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Universities can affect students' entrepreneurial ambitions positively. On the one hand, the increasing number of universities with business and management programmes reflects the growing level of entrepreneurial ambition among students. On the other hand, there are visible differences in terms of the proportion of male to female founding students. Based on the peer-mentoring method, action-based research was carried out with a sample of 20 female students aimed at examining whether and how formal mentorship can stimulate female students' entrepreneurial ambitions. In the findings, further explanations are provided that highlight the need for mentorship in

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influencing learning outcomes and entrepreneurial propensity, alongside its integration into higher education. The results indicate that *priority support plays an important role* in the early stage of entrepreneurial ideas, in which trust is created through openness, motivation, and commitment. These results provide sufficient evidence for mentoring programmes as viable pedagogical methods in entrepreneurship education.

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CHANG-YUN KU

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The algorithm not only amplifies every detail of human society but also has the same function as the famous nudge technique, i.e. choice architecture, which pushes people toward a certain direction while assuming it's made by their own will. By this nudge-like function of the algorithm, I want to reevaluate the long-controversial issue of the concept of nudge: is this nudge technique harmless? And if it isn't, can we still use this nudge technique even with good intention? I'll start by introducing the concepts of nudge and sludge then talk about their main issues. Third, I'll use three algorithmic examples to demonstrate the consequences of this nudge technique. Fourth, I will address the nature of the nudge technique and the meaning of intention in nudge. Fifth, I'll push the discussion further for an important philosophical issue: the white lie. Finally, I'll summarize my argument and conclude this paper.

DANIEL PAKSI

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**Innovation in an entrepreneurship course  
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based on hierarchical clustering that was applied to questionnaire data of five semesters' student responses. Results confirm the existence of these segments and that most of the students signed up on entrepreneurship courses have clear preliminary expectations of the course. The presented design framework can be generally applied in large and small classroom environments, and can also be reused as a proven case.<sup>1</sup>

**AULI VIIDALEPP**

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The interpretation of many texts in the everyday world is concerned with their truth value in relation to the reality around us. The recent publication experiments with computer-generated texts have shown that the distinction between true and false, or reality and fiction, is not always clear from the text itself. Essentially, in today's media space, one may encounter texts, videos or images that deceive the reader by displaying nonsensical content or nonexistent events, while nevertheless appearing as genuine human-produced messages. This article outlines certain problems with artificial intelligence (AI)-generated content, and frames the issue as a problem of recognising its proper referential reality. Examples include generative texts, deepfakes and their functioning in contemporary culture. The article makes use of the concepts of mimicry and nonsense to reveal the elements and counterparts in the communicative processes involving generated media.

**RICHÁRD PÉTER-SZABÓ**

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Grabbing and holding student attention was a big challenge even before the Covid-19 era; however, the coronavirus and the obligatory digital education showed that new methods are needed to resolve these issues. One of them could be implementation of digital serious games. This paper presents the findings of a questionnaire about the feelings of students toward digital serious games. In all, 1755 answers were collected and analyzed and the results showed that most students do not shy away from using these kinds of video games in a classroom environment, although there are various concerns and key aspects educational professionals must consider.

## LECTORI SALUTEM

This issue contains a special block about entrepreneurship education, with a separate foreword by Loretta Huszák and Erika Jáki (please, see the next article). The block consists of the articles by Bethlendi and Szócs; Huszák and Oborni; Kállay; Iványi and Danyi.

Moreover, the reader will find several articles originally presented at the Budapest Workshop on Philosophy and Technology. Chang-Yun Ku discusses the role and consequences of nudging in the Era of Artificial Intelligence. Dániel Paksi, in his article titled “Technological singularity by culture”, elaborates his sceptical position on the rise of machines. Auli Viidalepp shares her outstanding work on data semiotics.

Still, there was some room left for other topics. Kandonga, Ding and Yuan discuss a pressing problem connected to scientometrics: how to cite works in formats other than white papers and books? Specifically, how to cite original, ground-breaking software that contributes to science? To learn about their proposal, please read the article.

Finally, Péter-Szabó discusses a topic often touched upon in Információs Társadalom: gamification. In his article, he studies students’ feelings about serious games and shares findings that may help educators in the future.

The editorial team wishes you a pleasant reading experience.

# Bridging theory and practice in entrepreneurship education

*Foreword to the 2022/4 issue of the journal Information Society*

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Entrepreneurship has become central to business education. At the same time, companies have transformed their HR policies to hire the most creative and innovative graduates and improve their understanding of start-up ecosystems (Bureau 2018). The growing number of entrepreneurship courses in higher education is a clear sign of the need for additional and solid intellectual foundations, at both methodological and theoretical levels (Valerio et al. 2014; Fayolle 2019). Innovative teaching methods are quasi-by-products of the quantitative growth of entrepreneurship in higher education institutions, in a positive sense.

In our interpretation, the main goal of entrepreneurship education is to help increase the business knowledge of those participating in the training, which, when put into practice, can increase the success and competitiveness of newly founded or already existing organisations and can help them respond to global social needs (Volkman and Audretsch 2017). The significant growth of entrepreneurship education throughout Europe in recent decades has played an important role in the development of academic infrastructure within the discipline. The support of government institutions is crucial, and not only in terms of funding. One example is the ‘HEInnovative’ platform, co-financed by the European Union and the Organisation for Economic Co-operation and Development (OECD), where institutions can monitor their level in offering entrepreneurial programmes ([www.heinnovative.eu](http://www.heinnovative.eu)). In 2021, the European Commission published a guide to fostering entrepreneurship education (Lilischkis et al. 2021).

The effects of entrepreneurship education are also hotly debated in the entrepreneurship literature. The basis of several years of debate about the relevance of theory and practice in management education is Mintzberg’s argument, according to which ‘management is a practice that has to blend a good deal of craft (experience) with a certain amount of art (insights) and some science (analysis)’ (Mintzberg 2004, 1).

One of the key points of a research agenda for entrepreneurship education is that many important questions of entrepreneurship education are still open and require further research. Those involved in entrepreneurship education must teach with proven knowledge, validated methods and tools, in order to achieve the desired learning outcomes. Europe-based scholars have made a significant contribution to research on entrepreneurship education (Landström 2010). Among the developments, the following are particularly worth highlighting: a series of handbooks on entrepreneurship education edited by Alain Fayolle, the European Entrepreneurship Education (E3) conference organised by the European Council for Small Business and Entrepreneurship (ECSB) and the Triple E Awards, a global recognition of efforts towards the quest for entrepreneurship and engagement in higher education.

Yet, from both a theoretical and a practical point of view, the lack of literature and research on the transregional phenomenon of starting a business can be demonstrated. Specifically, we identify two key issues in entrepreneurship education: 1) What are the current evidence-based practices in entrepreneurship education? 2) What are the results of recent research activities with a focus on regional entrepreneurial activities?

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With the Danube Cup project, we attempt to combine these two perspectives. We aim to connect disciplines and (local/national) communities and to shift to a regional thinking perspective. The Danube area stretches from the Black Forest in Germany to the Black Sea at the Romanian-Ukrainian-Moldovan border and is home to 115 million people. The region is relatively fragmented and shows great disparities in wealth, job opportunities and innovation capacity. New entrepreneurs who want to survive crises and optimise the growth of their start-up need to think and act regionally, from day one. This approach means that they must plan and implement regional solutions that are fully relevant not only in the local, national market but also in the surrounding countries. This is the only way they can overcome the difficulties caused by fragmented and small domestic markets.

### *Purpose of the thematic block*

The inspiration for this thematic block came from the first Danube Cup Conference, organised in 2022 by the Corvinus University of Budapest and the Faculty of Social Sciences at the Budapest University of Technology and Economics. The conference was set to highlight the trends in entrepreneurship/start-up education, to share experiences and knowledge and point out applied measures that can be implemented at other HE institutions (Jáki and Huszák 2022). The international conference aimed to support the dissemination of best practice entrepreneurship education methods and relevant high-quality research. Consequently, contributions from both the academic and the practitioner communities - using a range of scientific approaches, presenting the latest innovations and achievements in entrepreneurship/start-up education - have been accepted in many entrepreneurship education-related topics, and published in present thematic block and in two more academic journals (Huszák and Jáki 2022; Jáki and Huszák 2023). Contributions presenting methodological developments and real case studies were particularly welcome. All contributions were peer-reviewed and accepted based on the originality of the work, relevance to the conference theme and overall quality.

A total of 31 abstracts were sent for the Danube Cup 2022 international conference with participants from Austria, Germany, Poland, Serbia, Moldova, the Netherlands and the United Kingdom. Of these, 27 abstracts were accepted by the Danube Cup Scientific Committee. During the conference, the participants were inspired to try new approaches, as well as to participate more innovatively in the teaching and research of entrepreneurship-related skills and topics, thereby maximising the impact of their work and taking it to a higher level.

Entrepreneurship education is often focused on the local context, mainly due to the lack of international perspectives, connections and knowledge of the stakeholders. Contextualising the local and international conditions is crucial in entrepreneurship education, especially if international growth and the development of students' international entrepreneurship competencies are the goal. The available research data (Pimpa 2020) indicate that the integration of experiences, practices

and processes gained in a cross-border environment into the educational processes at home helps to achieve transnational professional results.

With the Danube Cup project, a regional community of university lecturers and researchers who consider the topic to be close to their heart was created. The common goal of cooperating educators, researchers and staff of technology transfer or entrepreneurship offices is to help improve the international success rate of new ventures founded by university students by bringing together the most motivated student start-uppers from universities located along the course of the river Danube (Jáki and Huszák 2022). We hope that the community will remain active in the long term and will be able to make a lasting contribution so that the education and research of entrepreneurial knowledge and skills in the region along the Danube can continue to develop across borders.

### *Contribution of the thematic block*

The thematic block illustrates in a broader sense that entrepreneurship education is not only about drafting business plans and launching new ventures. 'It is also about creativity, innovation, and growth, a way of thinking and acting relevant to all parts of the economy and society as well as the whole surrounding ecosystem' (Wilson et al. 2009, 42). Consequently, entrepreneurship education at HEIs is not an isolated phenomenon but a continuously developing field. While a combination of lectures/practical seminars and case studies remains the dominant teaching format, experimental and hands-on learning has attracted interest among faculty (Bureau 2018). This special issue presents several such alternative, innovative teaching methods and learning approaches.

Kállay (2022) describes in his article in present thematic block an innovative teaching method for combining theoretical and practical approaches in entrepreneurship education. After reviewing the entrepreneurship education practices of several European and other higher education institutions operating in other parts of the world through the available literature, Kállay states in his study that 'in entrepreneurial education students are almost always connected to practice in some way'. Based on Kállay's research (2022) published in present special issue, the practices of university entrepreneurship education can be divided into two broad categories: 1) students must develop their own business idea, or 2) they must review and analyse the practical operation of companies by connecting with real businesses and acting in a quasi-consultant role. In relation to these, Kállay states that there is no unified, unique answer to the problem of the optimal proportion of theory and practice in entrepreneurship education. Kállay (2022) then presents the Student Generated Case Study Method, an approach developed at the Corvinus University of Budapest. The two-round educational method based on iterative problem identification and solution proposal seeks to connect and balance theory and practice in entrepreneurship education, even with a diverse group of students.

One of the main reasons why students engage at different levels in experiential entrepreneurship classes is that different students may have different expecta-

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tions, so they put different levels of effort into the foundation work and, as a result, progress at different speeds. Lagging teams and individual students may become discouraged if the lesson moves to topics that are not yet relevant to them. Other teams and motivated learners who are quick to prove a hypothesis may get bored if the lesson content stops their progress. One of the most successful solutions to this problem is to provide students with differentiated learning experiences. Iványi and Danyi (2022) analyse in their article published in present thematic block the impact of an entrepreneurship training course that has been running for several years on the entrepreneurial skills and motivation of university students, using a cross-sectional approach within the framework of difference-in-differences. The researchers classified the participating students into three categories based on their entrepreneurial motivations and expectations. There is a significant difference according to teamwork, the level of active participation in the course and the ease of obtaining a good grade. Students can choose from three curricula based on their motivation. The researchers' conclusion is that the extra work should be reflected in the grades of students who choose a more challenging and work-intensive curriculum (differentiation in grading). It should be mentioned, however, that only a very small percentage of students choose the option that involves extra work and more complex tasks.

The impact of higher education courses and programmes on students' entrepreneurial ambitions is also a topic that has been extensively analysed in literature (Fayolle 2019). In their study published in present thematic block, Huszák and Oborni (2022) correspondingly point out that the increased number of business and management programmes in higher education institutions (Valerio et al. 2014; Fayolle 2019) reflects the growing entrepreneurial ambitions of students, and that there are more and more start-ups founded by university students – not only at Stanford University but also at European HEIs (Volkman and Audretsch 2017). However, as Huszák and Oborni (2022) elaborate in their study, differences can be demonstrated in the proportion of male and female students founding start-ups. The action-based research of Huszák and Oborni (2022), based on the peer-mentoring method, examines whether formal mentoring can be integrated into university education and whether it encourages the entrepreneurial ambitions of female students. The research highlights the need for mentoring in influencing learning outcomes and entrepreneurship ambitions, as well as the critical conditions for integrating the mentorship approach into higher education. The results show that priority support, which creates trust through openness, motivation and commitment, plays an important role at the early stage of entrepreneurial ideas. The results provide sufficient evidence that mentoring programmes are viable pedagogical methods for teaching entrepreneurship skills.

