereas for the second one they should form groups of two or three to compare their solutions and discuss the questions on the worksheet.

If someone tells you that you won a trip to Hawaii, you should…		are from a legitimate source, but they're not.
Social engineering attacks can…		and create websites that look similar to sites that you already use.
…		…

Figure 26: Part of the sentence matching activity

Rationale

These two activities prepare the students for the YouTube video they will watch in the next step of this lesson plan. The sentence matching activity is not particularly difficult since some of the sentences can be connected by just looking at the underlying grammar. However, a few of them contain unknown vocabulary (taken from the YouTube video), and therefore it might be difficult for learners to understand what the sentences actually mean. The second task involves, along with several discussion questions, explanations for the new vocabulary.

Although the voice over in the video is quite clear and visual input facilitates understanding the content as well, pre-teaching the most relevant vocabulary that would not be easily understood from its context will help the learners to understand all the main points in the video.

D. YouTube Video: Stay Safe from Phishing and Scams (Booklet Task 5.7)

Description

The students watch the YouTube video together. Before the teacher plays the video, he or she should ask the students to pay attention to what the video recommends doing when a.) answering emails, and b.) visiting unknown websites. The learners should write these two points down

so they will pay more attention to the suggestions the video makes for these two actions. After the video, the teacher discusses the two points with the students and makes sure that the learners have understood the content.

Rationale

The chosen YouTube video is excellent for young learners because it addresses the most relevant issues regarding online scams in a creative and understandable way. The students should write the suggestions that the video makes down because they can memorise them better this way (for a solution, see Figure 27).

What do you need to look out for when…

- **answering emails**?
    - pay attention to the sender address in the email – attackers fake the 'From' address (e.g. mail@g00gle.com instead of mail@google.com)
    - do not use the reply function for odd emails – check the sender's address!
    - google official email addresses or (let your parents) contact institutions directly via phone

- **visiting websites**?
    - attackers re-create real sites and make them look really similar to the official ones → check the URL!
    - the URL should always start with https and have a padlock symbol next to it
    - internet ads cannot know if your computer is infected / compromised!
    - always download software from reputable sources

Figure 27: List of points that the YouTube video makes regarding online scams
(Booklet Task 5.7)

E. Micro:bit Project: Audio Alarm (Booklet Task 5.8)

Description

In the next lesson, the students should start working on the micro:bit project for this session right away. They have to create an audio alarm that goes off when the micro:bit is being shaken or moved (see Figure 28). This project can only be done if the teacher organises the necessary equipment beforehand (cables with crocodile clips and piezo speakers for at least every pair of

students). If the students ask how to connect the piezo speaker with the micro:bit, the teacher should refer to the booklet as it contains a detailed explanation of how to set up the speakers on the next page after the project description (see Booklet p. 38).

Program #5: Audio Alarm

You can use your BBC micro:bit as your own personal security alarm! You will need your micro:bit's battery pack, 2 cables with crocodile clips and 1 piezo speaker (ask your teacher for this equipment).

- Use the micro:bit's movement sensor for your alarm. If someone runs off with your schoolbag, for example, your micro:bit should sound the alarm!

- Think about how you want your program to behave. How should the alarm be triggered? Once the alarm goes off, how long should it last? And how should the alarm sound?

- The micro:bit programming interface can play sounds if your computer's loudspeakers work – however, the micro:bit cannot play sounds on its own. You need special equipment for this. On the next page, you can check how to connect the cables and the piezo speaker to your micro:bit.

Figure 28: Task description of the overall fifth program the students will write in this lesson sequence (Booklet Task 5.8)

Figure 29: Solution for Program 5: Audio Alarm (https://makecode.microbit.org/_XMYbf4d2L379)

Rationale

This project does not necessarily relate to online scams or the different booklet tasks, but raises awareness of general security measures the students can take on their own. The project also shows them that the micro:bit's functionality can be extended with additional equipment. The students learn how to attach cables to the micro:bit to use piezo speakers.

F. Project Discussion

The students reflect on programming an audio alarm. In addition to general questions about the project, the teacher may ask: How do you think could Bluetooth be used to improve your audio alarm? What if you connected multiple micro:bit devices via Bluetooth?

G. Game: Taboo (Learning Materials)

Description

Taboo is a great way to revise vocabulary but in a very fun and playful way. The teacher needs to prepare a few sets of cards with concepts and terms from the previous lessons (see Figure *30*). In pairs, the students have to explain these words (written in bold) without using the terms that are written below them. The students take turns after guessing every card, and whichever pair of students has guessed the most cards first, wins. If the learners get stuck at one word, they can decide to skip the card (but place it on a different staple than the correctly guessed words).

brute-force attack	**automation**
password	automatically
hack	work
appliances	**decryption**
dishwasher	encryption
microwave	encrypt
house	message

Figure 30: 4 out of the 26 Taboo cards (see section 4.9 for all cards)

Rationale

This activity gives the learners the chance to revise vocabulary from this lesson and the previous sessions. By playing Taboo, the pupils are asked to find synonyms and give slightly different explanations, which helps them to internalise the meaning of the new vocabulary. At the same time, the words the students are not allowed to use help them to remember what the term they need to explain actually means. If there is enough time, students should play another round with a different partner.

H. Homework (Booklet Task 5.9/6.1)

Description

The students should watch a video explaining the greenhouse effect and answer a few questions about this topic (see Figure 31). This will prepare them for the next session Green Technology. The link for this video and the questions can be found in the booklet, so the teacher does not have to prepare anything in this respect.

---

1. What we do we use greenhouses for? Why are they useful?
2. How exactly do greenhouses work?
3. Is the greenhouse effect in general bad for the earth? Why / why not?
4. The earth reflects some of the sunlight back into the sky. Why does part of this 'reflected radiation' (= the reflected sunlight) gets sent back to earth again and does not escape the earth's atmosphere?
5. How do humans increase the greenhouse effect?

Figure 31: The questions the students have to answer after watching a video about the greenhouse effect (Booklet Task 5.9/6.1)

4.7.6 Green Technology

Since the students have now learned how the Internet works and how it can, should, and should not be used, the focus of this unit now shifts to a more practical topic: Green Technology. This session deals with the use of technologies to achieve a positive impact on the environment. The students learn what the greenhouse effect is, understand the role of technology in combatting climate change, and learn simple measures how to counteract pollution.

Overall Objectives:

- The students can illustrate the greenhouse effect and demonstrate how it is related to global warming.

- They can list at least three different types of renewable energy and identify their advantages and disadvantages.

- They can argue in which ways technology can protect the environment.

- They can name concrete measures to save energy in their homes.

- They can use the micro:bit's sensors to measure the temperature and/or the current lighting condition.

Digital Literacy reference	"Gesellschaftliche Aspekte von Medienwandel und Digitalisierung" → "Chancen und Grenzen der Digitalisierung" (Social Aspects of Media Change and Digitalisation → Chances and Limitations of Digitalisation) "Computational Thinking" → "Kreative Nutzung von Programmiersprachen" (Computational Thinking → Creative Use of Programming Languages)
Micro:bit focus	- Using the micro:bit's light and temperature sensors
Language focus	- Acquiring vocabulary relating to global warming (e.g. renewable energy, pollution, fossil fuels, solar panels, …)

Table 8: Didactic functions of the session Green Technology

Preparation Steps:

- Sufficient amount of copies of the '20 Ways to Reduce One's Carbon Footprint' sheet and cut in pieces

- Access to Quizlet study set used in this lesson: quizlet.com/_6cmm0o (vocabulary with additional German definitions and accompanying pictures) and quizlet.com/_6cphkf (solely English terms and definitions)

- Sufficient amount of blank A4 sheets of paper for the 'Illustrating a Text' activity
- Access to YouTube video that explains renewable energy in two and a half minutes: youtube.com/watch?v=KEeH4EniM3E (Dane Bliss Design, 2015)
- For the homework: parent's *declaration of consent* for their children to create a Quizlet account using their personal data (needed as part of the "DVSGO", an Austrian regulation to protect one's personal data)

Planned Activities:

5min   **A. Discussion of Homework** (Booklet Task 5.9/6.1)

15min   **B. Order: 20 Ways to Reduce One's Carbon Footprint** (Learning Materials/Booklet Task 6.2)

15min   **C. Quizlet Study Set: New Vocabulary** (Booklet Task 6.3)

15min   **D. Illustrating a Text** (Booklet Task 6.4)

5min   **E. YouTube Video: Renewable Energy**

10min   **F. Short Speaking Task: Renewable Energy Types** (Booklet Task 6.5)

30min   **G. Micro:bit Project: The Environmentalist** (Booklet Task 6.6)

5min   **H. Project Discussion**

-       **I. Homework** (Booklet Task 6.7 & 6.8)

A. Discussion of Homework (Booklet Task 5.9/6.1)

Description

The teacher discusses the homework questions about the greenhouse effect with the students (see Figure 31).

Rationale

Before the students learn about green technologies, they need to understand the motivation – cutting carbon emissions to mitigate the greenhouse effect – behind them. Usually 4th form students are already familiar with the greenhouse effect from Geography lessons, but being able to explain and discuss this process in another language is expected to be very difficult for the learners. Watching the video and answering some questions will facilitate their understanding of the greenhouse effect.

Usually it is recommended to start the lesson with an activity that requires every student to speak and warm up, but this may not be possible in this session due to lack of time. Alternatively, the students could form little groups and compare their answer together – however, this does ensure that every group will have the correct answers.

B. Order: 20 Ways to Reduce One's Carbon Footprint (Learning Materials)

Description

The teacher explains that people can do a lot to reduce carbon emissions in their households. Then, every pair of students gets a set of paper strips. Each paper strip contains a measure that has a positive impact on the environment (see Figure 32). Every group has to sort the paper strips according to how ready they would feel to adopt the corresponding measure in their everyday life. For example, students might argue that they would find it very difficult to avoid buying sweets wrapped in plastic – consequently, they would place this paper strip at the top of their list. The learners are allowed to put two or three paper strips aside if they cannot agree on where to place them in their list. When they are finished, the teacher goes through the list of measures and asks the students to raise their hands if a measure is in their top 3 (very popular measures should be then discussed).
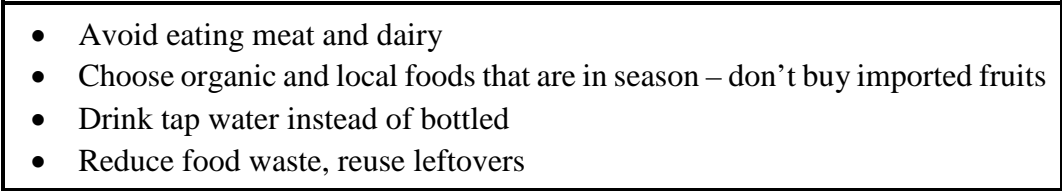
> - Avoid eating meat and dairy
> - Choose organic and local foods that are in season – don't buy imported fruits
> - Drink tap water instead of bottled
> - Reduce food waste, reuse leftovers

Figure 32: 4 out of the 20 measures to reduce one's carbon footprint (see section 4.9 for all measures)

Rationale

This activity engages students to talk about different measures to reduce carbon emissions (without including technology yet). The students do not only learn to evaluate the importance of different measures and their impact on their personal lives, but they also practice making compromises when they think differently about how easy it would be to adopt a particular measure. Moreover, a final comparison between the student groups may spark a lively discussion if there are striking differences between their individually sorted lists.

C. Quizlet Study Set: New Vocabulary (Booklet Task 6.3)

Description

The students use a Quizlet study set to learn new topic-related vocabulary. For more information about this activity, see activity *B. Quizlet Study Set: New Vocabulary* from section 4.7.3 The Internet of Things.

Rationale

This Quizlet study set contains important vocabulary that will occur in the text the students have to read afterwards (see Figure 33). It is essential to introduce the students to the new vocabulary as they will need to work intensively on the text.

to affect	to influence
	Example: Farmers and market gardeners have been badly affected by the drought (= Dürre, Trockenheit).
to replenish	[wieder auffüllen] to fill up again Example: We need to replenish our cookie supply asap!
tides	[Gezeiten, Strömungen] the regular rise and fall of the ocean's surface influenced by the moon's gravity pulling on earth

Figure 33: 3 of the 23 entries in the Quizlet vocabulary study set – quizlet.com/_6cmm0o (Booklet Task 6.3)

D. Illustrating a Text (Booklet Task 6.4)

Description

The students read a simplified transcript from a YouTube video about renewable energy and have to create a mind map that explains the text visually.

Rationale

Since the students now know about the greenhouse effect and common ways to reduce their carbon footprints, it is time to introduce the role of technology in this context.

Although the YouTube video is rather easy to understand, it can be very difficult for some learners to comprehend the concepts presented therein. By giving the students a simplified text and some time to work on it on their own, they will already know what the video will be about and therefore understand its content easier. This activity may be particularly helpful for visual learners as they need to create a mind map from the text. This gives the students the chance to get creative as well. The teacher should also allow students to work together and discuss how to visualise the ideas addressed in the text.

E. YouTube Video: Renewable Energy

Description
At the beginning of the next lesson, the teacher should finally show the YouTube video about renewable energy.

Rationale
As the students worked both on the vocabulary and the content of the text, they should be able to follow the points made in the video. Some of the students may deepen their knowledge about mind maps by observing how a learning video has visualised the ideas in their texts and comparing it to their own drawings. Most importantly, the students will understand the differences between fossil fuels and renewable energy.

F. Short Speaking Task: Renewable Energy Types (Booklet Task 6.5)

Description
The students match six different words (referring to types of renewable energy) to their corresponding picture, and, in pairs, identify at least one advantage and one disadvantage for every type of renewable energy.

Rationale
In this activity, students learn more about green technologies. By discussing every type of renewable energy separately, they will remember the different types easier. They will also need to use their common sense to identify benefits and disadvantages since they probably have not heard about renewable energy at all before this session.

G. Micro:bit Project: The Environmentalist (Booklet Task 6.6)

Description

The students need to create a micro:bit program that uses sensors to analyse the environment (see Figure 34). As they should be quite experienced by now, the students may implement their own ideas for this project, but they need to be aware that the focus should lie on writing a program that uses environmental data in some way. Ideally, they find a concrete way to use the BBC micro:bit to make a positive impact on the environment – but this is rather difficult as the device is quite limited in this respect. The students could, for example, program a thermometer using the device's temperature sensor, or experiment around with the light sensor.

Program #6: The Environmentalist

Will the BBC micro:bit make Austria 100% reliant on renewable energy? Well, who knows! One thing's for sure, though: We can use its sensors to analyse the environment.

As an experienced programmer, can you come up with your own ideas for a micro:bit program that could be used for the environment?

- In case you lack inspiration: perhaps you could create a **thermometer** using the micro:bit's temperature sensor? In the winter especially, people leave their heating on all the time or they forget how warm it already is. You could just wander through your home with your micro:bit and check the temperature: if any room is too warm, turn the heating down!

- You could do something similar with the light sensor as well: measuring how bright or dark your room currently is. Can you let your micro:bit show a message that the light is on? And maybe send this message to another micro:bit?

- The **temperature sensor** shows a number in degrees Celsius (°C).

