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OPTIMISATION OF IT TEACHING MATERIALS FOR STUDENTS OF HUMANITIES AND SOCIAL SCIENCES

Abstract
The demands of the 21st century mean that without digital competence and basic IT skills we cannot thrive in society. This is particularly true for students leaving higher education. Today, it is not only students in engineering and science who need to acquire ICT and IT skills. Although the latest version of the National Curriculum sets the development of digital competences as a task, the previous curriculum did not require students leaving public education to have these competences. For this reason, it is particularly important in higher education in the humanities and social sciences to develop digital competences in addition to IT skills. The paper presents the history of the introduction of IT and computing in higher education, and the process of how these subjects have been replaced in the humanities as well as in technical higher education because of the Bologna process. In addition, it presents the elements of the implementation of an IT course in an LMS system. It presents good practices and tools to increase not only students' knowledge but also their motivation, digital competences and interest in IT content.

Keywords: computer science; curriculum development; higher education

Introduction

In the 21st century, the focus in all aspects of life, be it education, the economy, or the labour market, is increasingly shifting from knowledge transfer to skills and their development. In addition, the idea that the use of computers and digital tools and content has become at least a basic requirement in our society cannot be disputed. The concept of digital literacy was introduced before the turn of the millennium in 1997 (Gilster, 1997), but its current meaning is most closely linked to Calvani's definition (Calvani et al, 2008). A key element of Calvani's definition is the idea that the development of digital literacy cannot be limited to either theoretical instruction in computing or the acquisition of an adequate level of competence in the use of computers and ICT tools. In Hungary, under the regulation imposed by the Covid19 pandemic, instructors had only a very limited time (maximum 1 week in higher education) to switch to fully online teaching (Nahalka 2021, p. 26). The success of the switch was largely determined by the previous knowledge, experience and preparation of the institution and the instructor in relation to e-learning, online course materials and the development of online course materials.

Although the ability to use ICT tools is higher among students, this does not imply an increase in digital competence and digital literacy (Tóth-Mózer & Kárpáti, 2016). In addition, there is a large difference in digital competence between students from different socio-cultural backgrounds. In their case, the digital divide can take several different forms:

the lack of physical devices (be it computers, laptops, microphones), as well as digital access, the lack of (or complete lack of) access to the internet, and digital literacy gaps. All of these factors can lead to problems that can hinder the successful delivery of an online or hybrid course.

Computer and information science is a very diverse discipline, which is why there are many possible ways to develop IT curricula on the e-learning platform and LMS. The heterogeneity of courses in higher education foresees that different types of curriculum development methods will be needed for a course that imparts purely theoretical foundations and a practice-oriented curriculum and course in a lab environment. In addition to this, it is important to note that nowadays the teaching of computer science is no longer confined to technical higher education, and therefore we also need to produce useful and effective curricula for students with interests in the humanities, for example.

In higher education, we need to consider all the above factors. We need to give students entering higher education the opportunity to integrate successfully into education, whether in traditional, online or blended environments. The concept of the "new normal" has emerged in many workplaces following the Covid pandemic, but we are also seeing a growing trend in higher education towards courses in online and blended learning environments. The "new normal" is not a set of tools, but an approach to creating a learning environment that is open, flexible and responsive to the learning objectives of the course, which best serves the interests of the students, supports students to successfully complete the course, and in doing so, gain the necessary IT and computing skills and develop their digital competence.

The aim of the study is to present the history of computer science education in higher education, with the aim of illustrating how education that started out in technical higher education has now been extended to other disciplines. The paper will then present a number of tools and methods for the development of IT and computing education in an online environment, based on examples of IT teaching materials developed in the course of the research. In addition, the paper will present practices where changes are made to facilitate the learning of IT curricula in LMS systems by humanities students, and where more complex IT topics can be easily learned by integrating them.

Teaching computer science/informatics in higher education

The concept of computer and information technology

Computer Science and Informatics is classified in the Technical Sciences Division under the heading Automation and Computer Science and Informatics, according to the nomenclature of the MTA, updated in 2016.

In Hungary, several terms have been used to describe these disciplines: computer science, computer engineering, information science, informatics. In my thesis, the concepts of computer science and informatics and their teaching are presented. These terms are often used interchangeably or synonymously in common parlance, even though they cover different disciplines. (Balogh, n.d)

"Computer science is the theoretical and applied technical science concerned with the tools of automated data processing and their use in various fields." (Hampel & Heves, 2019, p. 13.)

The term informatics was first used in 1965 at the annual symposium of the University of California (UCLA) (Papp, 2003) The English term informatics was coined as a combination of two words: information and automation; it originally described the science of automatic processing of information (Yatsko & Suslow, 2016)

According to the Oxford English Dictionary 2000 definition, informatics is: the discipline that studies the structure and properties (but not the specific content) of scientific information, and the regularities, theory, history, methodology and organisation of scientific information activity.

"Informatics is "a discipline, concerned with the recording, management, organisation and transmission of information. It does this mainly on computers. It is a science that has emerged from the integration of measurement, communications and computing, and deals with information systems as a whole" (Námesztovszki, 2018, p. 5).

"IT as an interdisciplinary field encompasses more than just information science. Likewise, informatics is more than just computer science. The interdisciplinary nature of computer science has made it possible to integrate the taxonomic theories and methods of information storage, retrieval and dissemination with new information technologies" (Papp, 2003, p. 420).

The field of information and computing has undergone a huge change. In the early days, it covered the study of the structure and general properties of information. Later, in the 1980s, it was seen as a discipline of computing tools and their applications in specific disciplines. In the late 1990s, a more holistic concept emerged, whereby it is understood as a discipline describing the laws of information processes in nature, in various technical systems and in society. Today, the term informatics is a combination of these three definitions (Yatsko & Suslow, 2016).

Information technology and the use of computing tools are now an integral part of all disciplines. In the following, I would like to outline the history of the development of computer science education in higher education, the process of how the teaching of a specific subject has become embedded in the everyday life of higher education and how the teaching of computer science and informatics has become more and more common in undergraduate courses in other disciplines.