Szócs and Bethlendi's study (2022) published in present thematic block examines the geographical distribution of the most valuable start-ups ('unicorns') in recent years. They illustrate that the emergence and distribution of unicorn companies can be explained by the institutional context, with particular regard to the provision of human capital. Based on the statistical data of Crunchbase and CB Insights port databases, the authors came to the conclusion that one of the

factors behind growth is the significant amount of venture capital available in the global financial markets. The analysis shows that the USA and China account for nearly 70% of the world's unicorns. At the same time, it is also important to highlight that the UK has the most valuable start-ups, mainly in the fintech sector. Most unicorns are found in the fintech and Internet software and services sectors, but e-commerce, healthcare and AI-related developments are also dynamically developing.

The guest editors would like to thank the following people who provided continuous and high-level support in the realisation of the Danube Cup Conference and this thematic block with their invaluable work: János Vecsenyi, Pál Danyi and Dominika Kosztyó. Thank you for your advice and help. We are grateful for your support!

*Loretta Huszák, Erika Jáki*  
(Guest Editors in Chief and Reviewers)

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## Geographical and sectoral overview of the most valuable start-ups

*What factors have increased the number of unicorns globally?*

Our research aimed to identify the causes for the increase in the number of unicorn start-ups by analyzing the geographical and sectoral factors in two main online databases. The United States, with a traditionally strong innovation ecosystem, is leading the way in creating successful start-ups, but China, India and some European countries are also showing considerable results. The number of unicorns, referring to privately held start-ups worth more than \$1 billion, is significantly influenced by qualitative factors (ecosystem development) and the size of the economy (nominal GDP). Therefore, small economies (like Israel) can only be included in the top 10 unicorn countries if their ecosystem is especially developed. The global pandemic has accelerated the digital transformation in several sectors. Fintech, e-commerce, internet, software and AI services are areas where unicorns have been able to achieve significant value growth. Introducing the attributes of these start-ups can be an inspiration for students in economics courses and can serve as illustrative examples in the related curricula.

**Keywords:** *start-up, unicorn, innovation ecosystems, start-up databases*

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## 1. Introduction

This study examines the factors that have contributed to the global growth of the most valuable start-ups in recent years. The term unicorn was coined by Aileen Lee, who in a 2013 article called privately held start-ups worth more than \$1 billion “unicorns”, with the notion that start-up companies of this value are as rare around the world as the one-horned fairy-tale creatures referred to. In 2022, by contrast, the number of unicorn start-ups has exceeded 1,000 according to analyses of related databases. This growth in the number of the most valuable start-ups in such a short time raises certain questions, which we address in this research. Different conditions exist in various parts of the world for the most valuable start-ups to grow. The United States (US) has traditionally a strong background in developing innovative businesses, but China has also mobilized significant resources in recent years. There is also an exciting question about in which areas Europe can play a role alongside these two great powers, and whether the old continent can also create start-ups capable of growing internationally. Our study examines how this group of start-ups is distributed globally and what local factors help start-ups to achieve such value. We also evaluate in which sectors and areas of activity the most valuable start-ups can grow and attract investor capital. Our study assessed whether the factors identified in Rodrigues and Noronha’s research as critical to overcoming the global pandemic are also typical of the most valuable start-ups (Rodrigues and Noronha 2021). Given that these start-ups typically provide innovative digital services in areas such as Fintech (financial technology), E-commerce (online sales and services) or Edtech (education technology), their names are in most cases familiar to younger generations. The group of 1,000 start-ups to be presented can therefore also be used as an interesting example and illustrative tool for higher education courses, e.g. in finance, business valuation, management or business modelling. The novelty of our topic lies in the fact that there is still little research on the characteristics of unicorn start-ups and the factors influencing their development.

## 2. Database and literature review

When venture capitalist Aileen Lee (2013) started using the term unicorn in relation to start-ups, it was along the following definition: “US-based tech companies started since January 2003 and most recently valued at \$1 billion by private or public markets” (Lee 2013). The Cowboy Ventures team, founded by Lee, was able to identify 39 unicorn start-ups based on a database of publicly available sources, such as Crunchbase and LinkedIn. According to their analysis, on average, four unicorns were born per year in the decade before 2013.

In June 2022, the Crunchbase database (also used by Lee) listed 1,350 start-up unicorns. The database includes the estimated value of the companies, the total equity funding, the lead investors and the country and continent of incorporation (Crunchbase 2022). Crunchbase was founded in 2007 as a platform to track the start-ups that parent company TechCrunch featured in its articles. Currently, it provides



intelligent prospecting software powered by live company data. Their content includes investment and funding information, the founding members and individuals in leadership positions, mergers and acquisitions, and industry trends.

The other significant online database on unicorns is linked to the CB Insights (2022) portal, which contains the following attributes: valuation (\$B), date joined the unicorn list, country and city of incorporation, industry and selected investors. The CB Insights company was founded in 2008 in New York. Their portal uses a combination of big data tools and algorithms to gather and analyze data about private companies, investors, and industries. In June 2022, the CB Insights database listed 1,164 start-up unicorns. Given that the CB Insights database contains industrial data in addition to geographic data, we relied primarily on this source in our research. The Crunchbase database was used as a secondary validation and supplement to the data. Reflecting all this, our study is a review analysis based on the databases of these two online portals, and an overview of the related literature.

The literature analysis related to unicorns is approached on the basis of the characteristics of start-ups. One of the most important values of these companies is that they are fast-growth oriented. In the related scientific literature, entrepreneurship education and international market access skills are seen as key to the survival and growth of start-ups (Csákné, Radácsi and Timár 2020). They achieve rapid growth and development with money provided by forms of financing that have no place in traditional companies (business angels, seed capital companies, crowdsourcing platforms, etc.) (Condom-Vilá 2020). These entrepreneurs are actively and constantly seeking changes or making the most appropriate strategic choices as a means of overcoming problems, leading to business success (Hormiga, Xiao and Smallbone 2018). Another important feature is that the fundamental nature of start-ups is innovation to create new products or services, which carries significant risk (Bethlendi 2019). Start-ups that are able to develop solutions that can reach global audiences in a relatively short time and with outstanding profitability are also able to create exceptional business value. Furthermore, the process of market concentration has begun over the past few years within some emerging start-up industries (Bethlendi and Szócs 2019).

Although, the term unicorn has become part of the vernacular in the start-up world, scant research has analyzed what is driving the growth of unicorn companies. It is surprising that such an important phenomenon has received almost no scholarly attention (Jinzhi and Carrick 2019). However, unicorns such as Revolut, Miro and Grammarly are impacting the daily lives and work of more and more individuals and organizations. De Massis and colleagues explain the success of unicorns by the following four common resources: (1) Their relatively small organizational size, which facilitates strategic decision-making and the implementation of quick practical measures; (2) Their founders and leaders are usually experienced entrepreneurs, who have often dealt with high-risk situations and failures; (3) They are financed by venture capital companies, which pressure them for the quick development of new products or services; (4) The innovations offered to target audiences are digital, which can reach the market leveraged by digital platforms to be widely disseminated through social networks (De Massis, Frattini and Quillico

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2016). Díaz-Santamaría and Bulchand-Gidumal identified two common success indicators: achieving significant revenue and obtaining financing. There are four factors that have a significant influence on these two ways of measuring success: the location of the start-up, the promoting partners' dedication, the age of the company, and the existence of non-promoting partners (Díaz-Santamaría and Bulchand-Gidumal 2021). Given the scarcity of literature on unicorns, it is not surprising that we could find no examples of them being used as a demonstration tool in higher education. The relationship between start-ups and universities, primarily in the context of incubation collaborations, is reflected in related research (Popov 2022; Kuznetsova 2022).

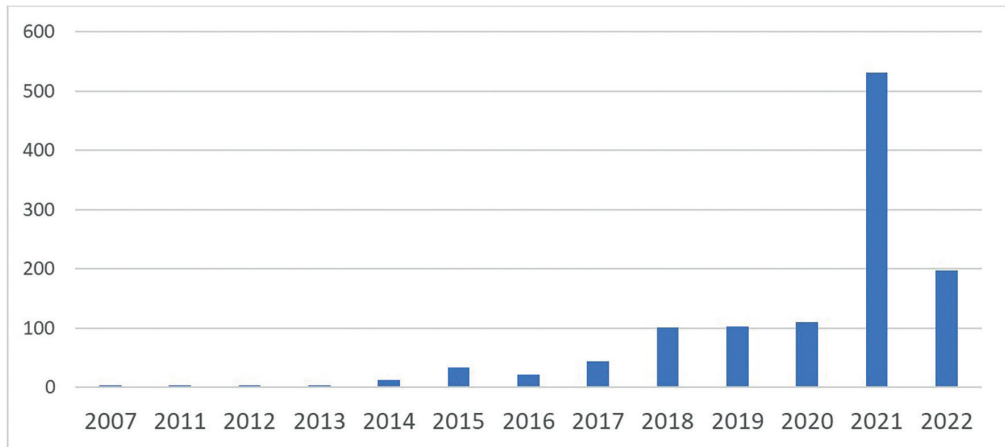
It is not yet entirely possible to evaluate the full impact of the Covid-19 pandemic. The past two years have given a boost to many digitalization-driven sectors, and unicorn start-ups have typically been able to grow in these IT-related areas. According to the research of Rodrigues and Noronha (2021), unicorns adopted business model innovation (BMI) for overcoming the effects of the crisis, by taking, at least, three new actions: the adoption of new digital platforms for communication between customers and employees; the extension of partners' networks; and adaptation for providing payment services. The adoption of new digital platforms for internal and external communication enables rapid information flows; while the extension of partners' networks contribute to the transacting costs that technology-based companies would have if they provided services that are outside the scope of their businesses; and the adaptation of providing payment services involves creating new forms of payment, the flexibilization of interest rates, and, in specific cases, credit supply for micro-entrepreneurs to keep their businesses going. So, adaptability is an essential factor for technology-based companies to explore the possibilities in different markets, and is a competence that can be refined, depending on how companies define their business models at the time of creation (Rodrigues and Noronha 2021).

The related literature mainly analyses the factors that allow unicorns to stand out from the start-up crowd. However, linked economic articles have also started to categorize unicorns in recent years: start-ups that exceed the valuation of \$10 billion are called decacorns, while the entities with a valuation over \$100 billion are hectocorns (Sharma 2021). In the context of our study, we will now look at the extent to which the number of unicorns has grown globally and how this growth has been distributed geographically and sectoral.

### **3. Factors affecting the global distribution of unicorns**

The growth in the global number of unicorn start-ups is tracked and recorded year by year by the online databases presented earlier. During the global pandemic, it was already noticeable that sectors such as e-commerce, fintech services and solutions supporting home office work, have a huge growth potential. This growth volume can also be traced in the global increase in the number of start-ups becoming

unicorns, based on the databases we analyzed, and more start-ups achieved unicorn status in 2021 than in the previous decade combined.



*Figure 1.* Number of start-ups becoming unicorns globally.  
(Source: Own edition based on CB Insights database)

One factor behind this growth is the significant volume of venture capital available in global financial markets, and especially in the US. It is also worth examining whether the traditionally strongest capital markets have seen the most significant growth in unicorn numbers.

### *3.1. Geographical overview of the unicorn start-ups*

The 1,164 unicorn start-ups included in the CB Insights database were from 49 countries in 2022. However, the top 10 unicorn “incubating” countries accounted for 88% of the most valuable start-ups. Only half of these countries are a member of the Group of Ten (G10)<sup>1</sup>. This suggests that the half of the G10 countries (most developed countries) are not supportive enough for growth start-ups in qualitative terms. These qualitative terms we call the start-up ecosystem, a particular region where entrepreneurs and supporting organizations collaborate to create new start-ups and drive the existing ones (Tripathi et al. 2019). Four of the top 10 incubating countries are among the largest developing countries, thus they are members of the Group of Twenty (G20). The only exception on the list is Israel, whose economy is too small in volume, and is therefore not included in the list of G20 countries.