- The **light sensor** shows a number between 0 and 255. 0 is very dark and 255 is very bright. **Generally, the value tends to be rather low**. Experiment around with it to see how your device reacts to light. Optional: If you want to fit this into a single digit range between 0 and 9, divide the number by 28!
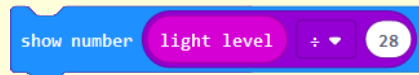
Figure 34: Task description of the overall sixth program the students will write in this lesson sequence (Booklet Task 6.6)

Rationale

This project gives the students the opportunity to get creative and implement their own ideas. The main objective of this micro:bit project is to learn how to analyse environmental conditions and use this data in a program. For example, they may create a micro:bit thermometer to check the temperatures in different rooms (for a solution, see Figure 35).
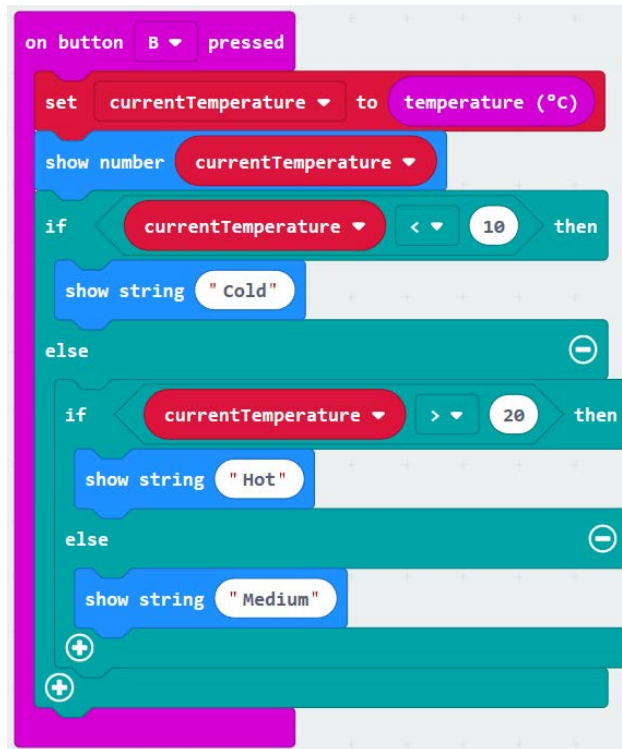

Figure 35: Program code for a thermometer (makecode.microbit.org/_WimKUL7TbFp3). Instead of showing strings, the students could display symbols (e.g. a snowflake for very cold temperature) or add any other effects. For space reasons, this example code was kept short.

H. Project Discussion

The students discuss their micro:bit projects. In addition to general questions, the teacher should explain that in IoT homes, devices such as the AC or energy-saving lamps work the same way – they also use sensors to analyse the environment and based on this data perform actions that ultimately have a positive impact on the environment. The students should be encouraged to think about what the micro:bit could do if it were an IoT device and/or if it could be controlled remotely via a smartphone. For example, several micro:bits distributed in a house could collect data about the current temperatures and send this to a person's smartphone, informing them which rooms need the most energy.

I. Homework (Booklet Task 6.7 & 6.8)

Description

The students need to create a Quizlet account and create their own study set using vocabulary from the chapters 4.7.4 Digital Communication and 4.7.5 Information Security. They need to revise the chapters in order to find at least 10 relevant (or difficult) words to add to their study set. A simple explanation (in German or English) is enough – the students should be allowed to decide on their own whether they want to add pictures or more information. Finally, they should send the link to their quizzes to the teacher's email address before next class.

Rationale

Doing this homework task, the students not only learn how to create their own Quizlet study set, but they also revise some of the vocabulary from previous sessions. They will be ready to do more revision in the next session.

4.7.7 Independent Project

In this session, the students revise what they have learned so far and practice some of the vocabulary they have acquired in the previous sessions. The main focus will lie on developing a BBC micro:bit program and writing a documentation for this program, which will conclude the lesson sequence New Technologies altogether.

Overall Objectives:

- The students can talk about different aspects of New Technologies and voice their opinion on them
- They can create a BBC micro:bit program that either serves a specific purpose or has high entertainment value
- They can design a document on the computer containing a short documentation explaining how a program works
- They can evaluate other students' programs and give feedback on the quality of their applications

Digital Literacy reference	"Mediengestaltung" → "Digitale Medien produzieren" (Media Design → Creating Digital Media) "Computational Thinking" → "Kreative Nutzung von Programmiersprachen" (Computational Thinking → Creative Use of Programming Languages)
Micro:bit focus	Creating a useful program without detailed instructions – specific micro:bit learning objectives depend on chosen project
Language focus	• Writing a report (software documentation) • Revising vocabulary from previous sessions

Table 9: Didactic functions of the session Independent Project

Preparation Steps:

- Access to Kahoot quiz: https://create.kahoot.it/share/new-technologies/6a6fa202-a40f-4a8d-8932-7a4da3d8d76a
- Sufficient amount of copies of the Feedback template sheet for all students (see Booklet p. 57)

Planned Activities:

10min   **A. Speaking Activity – The King's and the Queen's Banquet**

10min   **B. Kahoot Quiz**

20min   **C. Word Sneak** (Learning Materials)

10min   **D. Independent Project: Task Description** (Booklet Task 7.1)

35min   **E. Writing a Program Documentation** (Booklet Task 7.2)

15min   **F. Exchanging Programs** (Booklet Task 7.3)

-         **G. Homework** (Booklet Task 7.4)

A. Speaking Activity – The King's and the Queen's Banquet

Description

The students form a banquet – on the one side, there is the king, and on the other end, the queen (see Figure 36). In turn, they dictate what all the other students should talk about. The royals get the discussion topics from the teacher and announce them (see Figure 37). The goal for all students is to never stop talking because it would be rude to the king and the queen. The royals should talk to the students standing next to them as well (forming groups of three).

Rationale

This speaking activity is a great way to start the lesson since it engages all students in meaningful conversations and requires them to reflect on various topics from the previous sessions. The teacher should emphasise the goal of the activity, which is to talk all the time to please the king and the queen. If two students do not talk with each other or do not know what to say, the teacher should take the opportunity to join their conversation to facilitate communication between them.
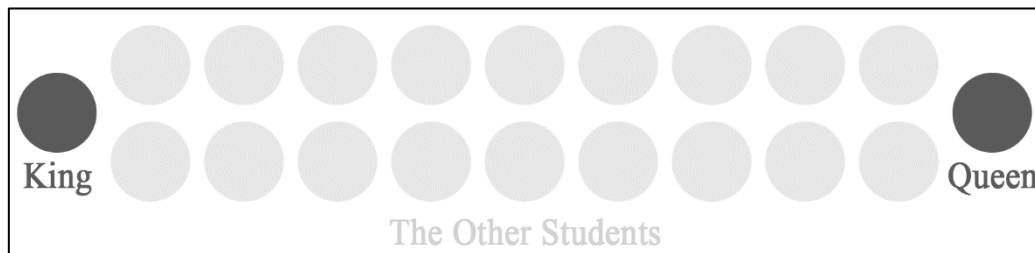
Figure 36: Positioning of students for the speaking activity

1. What do you think of IoT homes? Could you live in one, and why / why not?

2. Which social media apps do you use? Could you live without them?

3. Why do you think many people still get tricked online by scammers?

4. Which ways do you know to reduce your carbon footprints? And how useful are they for you?

Figure 37: Discussion questions that the king and queen will announce

B. Kahoot Quiz

Description

The students do a Kahoot quiz that contains questions about all the content they have learned so far. The questions for this quiz are attached in the Learning Materials as well (see section 4.9).

Rationale

Kahoot is an online game-based learning platform where multiple students can answer questions simultaneously and see the results live on the platform's website. The students usually love to play Kahoot quizzes since they play against all their classmates and can prove themselves to know more than their peers.

In this lesson, it serves the purpose to revise some key facts from the entire lesson sequence. After every question, the teacher should talk a little bit about the corresponding chapter. For example, after the students answered the question 'Name this process: CAESAR -> DBFTBS', the teacher should not immediately move on to the next question but discuss all the possible answers or add a few relevant details: 'As most of you have guessed, the correct answer is encryption. The opposite is decryption – and both processes belong to the field of cryptography, the practice of communicating with a secret system so other people cannot read your messages'. Ideally, the teacher lets students explain why the other answers were wrong in order to increase student talking time.

C. Word Sneak (Learning Materials)

Description

The students play the game Word Sneak. The teacher gives every pair of students a set of cards (see Figure 38). The students have to put the cards face down on the table in front of them. Both students need to pick five different cards without showing the words to their partners. In addition to the five words they picked, the students also need to add three words on their own. Finally, the students should write down their eight words on a separate piece of paper so they have a good overview of the terms they are working with.

Now the students need to talk about any topic they can come up with and find a way to work their words into this conversation as casually as possible. The goal is to guess which words

their partners picked – after the conversation, the person who is left with the most words not guessed (during the conversation) by the opponent wins.

Before the students start playing, the teacher should ask a single student to do a practice round so all the others see how this game works. The teacher should also take this opportunity to give good examples of how to sneak specific words into a normal conversation.

opportunity	environment	information security
green technology	Internet of Things	password

Figure 38: Some sample words for the game Word Sneak (see section 4.9 for full list)

Rationale

So far, the students have learned a lot of new vocabulary, but they have barely used it. This activity requires them to practice the new words and use them in a proper context.

D. Independent Project: Task Description (Booklet Task 7.1)

Description

The teacher explains to the students that they have to create a program on their own until next class (they should be given a couple of days to work on and finish their programs). The students can decide what they want to program – as long as their programs serve a specific purpose or have great entertainment value. The teacher should provide the students with a list of suggestions if they do not want to develop and implement their own ideas (see Figure 39). The students should use the remaining minutes of the lesson to decide what they want to program and whether they want to work individually or in pairs.

Rationale

For the final micro:bit project, the students can decide on their own what they want to program. This gives experienced students the chance to use their skills to program something more advanced than usual, whereas less motivated students may simply opt for an easier programming task. This activity will give the teacher valuable feedback as to how interested the students really are in micro:bit programming. Moreover, the independent project will hopefully leave a positive impression of micro:bit programming with the students since they finish the programming aspect of this lesson sequence with something they created completely on their own.
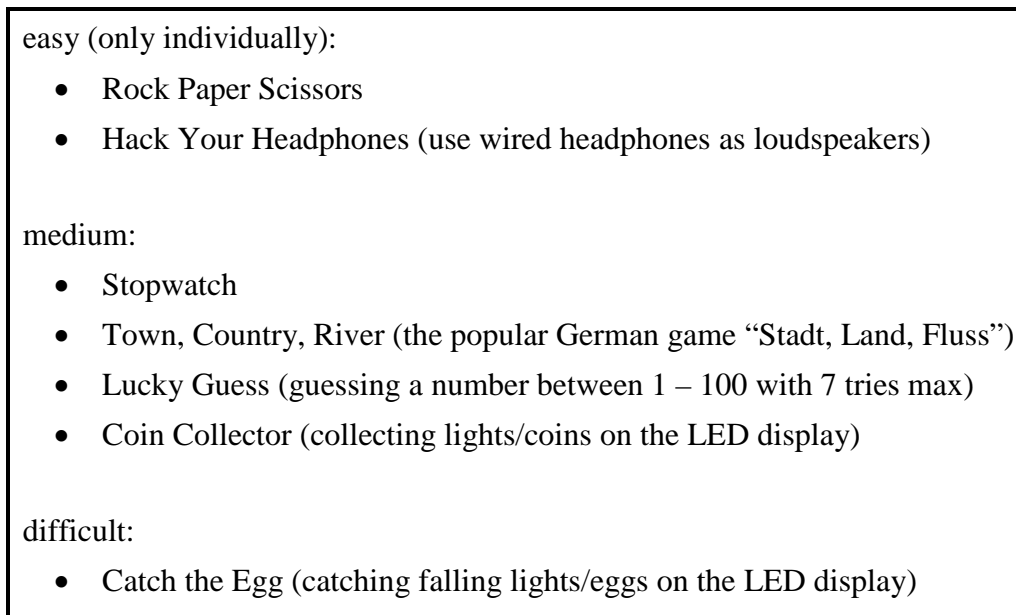
easy (only individually):

- Rock Paper Scissors
- Hack Your Headphones (use wired headphones as loudspeakers)

medium:

- Stopwatch
- Town, Country, River (the popular German game "Stadt, Land, Fluss")
- Lucky Guess (guessing a number between 1 – 100 with 7 tries max)
- Coin Collector (collecting lights/coins on the LED display)

difficult:

- Catch the Egg (catching falling lights/eggs on the LED display)

Figure 39: Short overview of the suggested programs the students could write (more specific information about each program can be found in the booklet)

E. Writing a Program Documentation (Booklet Task 7.2)

Description

The students write a short report on what their programs do. The reports need to have at least:

- a title
- the name(s) of the programmer(s)
- the online link to their micro:bit project
- an explanation of the program (50 – 80 words)
- a screenshot of the micro:bit code
- suggestions how their program could be developed further

An example of such a report is illustrated in Figure 40. When the students are finished, they should give this report to the teacher and then move on to the last activity of this session.

Rationale

This task serves a variety of purposes: firstly, it will heighten the students' sense of ownership for their program since they need to create a descriptive document tailored to the program and the solution they developed. Secondly, they practice how to write a report for a specific purpose using the computer. They need to format their report accordingly, take a screenshot of their

micro:bit code, and paste this screenshot into their document. Lastly, as the report should be written in English, the students are challenged to put their computational thinking into a coherent text in the foreign language.

Snap the Dot

Name(s) of Programmer(s): SpongeBob SquarePants

Link to Program: https://makecode.microbit.org/_32aMRMCTWfds

Program Description:

This program shows a single dot on the LED display that moves from one end of the display to the other, forever. If the dot is at the centre of the display, the player should press A, and if they succeed, their score goes up by 1. If they don't, it's game over and their final score will be shown.

Screenshot of Code:

More Programming Ideas:

The dot could move a little bit slower, and there could be two dots on different lines. The player would need to press A or B, depending on the line they are currently looking at.

Another idea would be to fill the straight line by pressing A on every dot as quickly as possible. After pressing A, the matching LED light is turned on permanently. If the player presses A on an LED light that is already turned on, the light should turn off again. The final score would be the time the player needed to completely fill the line.

Figure 40: Example of a program documentation

F. Exchanging Programs (Booklet Task 7.3)

Description

The students exchange their programs and give at least two other groups feedback using the feedback template sheet provided by the teacher.

Rationale

By exchanging and evaluating different programs, the students see what their classmates developed. The feedback sheet contributes to the idea of peer-to-peer feedback: the students need to evaluate at least two other projects, argue why they like or dislike the programs, and identify any weaknesses of the program.

G. Homework (Booklet Task 7.4)

Description

The students reflect on the lesson sequence by writing a text about what they liked or disliked about the New Technologies topics and what they found particularly interesting or difficult (see Figure 41).

Rationale

The last task of this lesson sequence should be a reflection about the whole lesson sequence altogether. The students are encouraged to give their opinion on the different IT topics that were covered throughout the course of this unit.

Additionally, the students need to include 7 terms from a Quizlet study set in their texts. This study set contains the entire vocabulary from the lesson sequence New Technologies. By just looking through the list, the students will revise the vocabulary again. Moreover, the learners are challenged to show that they can use the new terms appropriately.

In the previous lessons we talked about many different aspects of how technology is used nowadays. Write a text about *New Technologies* and give your opinion on what you have learned during the course of the past weeks.

Be sure to…

- **include at least 7 terms** from the following Quizlet study set: https://quizlet.com/_6dk1b2 – this study set contains all the vocabulary from this unit. **Clearly <u>underline</u> the 7 words you integrated in your text.**

- discuss your favourite chapter, and explain why you liked it the most (think about the difficulty of the topics, the activities, and how useful you found them)

- say what your least favourite chapter was, and give reasons for your choice as well

- give your opinion on using the BBC micro:bit in class to learn about programming

Write about **200 words**.