Computer and information technology education in higher education

The teaching of computer science in Hungarian higher education started in Szeged in the late 1950s, under the leadership of László Kalmár. László Kalmár, as a mathematician, was engaged in the study of cybernetics and computer science from 1956 onwards (Klukovits & Rácz, n.d.). He established a seminar at the Bolyai Institute of the University of Szeged, where research in cybernetics, computer science, computer science and mathematical logic was conducted. Within this framework, the Kalmár logic machine was built. Based on these research results, the training of applied mathematicians was launched in 1957, where the field of computer science was represented by the subjects Programming of Automatic Calculators and Numerical and Graphical Methods. In the years that followed, Computer Science was introduced in several places in the country, first as an optional and then as a compulsory course within other faculties (Karl Marx University of Economic Sciences, Eötvös Loránd University). In the 1970/71 academic year, the first college course, Computer Science, was launched at the Kandó Kálmán College of Electrical Engineering. In the academic year 1971/72, the programmer-mathematician course was launched at Eötvös Loránd University, the University of Szeged and the University of Debrecen, and the systems engineering course at the Technical University of Heavy Industry.

In 1972, the Ministry of Education issued a decree that computing must be taught in all science courses in higher education. In addition, in the 1980s, universities and colleges of economics, in addition to engineering and science faculties, integrated the teaching of mainly applied computing as a compulsory course in the curriculum, thus facilitating the acquisition of curricular computing skills related to the fields of study.

The Bologna process and the accession to the European Higher Education Area (EHEA) aimed not only to unify European higher education systems and make higher education more accessible, but also to adapt education and training to meet the new 21st century labour market requirements.

The Bologna process transformed the existing training courses into a three-cycle higher education system (bachelor, master and doctoral). The regulation of higher education is the Government Decree 289/2005 (XII. 22.), which included the description of the education, the courses that can be started and their credit values.

The Bologna-style transformation of traditional training was supported by the 2008 Recommendation of the European Parliament and the Council on the establishment of the European Qualifications Framework for lifelong learning. The European Qualifications Framework (EQF) defines eight levels of reference from public education to doctoral studies, with level 6 defining learning outcomes related to bachelor and level 7 almost to master level (Istenes, Kerek & Kozma, 2011). The framework attributed the learning outcomes to a triad of skills/competences, knowledge and competences.

Based on the Ministry of Innovation and Technology decree 65/2021. (XII. 29.) on the list of qualifications obtainable in higher education and on the establishment of new courses, the following higher education vocational courses can be obtained in the field of IT training: economic informatics, engineering informatics, program planning informatics (Figure 1)

Figure 1: List of IT courses

Informatika	Computer Science and Information Technology	gazdaságinformatikus felsőoktatási szakképzés	Business Informatics	felsőfokú gazdaságinformatikus-asszisztens	Business Informatics Assistant	5
		mérnökinformatikus felsőoktatási szakképzés	Computer Science Engineering	1. felsőfokú hálózati mérnökinformatikus- asszisztens	1. Computer Science Engineer Assistant in Networks	5
				2. felsőfokú rendszergazda mérnökinformatikus- asszisztens	2. Computer Science Engineer Assistant in System Administration	
				3. felsőfokú telekommunikációs mérnökinformatikus-asszisztens	3. Computer Science Engineer Assistant in Telecommunication	
		programtervező informatikus felsőoktatási szakképzés	Computer Science	1. felsőfokú fejlesztő programtervező informatikus-asszisztens	1. Computer Scientist Assistant in Software Development	5
				2. felsőfokú multimédia programtervező informatikus-asszisztens	2. Computer Scientist Assistant in Multimedia	

Source: 65/2021. (XII. 29.) ITM rendelet a felsőoktatásban szerezhető képesítések jegyzékéről

Today, computer science education in higher education encompasses the teaching of several related disciplines. It includes the English discipline of computer science, computer engineering or computer science, and the foundations of the discipline of information technology. Whereas in the past the teaching of these disciplines was primarily under the aegis of higher education in engineering and science, today they are integrated into the teaching of other disciplines in response to the demands of the information society. According to the Directory of Bachelor's and Master's Degrees, which includes all the bachelor's degrees accredited in Hungary, the teaching of computer science and computer engineering is no longer limited to the field of computer science.

In the field of humanities, all 15 bachelor's degree programmes include computer science among their basic subjects. In addition, two courses (liberal arts and history) include a strong emphasis on IT in the area of differentiated professional knowledge, and 4 courses (history, community organisation, liberal arts, archaeology) include a strong emphasis on IT in the area of professional competences, and cultural anthropology) The teaching of information technology and computing is included in the basic knowledge for the IT librarian and sociology courses, while for the other courses it is listed among the professional competences, mainly the knowledge of information technology and computing, mainly at the application level, mainly related to the discipline. In the case of teacher training related subjects, IT appears in the basic skills for all 5 subjects and in the case of teacher training in the field of education in the modules on the field of education.

In addition, there are specialised courses within the humanities and social sciences where there is a greater emphasis on IT-related subjects within the basic skills, such as the IT librarian course. From the point of view of my research, the Hungarian IT librarianship can be considered as a special field, where "The aim of the training is to train IT librarians who will acquire librarian skills and modern IT knowledge, which will enable them to fill the positions requiring practical expertise in various types of libraries and organisations that perform information, information processing and mediation tasks" (Felvi.hu, n.d.). The teaching of IT is given more emphasis in this course than in other social sciences and humanities courses.

Education in information technology areas

"IT education is not only about giving students content they can use later, but also about developing a mindset that is timeless in the face of constant change and that they can use in different areas of their lives." (Kátai, Nyakóné & Zsakó, 2008 p. 4)

The teaching of computer science and information technology lies at the intersection of these two disciplines and the discipline of pedagogy. Several didactic principles, such as the principle of combining theory and practice, active learning, project-based approaches can be incorporated into higher education, and lesson planning along the lines of subject requirements is essential, while respecting basic didactic rules and methods.

Teaching should consider the computer and information technology skills that students need to acquire, as well as effective ways of organising curricula, principles, the design of learning environments and curriculum design principles.