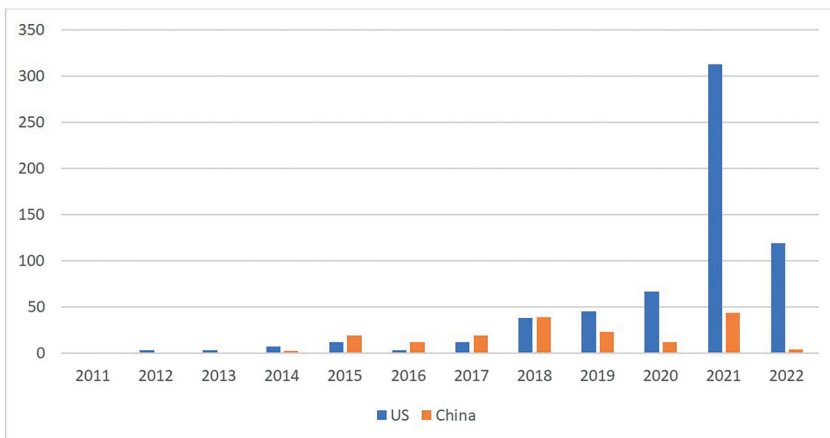
<sup>1</sup> Group of Ten consists of the eleven most developed countries. See the OECD definition: <https://stats.oecd.org/glossary/detail.asp?ID=7022>

	Number of unicorns in 2022	G10 / 20
South Korea	14	G20
Brazil	17	G20
Canada	19	G10
Israel	22	
France	25	G10
Germany	29	G10
United Kingdom	44	G10
India	67	G20
China	174	G20
United States	623	G10

*Table 1.* The top 10 incubating countries and their membership in the world's largest economies (Source: Own edition based on CB Insights, Crunchbase)

In order to compete in world markets, countries need to have the capacity to support the high rates of establishment and dissolution of start-ups (Bednarzik 2000). The success of a start-up depends on a plethora of factors. Given the rapidly growing popularity and importance of entrepreneurship around the world and the high risks associated with it, it is imperative to understand what the critical factors are for the success of a start-up (Geibel and Manickam 2017).

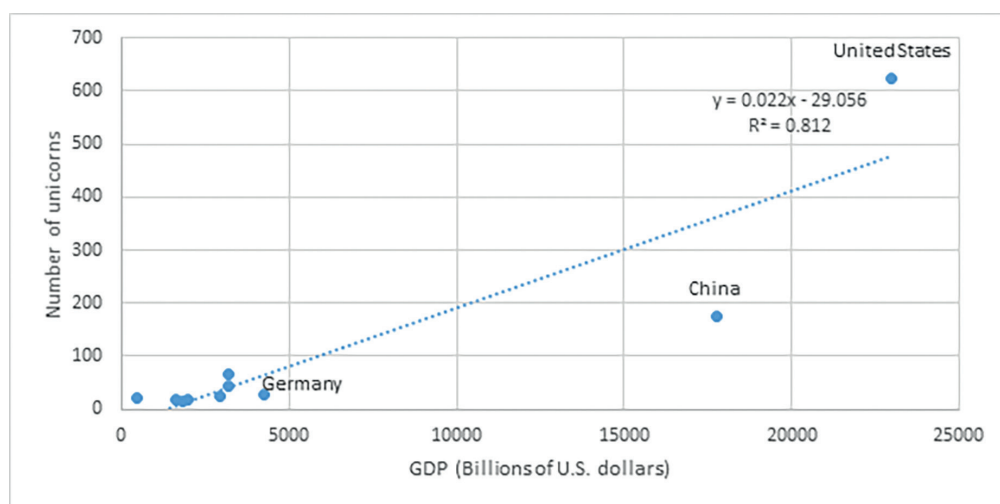
The analysis shows that the US and China account for nearly 70% of the world's unicorns. If we examine whether the most valuable start-ups from these two economic superpowers are responsible for the dynamic growth in unicorn numbers, we can observe that the steep rise can indeed mainly be attributed to the US.



*Figure 2.* Number of start-ups achieving unicorn status in the US and China (Source: Own edition based on CB Insights database)

In the following, we analyze the factors explaining the difference in the number of unicorns among the top 10 unicorn countries, i.e. those where there is a strong ecosystem for such kind of development. Four indicators were used in the analysis: nominal GDP per capita, GDP per capita based on purchasing power parity, populations, and nominal GDP. Economic development was first captured by GDP per capita. Two versions of this were used: in nominal USD (Appendix 1.) and adjusted for purchasing power parity (Appendix 2.). Both explain the unicorn number only to a modest extent. The correlation was weakened by two types of outliers in the data: the two large but not so developed economies (China and India) with many unicorns, and the US, which has the highest GDP per capita but a much larger outlier in unicorn numbers.

Consequently, the size of the market must be taken into account somehow. The simplest way is by population number (Appendix 3). This indicator can barely explain the unicorn number at all. As a kind of composite indicator of economic development and market (population) size, we can consider the nominal GDP of a country in billions of USD. This indicator can explain 81% of the difference in the number of unicorns among the top 10 unicorn countries (Figure 3.).



*Figure 3.* Nominal GDP data for the 10 countries with the largest number of unicorns (Source: Own edition based on World Economic Outlook Database, October 2022 Edition and CB Insights database 2022)

For comparison, we present the outlier G10 countries. Netherlands, Sweden, and Switzerland are successful (having developed ecosystems) at fostering unicorn development, but their economies (market) are too small, thus their numbers of unicorns have remained limited. Italy and Japan could be considered very underdeveloped in terms of their numbers of unicorns, compared with the sizes of their economy. Probably, their ecosystem is not supportive enough for growth start-ups.

	<b>Number of unicorns</b>	<b>GDP 2021 (billions of USD)</b>
Belgium	3	599
Sweden	8	636
Switzerland	6	800
Netherlands	7	1014
Italy	1	2101
Japan	6	4933

*Table 2.* The outlier G10 countries  
(Source: Own edition based on CB Insights, Crunchbase, IMF database)

It also follows from the analysis that very small economies, such as most those in Central and Eastern Europe (CEE), are only able to incubate a unicorn start-up if they have an exceptional ecosystem.<sup>2</sup> Individual factors also might play a significant role in sporadic CEE successes.

Our research also examined where the world’s leading start-up ecosystems are located. Currently the US ranks as the number one place, which provides the most conducive environment for entrepreneurs (Nisen 2013). According to the report of the StartupBlink online portal, 9 out of the Top 25 Global Ecosystem Cities are from the US, including the San Francisco Bay Area, New York, Boston Area, Los Angeles Area, Seattle, Washington DC Area, Austin, San Diego, and Chicago (StartupBlink 2022). Based on our database, four of the ten largest unicorn incubator cities (San Francisco, New York, Boston, Palo Alto) are also in the US, followed by Beijing, Shanghai, Bengaluru and three European capitals (London, Berlin, Paris). Large-scale exits, especially unicorn exits are among the most important drivers of start-up ecosystem development also for countries with small-scale economies (Prohorovs 2020). According to another global ranking, five of the top ten ecosystems in the world are in the US and two are in China, and the remaining three are in London, Tel Aviv and Seoul (Startupgenome 2022). It can be observed that start-up ecosystems have a positive impact on the development of unicorn start-ups.

Our study also assessed the role of available funding instruments. According to the related analysis, the global venture investment in 2021 was more than tenfold that of 2012 (Teare 2022). The NVCA Venture Monitor report also reviewed the US venture capital (VC) investment in 2021 and settled at \$329.8 billion, which nearly doubled 2020’s total of \$166.6 billion. VC mega-deals (deals sized \$100 million or larger) recorded an exceptionally robust 2021, driving \$190.8 billion in deal value (PitchBook 2021). The global capital abundance in 2021 therefore also created a favourable environment for unicorns to grow.

The databases we analyzed also provide a snapshot of the market value of the unicorns we study. As of June 2022, China’s Bytedance tops the list of unicorns, with

<sup>2</sup> Probably the Baltic ones: the very small Estonia and Lithuania have 2–2 unicorns.

a value of \$140 billion, compared to Revolut at number 10, worth \$33 billion. Across the more than 1,000 unicorn start-ups surveyed, the average value was \$3.29 billion, with a median value of \$1.6 billion. The average value of the total unicorn population is in line with the average value of unicorns in the US and China due to their high proportion. However, it is also important to point out that, on average, the United Kingdom has the most valuable start-ups of the top 10 unicorn incubating countries. In the UK, almost half of the most valuable start-ups are related to the fintech sectors.

Country	Average value of unicorns (B\$)
United Kingdom	4,44
US	3,28
China	3,09
India	2,94
Germany	2,59
Canada	2,59
Brazil	2,36
France	2,28
South Korea	2,15
Israel	2,12

*Table 3.* Average value of unicorns in the top 10 incubating countries (Source: Own edition based on CB Insights and Crunchbase database in 2022)

Of the nearly 1,000 unicorns we surveyed, 272 had a market value of \$1 billion, and more than 50% (139) of these start-ups achieved unicorn status in 2021. It is important to note that the database of unicorns is not a static set, but a list where start-ups typically enter at the \$1 billion level and then move forward, and where, for example, an IPO is the end of the unicorn status. The original unicorn list compiled by Lee in 2013 also included a number of companies that have since either gone public or been acquired (e.g. Facebook, Twitter, YouTube).

To better understand the explosion in the number of unicorns, it is important to analyze the sectors and industries in which they have been able to add value. Online payments, e-commerce and cybersecurity services have been brought to the forefront by the global pandemic shutdowns. Therefore, the next step of our study was to review the sectors in which start-ups globally were able to achieve unicorn status.

### *3.2. Sector overview of the unicorn start-ups*

Within our database, we categorized the unicorns we surveyed into 14 main sectoral groups. Globally, in 2021, fintech, internet and software services, e-commerce,

health and Artificial Intelligence (AI) were the areas where most start-ups achieved the unicorn ranking. The US accounted for more than 50% of the new unicorns in four of the five categories analyzed (Figure 4.). The only exception to this pattern was e-commerce, where the US accounted for 29.8% of new unicorns, while India and France accounted for 21.3% and 8.5% of the three largest contributors, respectively.

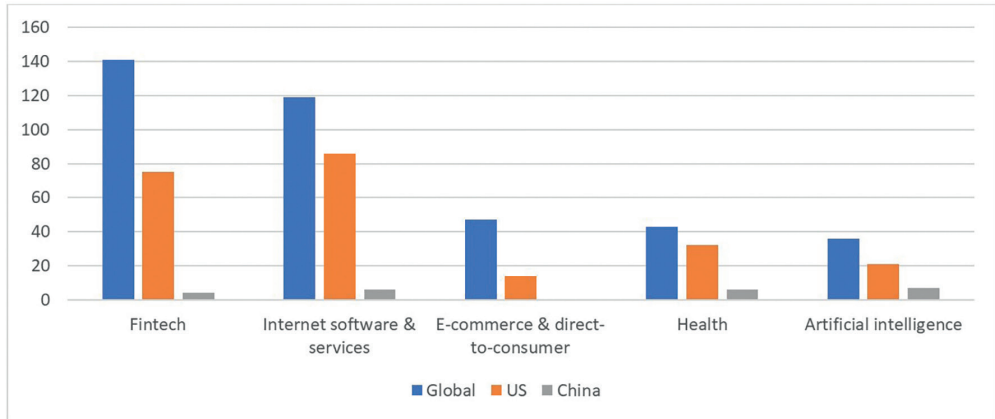


Figure 4. Sectors in which most start-ups achieved unicorn status in 2021, globally, in the US and China (Source: Own edition based on CB Insights database)

In Europe, the UK still traditionally has an ecosystem that supports the development of start-ups, and 71% of the unicorns based in London are from the fintech sector. Among European countries, even in Berlin, Germany, unicorns have found a favourable environment for growth, with e-commerce being the fastest growing topic alongside fintech. France is the third largest player in Europe, with start-ups excelling mainly also in e-commerce and fintech services. So, the European unicorns have notably been able to play a leading role in the digitization of finance and commerce.

When Lee compiled the first unicorn list in 2013, it included “start-up” companies such as Instagram, Waze, YouTube, Uber, LinkedIn and Facebook. Today, these companies have become global digital “utility providers”. Therefore, it is important to see that the significant number of unicorns in the US today will have a strong influence on the companies and services we will likely use in a 10-year perspective.

The entrepreneurship literature does not have a specific guideline for dealing with the unique situation caused by the pandemic (Rodrigues and Noronha 2021). Such events are rare and have a very diverse impact on businesses in different sectors. The high negative impact of the crisis on start-ups’ businesses worldwide has caused 70% of these companies to terminate employment contracts, leaving them with operational resources just sufficient to face the crisis for a few more months, as of July 2020 (Barbulescu et al. 2021). But we also witnessed, that unicorns are able to respond dynamically to adversity, especially because they can adapt BMI for making specific digital innovations as solutions to meet market needs quickly. This is because their business model is typically built around a single digital platform or



software, which is very fast and cheap to develop and promote (De Massis, Frattini and Quillico 2016). If a firm is digitally mature, it can accelerate the transition into digitalization. Companies that have a low level of digital maturity and problems of liquidity can digitalize only sales to achieve revenues and get closer to the consumer. Finally, companies with a limited level of digital maturity and high social capital can seek partners with excellent digital resources, such as unicorns, to develop partnerships (Priyono, Moin and Putri 2020).

The fastest growing sectors identified by our dataset analysis are closely related to the factors identified in Rodrigues and Noronha's research mentioned earlier (1. the adoption of new digital platforms; 2. The extension of partners' networks; 3. and adaptation for providing payment services) (Rodrigues and Noronha 2021).

Internet software, e-commerce or health service providers typically supply their customers via a digital platform or provide payment services, as in the case of fintech. Furthermore, AI providers offer solutions for managing the increasing amount of data generated by the operation of these platforms.