Figure 41: Final homework task for the lesson sequence *New Technologies*
(Booklet Task 7.4)

4.8 Robotics

If the students enjoyed working with the BBC micro:bit, an additional session concerning the topic Robotics may be held. The micro:bit can be attached to a robot-like gadget and be programmed to move around on its own (see Figure 42). For example, the *micro: Macqueen micro:bit* has additional sensors that allow the micro:bit to avoid obstacles, chase incoming light, follow specific lines on the floor, analyse different colours on these lines and assign them to different actions the robot should take (micro: Maqueen micro:bit Educational Programming, n.d.). Different micro:bit robots can be found online, and it is often a financial question which one to purchase, especially considering to provide sufficient robot gadgets for a whole class. The micro: Macqueen micro:bit, for example, costs around 20 euros per piece.

Figure 42: Setup for a BBC micro:bit robot that can move on its own

Setting up and programming a BBC micro:bit robot takes quite some time, which is why the students should get at least two to three school hours to experiment around with this device and its different functions. The language aspect would be rather neglected in this session since the primary focus should lie on programming with the micro:bit robot und understanding how robotic devices work to make the purchase of these robots a worthwhile investment. It might make more sense to use IT lessons (or both English and IT) for this or organise the Robotics session as a workshop after school.

If English lessons are used for the Robotics session, a creative introduction to Robotics would be appropriate to spark the students' interests. For example, an activity explaining the different ways robots are used nowadays (e.g. the Mars rover) offers the learners a perspective on the role of robots in today's world. After the programming session, the students could again reflect on this topic and, since they should know how robots work by then, might ask themselves how advanced robots are programmed and identify potential limitations of a robot's abilities.

The idea of Artificial Intelligence could also be addressed in this context. The students could discuss the potential effects of robots using Artificial Intelligence on society and how intelligent robots may influence our lives in the future. However, one should not forget that Artificial Intelligence and Robotics are almost two completely different subject areas – they only intersect when the discussion is about robots that actually use Artificial Intelligence to think independently, learn distinct behaviour patterns, and mimic human behaviour to some degree.

4.9 Learning Materials

The learning materials for the teacher guide contains necessary master copies for every session, and can be found in Appendix B. All the texts & images (except the Kahoot Quiz Questions) that are found there are *not* in the student booklet, which is why these materials must be prepared by the teacher before class.

5 Interviews: Discussion of Lesson Sequence

The lesson sequence *New Technologies* was evaluated by three different English teachers. Two of these teachers studied English and IT, whereas the other graduated in English and Math. All three teachers were fairly young, but already had a few years of teaching experience and were thus able to provide valuable feedback for this lesson sequence, which is now summarised in this chapter.

The ten interview questions that the English teachers had to answer can be found in Appendix A. The insights from the interviews that are summarised here do not follow the chronological order of the interview questions, but are rather structured according to their relevancy for the discussion of the lesson sequence.

5.1 Initial Evaluation of Students' Language Skills Is Critical

One of the most important insights gained from the interviews concerned the critical need to first evaluate whether the lesson plans are suited for the students' skills and language level. Although New Technologies is tailored to 4th form students ("8. Schulstufe"), the interviewees suggested that the planned activities may be too difficult, especially for NMS pupils. In Austria, it is no secret that there is currently a considerable competency gap between AHS and NMS students, which is why the same lesson plan may work in one school, but not at all in the other. Of course, every group of learners is different, and the teacher should always adjust their lesson plans accordingly, but for this unit in particular, an initial evaluation regarding the realistic use of the lesson plans in terms of language level of the target group is all the more essential. If the learners still struggle with A2 vocabulary or simple sentence structures, they will be overwhelmed with the language tasks in this unit. One should keep in mind that this lesson sequence also requires pupils to learn about different programming concepts and IT related topics – and if the language itself already represents a difficulty for the pupils, they are very likely to struggle with the tasks in this unit and not meet the learning objectives.

5.2 Independent Learning and Group Work as Prerequisites

Another point that teachers should consider when evaluating whether this English unit is suitable for their students relates to the pupils' learning skills. Many activities in this unit require the students to collaborate, think critically, and solve specific problems on their own or in small groups. If they are not accustomed to these approaches or skills, the pupils might be unwilling to participate in class or struggle with some activities due to the unfamiliar learning environment. The interviewees stressed that it could take students months, for example, to get used to work effectively in collaborative projects. Moreover, even students in their final school years sometimes indicate a lack of critical thinking skills. Therefore, teachers should also evaluate whether their target group is more or less already familiar with the types of tasks used in this lesson sequence to ensure the pupils are able to do the activities properly.

5.3 Integrating the Unit into the Curriculum is Problematic

The important question of how to actually include this lesson sequence during the semester was also addressed in the interviews. Generally speaking, many English teachers already feel challenged by the Austrian curriculum to cover certain grammar aspects, competences and topics in class, and including this lesson sequence in their agenda as well may seem somewhat unrealistic or stressful in terms of organisation and time management. Moreover, in Austria topics such as 'Modern Technologies' should be officially covered only in the 5th form or higher ("9. Schulstufe"), which may represent another argument that may discourage 4th form teachers from including New Technologies in the semester.

There are, however, different ways to include the unit in one's teaching: for example, during the interviews it was suggested to split up the lesson sequence over a couple of months or even the whole semester, and cover each topic at a time. For example, after major exams in particular, the teacher could use one or two English lessons afterwards to do some activities from New Technologies and let students work on something before moving on with the standard curriculum. Needless to say, this would need to be properly organised by the teacher – especially in terms of revising vocabulary and content, if the periods between the New Technologies sessions

are rather long. However, since the accompanying student booklet for this English unit comprises all information of the covered topics and also includes (most) task descriptions, the approach to divide the lessons over a longer period does not seem impractical at all.

5.4 Organisational Issue: Double Lessons

The lesson sequence New Technologies mainly consists of double lessons, which seemed problematic for all interviewees as they argued that this might be very difficult to organise in schools. Again, splitting up the lessons is possible, and even necessary if double sessions cannot be organised – however, both teacher and students would benefit from double lessons more as less time is wasted with organisational matters, and students can also stay focused on a single topic for a longer period of time.

Instead of using English lessons only, the interviewees suggested that IT lessons could be used as well for organising double lessons. Another suggestion was to organise project days where three lessons or more are used to cover one or two topic areas of New Technologies.

5.5 Need for Pre-Teaching and Co-Teaching

Using IT lessons as well to teach this lesson sequence seems reasonable, since the IT teacher could join the English teacher during the programming sessions to provide more guidance or support for the students. Moreover, if planned accordingly, this way the English teacher may not need to learn how to program with the BBC micro:bit if all the programming related tasks are 'outsourced' to the IT teacher. Organisational issues can, however, greatly affect the programming sessions, which is why such a cooperation should be carefully planned and executed.

Co-teaching is especially useful when the learners are working on a computer, because students are quick to ask for individual support. If there are more than twenty students in a classroom, one teacher will most likely not be able to offer adequate help for everyone. Here, the learners are particularly challenged to solve issues on their own (keyword: independent learning), which could work in a class where students are used to helping each other or researching something that will help them to solve a specific problem. However, if there are many students in class

who rely on the teacher and generally like to ask questions, a co-teacher should be organised to make the programming experience as positive as possible for all students.

Aside from co-teaching, it is also a good idea to use IT lessons to pre-teach certain programming concepts and explain how to use the BBC micro:bit before starting to work on the New Technologies topics in the EFL classroom. The interviewees claimed that the session '4.7.2 Early Programming: Crash Course' is far too short for the students to grasp the basic programming notions, so using a few IT lessons for this in advance might be particularly helpful.

5.6 Lots of (Hidden) Preparation Time for Teacher

Co-teaching may also reduce the preparation time for the English teacher. Since all the lessons deal with IT related topics, English teachers whose second subject is not IT do not only need to learn about all the IT related topics that are covered during the course of this lesson sequence, but they also need to make sure to feel confident enough to actually teach them. The lesson plans provide many helpful links to educate oneself about the different subjects, but the interviewees argued that there is even more private study necessary to be able to hold the respective lessons. If the teacher does not share a particular interest in the topics to begin with, this type of preparation can become very frustrating, which in turn might impede the quality of the lessons altogether.

5.7 More Time Needed for Planned Lessons

Less surprisingly, the interviewees also argued that the activities in the lesson plans will take much longer than planned, especially for the session '4.7.2 Early Programming: Crash Course'. Moreover, administrative tasks and time for students to get ready for class will give the teacher even less time to do all the activities planned for one session. Consequently, it may be impossible to meet all the learning objectives declared in the single sessions. This is why the lesson plans may be slightly modified (or simplified) to ensure proper time management. Alternatively, the teacher could also use an additional session to both slow down the pace of the lesson and do all the planned activities (with maybe one or two additional tasks).

5.8 Resource Problems: Computers, Wi-Fi, Smartphones

The interviewees also addressed potential resource problems. For example, at some schools, there is not a sufficient number of computers available for all students. However, this may be easily solved by, for example, letting two students work on one computer, which hardly influences the learning objectives substantially (in fact, this would even encourage collaboration).

The different smartphone policies at schools were also discussed in the interviews. All the sessions of this lesson sequence could be held without smartphones as well – however, for some activities, the teacher would need more time to prepare these accordingly (e.g. replacing Quizlet vocabulary tasks with printed flashcards). Alternatively, the activities may simply be skipped or substituted with another one.

Finally, it should not be assumed that all students have internet access on their smartphones (if they are allowed to use them in the first place). The school's Wi-Fi may not work properly either, and connection problems may interfere with or delay the lesson unnecessarily. The teacher needs to decide based on the school's resources whether it makes sense to do the activities requiring mobile devices. It is, however, recommended to try and use smartphones in class, since they not only add variety to the lessons, but they are in fact used purposefully in the sessions.

5.9 Positive Aspects

Although the interviewees identified a lot of practical problems for the lesson sequence New Technologies, they gave a lot of positive feedback as well: for example, they liked the activities and how they are used in all the lesson plans, particularly the switch between different competence areas (such as speaking skills, reading, etc.). They were also impressed by the overall coherent framework and how the content was carefully prepared. Lastly, the interviewees suggested that this lesson sequence also provides great starting points for the development of further materials or different lesson plans – especially since all the resources are licensed under CC BY as well – and claimed that due to the unit's universal topics, the lesson sequence could be extended to an entire term or year even.

6 Conclusion

This paper provided a lesson sequence called *New Technologies* for the EFL classroom to be used by 4th form English teachers ("8. Schulstufe") of Secondary Education I. The lesson sequence covers a variety of different IT related concepts and requires the students to create small programs with the BBC micro:bit. The goal of New Technologies is not only to teach both English and IT in the context of cross-disciplinary teaching, but also to incorporate different competence areas of Digital Literacy ("Digitale Grundbildung") as introduced in Austria in the winter term of 2017/18. In particular, the use of the BBC micro:bit aims to teach students Computational Thinking, one of the eight subareas of Digital Literacy.

Several interviews were conducted to identify potential problems of using this lesson sequence in class. Most importantly, the interviewees suggested that the teachers need to evaluate whether the language level and the type of the planned activities (e.g. group work, critical thinking) are appropriate for the students. In general, the language level is rather high, and for some classes the lessons might be more suitable for the 5th form ("AHS-Oberstufe, 9. Schulstufe"), for example. The interviewees also found it very difficult to integrate this lesson sequence into the curriculum; not only because of possible organisational and scheduling conflicts, but also due to the fact that the school's recourses (computers, smartphones, school Wi-Fi) might not be suited for the tasks in this unit. Lastly, they claimed that although the materials for all the lesson plans are provided, teachers will still need a lot of preparation time to inform themselves about the programming concepts and different IT topics – however, their preparation time may be greatly reduced if an IT teacher joins the English lessons whenever needed, for example.

The greatest strengths of New Technologies are its topic structure and potential to be developed by other teachers to offer even more OER materials and lesson plans dealing with the same or similar topics. The current approach to Digital Literacy may only be seen as an initial concept of teaching IT related competences in different subjects, and since all the materials of this lesson sequence are licensed under CC BY, the unit New Technologies may become particularly useful for teachers in the future. Further research how to integrate technological skills in the

EFL classroom will also help teachers to design better lesson plans, and ultimately provide better learning opportunities for the pupils.

Although cross-disciplinary teaching has plenty of benefits for the pupils, the interviews showed that there also many practical concerns, especially in terms of organisation and technological equipment. Moreover, many teachers feel overwhelmed incorporating Digital Literacy into their lessons as well, which begs the question whether it would not be more practical to increase computer and network resources in all schools and introduce separate, compulsory Computer Science lessons to Secondary Education I instead of giving schools the option to integrate Digital Literacy into different subjects. As a matter of fact, the BMBWF has already developed a plan to increase digitalisation in all Austrian schools, which should be executed by the end of 2023 (BMBWF, 2018c). This plan identifies three fields of action: providing schools with more technological resources, offering more training and courses about digitalisation for schoolteachers, and lastly, optimising the curriculum with regard to technological competencies (BMBWF, 2018c).

The current discussions to make Digital Literacy (or Computer Science) a separate, compulsory subject in Secondary Education I would eventually reduce the necessity for cross-disciplinary teaching. However, this approach would also open up opportunities for inter-disciplinary teaching: for example, students could learn about New Technologies in the EFL classroom, and put their knowledge into practice in the new subject Computer Science (which would, incidentally, already be possible for Secondary Education II). Whichever direction Austrian schools will finally take in this respect, the need for teaching materials about Digital Literacy remains high.

The lesson plans for New Technologies in this paper gave an example how to integrate Digital Literacy into the EFL classroom, but they can also be used for inter-disciplinary purposes. Since all materials are released under an open license, they can be freely adapted to the needs and requirements of the current educational system. Moreover, any teacher using or working on New Technologies will not only be able to give valuable insights into the world of IT in a classroom context, but also contribute to the movement of teaching Digital Literacy to young learners. The more teachers collaborate in designing OER materials, the more resources will be available for everyone. The New Technologies teacher guide and its accompanying student booklet for teaching Digital Literacy offer great starting points for this, and will hopefully encourage teachers of all subjects to contribute to this internationally growing movement.

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Appendix A: Interview Questions (German)

1. Was war Ihr **erster Eindruck** nach Lesen des Unterrichtskonzepts?

2. Wie **relevant und angemessen** finden Sie die **Themenauswahl** in diesem Kapitel (Internet of Things, Digital Communication, Information Security, Green Technology)?

3. Das Englischkapitel ist für das Ende der 8. Schulstufe (14-jährige SchülerInnen) gedacht.

    3.1. Finden Sie die Englischübungen in diesem Kapitel **sprachlich angemessen**?

    3.2. Wie finden Sie den **Schwierigkeitsgrad der Übungen (Englisch-Übungen & Programmierübungen)** für die SchülerInnen?

4. Wie hoch schätzen Sie den **Vorbereitungsaufwand als Lehrperson** für dieses Englischkapitel ein?

5. **Als Nicht-Informatik LehrerIn**: denken Sie, dass Sie mit den einzelnen Themen und BBC micro:bit Programmierübungen eventuell überfordert wären?

6. Was halten Sie vom **Einsatz des BBC micro:bits** in den einzelnen Stunden?

7. Welches Unterrichtsfach überwiegt in dieser Unterrichtssequenz Ihrer Meinung nach – **Englisch oder Informatik**?

8. Wie schätzen Sie die **Bereitschaft** von Englisch-Lehrkräften im Allgemeinen ab, sich BBC micro:bits zu organisieren und diese Unterrichtssequenz tatsächlich zu halten?

9. In diesem Kapitel werden konkrete Informatikthemen in englischer Sprache abgehandelt. Würde es Ihrer Meinung nach mehr Sinn machen, diese Unterrichtssequenz im Informatikunterricht nach dem Prinzip **CLIL** einzusetzen?