Computer science can be divided into two main areas, such as computer science and computer engineering. The main organisations active in the field of computer science and information technology are:

- ACM (Association for Computing Machinery
- Institute of Electrical and Electronics Engineers (IEEE) Computer Society
- Association for Information Systems (AIS)
- Association of Information Technology Professionals (AITP)

In collaboration with these organisations, the Computing Curricula 2020 (CC2020) report has defined the following key areas within the discipline of computer science and computing: Computer Engineering; Computer Science; Cyber security; Information systems; Information technology; Software Engineering (Association for Computing Machinery,2020)

These sub-disciplines cannot be completely separated but complement and support each other and cover the computing/IT discipline.

Since 2005, the Computing Curricula series has provided tools and background information in the field of IT education, and in the field of IT and computing curricula in higher education. The 2005 report was a collection and comparison of the curricula that existed in higher education at that time. The aim of the CC 2020 project is to present methodologies that cover the needs, different aspects and concepts of current IT education and that can help curriculum design in higher education. In previous years, separate guidelines have been defined for each computing discipline (Information System Curricular Volume 2010, Computer Science Curricular Volume 2013, Information Technology Curricular Volume 2017), but Computing Curricula 2020 aimed to publish a volume of guidelines covering the whole field of computing. The concept is the same, only the content of the curriculum may differ. The report is based on the Bloom taxonomy for pedagogical taxonomies.

The report puts a strong focus on the comparison of knowledge-based and competency-based computing/informatics education and outlines future educational trends in the field of IT education in higher education. Previous Curriculum frameworks, be it IT Curriculum 2013 or CC 2005, have primarily advocated a knowledge-based approach, but the 21st century has not yet brought a new approach. In the light of 21st century competency requirements, students' IT and digital competence gaps and the limitations of the knowledge-based approach, CC 2020 now calls for the integration of competency-based education in higher education in computer science. It proposes a shift in thinking on the format of computing curricula. It considers the first step in effective computer science education to be the assessment of the user's prior knowledge and the adaptation of the curriculum to this, while at the same time considering computer science education as an important task for the betterment of society. It illustrates with example tasks how motivating tasks could be prepared for students in each computing subject, which would not only increase digital competences but also help them to master the curriculum. The project focuses primarily on BsC and MsC computer science/informatics education programmes, but the principles, factors and methods defined can also be used for other disciplines related to the discipline.

Going beyond the specific guidelines for IT curricula, the Digital Competences Framework or the ECF framework is a good basis for the preparation of curricula. The European Competence Framework (ECF) contains 40 definitions of competences for ICT workplace performance, linked to 5 competence areas, using a common language to define the competences, knowledge, skills and proficiency levels that are considered important across Europe. The use of the e-CF by companies and organisations across Europe supports transparency, mobility and efficiency in human resource planning and development related to the ICT sector. They are also useful for educational institutions and training bodies, including higher education, professional associations, public and private sector organisations. The e-CF defines 5 proficiency levels, from e1 to e5, which are linked to the EQF learning levels 3 to 8 of the European Qualifications Framework. The Digital Competence Framework was developed by the European Commission in 2011 and is currently in version 2.1. The framework primarily uses the concept of digital competence as defined by the European Council and the European Parliament and is based on two existing frameworks, the European e-Competence Framework and the ICT Competency Framework for Teachers. The framework defines 5 domains, 21 key competences, which are essential for any European citizen in the 21st century to navigate in the digital world, and by defining several levels of competences, it provides a methodology that can be used in different areas, such as training students, teachers, skills development, transfer of competences for digital citizenship, and can also be used for measurement (Carretero, Vuorikari & Punie, 2019).

When an existing IT course needs to be converted to an online format, the first step is to choose the appropriate online platform that correlates with the course objectives. In addition to this, it is important to ensure online communication with students, to measure knowledge and to explore the possibilities for student assessment. Above all, however, the need to digitise existing course materials, textbooks and teaching aids for the course in question. The course material and the structure of the lessons need to be reviewed with a view to what changes are necessary to ensure that the course remains effective when integrated into an LMS system. In this paper I attempt to answer the last question.

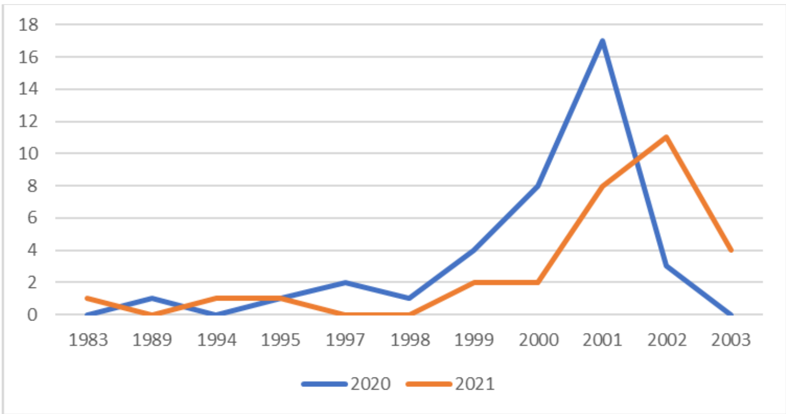
Further development of IT teaching materials

Presentation of the research

The research was conducted at the Institute for Human Development and Cultural Studies of the University of Pécs. During my research, I studied a course that is compulsory for first-year students in the first semester, the Informatics course. The students took the Computer Science course in a blended environment, where the practical course material was delivered face-to-face/in person in an online contact hour in the Teams interface, and the Moodle LMS (Learning Management System) learning framework was used for the theoretical learning. The course aims to introduce students to basic computing principles, software and hardware, and to develop their digital competences.

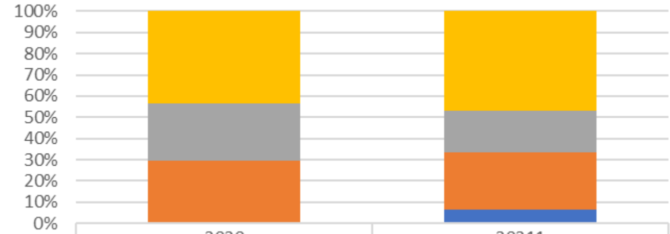
The research was conducted in two phases, in the autumn semesters of 2020 and 2021. The course was attended by students from 3 departments: a BA in Computer Librarianship, a BA in Community Organisation and a full-time BA in Teaching. 42 students took the course in the autumn semester 2020/2021, with approximately 35-37 students actively using the Moodle platform. To verify the results of the research, the research was also implemented in the autumn semester 2021, when some curricular elements were developed to optimise the course content. In the autumn semester 2021/2022, 32 students took the course, of which 26-27 students completed the tests related to the course materials. Of the students who took the course, 63.9% were female and 36.1% male in 2020 and 80% were female and 20% male in 2021. Looking at the age distribution of the students, most participants were born after the mid-1990s, so we can speak of Generation Z. (Figure 2) Geographically, about 70% of the students in both years came from a major city (Figure 3).