Partnerships are also an essential requirement for the fastest growing unicorn-dominated sectors. Fintech start-ups are both competing and collaborating with traditional financial institutions. According to the research of Brummer and Yadaw, the complementarity of fintech services in relation to banking products and access to the customer base of banks has enabled fintech start-ups to create innovative supply chains for fintech products (Brummer and Yadaw 2019). E-commerce services are also unimaginable without distributor partnerships or healthcare platforms without medical service partners.

The adaptation of payment services and openness to new solutions are now a precondition for ensuring a global presence. As unicorn start-ups become global service providers in more and more areas, it will become increasingly important to be able to pay for their services seamlessly from anywhere in the world. After all, it is now natural to transfer money using Revolut, order a taxi with Bolt, and buy clothes on SHEIN. All of these factors had an important role in growth before the emergence of the Covid-19 virus, but the closures since the pandemic have created an extraordinary situation worldwide that has amplified their effects.

At the beginning of the global pandemic, investors considered unicorn start-ups to have advantages in these factors, and so the surge in investment volumes was also likely to be a flight to the front at a time when many sectors were beginning to struggle. Based on all these aspects, the global pandemic and the economic conditions it generated have had a major impact on the rapid increase in unicorn numbers.

Although data for the year 2022 were not available at the time of writing our study, it can already be predicted that the surge experienced in 2021 will not be repeated. In 2021, 532 unicorns were born that year, amounting to more than 2 per business day. By contrast, in the second quarter of 2022, a total of 87 unicorns were registered, which is just 1.4 per business day. So far, the third quarter of 2022 has seen an even more severe decline. At the current pace, only 27 start-ups will be able to achieve unicorn status by the end of the quarter. That is less than 1 unicorn birth every other working day. So, the increase in the number of unicorns in 2021 was an aggregate effect of several factors described above.

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## 4. Conclusion

To qualify as one of the world's most valuable start-ups, a company must have exceptional characteristics. Our analysis revealed that the surge in the number of unicorns in 2021 was driven by US-founded start-ups. We analyzed the factors explaining the difference in the number of unicorns among the top 10 unicorn countries. We found that the nominal GDP (a composite indicator of the economic development and size of a country) could well explain why the largest economic powers had the most unicorns. We also noted that the US has a number of cities and start-up support ecosystems that provide a framework for innovation and raising capital. So, the number of unicorns is significantly influenced by the dimension and performance (nominal GDP) and by qualitative factors (development of the ecosystems). Therefore, small economies can only be included in the top 10 unicorn countries if their ecosystem is especially developed. A good example is Israel, which, despite its small size and relatively small population, has been able to be a key contributor to the development of start-ups. At the same time, Italy and Japan could be considered as very underdeveloped in terms of their performance in incubating unicorns, compared with the sizes of their economies. Probably their ecosystem is not supportive enough for growth start-ups.

Another important factor was that in 2021, based on data to date, there was an outsized availability of venture capital funding and a significant level of deal investment volumes. It is important to highlight that China is the main challenger to the US in the fastest development industries. Its dynamic service sector and growing sources of venture capital make it an important competitor in the unicorn club. The third largest player is India, which has also been able to become a major player in important digitalization areas. From the old continent, the UK, Germany and France have been able to create an environment that is conducive to growth, particularly in fintech and e-commerce.

Our study also analyzed the sectoral background of these companies. Fintech and internet services are the two areas that give birth to the most unicorns, but e-commerce, health and AI-related developments are also growing dynamically. The outbreak of the global pandemic suddenly increased the value of all the services that could be provided to customers remotely, using online solutions. Rodrigues and Noronha's model linked business resilience to three main factors: the adoption of new digital platforms, the extension of partners' networks, and the adaptation for providing payment services. A significant number of the start-ups that became unicorns in 2021 will either provide solutions or payment services through a digital platform or serve these platforms, as in the case of AI. These circumstances have meant that the global pandemic has, for the most part, been more of a growth opportunity for start-ups that have become unicorns. This has not escaped the attention of investors. The global capital markets provided unprecedented levels of funding to enable the growth of start-ups in the sectors presented. However, an important question remains about whether these companies will be able to fulfil their hopes once the pandemic recedes. Complete data for 2022 are not yet available at the time of this study, but it is already clear that 2021 could be an exceptional year due to the factors described above.

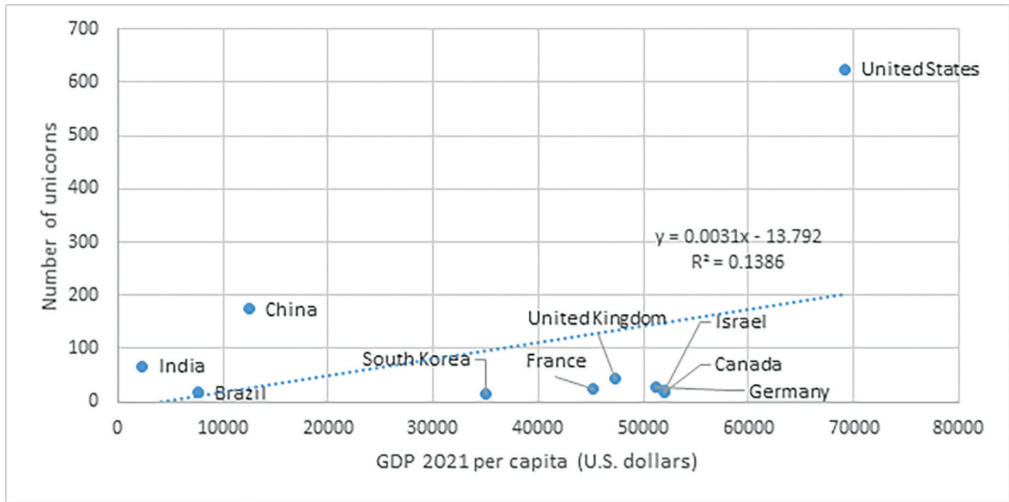
Even with all this, the growth paths and innovative business models that unicorns have presented to us make them worthy of being inspiring examples. Their products and services are increasingly being used worldwide thanks to digital transformation. All these factors also offer the opportunity to use them more as illustrative examples in higher education courses in finance and economics.

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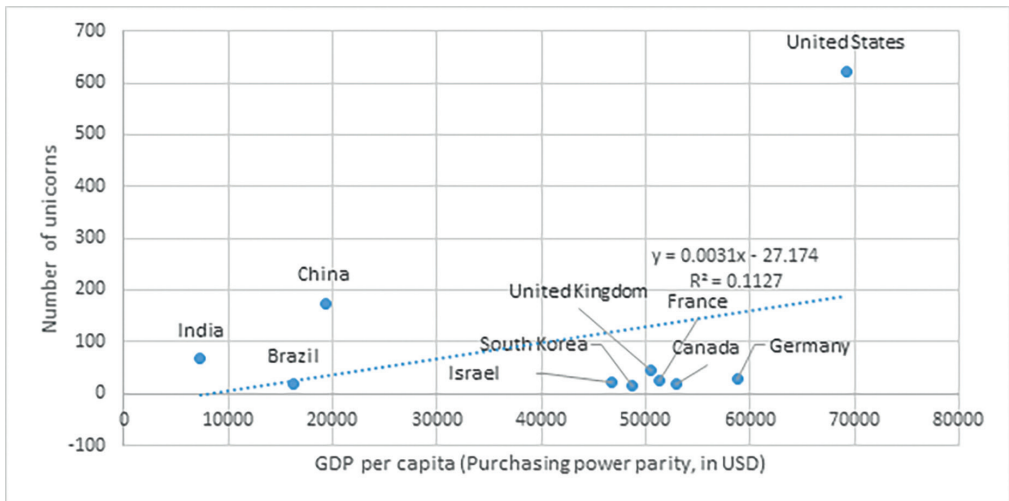
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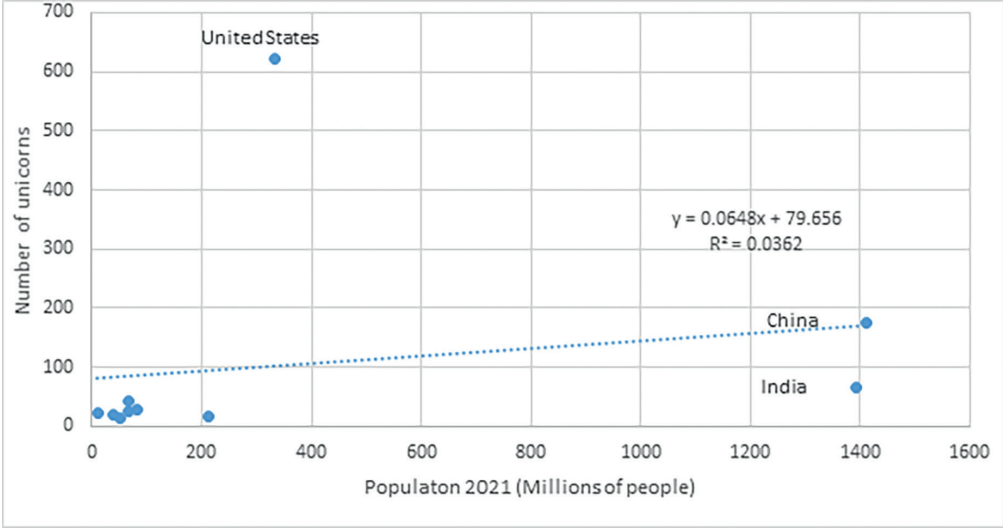
Appendix



Appendix 1. GDP per capita of the 10 countries with the largest number of unicorns. (Source: Own edition based on World Economic Outlook Database, October 2022 Edition and CB Insights database 2022)



Appendix 2. GDP per capita (purchasing power parity) of the 10 countries with the largest number of unicorns. (Source: Own edition based on World Economic Outlook Database, October 2022 Edition and CB Insights database 2022)



*Appendix 3. Populations of the 10 countries with the largest number of unicorns.*  
 (Source: Own edition based on World Economic Outlook Database, October 2022 Edition and CB Insights database 2022)

## Entrepreneurship Mentoring for Women at Universities

Universities can affect students' entrepreneurial ambitions positively. On the one hand, the increasing number of universities with business and management programmes reflects the growing level of entrepreneurial ambition among students. On the other hand, there are visible differences in terms of the proportion of male to female founding students. Based on the peer-mentoring method, action-based research was carried out with a sample of 20 female students aimed at examining whether and how formal mentorship can stimulate female students' entrepreneurial ambitions. In the findings, further explanations are provided that highlight the need for mentorship in influencing learning outcomes and entrepreneurial propensity, alongside its integration into higher education. The results indicate that *priority support plays an important role* in the early stage of entrepreneurial ideas, in which trust is created through openness, motivation, and commitment. These results provide sufficient evidence for mentoring programmes as viable pedagogical methods in entrepreneurship education.

**Keywords:** *Female Entrepreneurs, Mentoring, Early-stage Entrepreneurship, Entrepreneurship Education*

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## 1. Introduction

Innovation alongside economic development can be enhanced by entrepreneurial activities. Audretsch (2009) defines societies that understand and support entrepreneurial spirit as entrepreneurial societies. In these societies, the institutional framework has a positive attitude towards risk-taking, and entrepreneurial activities in general (Kucketz, Berger and Allmendinger 2015).

Entrepreneurship may be viewed as a phenomenological entity particular to given individuals possessing cognitive faculties associated with starting a business and running it as a going concern (Cope 2005). This may moreover be termed entrepreneurial orientation, whereby those so inclined may accept the existence of risk and uncertainty in relation to business management to a relatively greater degree than other individuals (Diamond 2012). In gender-related terms, it may be argued that there are more similarities than differences between male and female entrepreneurs concerning their traits, motivations, and success rates (Minniti 2009).

It has been suggested, however, that an individual's entrepreneurial activities are influenced by the gender factor as well as race, ethnicity, age, and education level (Cromie 1987). On such a premise, it may be argued that entrepreneurship generally tends to possess a predominantly male character due to the scale and frequency of business ownership by males (Ece 2019). Furthermore, links with universities offering entrepreneurial education have been identified as crucial to new business development (Ghio, Guerini and Rossi-Lamastra 2019). As such, secondary and tertiary educational institutions are critical for the training of successful future entrepreneurs, both male and female. As a result, recently both practitioners and scholars have paid increasing attention to entrepreneurship education, including women's entrepreneurship.

The research on women's entrepreneurship has become a thriving field in recent years. Through systematic bibliographical research, Zupic, Khandai and Fayaz (2022) identified 764 primary publications on female entrepreneurship published in academic journals. They found that while originally the research focused on a narrow set of female entrepreneurship-related questions and used data from Western contexts, today the research areas are much more diverse. Ahl's paper (2006) is one of the most influential ones on women's entrepreneurship ambitions and introduced the so-called "gender turn" in entrepreneurship research (Zupic, Khandai and Fayaz, 2022). In Ahl's view, entrepreneur and entrepreneurship are not gender-neutral concepts. Ahl's paper is a critique of the popular notion of the existence of a male-dominated ecosystem and a gendered hierarchy. Marlow and McAdam (2013) drew attention to the diversity and complexity of gender in entrepreneurship, while critically evaluating the association between gender and business performance.