10. Hätten Sie **Vorschläge oder Tipps**, wie man dieses Unterrichtskonzept (Inhalte, Organisation, Struktur) noch verbessern könnte?

Appendix B: Master Copies

This section contains all master copies for the lesson sequence New Technologies.

- *IoT: The Internet of Things, both versions*

  Session 5.4.3 The Internet of Things: the students do a listening comprehension. The text is attached twice as the gaps the students need to fill are at different positions.

- *Images for the Activity 'Match the Pictures'*

  Session 5.4.3 The Internet of Things: the students form **groups of three** and need to assign these pictures to their corresponding words in the text.

- *Four Minute Research Texts: 'What Are Biometrics?' & 'What is Malware?'*

  Session 5.4.5 Information Security: the students get two different texts at the beginning of the lesson. They get exactly four minutes to read/skim them, then the students have to turn the sheet over and talk to their partners what they can remember.

- *Taboo Cards*

  Session 5.4.5 Information Security: **in pairs**, pupils revise vocab by playing Taboo.

- *Setting Priorities: 20 Ways to Reduce One's Carbon Footprint*

  Session 5.4.6 Green Technology: the students work in pairs to sort 20 different paper strips each containing a concrete measure to reduce one's carbon footprint according to how easy they would find it to adopt the suggested measures.

- *Kahoot Quiz Questions*

  Session 5.4.7 Independent Project: the students play a Kahoot quiz. The questions, answers, and solutions can be found here.

- *Word Sneak*

  Session 5.4.7 Independent Project: **in pairs**, the students play the game Word Sneak.

IoT: The Internet of Things

The Internet of Things (or IoT) is influencing our lifestyle from the way we react to the way we _____. From air conditioners that you can control with your smartphone to Smart Cars providing the shortest route or your Smartwatch which is tracking your daily _____. IoT is a giant network with _____ devices. These devices gather and share data about how they are used and the environment in which they are operated. It's all done using sensors, which are embedded in every physical _____. It can be your mobile phone, electrical appliances, vehicles, barcode sensors, traffic lights and almost everything that you come across in day-to-day life. These _____ continuously emit data about the working state of the devices, but the important question: is how do they share this huge amount of data? And how do we put this data to our benefit?

IoT provides a common _____ for all these devices to dump their data and a common language for all the devices to communicate with each other. Data is emitted from various sensors and sent to IoT platform security. The IoT platform integrates the _____ data from various sources. Further analytics is performed on the data and valuable information is extracted as per requirement. Finally, the result is _____ with other devices for better user experience, Automation, and improving efficiencies.

Let us look at a scenario where IoT is doing wonders: In an AC manufacturing industry, both the manufacturing machine and the belt have sensors _____. They continuously send data regarding the machine health and the production specifics to the manufacturer to identify issues beforehand. A _____ is attached to each product before leaving the belt. It contains the product code, manufacturer details, special instructions etc. The manufacturer uses this data to _____ where the product was distributed and the Retailer's inventory, hence the manufacturer can make the product running out of stock available. Next these products are packed and parcelled to different retailers. Each _____ has a barcode reader to track the products coming from different manufacturers, manage inventory, check special instructions and many more. The compressor of the air conditioner has an embedded sensor that _____ data regarding its health and temperature. This data is analysed continuously allowing the customer care to _____ you for the repair work in time. This is just one of the million scenarios.

We have Smart Appliances, Smart Cars, Smart Homes, Smart Cities where IoT is redefining our lifestyle and transforming the way we _____ with technologies. The future of IoT industry is huge. Business Insider Intelligence estimates that 24 billion IoT devices will be installed by 2020 and ITC predicts that IoT revenue will_____ around three hundred and fifty-seven billion in 2019 resulting in a lot of job opportunities in the IT industry.

---

track // emits // collected // identify // contact // retailer // activities // barcode // connected // device // shared // attached // sensors // behave // reach // platform // interact

IoT: The Internet of Things

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environment // share // issues // analysed // tracking // track // reach // lifestyle // sources // available // send // improving // technologies // uses // industry // devices // sensors

Images for the Activity 'Match the Pictures'
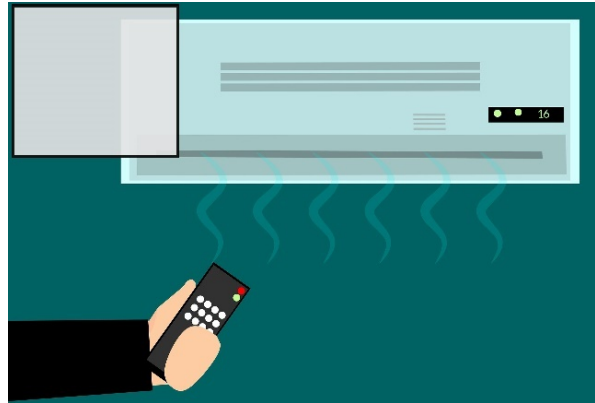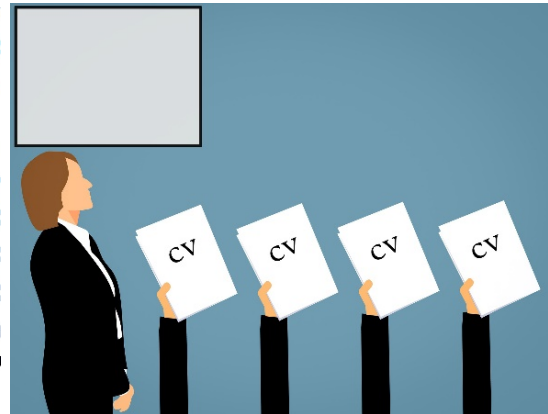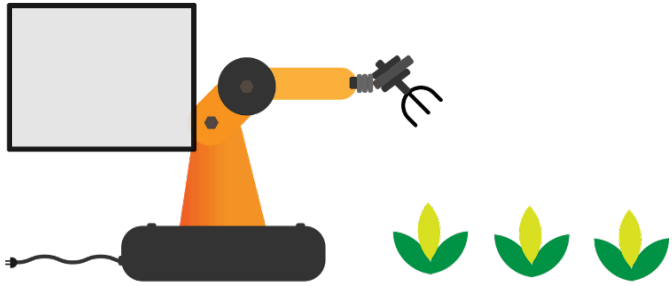
What Are Biometrics?

Biometrics are distinctive, measurable characteristics that are used to identify us. These identifiers are categorized as physical or behavioural characteristics, related the shape of specific body parts or a pattern of behaviour. Physical biometrics include fingerprints, facial structure and shape, hand geometry, iris patterns, even the shape of your ear. Behavioural biometrics refer to how we type, how we swipe our fingers on a touchscreen, our gait, or how we speak or sing.

Unlike passwords, biometrics are part of us. They can't be forgotten, lost or borrowed. And they are not easily hackable. That's why biometrics are more secure than passwords and convenient to use.

Fingerprints

A fingerprint is comprised of the ridges of the skin, or minutiae, on the tips of our fingers. These ridges are 100 percent unique, comprised of variations of loops, whorls (= Windungen), and arches (= Wölbungen), which can be copied using digital imagery or ink. Fingerprints have been used for centuries to mark or sign documents, or even as personal seals in clay pottery.

Face

The shape of the face is a very unique physical characteristic. Using computer vision technology, facial structure and shape can be identified and categorized, with specific "landmark" features, including the relative position and shape of the nose, eyes, jaw, and mouth. Advances in facial imaging today allow for 3D images, increasing the complexity and accuracy of face recognition algorithms.

Voice

Voice, or speech recognition, relies on specific characteristics of the spoken word. These include acoustic patterns, based on the size and shape of the mouth and throat, and behavioural characteristics, such as pitch, tone, and speaking style.

Iris

Iris patterns are considered one of our most unique characteristics. Even identical twins, whose face and voice might match, have irises that don't. Due to varying eye colours, iris patterns are best recorded in the near-infrared spectrum. These devices produce much clearer photos of the iris than the natural light spectrum can.

Behavioral

Behavioural biometrics, such as typing patterns and gait, are the latest development in biometric technology. The ability to record the length and pace of how we walk, or the specific way we type, allows for what is called continuous authentication, which can be used to verify identity over time, rather than during a single authentication session.

Source: What Are Biometrics? (n.d.). Retrieved from https://www.veridiumid.com/biometrics/

What is Malware? How Malware Works & How to Remove it

The term **malware** is a contraction of *malicious software*. Put simply, malware is any piece of software that was written with the intent of doing harm to data, devices or to people. When you hear talk of viruses, Trojans, spyware and the like, what you're really hearing is talk of **different kinds of malware**.

What does malware do?

The way malware goes about doing its damage can be helpful in categorizing what kind of malware you're dealing with. The following is a list of common types of malware:

- **Virus**: Like their biological namesakes, viruses attach themselves to clean files and infect other clean files. They can spread uncontrollably, damaging a system's core functionality and deleting or corrupting files.

- **Trojans**: This kind of malware disguises itself as legitimate software, or is included in legitimate software that has been changed. It tends to act discretely and create backdoors in your security to let other malware in.

- **Spyware**: No surprise here: spyware is malware designed to spy on you. It hides in the background and takes notes on what you do online, including your passwords, credit card numbers, surfing habits and more.

- **Worms**: Worms infect entire networks of devices, either local or across the internet, by using network interfaces. It uses each already infected machine to infect more.

- **Ransomware/Scareware**: this kind of malware can lock down your computer and threaten to erase everything — unless a ransom (= Lösegeld) is paid to its owner.

- **Adware**: Though not always malicious in nature, particularly aggressive advertising software can undermine your security just to serve you ads — which can give a lot of other malware a way in. Plus, let's face it: pop-ups are *really* annoying.

How do you remove malware?

Each form of malware has its own way of infecting and damaging computers and data, and so each one requires a different malware removal method. Avoiding suspicious emails, links or websites are good online habits to have, but will only get you so far: attackers can sometimes compromise even legitimate websites.

The only way to really stay protected or remove an infection is by using anti-malware software, more commonly called an **antivirus**. The best malware removal tools are included in the most advanced antivirus, and even free ones like AVG AntiVirus FREE have all you need to stay safe from the most common threats.

Source: Lemonnier, J. (2015, June 06). What is Malware? How Malware Works & How to Remove it? Retrieved from https://www.avg.com/en/signal/what-is-malware

Taboo Cards

variable	**algorithm**	**loop**	**condition**
program	program	forever	statement
value	instruction	while	do
change	step	repeat	else

benefit	**suspicious**	**brute-force attack**	**automation**
give	scammer	password	automatically
advantage	bad	hack	work
money	doubtful		

LAN	**to encrypt**	**appliances**	**decryption**
Wi-Fi	decrypt	dishwasher	encryption
WLAN	decryption	microwave	encrypt
wired	text	house	message

modem	**ISP**	**client**	**server**
Wi-Fi	internet	server	client
WLAN	wire		
ISP			

Alan Turing	**cryptography**	**network**	**opportunity**
cryptography	encrypting	computers	chance
Julius Caesar	decrypting		

Smart home	**online scam**	**Bluetooth**	**cloud**
IoT	phishing	wireless	sky
devices	dangerous	channel	weather
appliances	trick	radio group	sun

wire	**radio waves**
underground	Wi-Fi
connected	WLAN
server	Bluetooth

Setting Priorities: 20 Ways to Reduce One's Carbon Footprint

- Avoid eating meat and dairy

- Choose organic and local foods that are in season – don't buy imported fruits

- Drink tap water instead of bottled

- Reduce food waste, reuse leftovers

- Compost your food waste if possible

- Don't buy fast fashion

- Buy vintage or recycled clothing

- Buy less stuff! And buy used or recycled items whenever possible

- Bring your own reusable bag when you shop

- Try to avoid buying items with a lot of packaging

- Support and buy from companies that are environmentally responsible and sustainable

- Switch lights off when you leave the room and unplug unused electronic devices

- Don't buy sweets or food wrapped in plastic

- (Ask your parents to) sign up to get your electricity from clean energy

- Drive less – walk, take public transportation, carpool, or bike to your destination

- Wash your clothes in cold water

- Get politically involved and stand up for the environment

- Use laptops instead of PCs – they require less energy

- Avoid flying if possible; on shorter trips, driving may emit fewer greenhouse gases

- In your home, turn off the heating and put on warmer clothes

Kahoot Quiz Questions

Link: create.kahoot.it/share/new-technologies/6a6fa202-a40f-4a8d-8932-7a4da3d8d76a

The correct answers were written in **bold**.

Q1: Which word is **not** a basic programming concept?

Loop // Condition // Algorithm // **BBC micro:bit**

Q2: A **flow chart**…

explains how if/else statements work // **visualises the different ways a program can behave** // displays how variables work // shows the steps in a program

Q3: Which of the following devices could **not** be an IoT device?

AC // car // microwave // **All could be used as an IoT device.**

Q4: Which word does **not fit** here?

Radio // Remote Control // **LAN** // Car Navigation System

Q5: Name this process: CAESAR -> DBFTBS.

Encryption // Decryption // Cryptography // Bananas

Q6: Who cracked the machine ENIGMA the Germans used to communicate in WW II?

Your English teacher // Alan Turing // Julius Caesar // Albert Einstein

Q7: What is **not** a type of renewable energy?

Biomass // **Gas** // Geothermal heat // Solar panels

Q8: We **cannot** draw energy from...

human poop // **solar filter** // decomposed plants // nuclear reactors

Q9: An ISP provides you with internet access for free.

True // **False**

Q10: Which of the following ways does **not** help to reduce carbon emissions?

Buy vintage or recycled clothing // **Choose foods that are out of season** // Wash your clothes in cold water // Plants trees and plants

Word Sneak

suspicious	to increase	to rely on
server	pollution	to influence
client	fossil fuels	to track (smth.)
Instagram	solar panels	benefit
Snapchat	wind power	to provide
Bluetooth	to affect	to identify
issues	loop	condition
to interact with	algorithm	variable
opportunity	environment	information security
green technology	Internet of Things	password

Appendix C: Student Booklet

This section contains the student booklet that was designed for the lesson sequence New Technologies.

NEW TECHNOLOGIES 2019

BBC Micro:bit
Student Booklet

produced by Daniel Wachmann & Maria Grandl
Graz University of Technology

Author: **Daniel Wachmann**

Contributors: **Maria Grandl, Martin Ebner**

This booklet was designed for the lesson sequence *New Technologies* and contains an introduction to programming and a variety of BBC micro:bit projects tailored to this teaching unit. The lesson sequence and all the materials (including this booklet) were created as part of a diploma thesis at the Graz University of Technology.

All information and data contained in this work were carefully gathered and developed by the author and effective quality assurance measures were taken to ensure their validity. However, errors cannot be excluded completely. Therefore, the author is forced to declare that they can neither guarantee nor assume any legal responsibility for consequences resulting from incorrect information. Internet addresses or version numbers are based on the available data and information at the time of publication. The author is in no way liable or responsible for any changes that might arise from any cause beyond their reasonable control.

BBC micro:bit is a trademark of the micro:bit Educational Foundation *http://microbit.org/terms-of-use/*. This is not an official BBC micro:bit product. It was neither approved by the micro:bit Educational Foundation nor is it related to BBC micro:bit.

Table of Contents

I.   Introduction

This booklet gives a basic introduction to programming with the BBC micro:bit and provides a variety of different micro:bit projects that help you understand how to create programs with this device. You can start right away with the programming tasks if you like!

Note that this booklet does not only offer information about different aspects of programming with the BBC micro:bit, but it also contains activities that give you a chance to practice your English skills as well. Be sure to notice the following markers in the chapters as they indicate what you need to do:

Good to Know!
This gives you useful advice regarding difficult technical terms and micro.bit programming, and therefore might help you with the programming tasks.