Figure 2: Distribution of students' year of birth (N= 67)



Source: own editing

Figure 3: Distribution of students' year of birth (N= 67)



	2020	20211
city	43,24%	46,67%
county town	27,03%	20,00%
village	29,73%	26,67%
capital city	0,00%	6,67%

Source: own editing

A good measure of students' future progress can be the analysis of the existence of exams related to previous IT knowledge. In 2020, 31.25% of students graduated at intermediate level and 3% at advanced level in IT. In 2021, there were no students graduating at advanced level, and 35.29% of students at intermediate level passed the maturity exam. In addition, 11% of students in 2020 and 8% in 2021 were ECDL certified. This shows that about 2/3 of the students on the course do not have a previous knowledge exam. Although having a final exam certificate and knowledge of the ECDL modules provides a good basis for IT knowledge, it does not cover all areas of digital competence, so for these students it is necessary to deepen their previous knowledge and orient them further.

The students on the Computer Science course learned the theoretical material through self-paced learning in the Moodle LMS. The framework consisted of 6 learning units, each consisting of 4 lessons. The 4 lessons were delivered in 4 different curricular structures, some parts of the curricula were available in a specific Moodle lesson, others were supported by video and images. In addition, the curriculum included embedded digital literacy elements, mainly in the areas of information and data management, digital content production and communication digital literacy. Completion of the subject consisted of the acquisition of theoretical and practical knowledge, but this study focuses only on the online learning materials and their development. The study of the effectiveness of the course materials uploaded on Moodle was based on the results of test assignments, the analysis of student scores and the analysis of a questionnaire completed by the students.

The first step in designing and developing the course was to define the IT type of the course. This is necessary because the methods used need to be distinctly different across the types of courses and disciplines within the field of informatics. Determining which category the course we are teaching falls into will help us to use methods and software to effectively transfer knowledge to students. The following three types of courses can be clearly distinguished: a theoretical-focused course, an applied IT-focused course with software requirements and applied IT-focused course with hardware requirements. It can be said that a complex curriculum management and learning support platform is needed where both teaching and learning can take place. Ideally, software should be able to use e-learning materials, video-conferencing, digital collaboration tools, student accountability, competence development and activity enhancement, and gamification. For all courses, it is important to provide students with the required literature or course material online. Ideally, this should be an optimised, interactive courseware in a dedicated LMS system with different learning paths for the students. In addition, each course has elements that are specific and require discipline-specific support environments and software. This includes whether virtualisation is required, whether the specific need can be addressed using a browser, and whether a free software solution is available for the specific subject.

The special feature of this Computer Science course is that it does not focus on any one sub-field within computer science (such as networks, database management, operating systems), but gives a broader view of the discipline of computer science, starting with a historical overview, practical aspects and including a presentation of future trends.

As the theoretical part of the course is very complex, covering a wide range of IT topics, the different elements of the course have been structured in different ways. As already mentioned, the theoretical knowledge of the course was delivered in the Moodle framework, using several different types of course materials. In addition to text, image and video content, this platform allows the integration of different quizzes, questionnaires and interactive learning elements to facilitate the understanding of the course material. In addition, these tools can also help students to develop their competences.

The aim of the course is to provide students with an understanding of IT and computer science that will enable them to become more comfortable with different IT problems and systems, more confident in using them and more motivated to consume this content, which, as mentioned above, will be essential in many areas of their daily lives.

Online learning support systems provide a range of tools to increase student motivation and improve the effectiveness of learning materials in online courses. When adapting course content, it is necessary to consider the characteristics, prior competences and skills of the target audience, in addition to the examination of the course content. To determine these characteristics, at the beginning of the course, students completed a questionnaire in which they indicated their digital competences, their confidence, their practice in different areas of digital competence, and various demographic information. Data on students' competency levels have been presented in a previous study (Kovács, 2021).

The computer science course studied was taken by first-year university students with a graduation, 90% of whom were Generation Z students. Students are characterised by a high ICT tool usage and confidence in using ICT tools, but a lack of interest or a complete lack of interest in IT at a deeper level. (It should be noted here that digital competence as an umbrella concept is not just one competence, but a set of interrelated competences. The students tested had a high level of competence in some competences at the beginning of the semester, but in other competences there were gaps.)

In the following, three different types of learning materials are presented, which have been used to develop the already existing online learning content with a theoretical focus. The course materials were developed based on student feedback received during the first semester, student outcomes, and suggestions from the literature. The development of the course materials focused on the adaptation of course elements that were largely text-oriented during the first semester and those that integrated several different types of media and that, based on student feedback, contained too many different types of information and were difficult for students to process.

The study presents, in a non-exhaustive way, an improved curricular content for each type of content and the related results. To evaluate the results, the results of the tests related to the curriculum and the end-of-semester evaluation questionnaire completed by the students were used. Students were asked to rate the units of the course material, both individually and, on a Linert scale of 1 to 5, based on usefulness, interest, well-structured content, and followability. In addition to this, we also looked specifically at which elements of the curriculum were particularly popular with students and what they were not satisfied with. The following types of content were used/created in the enhanced learning materials: interactive content, short animated videos; infographics; and H5P interactive curriculum content.

Interactive content, short animated videos

In the case of Generation Z students, longer videos (often over 10 minutes) often fail to achieve the desired results. Generation Z young people have good attention-splitting skills but find it difficult to use them in the learning process. Their average attention span has decreased from 12 seconds to 8 seconds compared to previous generations (Mládková, 2017).

However, short videos lasting a few minutes (2-3 minutes) can be very useful to arouse students' interest in a given topic, which in some animated version can increase their interest in the learning material and increase motivation by appealing to more of their senses. Such videos have been used in a few cases in the case of learning materials produced on Moodle. A Moodle lesson type learning material has been created for each unit, where each unit is complemented by a series of quizzes. The first part of each of these lessons contained a short video, which drew the students' attention to interesting facts and information about the given subject.