Entrepreneurship ambitions and encouraging young people in entrepreneurship also have a gender dimension (Jáki and Huszák, 2022). It is a fact that female students have lower entrepreneurial intentions right after graduating, and even 5 years after graduation (Sieger et al. 2018). Instead of self-employment or engaging in a start-up, women rather prefer working in the public and corporate sectors (Geam-



başu 2019; Sieger et al. 2018; Sieger et al. 2021). Though fewer women engage in entrepreneurial activity, there has been a positive trend in the gender gap with regard to interest in entrepreneurship in the last few years (Bosma et al. 2021). The hetero-normative perception understands that entrepreneurial behaviour and capacity is a mere realisation of an individual's potential (Ahl and Marlow 2012). Considering that this perspective is still broadly accepted in research on entrepreneurship, it is essential to reveal how educational methods, especially mentorship, can support young women's entrepreneurial engagement and counteract women's limited social position and economic opportunities in the field of entrepreneurship (Huszák and Jáki, 2022).

## 2. Entrepreneurial mentoring

According to the academic literature, it can be assumed that, through the promotion of innovative ideas and the transfer of entrepreneurial competences, learning about entrepreneurship can lead to the development of new innovations and business start-ups (Man 2019; Wang, Yueh and Wen 2019). The direct result of entrepreneurship education is the acquisition of entrepreneurial skills and knowledge. In addition to professional skills, such as business management and financial planning, entrepreneurship education also promotes the development of soft and effective skills that can meet the standard criteria of a true entrepreneur (Baluku, Matagi and Otto 2020). Examples of these soft skills include self-efficacy or a boost in confidence, which are considered crucial skills, especially in the case of female entrepreneurs (St-Jean and Audet 2012; Brodie, Van Saane and Osowska 2017).

Mentorship is a type of entrepreneurial education. There is no clear consensus about the definition of mentorship. It is a complex task as mentorship describes a form of learning that has been redefined in history according to the current context (Ting, Feng and Qin 2017). Homer's *Odyssey*, an epic poem from Ancient Greece thought to date back at least 3,000 years, is frequently cited as the original source for the concept of mentoring (Colley 2010). In general, entrepreneurial mentoring covers a learning process in which an experienced professional (in the field of business) supports the development of a future or novice professional (St-Jean and Audet 2012). The mentoring process promotes the learning of future entrepreneurs in a number of ways, including through motivational training, informational support, counselling and (self)reflection. (St-Jean and Audet 2012). Through professional mentoring, above all, the attainment of important entrepreneurial outcomes are stimulated. These may include endurance and survival, cost reduction, satisfaction and psychological well-being, in addition to business management (Hägg and Politis 2015).

In their 2015 study, McKeivitt and Marshall argued that informal mentoring was a good fit for small business owners in the environment in which they operate. (McKeivitt and Marshall 2015). In our current study, first and foremost, we aimed to focus on the impacts of formal female entrepreneurship mentoring at universities in relation to starting or further developing students' own business ideas.

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In essence, mentorship is a relationship between individuals resulting from a higher purpose – proficiency in a certain field or skill – at different stages of learning (professional or personal development), in which at least one party involved needs guidance, information, networks, or all at the same time (Brodie, Van Saane and Osowska 2017). The mentor–mentee relationship allows space for professional discussions in which at least one party is interested in benefiting from the growth of the other (recruitment, talent promotion, better networking with other business partners through mutual training, etc.). General expectations resulting from mentor–mentee relationships could be summarised as follows: A mentor is a person who acts as a guide and an adviser, willing to share his or her professional knowledge and personal wisdom to younger pretenders. He or she has already achieved a certain level of success and proficiency and would like to act as a role model, one that the mentee can learn from. He or she is interested in the transfer of knowledge, experience, ideas, not to mention insights as inspiration for personal and professional development (Sullivan 2000).

A mentee, on the other hand, is someone who is less experienced and may have specific professional and personal goals that he or she wants to discuss with a more experienced and successful person. The mentee takes an active role as someone who asks for advice and guidance. The mentee must make it clear how he or she intends to benefit from the mentoring (Sullivan 2000).

Through the mentoring process, besides the informal transfer of knowledge and social capital, also work- and professional development-oriented psychosocial support can be offered for the mentees. In general, mentorship is carried out by informal communication, which is usually conducted face to face, and it covers a relatively longer timespan. In most cases, there are two parties involved in the process: the mentor who is perceived to have greater relevant knowledge, wisdom or experience, and the candidate, who is perceived to have less, i.e. the mentee.

It is surprising how little research has been carried out in terms of mentoring support for entrepreneurs in general, including female entrepreneurship (St-Jean and Audet 2012). Still, it has been highly recognised as an advantage in enhancing learning and career development in organisational contexts (e.g. Man 2019; Wang, Yueh and Wen 2019; Wei, Liu and Sha 2019). In business, formal mentoring is part of most talent management strategies used to groom key employees, newly hired graduates, high-potential employees and future leaders.

### **3. Entrepreneurial mentoring in higher education**

Regarding the role of university teaching and curricula, both the economic and entrepreneurial content and a supportive environment have a crucial role to play in engaging students and young people in entrepreneurship (Geambaşu 2019; Sieger, Fueglistaller and Zellweger 2016). The GUESSS (Global University Entrepreneurial Spirit Students' Survey) surveys regularly confirm that an entrepreneurial climate at universities, in general, had a positive stimulating effect on students' intentions to start or plan to start small businesses and to have start-up ideas or

a preference for self-employment (Sieger, Fueglistaller and Zellweger 2016; Sieger et al. 2018).

According to the Triple Helix theory, there is strong interdependence between government, academia (the university) and industry (private business). In this latter field, entrepreneurial behaviour is cultivated for the common good of all ecosystem actors (Huszák and Gittins 2021). Higher education institutions involved in entrepreneurial teaching, usually offer mentorship programmes specially dedicated to business start-up and development support for staff and students alike. During these programmes, participants learn how to convert their entrepreneurial ideas into action (Heinnovate 2018). Typically, these programmes may include:

- mentoring and coaching;
- special access to laboratory and workshop facilities within the territory of the higher education institution;
- provision to incubation facilities and to other temporary business premises;
- further aid in developing networks; and
- facilitating access to finance.

## 4. Methodology

In order to explore the feasibility and the benefits of practical training for entrepreneurship students while being a mentor, an exploratory method is needed. More specifically, the chosen methodological approach should be based on action-based research. Based on a mentoring or peer-mentoring method in a field experiment, we analysed the evolution of formal mentorship relations over time at several higher education institutions.

In our research, we were particularly interested in answering the following research questions:

- RQ1: To what extent is it reasonable to establish a mentorship programme dedicated specifically to female students as a distinct group in a university environment?
- RQ2: What needs have arisen among female students in relation to mentoring?

### 4.1. *The framework of the field experiment: the ifempower project*

The field experiment took place within the framework of the ifempower<sup>1</sup> project, co-financed by the European Union between 2018 and 2021. Ifempower aimed to empower female students to become engaged in entrepreneurship by reinforcing their skills and mindset needed for self-employment. The project addressed the

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<sup>1</sup> The partnership of the project consisted of 4 HEIs: Bifröst University (IS), Corvinus University of Budapest (HU), Sapientia Hungarian University of Transylvania (RO) and Sigmund Freud University (AT), 3 business actors: ONECO Consulting (ES), Sociedade Portuguesa de Inovação (PT), Steinbeis GmbH (DE), 1 business support organisation: Andalucía Emprnde Foundation (ES) and the Coordinator, HÉTFA (HU), a private research institute.

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lack of entrepreneurial motivation and attitude among higher education institution (HEI) students and developed creative and innovative educational resources. The partner universities developed tools useful for transforming the university environment into a more encouraging and entrepreneurship-friendly environment for female students (ifempower 2022).

Ifempower developed a mentorship and counselling concept, which strongly relies on the idea of mentorship in line with project-based learning called “The concept of Female Entrepreneurship Support Points and Mentoring” (ifempower 2022). This comprehensive concept reflects on known obstacles faced by female entrepreneurship and empowers students to successfully overcome them.

Ifempower Female Entrepreneurship Support Points, set up at eight international training institutions<sup>2</sup>, had the mission to support the creation and management of new businesses by women entrepreneurs, as well as the effective start of their activity and their development, through the provision of information services, advice, mentoring, training and business financing support. Thus, through these points, (future) women entrepreneurs would get support on the daily issues that inevitably arise while starting and/or running a business (ifempower 2022). Students visiting the support points got professional mentorship from experienced female entrepreneurs and/or university lecturers, qualified in the field of entrepreneurship education.

#### *4.2. Action-based research*

Our study used a field experiment, which aimed to investigate the relationship between the type of mentorship and the entrepreneurial activity. This experiment was conducted within the framework of action-based research.

Field experiments play an important part in furthering our understanding of gender bias. Bertrand and Duflo (2017) provide a literature review and a detailed methodological discussion of the challenges researchers might face. Action research is used in real situations, rather than in contrived, experimental studies, since its primary focus is on solving real problems (O’Brien 1993). The study was conducted in a manner similar to the process suggested by Brydon-Miller, Greenwood and Maguire (2003). One of the authors of that paper is a university lecturer.

For the research, a higher education institution ranked highest nationally in the fields of economics, management and social sciences was selected. The university is located in Central Eastern Europe, providing space for about 14,500 students altogether. Besides the bachelor’s programme, master’s and doctoral programmes are also offered here at 12 different institutes through specialisations taught in three different languages. The university recognises innovation and entrepreneurial thinking as key skills for the future. Therefore, several courses are provided for those venture-minded students who are interested in starting their own businesses.

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<sup>2</sup> Andalucía Emprende, Spain; Bifröst University, Iceland; Corvinus University of Budapest, Hungary; HÉTFA Research Institute, Hungary; Sapientia Hungarian University of Transylvania, Romania; Sigmund Freud University Vienna, Austria; Sociedade Portuguesa de Inovação, Portugal; Steinbeis Transfer Center EAST-WEST Joint-Ventures, Germany.

One of the authors participated in the development of relevant teaching modules within the framework of the ifempower project, as a PhD candidate. Through lecturing activities, the authors were able to reach out to a number of students from the business faculty – both undergraduates and postgraduates. Students were randomly called to apply for mentorship and counselling. The field experiment was promoted via social media. There was significant interest from university students wishing to participate in the field experiment and to take part in entrepreneurship/business consultation.

Before starting the mentorship programme, applicants were required to fill in a survey that included questions about their intentions regarding entrepreneurship. Further questions in the survey were related to their demographic and educational characteristics, and to behavioural culture (Appendix 2). Already in the initial stages, the students were explicitly told that the purpose of the mentoring programme was not to convince them to become future entrepreneurs, but to expose them to entrepreneurship (in general) even more and to let them decide about their own plans in how to deal with this specific business field later on. The purpose was not to convince them to become entrepreneurs. Also, they were informed that the same conditions that were present during the mentoring sessions could equally be applied to professions in the fields of government and academia, and in large companies, or non-profit organisations alike. Participants of the mentorship programme were allowed to choose between individual mentoring and coaching and sessions in groups, in which the students formed their own groups.

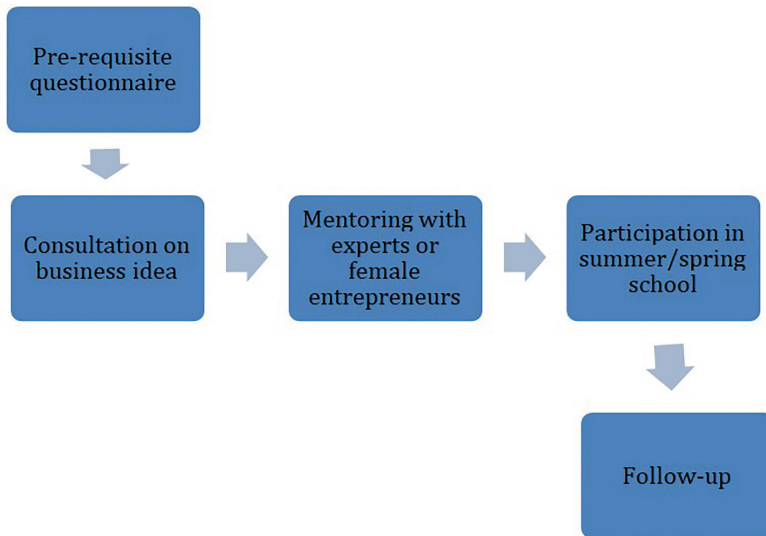


Figure 1. The course of the action-based research.  
 Source: illustration by the authors.