Task!
This just decribes a short task that you can do within a matter of minutes. If the task requires you to program something, you are not expected to save the program and run it on your device, but it is fine to only use the micro:bit interface on the website.

Let's Code!
If you see a Let's Code sign, it means you should write a program, save it on your computer and also try it out on your micro:bit to see if the program is working as expected.

Homework Task!
Well, this one is quite obvious now. You should do this task at home.

What are New Technologies?

The term **New Technologies** refer to technological devices or systems that have become very important in the recent years. Have you ever heard of a fax machine? Or dial-up Internet? Probably not – this is because these technologies are rather old and not really used anymore. However, you may have heard about Bluetooth headphones (like the iPods), virtual assistants such as Alexa or Siri, or – something you are familiar with for sure – surfing on the Internet via Wi-Fi (WLAN). These are examples for New Technologies since they are currently used in everyday life.

What does programming mean?

Programming means that we create computer programs that give the computer commands regarding what to do and how to react. The computer can only understand a few commands, and as programmers we have to use these commands cleverly so that the computer knows what we want do. All the commands we use to solve a specific task are finally combined to one **program**. When computers execute a program, they carry out all its commands that were specified by the programmer beforehand.

What is the BBC micro:bit?

The BBC micro:bit is basically a mini computer (produced by an English company called BBC) that allows us to create and run programs in a very simple way. On the next two pages, you will find information about all the device's features, how to connect the BBC micro:bit to the computer and how to copy your own programs onto the device.

Features of the BBC micro:bit

Micro-USB Port
to connect the micro:bit with the computer or to supply it with power

RESET Button
to restart a program

Bluetooth Antenna
to send and receive messages between two or more different micro:bit

Battery Connection
to supply your micro:bit with power

Temperature Sensor

Microchip
processor and memory; the "brain" of the micro:bit

Compass
to determine the physical direction the micro:bit is pointing to

Acceleration Sensor
to determine the current movement of the micro:bit

Back side of the BBC micro:bit

Light Sensor
to determine if the environment is bright or dark

LED-Display consisting of 25 (red) LEDs
to show symbols, numbers, signs or text; every single LED can be controlled individually

Front side of the BBC micro:bit

Button A
to control the program

What should happen after pressing the button?

Button B

Input/Output-Pins
react to electrical currents

The Pins 0, 1 and 2 can send and receive micro currents.

Power-Pin
with a voltage level of 3.3 Volt

Ground-Pin
to close the electrical circuit

Ports for additional electrical components
visit http://microbit.org/guide/hardware/pins/

How can I use the BBC micro:bit?

Use the **Micro-USB Port** and the USB cable to connect your BBC micro:bit to the computer. You can save your program onto the micro:bit by downloading and moving your program file to the micro:bit folder on your computer (just like you save files onto a USB stick). After copying your file into the micro:bit folder on your PC, the file is automatically deleted after a few seconds – this is normal!

After copying your program into the micro:bit folder, the program will run automatically – look at your device! Press the "**RESET-Button**" to restart your program.

You may also use the portable charger ("**Battery connection**") instead of the micro-USB cable if you want to run your program without the computer and a USB cable. This can be particularly helpful for projects that require you to go outside, for example.

What can I do with this device?

During this course you'll learn many different ways in which the BBC micro:bit can be used! If you want to get a sneak peek, you can watch this short introductory video from the company (BBC) who has produced the micro:bit:

YOUTUBE.COM/WATCH?V=WUZA5WXIMKC

tinyurl.com/nt19-booklet-1

II.   Early Programming: Crash Course

Task 2.1

Let's start with a simple task: analysing a program and discussing what it does. Your teacher will give you a micro:bit program that you need to copy onto your BBC micro:bit. Then, look at your micro:bit - what does it show on the display?

ALGORITHM

A sequence of instructions to solve a problem step by step is called an **algorithm**. Think of a cooking recipe: you follow each step so you can enjoy a delicious cake at the end. This is how computers work: we give them algorithms so they know exactly what to do. Algorithms can have a lot of instructions – but just like a cooking recipe, you'd like as few instructions as possible, right?

Task 2.2

Finish this algorithm consisting of only 5 instructions describing how you get ready for school:

1.) *Wake up*

2.)

3.)

4.)

5.)

Unlike humans, computers can only understand a limited set of instructions that we can actually use to write programs. However, as you will see, we can use these instructions in a lot of different ways to do a lot of cool things!

If you're not quite sure yet what an algorithm is, you can follow the QR code on the left and watch a short video about algorithms on your smartphone (be sure to use headphones so you do not disturb your colleagues!).

tinyurl.com/nt19-booklet-2

CONDITIONS: IF/ELSE

"If you clean your room, you can go watch TV all day. But if you don't…" Does that sound familiar to you? In programming, if statements like that are, just like in everyday language, very common and work almost the exact same way. In programming, we like to call them **conditional statements**.

Task 2.3

Create a conditional statement for this situation: *You have an important test next week. What needs to happen now so you will pass the test? What will happen otherwise?*

if	
then	
else	

Good to Know!

The micro:bit █ ∩ Input block "on button A pressed" is basically an if statement as well: if this button is pressed, do…
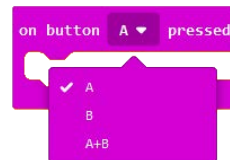
Program 1: Let's get it started

Let's Code – Task 2.4

Your first BBC micro:bit program! Let's make it a good one, but keep it short and sweet.

- When the program starts, it should say "Hey" on the LED display.

- Afterwards, the program should **always** show the following four symbols:
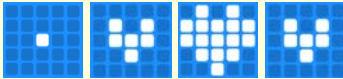
  If you've programmed the sequence correctly, your algorithm makes sure that your micro:bit's heart will forever pump for you!

Here's another idea: if you **shake** the BBC micro:bit (have a look at the category), it should show your name on the display. After your name was displayed, the hearts should appear again automatically.

Good to Know!

In micro:bit programming, use the "**on start**" block to tell the computer to execute your algorithm only **once**, when your program starts. Use the "**forever**" block to let the computer repeat the same instructions all over again – **forever**, not only once!

VARIABLES

A **variable** is a symbol (or simply, a name) that represents a value that can be changed at any time. For example, think about a video game where you have a score: at the beginning your score is probably 0 because you haven't collected any points yet. As you play, you get more and more points: the value of your score is changing all the time. That's just what a variable is!

Task 2.5
Can you come up with more examples for variables in real life?

- video game score
- age
- _____

- _____
- _____
- _____

Let's try it out! In the micro:bit interface, go to ▌ ☰ Variables and create a variable by clicking on: [Make a Variable...]

You can always change its value by using these instructions:

[set score ▼ to ◯] or [change score ▼ by ◯]

Good to Know!
If you want to show the current value of a variable, you can take a (roundly-shaped) block of your [show number score ▼] variable and drag it into the "show number ___" block.
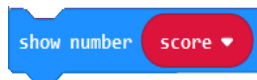
Variables can be found everywhere nowadays – high scores in video games, a visitor counter for popular clubs or events, or even counting the last few minutes of a long and exhausting school day. So why not program something we can actually use as well?

Program 2: The limit does not exist…

Let's code – Task 2.6

Create a program that helps you to count up or down by pressing the buttons A or B!

- Starting the program, the counter should be 0 and is shown on the display.

- Pressing button B means you add 1 to the counter.

- Conversely, pressing button A means you subtract 1 from the counter.

- Example: Pressing B two times and A four times would show the final result -2!

- Pressing both buttons at the same time should reset the counter to zero.

Do you have any ideas to develop your program even further? How about an upper limit so you can only count to a specific value? What happens then? Or maybe let your program count automatically up or down every second? You decide!

LOOPS (advanced)

A **loop** repeats something over and over again until it has reached its goal. If you've followed this tutorial properly, you should have already used the micro:bit "forever" block, which is, in fact, an infinite loop that never stops running!

However, you can also create loops that do not go on forever. For example, when you have to empty the dishwasher, you put all the dishes one after the other into the kitchen cabinets **until** the machine is empty. So instead of going on forever, you tell the computer when to stop the loop. In micro:bit programming, you use a "while" block to achieve this. For example:
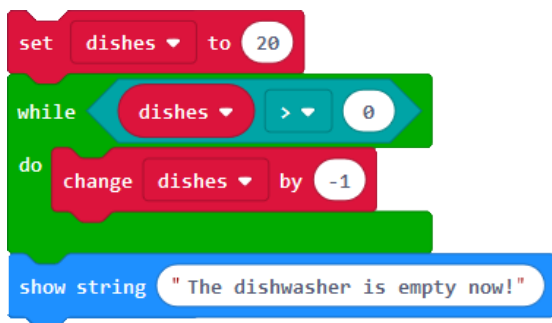
What is happening here?

In the green "while" block, the program checks if the variable "dishes" is bigger than 0. Since this is true for the first run, the program executes the instruction "change dishes by -1", which subtracts 1 from 20. Now, the program checks again if the variable "dishes" is bigger than 0… all this repeats until the condition (the turquoise block: "dishes > 0") is not true anymore.

FLOW CHARTS

Sometimes it can be quite helpful to visualize loops to understand them better, especially in the early stages of learning how to program. Look at the following chart that describes the behaviour of the program you just looked at on the previous page:
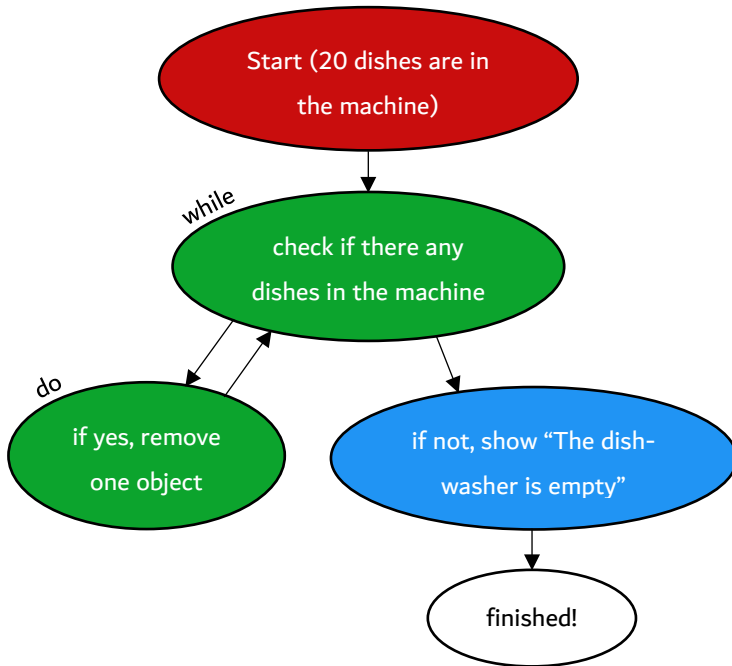
This is called a **flow chart** because it describes the 'flow of the program', or, in other words, **all the possible steps** your algorithm can take. You start at the top and follow the arrows that represent the instructions of your program. In this example, the program finishes at some point (in fancy programming language, we also say that the program 'terminates') because the 'while' loop ends at some point and there are no instructions left in this program after showing the final message. However, some programs may never terminate – can you guess why?

Can you draw a flow chart for the heart animation of 'Program 1: Let's get it started…'? **Note: You do not need to include the 'on shake: show name' feature.**

Start
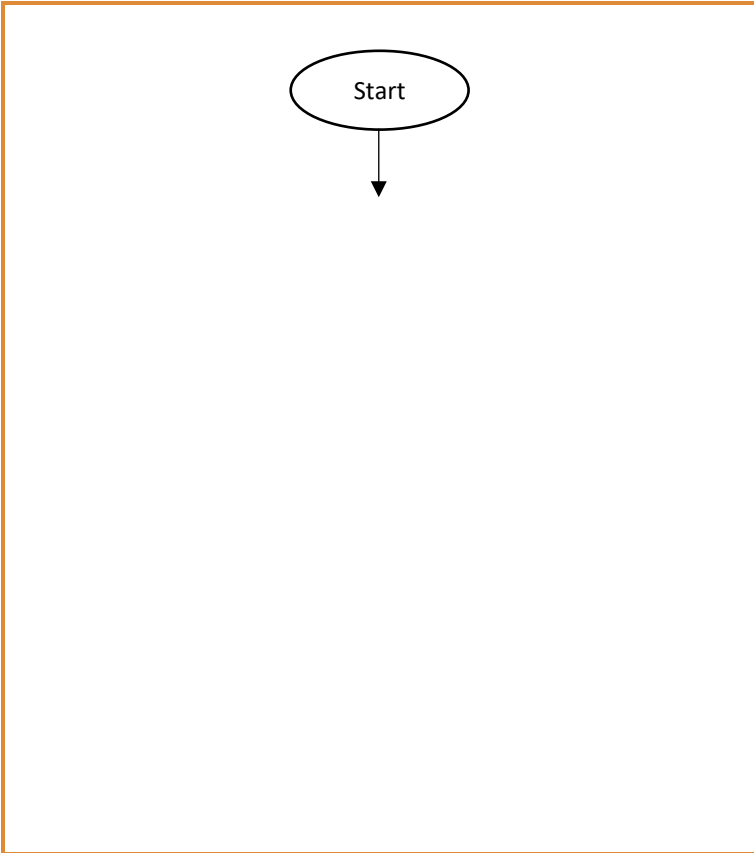
III.   The Internet of Things

The Internet of Things (or IoT) is a plat-form where everyday devices are connected to the Internet, so they can interact and exchange data with each other. The Internet is often represented as a cloud because it is possible to save data 'up there, in the air' and access it from everywhere (for example: Dropbox, Microsoft OneDrive, Gmail or Hotmail, Apple iCloud etc.).
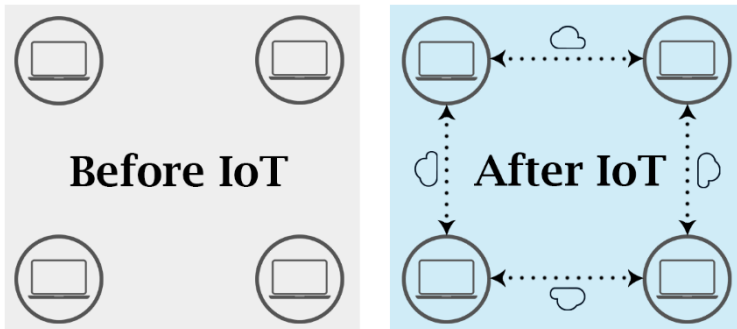
For example, imagine your parents had a car and an air conditioner at home that were connected to the Internet. It's a very cold winter day, and you've just spent the whole day skiing with your family. You're about to arrive home soon. With IoT, your car could now interact with your air conditioner and notify the AC to turn on automatically before your arrival since these devices know you'll be home in a few minutes. Your room (and the rest of the house) would be perfectly warmed up when you arrive! Since the AC also analyses and tracks your favourite temperature during the seasons, it'll know exactly how warm you'd like the temperature to be.

Task 3.1

tinyurl.com/nt19-booklet-3

Find a partner to work with and use your smartphone to follow the QR code on the left. You'll find a link to a Quizlet study set – enter this link into your browser. Click on the 'Flashcards' button. Go to

ANSWER WITH

Definition ⌄

(options) and make sure that under 'Answer with' the option 'Definition' is selected. You should also select 'Shuffle' so you do not get the same words like the groups sitting next to you.
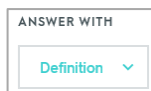
You're all set now! Ask your partner what the term you see could mean. Then click on the card, and read the definition with the example. Then your partner takes the phone, gets the next term by clicking on the right arrow (▶) and asks if you know what the new word means. Continue until you've studied all terms.