Figure 4: Fundamentals of Networking, the first introductory video of the Moodle lesson type curriculum of the Internet unit on Moodle

Source: own editing

Figure 4 shows the first introductory video of the Moodle lesson type of the Internet Basics courseware unit in the Moodle interface. The integrated video presents an activity that plays a key role in the students' daily lives, integrating information that is fundamental to the curriculum unit (networks, internet), yet little encountered by the students before. The video is 4 minutes long and aims to arouse the students' interest in the deep layers of the topic.

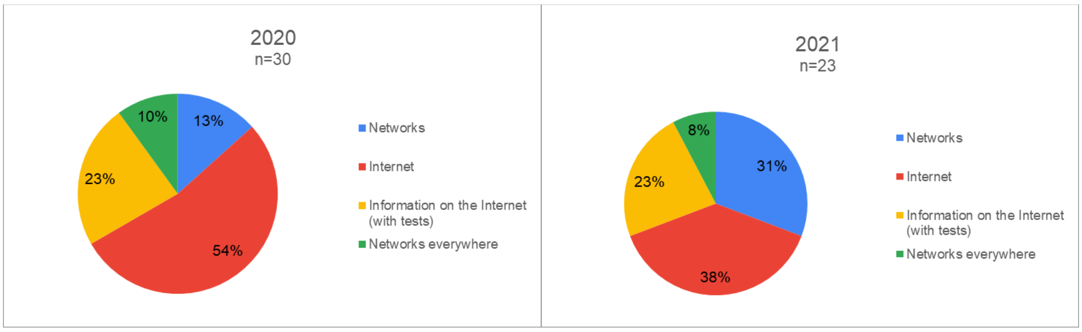
In addition to this, the students were shown a 4-minute TED-Ed video on how the World Wide Web works in the second lesson of the curriculum.

“TED-Ed — TED's youth and education initiative — aims to spark and celebrate the ideas and knowledge-sharing of teachers and students around the world The TED-Ed project — TED's education initiative — makes short video lessons worth sharing, aimed at educators and students. Within TED-Ed’s growing library of lessons, you will find carefully curated educational videos, many of which are collaborations between educators and animators nominated through the TED-Ed platform.” (TED, n.d.)

The TED-Ed videos include animated videos on a range of topics related to our own field, or we can create our own. The creation of these types of videos requires a large investment of time and a high level of competence in video and animation software, so in many cases it is useful to use existing videos available as OER (Open Access Resources). In such cases, however, we need to monitor the life cycle of the videos to see if they are still available to students at the external source site or url. In the case of videos in foreign languages, it should be ensured that subtitles are available for the video so that the foreign language text does not hinder the understanding of the text.

In response to the question "Which of the following units did you like the most?", the students who took the course chose the two video units (“Information on the Internet” and “Internet”) shown in Figure 8, in both 2020 and 2021, by the highest percentage:

Figure 5: The effect of course units containing short animated videos on students



Source: own editing

In the year 2021, the effectiveness of these teaching materials decreased slightly, but as we can read below, these teaching materials already contained improved teaching materials, such as infographics and H5P teaching materials.

Using infographics

In most cases, information is delivered through a combination of different media elements on an online platform. In addition to textual information, a variety of illustrated content is used to effectively convey knowledge. These can be photos, graphs or infographics related to the topic. Infographics "belong to the broader field of visualisation, i.e. they make things that are not self-evidently visible visually perceptible" (Barátiné Sipos, 2021). Its aim is not (only) to please the eye, but to see deeper into a set of data. It is a tool for analysis, communication and understanding (Cairo, 2012).

Several attempts have been made to define the term infographics, but for the purposes of our research, the following definition most fully captures the concept of this media element: "the transformation of an already created information file, typically consisting of data, numerical series, statistical raw material or formalizable units of knowledge, into a form that makes understanding easier and faster and the recognition of key relationships possible." (Csatlós, et.al, 2011)

Based on Pavio's 1970 theory of Dual Coding, when processing information, memory uses two separate but related codes, one verbal and one visual. According to this, when both verbal and non-verbal elements are used to transfer knowledge, more brain activity takes place, making it easier to retain newly acquired knowledge (Csatlós, et.al. 2011).

In all cases, an infographic is made up of three main elements: data and information, the message to be conveyed, and some graphic element to support the knowledge and help the listener to absorb the information.

Heber define infographics as a visual medium that is informative, has a meaning-filtering quality, is produced in a comprehensible form, is memorable, aids comprehension, strikes a balance between a lot of information and a little information, and is produced in an ethical way (Heber, 2018).

Ritchie, in his typification of infographics in 2020, distinguishes three types of infographics, such as data visualization, information model and editorial infographics. In terms of content type, Adams (2011) distinguishes causal, chronological, quantitative, directional, product-specific infographics.

Adams categorises infographics along this static-dynamic axis (static, dynamic, interactive), where the degree of user involvement varies, but classically, an infographic is considered as a content element produced in a static form.

In LMS systems, to increase the efficiency of the information related to our course, we can use infographics, be it data visualization or information model type graphics, where we put different concepts, processes, hierarchies, chronological type data in a graphical form.

In his 2013 study, Cs. Péntek writes about the role of infographics in scientific communication and defines the following types in terms of content and way of data presentation: data visualisation, process or explanatory diagram, map or poster type or complex infographics.

The production of infographics requires additional competences on the part of the creator, such as visual vision, the ability to use graphics software, the ability to condense information into an effective form.

There are several free online software (Canva, pictochart, Venngage, Visme, Infogram, etc.) which include built-in templates that can be used to create most types of infographics

Within our own educational/research field, the first step is to determine the purpose of the infographic, what type of information we want to display, whether it is for data visualisation, to illustrate certain processes or phenomena, or to supplement the text-based learning material. Within the framework of the computer science course, Adams' typology has been used to create and integrate infographics of a causal and chronological type. These were presented (see Péntek) in the form of flow or explanatory diagrams, posters and composite infographics. The figure below shows an infographic illustrating the computing tools used in the history of computing for the 'Before the spread of computers' section of the curriculum, which presents and illustrates each tool in chronological order. The infographic is presented in addition to the textual content, with a more detailed description of each tool and a verbal explanation of one of the calculation methods. There were two test questions related to the completion of the unit, which caused difficulties for students in the 2020 school year, hence the infographic.