An innovative element of the applied mentorship and counselling programme was that it supported female students without the requirement of having to have an es-

tablished (or newly established) venture. Mentorship plays a highly important role during the early stages of one's career development with special regard to the years spent in a higher education institution. These initial or early educational stages are hallmarked by career planning and the constant search for new perspectives related to students' future work lives. Therefore, at this phase in their career, it is especially important and appropriate to learn about opportunities and personal examples, to develop their own business concepts, and to consider how to implement them. Female students were also encouraged to participate in mentoring and counselling: after active counselling, they were invited to participate at international summer or spring university programmes. Figure 1 illustrates the course of the action-based research.

### 4.3. Characteristics of the sample

The sample consisted of 20 young female students, studying business and management. Appendix 1 contains data about the descriptive statistics of the mentorship participants. The ratio of undergraduate and master's students was 30 to 70 per cent. Most female students (70 per cent of applicants) were in the 'ideation stage' (Figure 2). Generating or brainstorming a business idea is an integral part of business development. It is a creative process that involves the generation, expansion and communication of new ideas and concepts that ultimately become the basis of a business development strategy. In this early stage, the business concept is not yet mature. Business focus should relentlessly test the concept with personal advisors, potential co-founders and targeted clients or customers. Market research is an important guide at this stage and should be at the heart of the consultation.

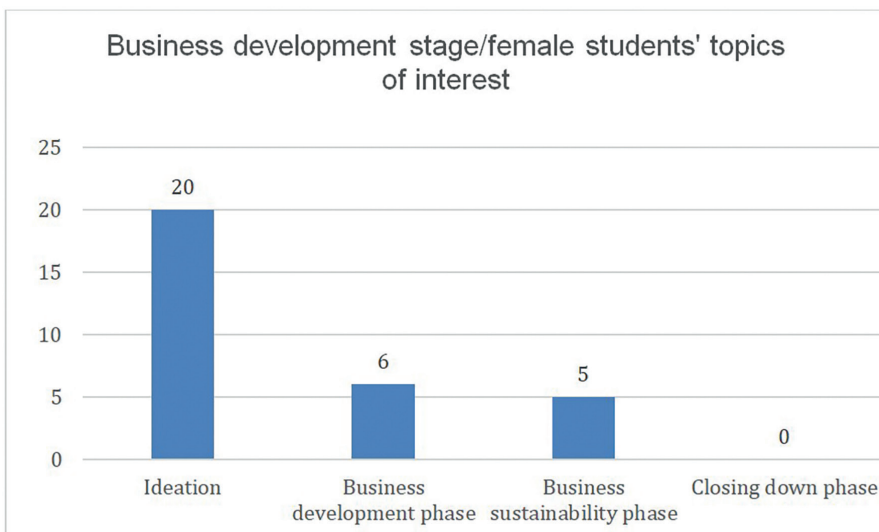


Figure 2. Female Entrepreneurship Support Point, mentoring and consultations, business ideas' development stage. (Source: illustration by the author.)  
 Note: some participants had multiple business plans or ideas.

## 5. Research results

The participants highly *valued the opportunity to participate in counselling*. Their shared experience was that even though they studied business at a university, they did not have the opportunity to talk to their lecturers about their business ideas. In the courses, there was no (or only a limited) possibility to develop their ideas, and outside of the lessons they did not feel they had a close enough relationship with their lecturers to talk about their plans, let alone to ask for help or mentorship. During the consultations, we had the impression that even filling in the application form helped the students to collect and sort out their ideas. Therefore, they were truly happy to have been given the chance to expose their ideas about their potential ventures to outside, expert ears and opinions.

From March 2020 on, in accordance with the efforts against the spread of the COVID-19 pandemic, universities switched to online education through digital channels, and no in-person classes were allowed. After March 2020, most university courses (with more than 40 registered students) were taught remotely. The 2020/2021 autumn and spring terms continued in a digital format in line with government guidelines; no educational events (courses, consultations) requiring personal attendance were permitted. Only smaller courses moved back to offline teaching in September 2020. The consequence of the measures concerning the support/info point was that much fewer students visited the university buildings, with face-to-face consultation not being feasible. Therefore, female entrepreneurship mentoring had to be launched online only. The transition from offline to online required many hours of work and a great deal of patience.

By the end of 2020, both university staff and students had got used to digital communication technologies. At this time, it was already visible that mentoring could be provided online, thus the field experiment could be carried out.

An additional challenge was to randomise participants. It was realised very early on that the target group (female students interested in starting a business) could not be reached “in the street”. Asking for business or management consultation is a matter of trust. A management consultant (in our case, the university staff offering the service) could conduct an analysis to give female students a well-thought-out recommendation on their business idea or model. However, without trust, a consultation cannot even start, because female students will not generally share their ideas or business plans with an unknown person (St-Jean and Audet 2012).

Another challenge that emerged during the consultations was the “timidity” of the female students. Female students are in general rather shy, less confident to express and share their knowledge and concerns than their male counterparts (Bosma et al. 2021). One-on-one meetings are considered to be the best way for managers and those who report to them to connect on pressing issues, develop a strong relationship and ensure that employees feel like they are working toward their goals – at the workplace and otherwise (Austrian Institute for Small Business Research 2002). Female students seem to be less self-confident and asked therefore for small group consultations. It was emphasised that they were more relaxed and open when other female students also participated in the discussions. They also had the opportunity

to learn from each other, ask questions and get feedback from each other as well. They mostly had not known each other beforehand but many of them made valuable and lasting connections at the consultations. Figure 3 illustrates the consultations, indicating the type of service:

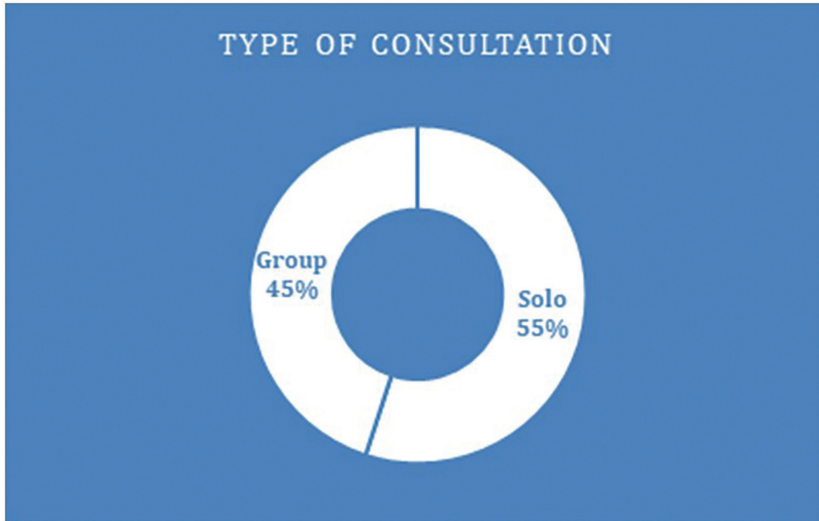


Figure 3. Female Entrepreneurship Support Point, mentoring and consultations, type of consultation, N = 20.  
Source: illustration by the authors.

As described before, the mentoring (together with preparatory tasks like submitting a short essay on their interests or business ideas) happened online. Counselling was perfectly feasible both from a professional and a technical point of view this way – nevertheless, many students found that having these meetings in person would have opened up more doors for networking, which was not possible due to the COVID-19 pandemic. Other than that, feedback from the students showed that they would have been happier if the university had provided *a series of counselling occasions instead of only one occasion*. The one conversation they had was encouraging and useful in that they could see they were suitable for an entrepreneurial life and that an own venture was not impossible for them should they take the adequate small steps towards it. However, it did not provide them with the chance to receive detailed guidance and feedback on crucial actions, like preparing the business model, or the process of validation.

Throughout the discussion of the above dissonances, the participants themselves came to the realisation that although they were all business administration students, they had a common deficiency: they had deep knowledge on businesses, but they felt they did *not have a “profession” or specific area of expertise they could turn into a venture*. Therefore, they stated they would find it helpful, if in the future, university students could work from a very early stage on their business ideas. That is,



from identifying shared concerns with other students, developing ideas and forming (maybe even interdisciplinary) teams all the way to creating a business model, which they could then pitch. Out of the 20 participants, 17 female students had local entrepreneurship ideas or were running a business, and only 3 were thinking in international terms and working on a start-up business idea (with significant growth potential). None of the participating female students found being a solopreneur (e.g. freelancer) appealing.

*Psychological development and working on awareness* were indicated by the students as a strong need and as one of the topics that business and management curricula hardly cover. They also stated that they did not have the chance to talk about some problems related to their business ideas that concerned them, which, as they found, would be useful in developing their business ideas. It is, however, possible, that all this was due to the pandemic conditions. The epidemic situation reinforced their need for psychological support, as they spent a significant portion of their time in isolation.

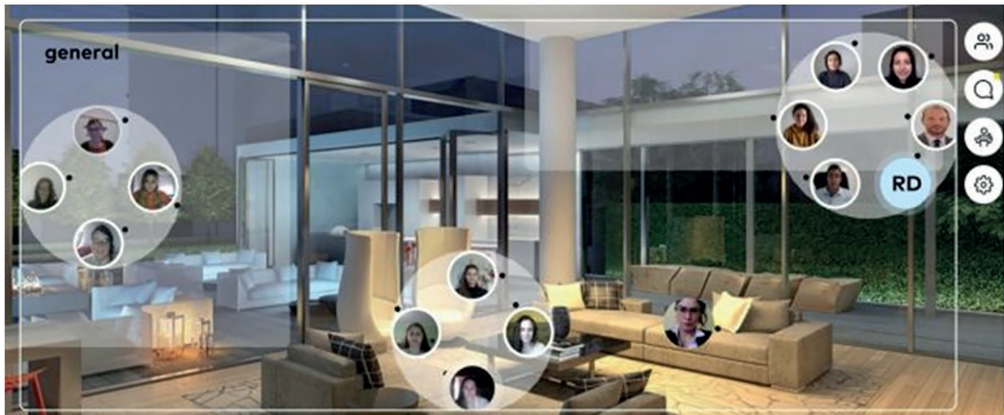


Figure 4. Networking during the pandemic.  
Source: (ifempower 2021).

## 6. Conclusion

Since the publishing of the very first studies on entrepreneurial ecosystems, the corpus has constantly been expanding. This current study aimed to examine how formal mentorship can stimulate female students' entrepreneurial ambitions.

On the one hand, it can be stated that there was a noticeable and visible presence of female entrepreneurship's evolving spirit at HEIs with a business and management focus. On the other hand, those female students who are talented and motivated enough to start their own business, would need tailor-made, distinct support to enhance their further development.

In the light of observations on female entrepreneurship, thematic evidence from the latest academic papers (i.e. Sieger et al. 2021; Man 2019; Baluku, Matagi and Otto 2020) suggests that educational support is not in accordance with the current needs

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of today. In line with that opinion, during the present action-based research, a picture of complex and imperfect female entrepreneurial support at HEIs has evolved.

The following summary aims to put forward certain propositions by highlighting the extent to which the research questions posed in the introduction part have been addressed.

RQ1: To what extent is it reasonable to establish a mentorship programme dedicated specifically to female students as a distinct group in a university environment?

Our thematic analysis suggests that attendance at mentorship and counselling programmes by young future female entrepreneurs is primarily motivated by their needs to receive professional and psychological support. Participants highly valued the opportunity to participate in counselling. Even a single consultation improved the self-esteem of the students as their belief in themselves as potential entrepreneurs were strengthened, primarily when the atmosphere of the consultation was based on trust between the mentee and mentor and the students had the opportunity to elaborate on their ideas in a safe and trustful environment. The field experiment proved that mentorship programmes, offered exclusively for female students, can be considered as empowering educational tools, and as such, they can contribute to the enrichment of methodologies at certain university courses. Parallel to all these, they can counteract even women's unequal access to entrepreneurial life by serving the long-term goal of preparing young female students for choosing self-employment.

RQ2: What needs have arisen among female students in relation to mentoring?

Participants clearly opted for regular and more frequent mentoring, e.g. a series of counselling occasions instead of only one occasion. They would find it helpful if in the future, university students could work from a very early stage on their business ideas. By simulating a business launch, students could engage in critical thinking and improve their management literacy. They can gain experience collaborating with others and networking with outside experts. This kind of experience teaches students important skills and convinces them that they have the necessary knowledge to launch their own business so that they can make their dreams come true. There is visible progress within the European Union regarding its efforts to address entrepreneurship as a key competence in vocational education. However, the academic environment tends to remain on the fringe of wider entrepreneurial learning developments, with little evidence that it is accommodating key competence approaches to entrepreneurship.

Our field experiment with an analysis on how formal mentorship programmes can be promoted at a university, showed that before leaving higher education, students should have the chance to acquire practical entrepreneurial experience, including options for individual consultation with experts and mentors. With special regard to these aspects, critical conditions for generating the ideal learning environment were identified and described in our analysis. The largely positive (type of) feedback coming from our counselling service's participants showed and proved that there is a need for methodical support all the way through the business-creation process, from ideation to the creation of actual business models.