Homework Task 3.2

After you've studied the new vocabulary, use an-other Quizlet set (follow the QR code on the right) at home to practice. This study set contains the same vocabulary, but without pictures, German definitions, and example sentences. Feel free to try

tinyurl.com/nt19-booklet-4

other things than 'Flashcards' – for example, for this quiz, the activities 'Spell' and 'Test' are very useful as well!

If you want to watch the video that uses this new vocabulary again, follow the QR code on the right (or directly use this link:
YOUTUBE.COM/WATCH?V=LLHMZVL5BM8)

tinyurl.com/nt19-booklet-5

SENSORS

The BBC micro:bit cannot connect to the Internet, but it does provide you with a compass and a light, temperature, and motion sensor – this means that it can measure how dark or bright the environment is, how warm or cold it is and whether the device is being moved (for example, if you shake it).

Task 3.3

With a partner, can you come up with one or two examples how to use the micro:bit's sensors to make life easier for you (or achieve something positive for the environment)? And what if you could connect your micro:bit to your smartphone (or the Internet in general) – what new opportunities would it bring? You may want to look at the micro:bit's features on p. 3 again to see what the device can do.

More about the BBC micro:bit Compass

The micro:bit compass is using a sensor to tell you the direction that the device is heading to. The sensor measures the orientation of the device in degrees (°) and stores it in a variable. When you move your micro:bit, you change the value of this variable. Therefore, the value from the new position of the micro:bit needs to be updated again and again (with conditional statements and **logical operators**) to avoid outdated (and wrong) information.
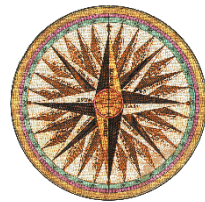
Good to Know!

If we talk about **logical operators**, we mean symbols that connect two variables or statements with each other. For example, the 'and' block can link two statements together. If both statements are true, the final result will be true as well!
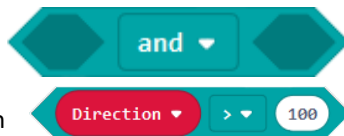
Program 3: Never Eat Shredded Wheat

Let's code – Task 3.4

North, East, Sou-, … ummm… if you ever get lost, a compass may come in quite handy. Create a program that displays the first letter of the direction (N, E, S, or W) that the micro:bit is currently pointing to.

- Create your own variable and make sure it is **always** updated to the `compass heading (°)`.

- Don't forget that you want to **show** your variable too. Also, you need to `calibrate compass` **calibrate the compass** by pressing, for example, the button A, so the micro:bit can always be calibrated and is aware of its current position. Otherwise, the sensor won't work!

- Calibrating the compass, it should say "TILT TO FILL SCREEN" before showing the value – this is normal! Just move your device around until all LEDs on the display light up.

- Later, if you see a value that updates all the time while you are moving the device, you're on the right track.

- Example: if the value is between 45° and 135°, it should show the letter E (for East) on the display. You will probably need to use a few **conditional statements** 😉

- **Remember: the shorter your algorithm, the better!**
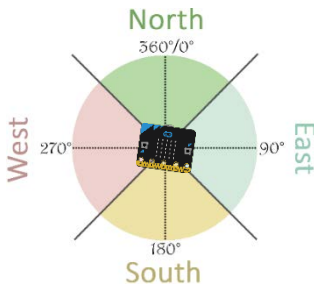
Do you any ideas how to further develop your program? Can you maybe show an arrow on the display that always points to North instead of displaying the letters N, E, S, W?

Homework Task 3.5

Answer the following questions:

1. How do you think compasses can operate as IoT devices in real life?

2. IoT has had a huge influence on the way people use technology. Give at least three benefits of using IoT devices.

3. Can you identify any issues of living, for example, in a Smart Home where almost all appliances are connected to the Internet?

4. In your opinion, does IoT have a positive influence on one's fitness and health? Why / why not?

5. With IoT, more and more manufacturing companies are able to use Automation to produce their products. Give at least three **advantages** of Automation **for companies**.

IV. Digital Communication

Digital Communication means the use of technology to communicate with other people or devices. The most popular form of digital communication is the Internet – we use computers and smartphones to connect with the Internet so we can use social media, play online video games, or get our daily dose of cute cat videos.

In this session, we will look at practical, real-life examples of digital communication (**social media**) and how digital communication works from a technical perspective (**the Internet**).

A. Social Media

It's human nature to socialise with other people – it all began in the stone age where we would seek to be close to other people to increase our chances of survival. In this respect, nothing's changed! Although we may survive completely on our own today, it's in our bones to socialise, make friends, and expand our social circles.

Social Media allows us to use technology to satisfy our social demands. However, some people say social media has negative effects on us, and even argue that it makes us feel more **alienated** from the real world. Do you agree? Have you ever felt lonely although you could have used social media to connect with other people?

Task 4.1
Analyse one of the poems on the next two pages. Take a few minutes to write down what you think of the poem you selected.

Unseen Friends

Although you are a friend of mine
And letters we exchange
I would not know you on the street
And doesn't that seem strange?
You hold a place within my life
Unusual and unique
We share ideals and special
dreams
And still we do not speak
I picture what I think you are
Perhaps you picture me?
An intriguing game for both of us
For someone we cannot see.
So for this friendship we possess
We owe this mail a debt
Perhaps the charm lies in the fact
That we have never met.

Anonymous (n.d.)
https://lustidecosta.wordpress.com/internet-friends/

internet best friends

people always tell me that people on the internet are scary
if they are, then why in the middle of the night when I need
someone
to be there for me because no one else is,
it's always the people online that are?

Written by FallenAngel33 (November 2018)
https://hellopoetry.com/words/internet/

Social Media

Almost asleep when my phone ticked;
'A notification,' it says.
Your name was there, you liked my photo.
And my stomach drowned in butterflies—
Scratch that—moths, surely they're moths.
Stronger, buzzier, like your power
To occupy and stay in my brain
With that single heart emoji beside your name.
Thinking that the double tap
Is as if you love me just the same.

Written by Débijonne (August 2018)
https://hellopoetry.com/words/socialmedia/

Online Only
Cut copy paste,
status what a waste.

Life became negative,
mostly online based.

Cut copy paste,
never met face to face.

Hi reality here,
come on out,
for a beer.

Cut copy paste,
the real world,
give it a taste.

Written by Stephen M (2018)
https://allpoetry.com/po-
ems/about/social-media

Snapchat Filter
That snapchat filter will always linger
And never fade...
Those cute ears will remain
The same in that frame
A static image of humor and fun
Not didactic in any way
Except to say
I am here and forever young...

Written by Donny Shaun Victor Elliott (July 2017)
https://hellopoetry.com/tag/snapchat/

buzzy	lebhaft		**frame**	Rahmen
charm	Reiz, Charme		**give it a taste**	etwas ausprobieren
debt	Schulden		**ideals**	Idealbilder, Leitbild
didactic	belehrend, lehrhaft		**intriguing**	faszinierend
double tap	Doppelklick		**to linger**	verweilen
to drown	ertrinken		**moths**	Motten, Nachtfalter
to fade	verblassen		**to occupy**	besetzen, beschäftigen
to owe	verdanken, schulden		**to remain**	(ver)bleiben
paste	einfügen		**static**	stillstehend
perhaps	vielleicht		**unique**	einzigartig
possess	besitzen			

Debate

In a debate, you share your opinion with other people and discuss about a specific topic. If you've thought about on one of the poems, you should have (some kind of) an opinion about social media, right? Well, then let's hear it!

Task 4.2
Take a few minutes to read through the pages 21 – 23 and then follow the instructions of your teacher.

Arguments

As a debater, you want to find good and solid **arguments** to convince your opponent of your view. Arguments are **reasons that support your opinion**. For example,

> *"I think that we should learn more about technology in school (<u>opinion</u>) **because** we can use technology to learn more efficiently (<u>argument</u>)."*

You can also give an **example** to make your argument stronger, e.g.

> *"I think that we should learn more about technology in school (<u>opinion</u>) **because** we can use technology to learn more efficiently (<u>argument</u>). There are many websites and mobile apps that provide great learning opportunities. For example, with Quizlet we can improve our English skills by studying new vocabulary (<u>example</u>)."*

Discussion Topics

Statement 1: Popular social media apps such as Instagram and Snapchat should change the age limit for creating an account from the age of 13 to 16.

Statement 2: Social media is making us more anti-social.

Rules of the Debate

1. **Keep it cool, stay objective, and respect your classmates. We are here to practice, not to judge.**

2. Two students will be the debaters, whereas the third one (the youngest in the group) will be the evaluator.

3. On page 22, you will find two discussion statements for the debates. One debater will always argue **for** an idea, whereas the other one will argue **against** it.

4. The debaters get **three minutes to prepare themselves**. Meanwhile, the evaluators also think about possible arguments for both sides.

5. The debate should last **five minutes max**.

6. The evaluator needs to use the **evaluation sheet** (look at the next page) for the debate to be able to determine the winner at the end.

7. The winner gets to decide if they want to hold another debate (and discuss with the evaluator) or play the evaluator for the next round (in which case the other two of the group hold the next debate).

Evaluation Sheet

Name of Evaluator: _____

Names of Debaters: _____, _____

Give the debaters A and B a ✓ for something they did right.
If you end up with the same amount of ✓, you have two winners!

A	B	Criteria
		… stayed objective & did not attack the opponent personally
		… did not interrupt their opponent when he or she was speaking
		… used full sentences and spoke clearly
		… was able to convince the opponent with one of their arguments
		… answered the opponent's questions and did not distract from the topic
		… provided arguments that were logical and easy to follow

Further comments:

Winner: _____

objective	sachlich, unparteiisch	to convince	überzeugen
to interrupt	unterbrechen	to distract	ablenken

B. The Internet

Now we will look at the reason why digital communication is even possible. Well, obviously **the Internet** allows us to connect with people all over the world! But it hasn't been always like that...

Can you name other forms of communication that do **not** require the Internet?

- _____
- _____
- _____
- _____
- _____

How Does the Internet Work?

Nowadays the Internet is everywhere, and most of us use it on a daily basis. In the previous chapter, we said that the Internet is often represented as a **cloud**. However, physically speaking, the Internet is actually just a **wire** buried in the ground! Computers use this wire to communicate. There are two types of computers that are connected to this wire: **servers**, and **clients**.

- A **server** is directly connected to the wire (= the Internet). Servers contain all the webpages that you see when you surf the Internet, or manage data from different clients.

- A **client** is not directly connected to the wire. A client uses an **Internet service provider (ISP)** that is directly connected to the Internet. In Austria, examples for ISPs are A1, T-Mobile, Orange, HoT, Drei, etc.

For example, you are at home and want to send your friend a WhatsApp message:

- Since you are connected to the Wi-Fi, you (the client) send your text in the form of a parcel to your **modem** (the modem, or router, is the little device you use at home to connect to the Internet). The modem writes your home address on the parcel (so your friend knows who sent it) and sends it to the ISP server (e.g. A1, or HoT).

- Then, the parcel literally travels underground through the wire to the **WhatsApp server**.

- The WhatsApp server sends the parcel to your friend's ISP address. The parcel travels again underground to your friend's ISP.

- Your friend's ISP checks the address on the parcel, and sends it to your friend's home. Done!

Good to Know!

The WhatsApp parcel also contains information such as the "Received" / "Seen" checks. So if your friend reads your text, he or she also sends a "Seen" parcel on the same way back to you!

Wi-Fi vs. The Internet

A lot of people think that the Wi-Fi and the Internet are the same, but as you should know now, this is not true. Wi-Fi works without a wire, and a Wi-Fi signal is only strong enough to work in a small area (like your home, a restaurant, or your school). It just sends data from your device to the modem. In contrast, the Internet consists of physical wires that are connected all over the world (even on the ocean floor!).

Only web servers (Google, Facebook, Wikipedia, …) and ISP servers are directly connected to the Internet.

With a partner, try to complete this chart that shows how the Internet works based on the example above.
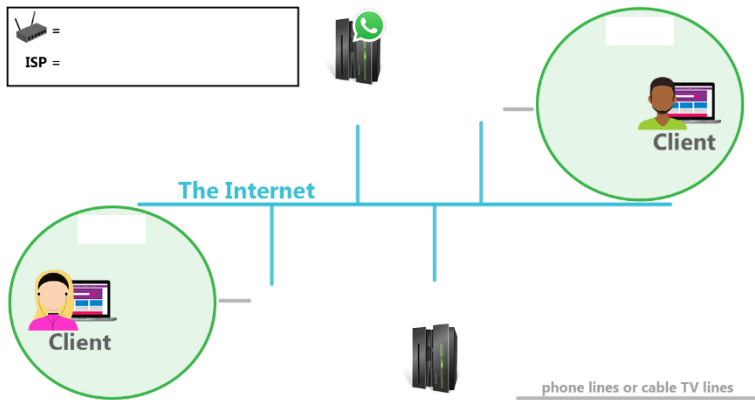
Wi-Fi does not need a wire because it uses **radio waves** to transmit and receive information. Yes – just like the radio that was invented over 100 years ago! Which other devices or technologies do you think use radio waves to communicate wirelessly?

- _____   - _____
- _____   - _____
- _____   - _____
- _____

Wi-Fi Alternative: LAN

Pro tip: if your Wi-Fi is too slow on your computer at home, you can also use a **wired connection** such as **LAN**. Unlike Wi-Fi (or **W**LAN), LAN uses an **Ethernet cable** to connect to the modem. This usually results in a faster connection since cables are more efficient than radio waves.

LAN is just a wired alternative to a Wi-Fi connection, and provides better performance and reliability. However, Wi-Fi is very popular because you often have a lot of devices at home that need wireless Internet connection (laptops, smartphones, tablets, gaming console, …).

Bluetooth

As mentioned before, Bluetooth provides another way to communicate wirelessly between electronic devices. The major difference between Wi-Fi and Bluetooth is that the Wi-Fi signal is stronger and works for a whole house, whereas Bluetooth devices usually only work in the same room.

Homework Task 4.6

Write a short text (150 words) about one of the debate topics you discussed in class. Give your **personal opinion** on the topic and make sure to have **three separate sections**:

- **Introduction**: what are you writing about / what is your general opinion?

- **Arguments**: explain in detail why you are either for or against this idea

- **Ending**: summarise your arguments in one or two sentences

Program 4: Blue Teeth

Let's Code – Task 4.7

Your BBC micro:bit supports Bluetooth! Find a partner and develop programs that use Bluetooth to send each other (nice!) messages. Keep in mind that both of you have to create a program.

- **At the <u>start</u> of <u>both</u> of your programs**, you need to make sure that you use the same channel to communicate. Pick a different value than 1, or otherwise other students may read your messages! 😱

  `radio set group`

- By pressing a button, one of you **radio sends** a message. This message can be seen as a variable: it could be 1.) a number, 2.) a string (= word) with a number, or 3.) just a string.

- Your partner, the receiver, needs to check if he or she **on radio received** the variable. If yes, he or she should then **show** the variable/message on their LED display.

If you managed to send your partner messages, find another group to work with. Can you figure out how several micro:bits can send messages to one single micro:bit? Try it out!

Also, can you think of a scenario in real life where multiple micro:bits sending signals to one micro:bit could be useful? Think about scenarios in which you need to count something!

Summary

The Internet is the main component of digital communication. Although the Internet is often referred to as a cloud, it in fact just consists of wires underneath the ground that are connected all over the world. In other words, the Internet is just millions of computers physically connected together with wires.