Table 1: History of Computer Science test questions

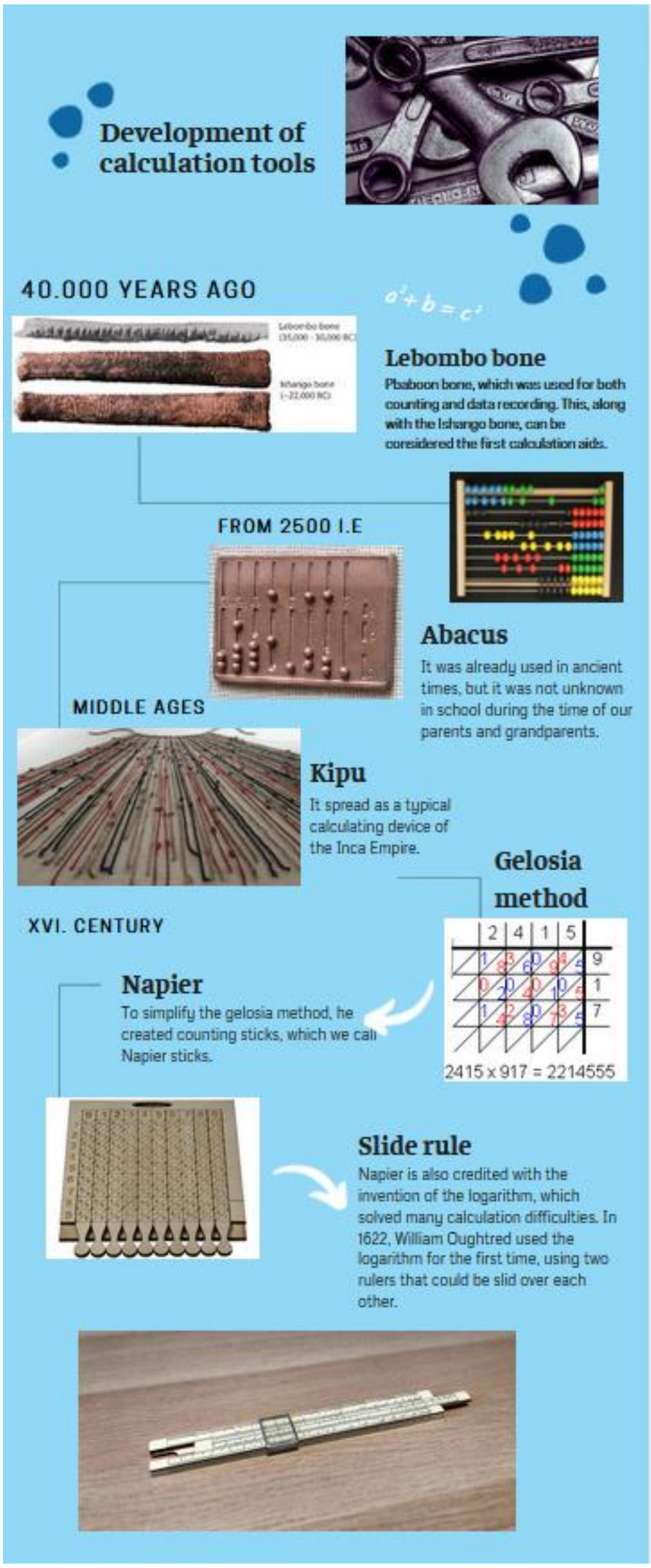
Question 3: Put the following tools and methods in ascending order of when they were first used. * logarithm * Lebombo bone * Napier sticks * abacus * Gelosia method
Question 4: Which of the following people is credited with inventing the logarithm?

Source: own editing

The above questions cover the time dimension of the unit in a complex way, and the success rate of the answers to question 4 was the lowest in the previous semester. For question 4, 40% of students answered correctly in 2020, while for the other questions almost 95% of students answered correctly, the standard deviation of the scores for this question was 0.3 but based on the 2021 results the standard deviation has decreased to 0.2.