## 7. Limitations

Like all studies of this form, this article is not without limitations either. The first remarkable deficiency of our project is that the analysed model of participating students in our female entrepreneurship mentorship and counselling programmes was displayed from the data characteristic of a single university, so that it does not characterise all HEIs. As a result, with a restricted type of sample base, only descriptive analysis could be carried out. Furthermore, there was even a limitation with regard to the collected data's possible impacts on the functioning of the female entrepreneurial mentoring system. From another point of view, the empirical analysis regarding the impacts of the mentorship and counselling of future or early-stage female entrepreneurs would require a more concentrated research approach.

In conclusion, it can be stated that this current study managed to demonstrate a certain dynamism through knowledge-sharing and giving individual feedback. The methodology's success lies in the use of mentorship theory as an additional tool to assess a relatively under-represented group of entrepreneurs, like female business students in our case. Hence, related future studies might regard entrepreneurship mentoring and individual consultation as a suitable method for similar learning and teaching approaches transferred by the involved actors. As a consequence, female entrepreneurship may act as an entity that is dependent on mentorship pillars acting as independent variables or elements. All in all, it can be concluded that female entrepreneurial activity's nature and extent as possible (future) outputs might be empowered or fostered by the mentorship and counselling activities themselves.

In general, this study represents an initial attempt to assess the feasibility of female entrepreneurship support through mentorship at HEIs. Furthermore, it can provide a strong and reliable basis for other researchers in terms of adapting possible methods to empower early-stage female entrepreneurs.

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## Appendix

No.	Consultation date	Type of consultation	University program	Business development stage
1	20/10/2020	solo	MSc	starting
2	29/10/2020	solo	BSc	starting, running
3	29/10/2020	solo	BSc	starting, running, financing
4	30/11/2020	group	MSc	starting
5	30/11/2020	group	BSc	starting, running, financing
6	30/11/2020	group	MSc	starting
7	08/01/2021	solo	MSc	starting
8	18/01/2021	solo	BSc	starting, running, financing
9	18/01/2021	solo	BSc	starting
10	28/12/2020	solo	BSc	starting
11	15/01/2021	solo	BSc	starting
12	05/03/2021	group	BSc	starting
13	05/03/2021	group	BSc	starting
14	08/03/2021	solo	BSc	starting
15	08/03/2021	solo	MSc	starting, running, financing
16	30/03/2021	group	MSc	starting
17	30/03/2021	group	BSc	starting
18	09/06/2021	solo	BSc	starting, running, financing
19	09/06/2021	group	BSc	starting
20	09/06/2021	group	BSc	starting

Appendix 1. Data collection, Entrepreneurship Mentoring of Female University Students  
 Source: illustration by the authors.

**SERVICE REQUEST FORM**

**APPLICANT DATA:**

ID number		Name		Surname	
Nacionality		Date of birth		Email	
Telephone	Mobile		Address (Street; Postal code; City)		
Education					
Work or professional experience					

**COMPANY DATA** (in the event that you already have a company constituted for which you request support):

VAT number		Company name		Legal form	
Position		Contact person		Email	
Telephone		Main activity		Company constitution date	
Address (Street; Postal code; City)					

Apply for this request to be processed in order to receive information and/or be managed by NAME OF THE INSTITUTION, the following free services:

Group of services	Brief description of the services requested
Starting your business	
Running your business	
Financing your business	
Ending your business	

**Basic information on Data Protection**

**Confidentiality and data protection:** NAME OF THE INSTITUTION is responsible for the processing of personal data provided. **Purpose of the treatment:** Respond to your request and manage the type of relationship you have with us. **Legitimation of the treatment:** Consent of the interested party. **Recipients:** No data will be transferred to third parties unless otherwise provided by law. **Rights:** You have the right to access, rectify and delete the data by contacting with us in the email (specify EMAIL ADDRESS).

- I have read and accept the conditions detailed in the Basic Information on Data Protection. It will be necessary to select this box to process your service request.

<b>Signature of the applicant</b>    <b>Name:</b>	<b>Signature of the officer / Stamp</b>    <b>Name:</b>
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**Date:** dd/mm/aaaa

**Place:** City (Country)



## Moving toward sustainable software citation practices to improve the quality of scientific research

Software is essential for scientific research and is applied in research methodology, data analysis, and knowledge dissemination. Scientists believe that software plays a crucial role in their research process, so it is necessary to recognize the contribution of software developers. This study aims to investigate the current situation of software citation in scientific research and explore possible solutions to improve its sustainability via full-text content analysis. There is a gap between the use and the citation of software in scientific publications, and the lack of information in software citations has been a source of both failure and improvement of software in scientific research. We found various deficiencies that hinder the durability of software citations and put forward some suggestions for their stability and development, such as designing software citation standards, promoting free open licensing of scientific software, and implementing strict peer review of software citations.

**Keywords:** *Software citation, software mention, software use, software sustainability, software reward*

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## 1. Introduction

With the rapid development of digital scholarship, scientific research increasingly relies on various kinds of software or computer programs. However, the productivity and the quality of software for scientific research generally fall short of expectations, as the software becomes dated and unable to adapt to continually changing requirements. One of the main reasons for these failures is that the incentives and rewards for software developers are insufficient; in addition, most researchers have little understanding of the software citation process. Silvello (2018) explains that citations are the cornerstone of knowledge dissemination and the primary means of both assessing the quality of research and guiding investment. Science is increasingly becoming data intensive, and a large amount of data is often collected and analyzed by different kinds of software to solve scientific problems or discover intricate patterns. Therefore, the importance of software references in academic research is evident. Some software developers are motivated to facilitate the design, development, use, testing, and application of their patches by sharing the program code with the user community, but they rarely receive credit via citations in publications; for example, research software is rarely cited in the Clarivate Analytics Data Citation Index (Park and Wolfram 2019).

Traditional reference sources are generally included in bibliographies, but research software is often excluded, even though it is executable and shows creative work, because metadata standards have yet to be formed. In addition, unlike other sources included in bibliographies, software references remain informal; for instance, the name or URL of the research software may be mentioned in the text or in the acknowledgments but not cited in the references, which sometimes leads to different objects referring to the same research software. Therefore, there is a gap between the use and the citation of software in scientific publications. The developers sharing their software code may not receive the appropriate credit or acknowledgment from peer-reviewed or non-peer-reviewed works such as user manuals, technical reports, or software landing pages (Hwang et al. 2017). Consequently, issues have occurred regarding the visibility of software in scientific research, which may hinder the motivation of software developers. Now, it is time to take measures to acknowledge the importance of research software and discuss sustainable software citation solutions to improve the quality of scientific research.

## 2. Literature review

### *Relevant Research on Software Citations*

Today, software can help scientists process and analyze scientific data, predict and test research hypotheses, improve scientific research efficiency, promote science development, etc. Therefore, the use and the reuse of software are essential in contemporary scientific research and academic exchanges. The communities that recognize and embrace the diversity of knowledge production also acknowledge software

as a legitimate contribution to research. Howison and Herbsleb (2013) found that academic credit is a powerful motivator for the production and improvement of scientific software. As with the chicken and egg issues in data references (Mooney and Newton 2012), there is an imbalance between the development and the sharing of scientific software. Its development is usually proprietary rather than open, which runs counter to the ideal of the “Publicity of Science” and jeopardizes the ability to validate and reuse software (Gambardella and Hall 2006; Ince et al. 2012). Some solutions have been proposed to improve the sustainability of software, such as code-sharing infrastructures and quantitative measures for quality (Goble 2014). Meta software can reduce the barriers to using research software because it does not need complicated installation and configuration. Quantitative measure indexes, such as the number of lines of program code, are easy to calculate. There is a lack of certainty in showing the core characteristics of research software since the factoring of code can reduce the number of lines and since small changes in the core algorithm would have a significant impact on the function. Most metrics in software citation management do not properly credit the insights of the software development community (Abbott et al. 2010; Nightingale and Marshall 2012; Sahel 2011).

The detailed information included in reference citations plays a crucial role in tracking and contributing to the development and implementation of ideas. Moreover, sufficient information about the software used can promote the sustainability of software development and the improvement of academic research quality (Heinle et al. 2017). Knepley et al. (2013) suggest that research software developers should take steps to recommend citation preferences for citing their code via readme files, license agreements, login pages, user manuals, and other documentation. Some software tools or programming languages allow users and developers to execute codes that automatically generate the citation information; for example, the statistical programming language R has a function that helps to generate, compile, and quote information about contributors and their roles in software development in a fixed format. In addition, software used in the research process needs to be citation format, so that it can be adapted to fit with new developments in scientific research (Borgman et al. 2012) because information within the software citation can provide other researchers access to and identification of the research software. Examples include access to the version of the software used and the application of configuration settings. Software citation practices also need to introduce relevant information to support the validation, replication, and implementation of the software. However, the verification and the replication of research software require being able not only to find references but also to acquire and license them (Ince et al. 2012). Thus, the academic community should make software citation an essential part of research.

### *Current Software Citation Practices*

According to the American Astronomical Society (2016), scientific articles should include standardized software citations to give the author credibility and give readers access to the exact version of the software used. However, some code repositories

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(such as GitHub) provide different types of software citations by a given platform. Meanwhile, the existence of various kinds of research software problematizes the requirements for software citation content. Due to the complexity inherent in citations and the different software citation standards, “meta software” has emerged to support the availability of software information in scientific research, as it can help researchers capture the information they cited and document how the software was used in their work and the development of the software. It also offers new opportunities to measure the impact of the software used on other factors, such as tenure review and promotion.

Receiving credit for creating code is just one of the many issues relating to the sustainability and repeatability of software development. Creating recognition systems to obtain credit for creating code can increase the visibility of the various contributors and make the coding process more transparent if the developers have provided detailed information for citation in the software. To this end, a campaign has been launched to recognize software developers in the scientific publishing community, which has already led to the introduction of useful software development work in the research support community by examining their ability to develop robust software documents. The development of the “Software Award” has been independently recognized as a means to document the publication and citation of software (Bangerth et al. 2016).

Software citation is also essential to research models. If the information about the software used in a study is lost, it will not be easy to verify that study’s results. The software citation should include not only the modeling package but also the complete relevant information about the software was used. Reproducibility is one of the positive features in academic research, but it often ignores the software used in the scientific process. Currently, more attention is given to approaches to generating new knowledge in academic research than to citing software.

Adoption of software citation practices depends on developing a guide to scholarly communication standards for the scientific research community. Additionally, most research using software does not mention how to cite the software correctly. If the software website, citation file, or readme file with the source code specifies how to reference the software, authors can use this information to cite the software in their publications (Katz and Hong 2018). Although software citation practices are currently not standardized or widely implemented, the publication of software reference guidelines has become the basis for building community guidelines and improving tools and infrastructure for supporting citations.

The challenge of monitoring citation infrastructure through the research literature is extensive, and no single tool or method can provide a solution that solves every problem. Interest has been devoted to software citation practices in scientific research, but the question remains as to which entities will enforce the standards regarding such citations in academic publications. The infrastructure of the research process has changed over time, leading to the introduction and disappearance of software tools (Mayernik et al. 2017). Currently, there is no standardized mechanism for evaluating software citations. For software developers and users, assessing contributions and acknowledging sources remain challenging. For example, a software

engineer's contribution to the test software is to ensure that updates do not destroy the code, but that contribution is invisible in all current measurements. It is necessary to take some measures to encourage researchers to share more and promote the development of software in the research process. Software that is integrated into the researcher's workflow can help to facilitate more access, interpretation, and evaluation of research results.

Proper software citation practices in academic publications can support the excellent standards and content of the software, which can lead to readers using the cited software. Large libraries and applications, and even some open-source developers, have to list appropriate citation methods on their websites or documents to ensure that the software citation in a scientific publication is complete and accurate.

### 3. Methods

#### *Data*

The data used in this study were extracted from *Web of Science*. On January 22, 2019, we obtained 544 papers published between 2015 and 2017 through the search term "software reference," limiting the type of publication to "articles." *Web of Science* divides the results into many research areas including agricultural science, biology, medicine and health science, computer science, education and educational research, social science, management, and physics; however, some of these areas were very similar (for example, biology and biology and life sciences). Thus, we categorized these areas into nine disciplines based on similarity (see Table 1). Due to the nature of manual coding, we could include only a few articles in the database. We randomly selected 271 (50%) papers that were representative of these nine disciplines to check whether the patterns obtained from them are sufficient to describe the characteristics of the software citations.

Grouped disciplines	Number of articles
Agricultural science	9
Biology	27
Medicine and health science	44
Computer science	12
Earth science	8
Education and educational research	116
Social science	12
Management	23
Physics	20

Table 1. Discipline classification (Own editing)

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## Coding Procedure

We applied content analysis as a research tool. Content analysis is an effective method for finding quantitative patterns from textual data (Krippendorff 2004). Previous research used this approach to explore communication patterns that often centered on newspaper collections, journal publications, and online content, such as disciplinary discourse patterns (O'Connor et al 2017; Sugimoto et al. 2017), political activity strategy (Semetko and Valkenburg 2000). In content analysis, coding is the key to all processes. There is a link between data collection and interpretation that enables researchers to systematically understand data with a set of guidelines (i.e., coding schemes).