A Wi-Fi connection and the Internet are two separate things. We usually use Wi-Fi only to connect to a **modem** that communicates with an ISP, but we could use Wi-Fi even without an Internet connection: if two computers were connected via Wi-Fi, they could transfer files between them, for example. This is because **Wi-Fi uses radio waves** to exchange information.

The Internet needs clients and servers to work. **Servers** are computers that are usually connected to the 'internet wire' and they store all the information we can find on the Internet, whereas the majority of people are clients just surfing the Internet. **Clients** are not directly connected to the wires, but communicate with an **Internet Service Provider (ISP)** server such as the Austrian ISP A1. Both clients and servers send each other packets with information about the sender and the receiver so we can communicate with people worldwide.

Social media exists because of this whole system of servers, clients, Internet service providers, and countless kilometers of wires buried underneath the ground. Who knows what kind of social media will exist in 100 years?

V.   Information Security

Since the Internet and social media networks are growing every day, we need to make sure that all the information we exchange does not fall into the wrong hands. Nowadays many people share their personal data (e.g. Netflix password, credit card number) with their family or best friends via social media networks or messaging services such as WhatsApp. But how safe is this actually? For example, could your friends – or even worse, a complete stranger – find a way to intercept and read your messages?

Task 5.1
Look at the two BBC micro:bit programs below. Discuss with a partner: How do Alice and Bob communicate? Do you think their conversation is safe? Why / why not?

Wi-Fi

As you know, Wi-Fi uses radio waves to exchange information with other devices. Consider the diagram on the right: all the messages that get sent from the clients to the modem basically *float in the air* until they reach their destination. This means that all users that are connected to this Wi-Fi network could intercept and read whatever messages you write online (using special software). However, keep in mind other people can only do that if they know the Wi-Fi password and thus were able to connect to the same network. This is why keeping your Wi-Fi password safe is extremely important!
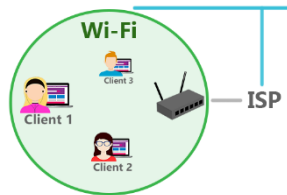
Encryption – Decryption

Imagine it is already summer and you're on your way to your holiday destination. You are currently waiting at the airport and surf the internet via the Wi-Fi provided by the airport. There are hundreds of different people connected to the same Wi-Fi network. How does this work? Couldn't other people just read whatever you do on social media?

Well, thankfully computers **encrypt** our messages automatically. Encryption means you take a message and use a secret system to change it into something unreadable. When you send this message to your best friend, no one will be able to read the message since it's gibberish. However, your best friend can **decrypt** the message because they can use the same secret system to change it back to the original text!
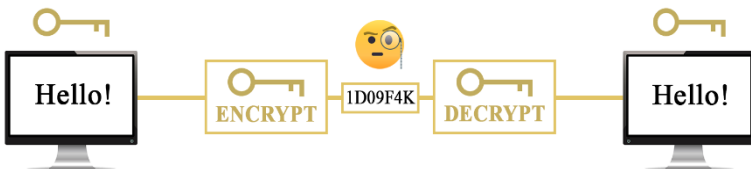
Your social media apps and computer programs **usually** do all this encryption and decryption stuff on their own. That's why you can be in the same Wi-Fi network with other people and not worry too much about someone being able to read your messages since they are encrypted anyway. However, **pro hackers** still might be able to find out the secret system you used and therefore **decrypt your encrypted messages**! That is why you should never use passwords or enter personal data when you're connected to public Wi-Fi networks such as at airports, restaurants, city hotspots etc.

Task 5.2

Look at this encrypted text:

G JGIC RFC ZZA KGAPMZGR

Can you guess what the original text means? Hint: you do not have to change the position of the letters, but you *may* want to change the letters to different ones...
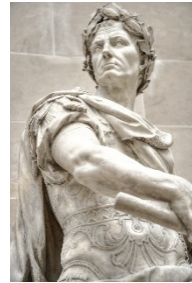
Cryptography
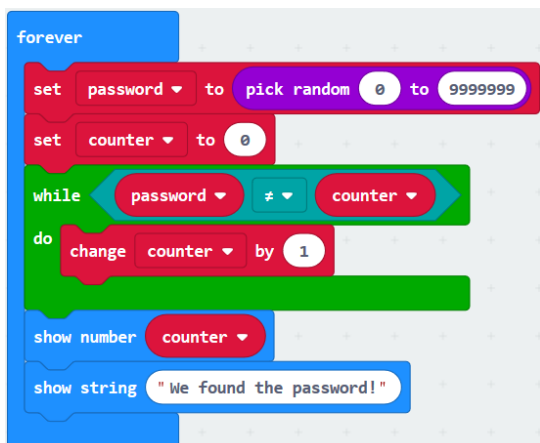
the communication system
ENIGMA

The art of encrypting and decrypting is called **cryptography**. One of the most famous figures in this field is the British mathematician **Alan Turing**. Turing was able to create a machine to crack the ENIGMA, which was the name of the machine the Germans used during World War II to communicate with each other. If you're interested in this particular topic, you might want to watch the movie **The Imitation Game** (2014) to see how difficult it was to hack this machine.

Passwords

Task 5.3

Look at the micro:bit program below. What does it do, and how? How long do you think this program will execute?

A strong password helps you to protect yourself against hackers. The stronger your password, the more resistant it is against guessing and attacks. Follow these 6 rules below to keep your accounts safe:

1. **Make your password at least 10 characters long**

2. **Use upper case & lower case letters and special characters:** e.g. 'MiLkY.MArs!' instead of just 'milkymars'

3. **Don't use personal information:** this includes your birthday, the names of your best friends, etc.

4. **Avoid easy sequences:** for example "1234", "asdf", etc.

5. **Use acronyms**: e.g. 'BIhCaiyflarwaf' for '*Because I'm happy, Clap along if you feel like a room without a roof*'

6. **Avoid using dictionary words:** Hackers can compare dictionary words with your password; even combination of words or names, e.g. 'DarkHorse' or 'JohnCena'

Hackers often use **brute-force attacks** to guess your password. A brute-force attack means that you try all the possible combinations of numbers and letters until you find the correct one.

tinyurl.com/nt19-booklet-6

Do you want to know how long it would take for a hacker to crack your password (regardless of numbers, letters, symbols, etc.) with a brute-force attack? Then use the QR code on the left or follow this link directly: HOWSECUREISMYPASSWORD.NET/! Beware that you should not type in your real password but maybe a change a few characters in case someone's spying on you… 👀

How to Avoid Scams

You could have the strongest password on earth, but if you give it to someone else, you're as safe as a person with no password at all. Unfortunately, there are lots of bad guys on the internet that try to steal your password and get access to all your personal data. These bad guys are called **scammers**.
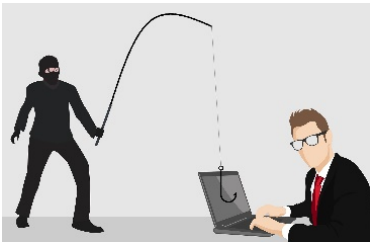
Scammers often claim to be 'the good guys' who just want to help you. They may send you emails or contact you on social media – even pretending to be your age, know your family, etc. This is called **phishing**.

Match the sentences

Task 5.5

Connect these sentences by drawing lines, or numbering them!

If someone tells you that you won a trip to Hawaii, you should…	are from a legitimate source, but they're not.
Social engineering attacks can…	create websites that look similar to websites you already use.
It's important to never send personal information…	be suspicious of the content and the intention behind it.
Remember to always download software…	unless you are absolutely sure who you are sending it to.
Social engineering is a technical term for content…	if your machine is compromised (= was hacked).
A website or an ad cannot tell…	that tricks you into revealing personal information.
Scammers will generate a sense of urgency (like an emergency) and…	happen over email, ads, or webpages.
Social engineering emails look like they…	from reputable sources.

Discussion

With a partner, discuss the following points:

1. **Scammers** are people who want to trick you to steal some money or personal data from you. Have you ever experienced an online scam? Or have you heard about scammers in the offline world (= in real life) or in the media (newspapers, radio, movies, …)?

2. Many people still click on links in emails asking them to download software that will make their PCs 'more powerful'. This software called **malware** harms your device and may delete all your data! Why do you think some people still fall for this scam?

3. **Legitimate** or **reputable** online sources are websites that you can fully trust. How do you think could you find out if a website is legitimate, or **suspicious** (= not to be trusted at all)?

4. Hackers often use ads (short for advertisements) to make you click on their **ads**. If you were a hacker, how would you create an ad? What would you write so people paid attention to it?

Follow the QR code on the left to find out how to stay safe from phishing and online scams. Make sure you pay attention to suggestions what to do when a.) answering emails and b.) visiting websites!

tinyurl.com/nt19-booklet-7

Scammers cannot only be found online. There may be a scammer in the same room as you are right now!

There are many ways we can stay safe in the real world – e.g. locking the door, always keeping your wallet in your bag, or cleaning your room as your parents told you! However, sometimes there's only so much we can do. Maybe it's time we programmed us some help.

Program 5: Audio Alarm

Let's Code – Task 5.8

You can use your BBC micro:bit as your own personal security alarm! You will need your micro:bit's battery pack, 2 cables with crocodile clips and 1 piezo speaker (ask your teacher for this equipment).

- Use the micro:bit's movement sensor for your alarm. If someone runs off with your schoolbag, for example, your micro:bit should sound the alarm!

- Think about how you want your program to behave. How should the alarm be triggered? Once the alarm goes off, how long should it last? And how should the alarm sound?

- The micro:bit interface you are using to create programs can play sounds if your computer's loudspeakers work – however, the micro:bit cannot play sounds on its own. You need special equipment for this. On the next page, you can check how to connect the cables and the piezo speaker to your micro:bit.

Think about how you could let your micro:bit guard other things. For example, every time someone opens the door to your room, your micro:bit…

How to Give Your micro:bit a Voice
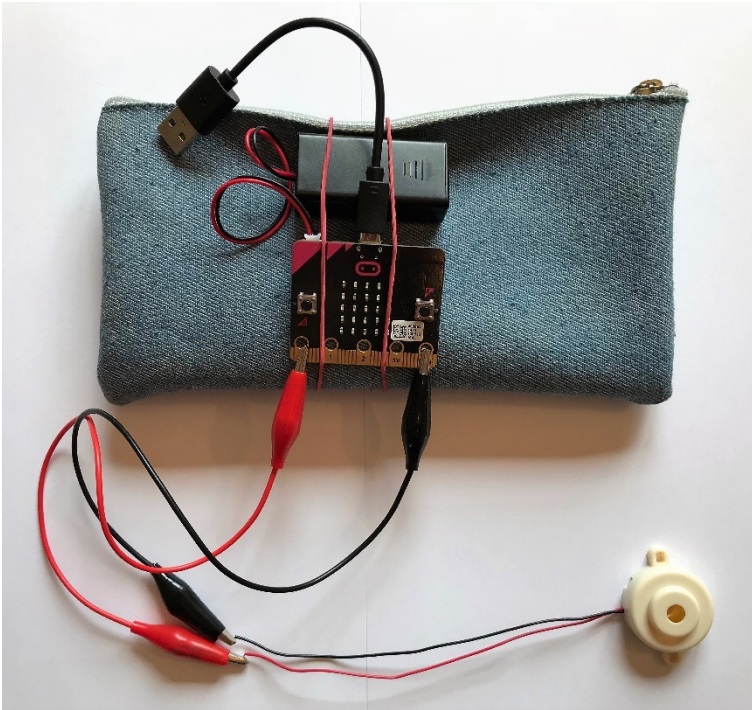
Here you can see a BBC micro:bit attached to a pencil case. The two cables with the crocodile clips (red and black) are connected to the piezo speaker (bottom right). The other end of the red crocodile clip is attached to the Pin '0' on the micro:bit whereas the black one is attached to the Pin 'GND'. These Pins allow us to create circuits and experiment around with devices such as piezo speakers.

VI.   Green Technology

So far, we've talked a lot about the Internet: the benefits of being able to connect people with all over the world, the issues that arise from this interconnectivity, and the technical background behind all this. In this session, we will focus less on the Internet but rather on technology itself.

In particular, we will look at **green technology**. How can we use technology to help protect the environment? What current technological innovations already exist that have a positive impact on the environment? What can we do as individuals to reduce our carbon footprints?

Homework Task 5.9/6.1

Before you learn more about green technologies, **read the questions** and **review the vocabulary** on the next page – **only then watch** this video about the greenhouse effect: YOUTUBE.COM/WATCH?V=BPJJM_HCFJ0. Answer the questions to make sure you understand what the greenhouse effect is. After all, this effect is one of the root causes for global warming, which includes ice glaciers melting, sea levels rising, hurricanes becoming more destructive, etc. When you've understood the greenhouse effect, you will learn more about **pollution** and technologies to counteract reduce the amount of CO2 emitted into the air.

tinyurl.com/nt19-booklet-8

The Greenhouse Effect

1. What do we use greenhouses for? Why are they useful?

2. How exactly do greenhouses work?

3. Is the greenhouse effect in general bad for the earth? Why / why not?

4. The earth reflects some of the sunlight back into the sky. Why does part of this 'reflected radiation' (= the reflected sunlight) gets sent back to earth again and does not escape the earth's atmosphere?

5. How do humans increase the greenhouse effect?

to penetrate = eindringen	**to obtain** = erhalten, bekommen
to rise or to increase = erhöhen	**soil** = Erde
to absorb = aufnehmen	**pollution** = Verschmutzung
carbon dioxide = CO2	**radiation** = heat (in this context)

The Carbon Footprint

If we manage to reduce CO2 emissions, we can minimize the influence humans had on the natural greenhouse effect and therefore stop global warming. Although big corporations and manufacturing companies have a huge impact on the environment, we can also change our lifestyle to reduce the overall amount of carbon emissions.

A **carbon footprint** is the amount of carbon dioxide (CO2) released into the atmosphere as a result of the activities of a particular individual. For example, traditional cars emit a lot of carbon dioxide as part of their emissions – they need to burn gas in order to work. Driving by car – especially alone – increases your carbon footprint because more CO2 is emitted into the air. If you go by bus, you reduce your carbon footprint because you share the bus with many other people. Moreover, the bus would operate anyway, with or without you! Ideally, you'd just walk or ride your bike, which, by the why, also improves your fitness 😉 .

Task 6.2

Your teacher will give you 20 paper strips, each containing a different measure to reduce your carbon footprint. With a partner, order these measures **according to how easy you would find it to do them**. Put the measures you could take easily at the bottom – and at the top, place the measures you think would be most difficult to take in your everyday life. If you and your partner **fully disagree** on where to put a certain paper strip, set the piece aside (but try to agree on as many as measures as possible).

20 Ways to Reduce Your Carbon Footprint

- Avoid eating meat and dairy
- Choose organic and local foods that are in season – don't buy imported fruits
- Drink tap water instead of bottled
- Reduce food waste, reuse leftovers
- Compost your food waste if possible
- Don't buy fast fashion
- Buy vintage or recycled clothing
- Buy less stuff! And buy used or recycled items whenever possible
- Bring your own reusable bag when you shop
- Try to avoid buying items with a lot of packaging
- Support and buy from companies that are environmentally responsible and sustainable
- Switch lights off when you leave the room and unplug unused electronic devices
- Don't buy sweets or food wrapped in plastic
- (Ask your parents to) sign up to get your electricity from clean energy
- Drive less – walk, take public transportation, carpool, or bike to your destination
- Wash your clothes in cold water
- Get politically involved and stand up for the environment
- Use laptops instead of PCs – they require less energy
- Avoid flying if possible; on shorter trips, driving may emit fewer greenhouse gases
- In your home, turn off the heating and put on warmer clothes

Applications of Green Technology

At this point you should know what the greenhouse effect is and how you can reduce your carbon footprint. Now we have the necessary background knowledge to discuss the role of technology in the challenge to combat climate change!