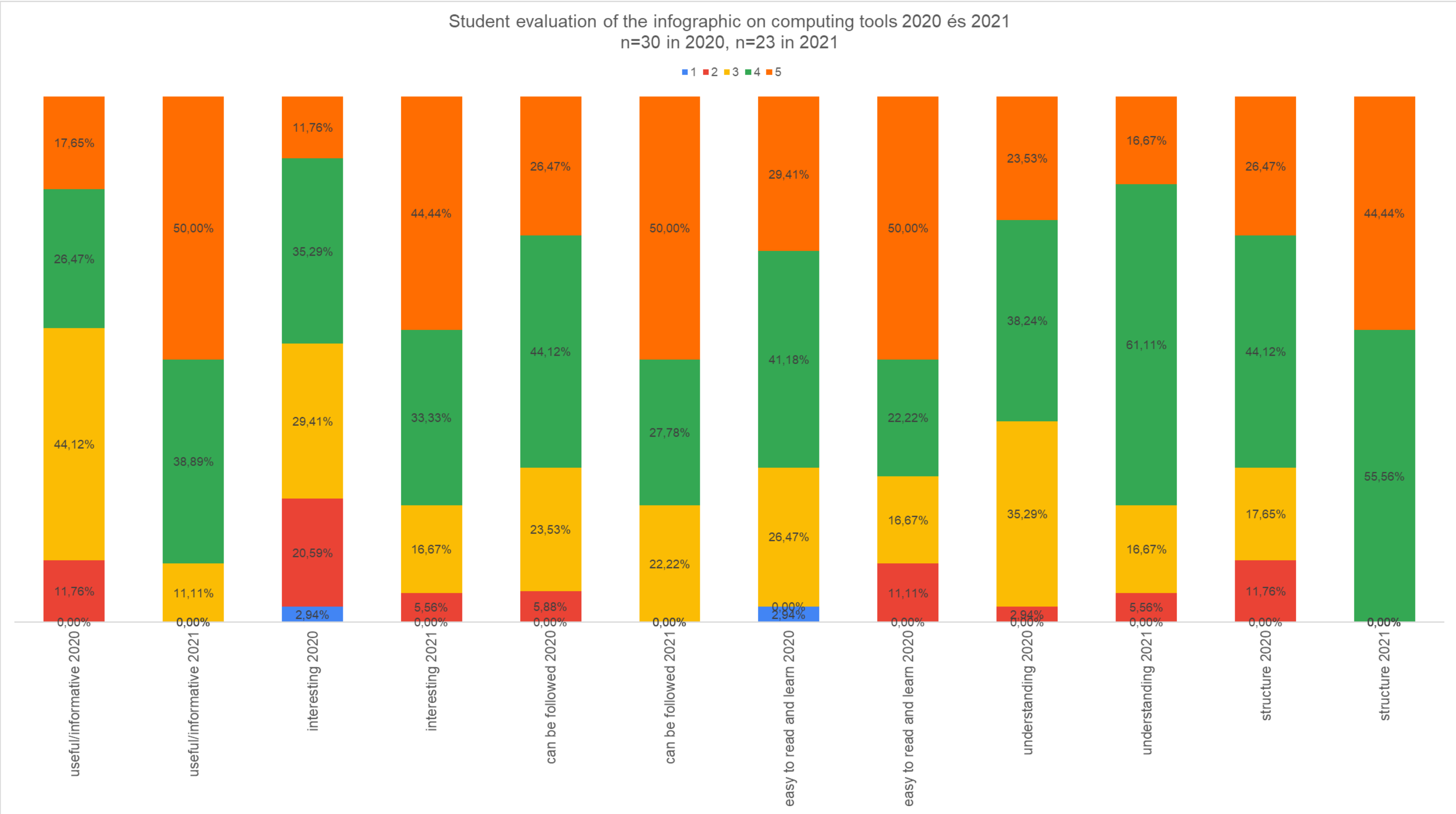
The students were also given a more complex task related to the topic, where they had to search for credible and relevant information on a topic related to the course content. For this question, the percentage of students achieving the maximum score also increased slightly from 60 to 62% and the standard deviation of the scores decreased from 0.46 to 0.38.

Figure 6: Computing tools infographics



Source: own editing

Figure 7: Student evaluation of an infographic on computing tools



Source: own editing

Based on the students' evaluations, the complete curriculum has also improved compared to the first semester of the 2020 academic year, with more than two thirds of the respondents giving a 4 or 5 in all aspects (useful/informative, interesting, well-structured, easy to follow, understandable).

H5P

The H5P content is based on the latest version of HTML (Hypertext Markup Language), HTML5, and can be used to create responsive, mobile-optimised content, with the added benefit that students will get the same content experience whatever type of ICT device (smartphone, tablet, laptop, personal computer) they use to access the content. The H5P plugin can be integrated into any Moodle system and allows curriculum creators to create content such as interactive videos, interactive books, presentations, interactive quizzes.

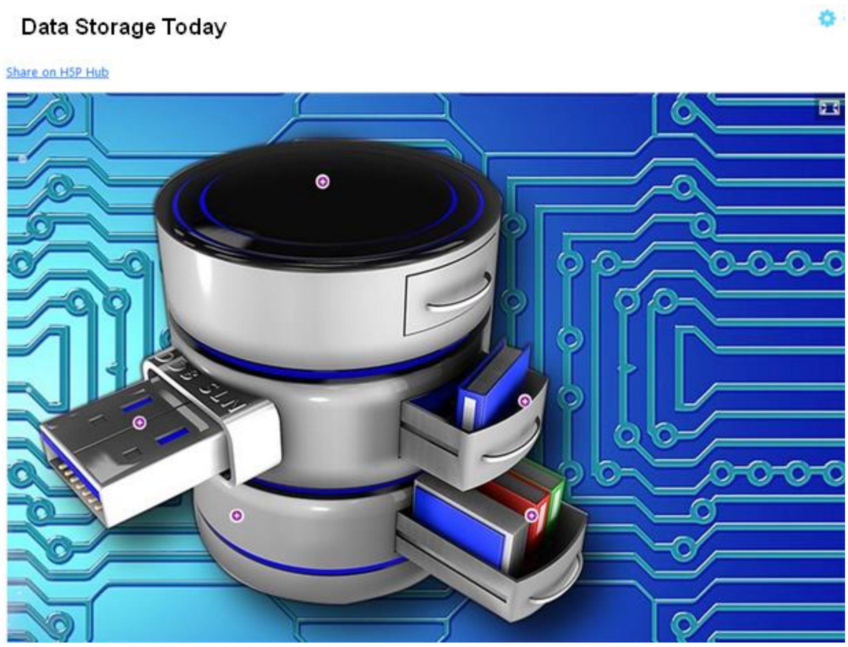
"H5P makes it easy to create, share and reuse HTML5 content and applications. H5P empowers everyone to create rich and interactive web experiences more efficiently - all you need is a web browser and a web site with an H5P plugin." (H5P, n.d.)

Several H5P contents have been created within the IT course, one of them being an "image hotspot" type content.

The subject of the course was Data Storage Today, which aims to provide a practical overview of modern data storage options and to introduce the basic concepts and principles of data storage.

In the enhanced curriculum, the content information was placed in an H5P element, an image hotspot. This HTML5-based content type helps to reveal detailed information in the form of text, videos, images in a pop-up window when a user clicks on a hotspot. With image hotspots, we can create more interactive online lessons and increase learner engagement and motivation.

Figure 8: Data storage today H5P curriculum element



Source: own editing

In this case, the image contained 5 hotspot areas. Each hotspot covered a larger topic area, where information on the topic was created by integrating text, images and short video content. Each hotspot dealt with the future evolution of data storage, partitioning, protection of data storage, data storage problems. Each of these topics is an area that students will encounter in their daily lives.

The topic assumes a higher level of computing competence than the previous two chapters of the subject, so a more interactive content will help the student to master complex areas of IT related to data storage. As in this case the content was more complex and not focused on the acquisition of a specific fact, both semesters were assessed with open-ended questions.

Data analysis was based on responses where all questions were answered, and the full test was completed. Students were awarded a maximum of 2 points per question and scored in half-point units. It can be said that the average scores did not change significantly over the two semesters studied, but in both cases the students scored very well. The average scores for the tests were 90%.

The first question was the most technology-oriented question: "Summarize in a few sentences what and how RAID technology can be used." This is the topic that students encounter the least in their daily lives. The other two questions appear more frequently in everyday life. What do/can you do to protect the health of your hard disk? What is partitioning, what is it used for? Based on the 2021 data, the percentage of students achieving the maximum score has not increased, however, for the first question, only 1 student did not achieve the maximum score, compared to 85% of students who were able to achieve the maximum score in the previous semester.

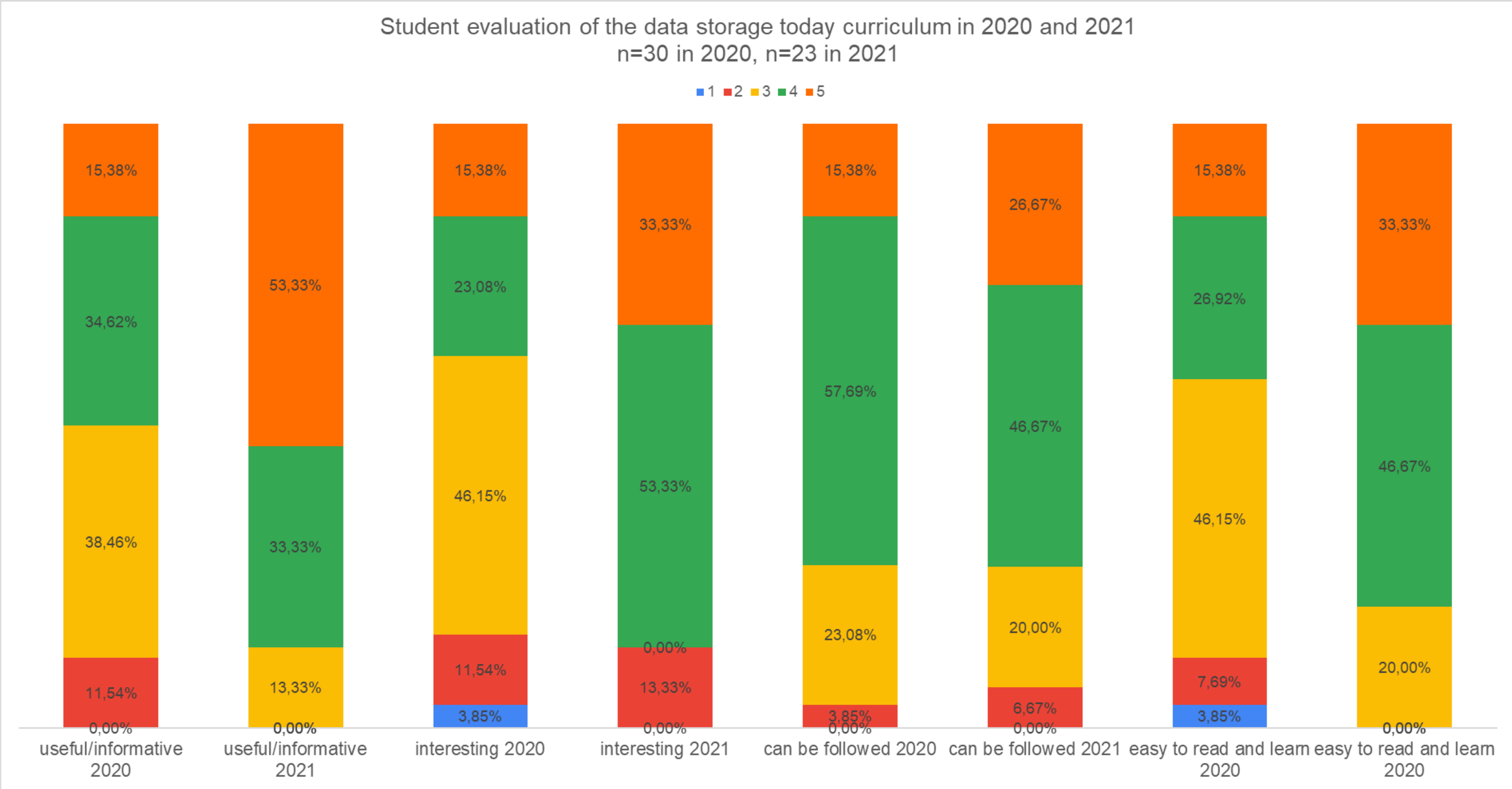
Based on the above results, we do not see significant progress in the acquisition of the curriculum, but there is an improvement in the interest and engagement of students. Based on data from the end-of-semester questionnaire.

Relevant answers to the question "Was there anything you particularly liked about the COMPLETE curriculum? Which part and what! (relevant, interesting, surprising, etc.)"

- "I liked "Data Storage Today" the most as it was very creatively solved and made it much easier for me to learn."
- "Data Storage Today course material contained a lot of interesting information."
- "I didn't know before how exactly data storage works and now I understand it better."

Students rated each curriculum element based on interest, structure, informative content, and followability. On all four criteria, the chart shows an improvement, with orange (5) and green (4) responses accounting for more than 80% of the total responses in terms of usefulness, interest, structure. The smallest change is seen in terms of comprehension, the ability to follow the curriculum, but here too the maximum score is higher, with 26% of respondents scoring the maximum score on this aspect of the curriculum, compared to 15% in 2020 (Figure 9).

Figure 9: Student evaluation of the data storage in everyday life curriculum in 2020 and 2021



Source: own editing

Summary

The field of computer science presents a very diverse picture. The body of knowledge behind it can be presented in a wide variety of formats, depending on whether you are producing a course for a professional, a layperson or even a student or teacher in another discipline. However, the various LMS systems nowadays provide us with a wealth of possibilities to make a computer science course material enjoyable even for those who are not technically inclined. The results of the research show that the acquisition of the learning material takes place in the case of "traditional" knowledge material with illustrations and text, as well as in the case of enhanced learning material. The difference can be seen in the increase of students' interest and motivation, as an interactive H5P learning material with interactive elements, interactive books, infographics or videos was more positively evaluated by first year humanities students.

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