So, the goal of Green Technology is to use technology to lessen or reverse the effects of human activity on the environment. We can find Green Technology in various parts of our lives, which is why it is commonly divided into four categories:

 Renewable Energy (using clean energy such as solar/wind/geothermal energy etc.)

 Green Purchasing (only buying eco-friendly appliances & devices)

 Green Building (building sustainable cities and houses)

 Green Chemistry (using eco-friendly chemicals, such as biodegradable plastics or medicine producing less toxic waste)

In this lesson, we will only focus on the first point **Renewable Energy**.

 Task 6.3
Another Quizlet study set! You know the drill.

tinyurl.com/nt19-booklet-9

It's time to get a little creative! Here you can see a text called "Renewable Energy vs. Fossil Fuels". **Read this text** and try to **highlight the most important points**. Then, take a blank A4 piece of paper and **try to draw a mind map that explains the text visually**. You should be able to explain your drawing to a person who hasn't read the text at all! You should add some important words from the text to your masterpiece so it's easier to understand.

Renewable Energy vs. Fossil Fuels

Energy consumption is a huge part of our daily lives: we eat with energy, we travel with energy, and we work with energy.

But where does all this energy come from? Today we gather most of our energy from coal, oil and natural gas – also known as fossil fuels. Additionally, we gather energy from biomass, nuclear, and renewables.

- Fossil fuels consist of decomposed ancient animals and plants that existed millions of years ago.

- Biomass burns plant and animal waste to produce energy (= bioenergy).

- Nuclear energy is released during nuclear fission.

- Lastly, renewable energy comes from a source that's not depleted when used such as wind or solar power.

But what's the difference between these 4 energy sources? How do they affect our planet?

a gas pump station

Fossil fuels cost more than what we pay at the *pump* and impacts our environment in many ways. These impacts include global warming, air quality deterioration, oil spills, and acid rain. It's also projected that fossil fuel resources will be depleted within the next 50 to 100 years. Biomass and nuclear energy also have similar issues.

We need a solution really fast and luckily, we have one: renewable energy comes from resources which can actually replenish in our lifetime whereas fossil fuels are a one-time use resource in the human time scale.

Resources for renewable energy include sunlight, wind, rain, tides, waves and geothermal heat. The best part is that we don't need to damage our planet to use it, nor do we have to rely on other countries for these resources. In theory, we do have the technology to be 100% renewable reliant. However, the truth is that at the moment our infra-structure still depends heavily on fossil fuels.

Dane Bliss Design (2015, December 15). *Renewable Energy Explained in 2 1/2 Minutes*. Retrieved from https://www.youtube.com/watch?v=KEeH4EniM3E

Types of Renewable Energy

Task 6.5

Match the following words to the pictures below. After you checked the answers with your teacher, with a partner try to identify **at least one benefit** and **disadvantage** of producing energy with every type of renewable energy you see here.

Bioenergy / Hydroelectric power / Solar panels /
Geothermal heat / Tidal power / Wind turbines

_____

_____

see footer for license

_____

_____

_____

_____

100% Renewable Energy?

You've seen that there are many alternatives to fossil fuels, and the amount of renewable energy used in our world is sure to increase over the coming decades. In fact, Iceland is already doing extremely well when it comes to renewables: **all (!) of their energy** comes from renewable sources – 95% geothermal energy, and 5% hydropower (Seydel, 2015). Of course, it's not that easy for other countries if you think about factors such as population density (= how many people live in a certain area) and the opportunities the landscape can offer to actually build and use geothermal power plants. But still, 100% is pretty amazing!

Kirkjufell Mountain in West Iceland

tinyurl.com/nt19-booklet-10

Austria currently uses 75% renewable energy, which is not too bad either. If you're interested in how other countries are doing, check out Wikipedia's list of countries sorted by electricity production from renewable sources (follow the QR code on the left). However, keep in mind that all these numbers in this list may not be very accurate!

As individuals, we can have a pretty big impact on the environment – for example, there is a village in Germany called Wildpoldsried that generates **500% more energy than it actually needs**! It seems that the community in this village never forgets to turn a light off when they leave a room… maybe they use some kind of system or device that keeps reminding them if a light is still on? 🧐

Seydel, L.T. (2015, October 01). Iceland: World's Largest Clean Energy Producer Per Capita. Retrieved from https://www.ecowatch.com/iceland-worlds-largest-clean-energy-producer-per-capita-1882105880.html

Program 6: The Environmentalist

Let's Code – Task 6.6

Will the BBC micro:bit make Austria 100% reliant on renewable energy? Well, who knows! One thing's for sure, though: We can use its sensors to analyse the environment.

As an experienced programmer, can you come up with your own ideas for a micro:bit program that could be used for the environment?

- In case you lack inspiration: perhaps you could create a **thermometer** using the micro:bit's temperature sensor? In the winter especially, people leave their heating on all the time or they forget how warm it already is. You could just wander through your home with your micro:bit and check the temperature: if any room is too warm, turn the heating down!

- You could do something similar with the light sensor as well: measuring how bright or dark your room currently is. Can you let your micro:bit show a message that the light is on? And maybe send this message to another micro:bit?

- The **temperature sensor** shows a number in degrees Celsius (°C).

- The **light sensor** shows a number between 0 and 255. 0 is very dark and 255 is very bright. **Generally, the value tends to be rather low**. Experiment around with it to see how your device reacts to light. Optional: If you want to fit this into a single digit range between 0 and 9, divide the number by 28!

Homework Task 6.7

Create your own Quizlet Study Set! Find at least 10 words from the chapters 'III. The Internet of Things' and 'IV. Digital Communication' that you find difficult and put them into your study set. Add a good explanation (English or German) to the words you picked – you can add whatever information you like (links, pictures, etc.). Use the internet to search for more definitions and examples so you really know what the word means.

You need to create a Quizlet account to be able to use the website's functions. **You must not upgrade** your account (trying a free 7-day trial) – creating a study set is completely free. After you created an account, click on the 'Create' button at the top of the website to start working on your own study set!
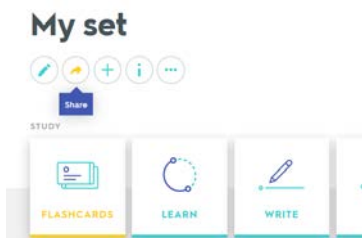
When you're finished, be sure to **share your set with your teacher**. Click on the share button, enter your teacher's email address, and click on 'Send email'.

Homework Task 6.8

If you want to revise vocabulary from the sessions The Internet of Things and Green Technology, use the QR codes below!

The Internet of Things

tinyurl.com/nt19-booklet-11

Green Technology

tinyurl.com/nt19-booklet-12

VII. Independent Project

The end is near – sadly! In this course we've talked about lots of different IT related topics and developed a variety of programs with the BBC micro:bit. Since you're a micro:bit programming expert at this stage, you don't need any instructions anymore. Take whatever idea you have for a useful program – and program it!

Let's Code – Task 7.1

Create your own program! Make sure it either serves a specific purpose (e.g. a compass) or it has high entertainment value (e.g. a video game). You can write your own program, or work with a partner together. If you decide to do this project with a friend, make sure your program is not *too simple*.

If you lack inspiration, here are a couple of ideas:

Easy (only for individual projects):

- **Rock Paper Scissors**

  Two micro:bits could be used to play the popular decision game: Rock, Paper, Scissors! You'd have to make sure that the micro:bit chooses the symbols *randomly*.

- **Hack Your Headphones**

  Do you still have wired headphones instead of Bluetooth ones? If yes, you can connect these headphones to your BBC micro:bit and use them as loudspeakers! You need to borrow some cables with crocodile clips for this, though.
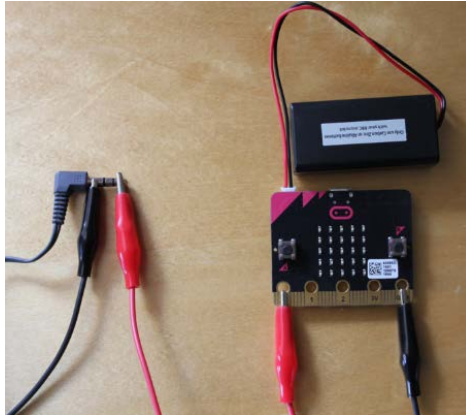
  "Datei:Hack4.png" by Leonie Dreher is licensed under CC BY 2.0

Medium:

- **Lucky Guess**

  A program can guess any number between 1 – 100 with just 7 tries! With every guess, you just need to tell the algorithm if your secret number is higher or lower. Repeat this six times, and the algorithm knows your number!

- **Stopwatch**

- **Town, Country, River**

  Your BBC micro:bit can help you play this popular German game! If you press button B, for example, the micro:bit could show a random letter from A to Z for every round. You will need to use **arrays** for this .

- **Coin Collector**

  You could assign a single LED light to the player, and let different LED lights (= coins) show up on the micro:bit display. The player needs to use the movement sensors to move to and collect these coins! If they collect one coin, the light goes away and should show up somewhere else on the display. You will need to use **sprites** for this .

Difficult:

- **Catch the Egg**

  You can create a lot of different games if you use the micro:bit's LED display. For example, at the bottom row of the display you could have a single light (a 'basket') that you move left or right by pressing A or B, and you need to catch eggs (also single lights) that are falling down from the top row. You will need to use **sprites** for this game as well .
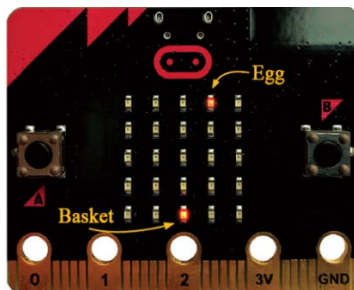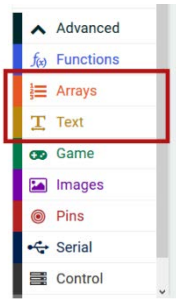
Arrays

Creating an Array

An array is basically just a variable too – only that it can have multiple values! For example, when your parents go shopping, they usually have a shopping list:

Shopping list = Milk, Rice, Bread, Eggs, Flour

In micro:bit programming, it would look like this:

Clicking on "Advanced" opens up this list

You create a variable called 'shopping list' that has 5 text values (numbers work too!). You can also insert variables in this list, but here we used values so it's easier for us to work with the array.

Changing an Array

If you want to change a specific value of the array, you need to tell your program at which **position** you want to change the value. For example, if you want to change "Rice" to "Pasta" and show the result on the LED display, you need to set the new value at position 1.


> **Good to Know!**
>
> **An array <u>always</u> starts counting at 0!** This means: "Milk" is at position 0, "Rice" at position 1, "Bread" at position 2, etc.

Sprites

In micro:bit programming, a sprite is basically a single LED light that you can control, like a character in a video game! You can tell it to move around, turn 90°, and check if it has touched another sprite.

Here's the tricky thing: you need to create a variable that 'carries' the sprite. For example:
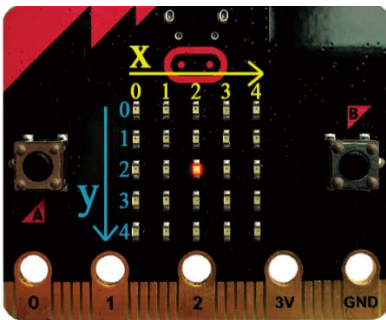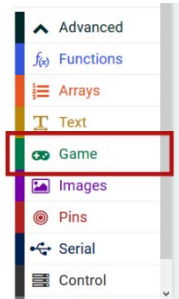
Here you create an LED sprite at the position x = 2, and y = 2. As you can see in the left image, this sprite would be right in the middle. Now you can use more **Gam** blocks to control this object: for example, pressing button A moves this LED sprite to the left, and button B moves it to the right on the x-axis.

There are many other blocks in the **Gam** category that can be quite useful if you want to create a game.

Check this link out to find out more about sprites and Scoring blocks that create cool animations for games automatically:

MAKECODE.MICROBIT.ORG/REFERENCE/GAME

tinyurl.com/nt19-booklet-13

In real life, programmers often write a detailed documentation of what their applications do. This helps them to be more organised and other people can understand how this program works as well without hassling the programmers to explain it to them.

Task 7.2

In class, write a report for your micro:bit project! In this documentation, you should include:

- a title

- the name(s) of the programmer(s)

- online link to your published project

- explanation of what your program does (50 – 80 words)

- a screenshot of the micro:bit code

- ideas how your program could be developed further
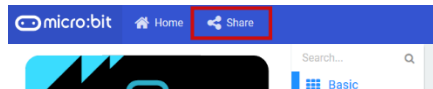
Look at p. 56 for example of a documentation for a program called 'Snap the Dot'.

Task 7.3

If you've written your report and handed it in to your teacher, you should have a look at your classmates' projects! Give feedback on at least **two** other projects **using the Feedback template** your teacher provided you with (or write your feedback on a separate sheet of paper – you can find the template on p. 57).

Snap the Dot

Name(s) of Programmer(s): SpongeBob SquarePants

Link to program: HTTPS://MAKECODE.MICROBIT.ORG/_32AMRMCTWFDS

Program Description:

This program shows a single dot on the LED display that moves from one end of the display to the other, forever. If the dot is at the centre of the display, the player should press A, and if they succeed, their score goes up by 1. If they don't, it's game over and their final score will be shown.

Screenshot of Code:

More Programming Ideas:

The dot could move a little bit slower, and there could be two dots on different lines. The player would need to press A or B, depending on the line they are currently looking at.

Another idea would be to fill the straight line by pressing A on every dot as quickly as possible. After pressing A, the matching LED light is turned on permanently. If the player presses A for an LED light that is already turned on, this light should turn off again. The final score would be the time the player needed to completely fill the line.

Feedback Template

Program Name:

Name(s) of Programmer(s):

Feedback

Did you understand the program? How useful **and/or** entertaining is it? Did you notice any errors or things you disliked? What did you like in particular?

Program Name:

Name(s) of Programmer(s):

Feedback

Did you understand the program? How useful **and/or** entertaining is it? Did you notice any errors or things you disliked? What did you like in particular?

Homework Task 7.4

In the previous lessons we talked about many different aspects of how technology is used nowadays. Write a short text about New Technologies and give your opinion on what you have learned during the course of the past weeks.

Be sure to…

- **include at least 7 terms/phrases** from the following Quizlet study set: HTTPS://QUIZLET.COM/_6DK1B2 – this study set contains all the vocabulary from this unit. **Clearly <u>underline</u> the 7 words you integrated in your text.**

  tinyurl.com/nt19-booklet-14

- discuss your favourite chapter, and explain why you liked it the most (think about the difficulty of the topics, the activities, and how useful you found them).

- say what your least favourite chapter was, and give reasons for your choice as well.

- give your opinion on using the BBC micro:bit in class to learn about programming.

Write about **200 words**.

VIII. Summary

If you've come this far, this means that you're a certified New Technologies expert. You know how the internet works, how we use it, and how technology plays a central role in our society. Technologies change every day, and maybe in a few years' time this very booklet may already be considered 'old' or not 'up-to-date'. It will be your responsibility to catch up with modern technologies!

If you've enjoyed working with the BBC micro:bit and don't want to say Goodbye just yet, you could try to convince your parents to buy you a BBC micro:bit **robot**! Have you ever seen a flat vacuum cleaner that moves around the floor on its own? Or a lawn mower? You could do the exact same thing with your micro:bit (well, except the cleaning part)! Ask your teacher to give you more details about good offers on the internet if you're interested in programming a micro:bit robot.

We hope you liked working with this booklet and that it hopefully showed you how awesome programming can be!