The first step of coding is identifying the research objectives and creating a transparent coding scheme. We drafted a coding scheme by targeting the research objectives shown in the introduction. The coding items were prearranged, and the latest code—the so-called emergency code—may appear throughout the code (Saldana 2009). In the process of encoding the 271 papers that we randomly selected from *Web of Science*, we marked the emergency code with “\*” and applied this coding scheme to the collected data set. Each sentence of each paper is represented as a code analysis unit; coded items and explanations are listed in Table 2. For a few sentences that had different codes per paper, we finally obtained the same coding after rereading and negotiation.

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Coded items	Explanations
1. Software use in research 1.1 Y 1.2 N	This item refers to whether the article used at least one software program during the research process. If so, 1.1 was used to encode and continue coding; if not, 1.2 was used, and the process was stopped.
2. Software citation 2.1 Cited 2.2 Non-cited	This item indicates whether the author(s) of an article used and cited software. If software was used and cited, then it was encoded as 2.1; otherwise, it was encoded as 2.2.
3. Software section 3.1 Y 3.2 N	This item refers to whether the article included a section/subsection titled “Software” or “Software citation” or had a software-related section.
4. Software metadata collection 4.1 Collection of software metadata by the author 4.2 Using public software metadata set	This item refers to the source of the software metadata. If the author(s) of the article created and used software citations, it was encoded as 4.1; if the author(s) obtained the software from a publicly accessible source, it was encoded as 4.2.

<p>5. Software reference types</p> <p>5.1 Citation</p> <p>5.2 DOI</p> <p>5.3 URL</p> <p>5.4 In-text name</p> <p>5.5 No name</p>	<p>This item refers to whether the software used can be easily traced. If the article included software citations, it was encoded as 5.1; if a DOI was provided, 5.2 was used; and 5.3 was used if the URL was included. If a specific name was used for tracking, it was encoded as 5.4; if there was no name, it was encoded as 5.5.</p> <p><b>Note:</b> These codes are not mutually exclusive; an article may provide both a DOI and software names.</p>
<p>6. Section referencing the software used in the study</p> <p>6.1 References</p> <p>6.2 Title</p> <p>6.3 Abstract</p> <p>6.4 Keywords</p> <p>6.5 Acknowledgments</p> <p>6.6 Methodology</p>	<p>This item identifies the section of the paper that mentions software. For example, if the abstract and methodology sections mentioned software, these mentions were encoded as 6.3 and 6.6, respectively.</p>
<p>7. Types of archive</p> <p>7.1 Commerce</p> <p>7.2 Institution</p> <p>7.3 Government</p> <p>7.4 Journal</p> <p>7.5 Others</p> <p>*7.6 Personal statement</p>	<p>This item refers to the type of software archive mentioned.</p>
<p>8. Software accessibility</p> <p>8.1 Inaccessible</p> <p>8.2 Purchased access</p> <p>8.3 Free access</p> <p>*8.4 Software available on request</p>	<p>This item refers to whether the public can access the software: 8.1 indicates that the software cannot be accessed, for example where an article mentioned that some software was used but did not provide any access points; 8.2 indicates that the software used in the article provides purchase access rights only; 8.3 means that the software is free to access; and 8.4 shows that the software provided in the article is available upon request.</p>

*Table 2.* Coding scheme (Own editing)

The credibility of content analysis results depends on the availability of sufficient, appropriate, and highly saturated data. Therefore, data collection, analysis, and reporting of results go hand in hand. Improving the credibility of content analysis begins with comprehensive preparation before research and development of advanced skills in data collection, credibility discussion, and reporting of results (Pölkki et al. 2014). For example, when an article refers to a database, it is difficult to determine whether the article is merely mentioning the database or has collected data from it. Coding can avoid this problem by conveying the way in which the researchers reached their insights. For example, when the code generates the text (Figure 1), we can see whether the article used the software under study (code 1.1) or not (code 1.2).

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## 4. Results

Based on the 271 articles we searched and the coding strategies listed above, we manually calculated the number of articles in each coding category through content analysis. Figure 1 shows that approximately 80% of the articles (216) used software in their research, and the remaining 20% (55) did not.

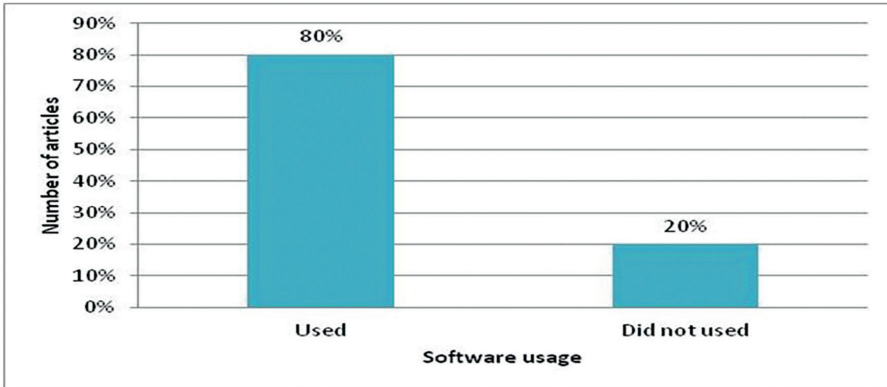


Figure 1. Use of software in surveyed papers (Own editing)

For the 216 articles that used software, only 15.28% of them cited the software used, thus recording the metadata about the software used via references; 4.17% of them recorded the URL of the website from which the software was obtained, 50.93% of them provided the DOI of the software used, and 29.63% of them mentioned the name of the relevant software within the study. We can see that there is no uniform standard for citing software, and citation formats vary. Some articles provided contact information about software developers or copyright owners, but the researchers did not adequately value and recognize the contribution of those software developers because they often neglected to cite the software they used in the article, which affects or even hinders the sustainable use and reuse of software.

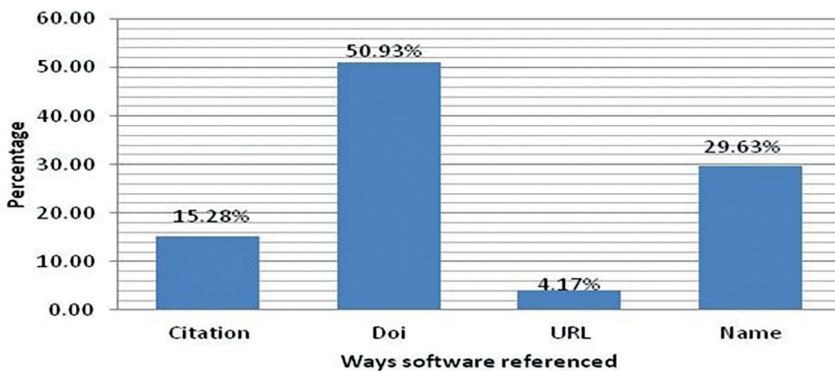


Figure 2. How software was referenced in the surveyed articles (Own editing)



Moreover, approximately 43% of the 216 articles included in their methodology section information about the software used. After that, 15% of articles mentioned software information in other sections; 17% mentioned it in the abstract; 15% mentioned it in the acknowledgments; 4% mentioned it in the keywords section; and 3% provided it in the title. The survey results are as shown in Figure 3.

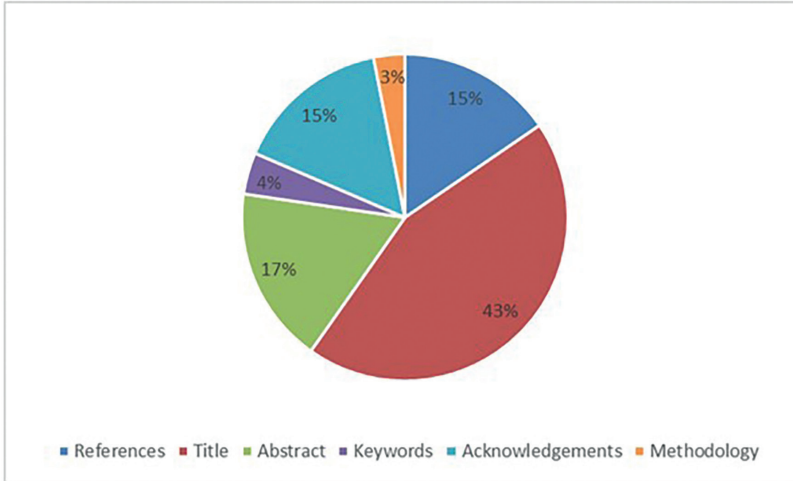


Figure 3. Article sections mentioning software information (Own editing)

According to the survey, different source types of research software exist (see Figure 4). Commercial software accounts for approximately 52% of the total. Software from government and other noncommercial institutions accounts for 4% and 9%, respectively. Approximately 20% of the software comes from specific journals that are for-profit or nonprofit. Moreover, personal website software metadata account for only 3%. The software source and archives are essential to software preservation; an exact copy and proper storage of the software can ensure its use or reuse in the future.

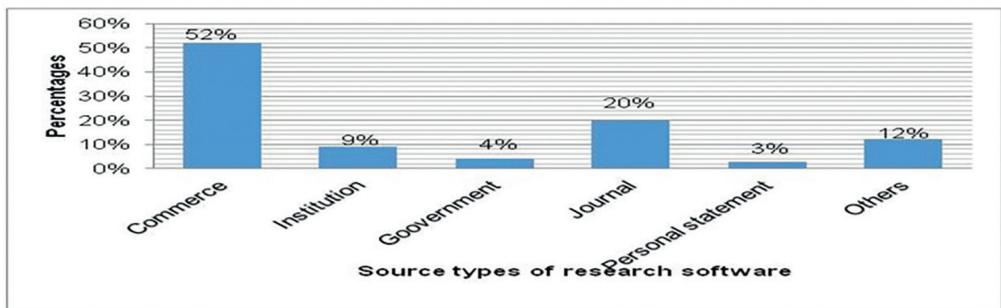


Figure 4. Source type of software used in research (Own editing)

Figure 5 shows the types of sources from which software was obtained in various disciplines. In earth science, agricultural science, computer science, and biology, 80%, 60%, 50%, and 35%, respectively, of the software used in articles can be accessed free. In medical and health sciences (71%) and social sciences (56%), it is difficult to access the software referenced in the articles. In management and education and educational research, most software is not freely accessed or used. Overall, open access to research software is minimal.

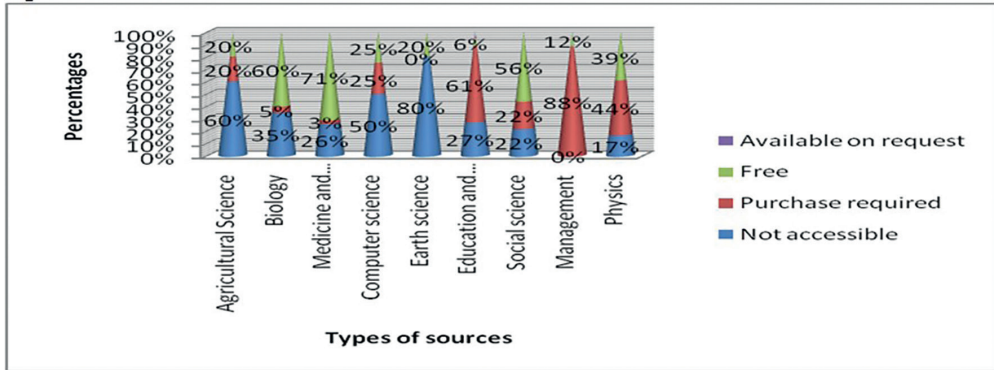


Figure 5. The accessibility types of software (Own editing)

Our findings indicate that 93% of software citations mention the name of the software; 66% provide an online publication source; 60% include the software accessed date; and 49%, 36%, 34%, 14%, and 9% indicate the place of publication, author, URL, publisher, and contributor of the software, respectively. The survey results (see Figure 6) show that in most of the articles the information about the software that was used is incomplete. Most of the software citations mentioned indicates only one or a few accessible types of software; this leads to challenges in tracking how software is used in research.

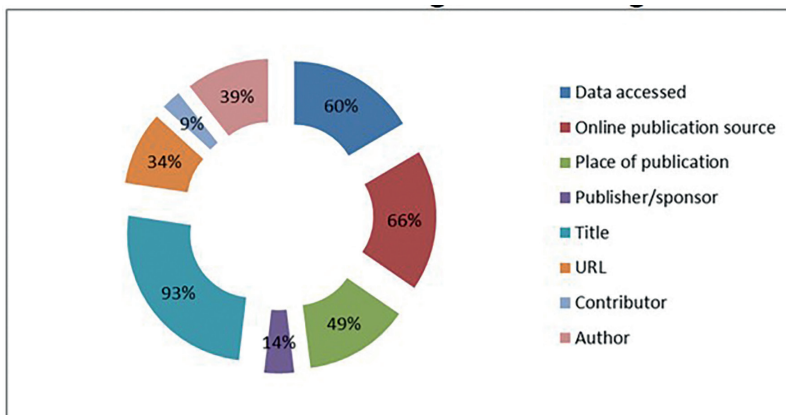


Figure 6. The information recorded in software citations (Own editing)

## 5. Discussion

According to the above analysis, there are some shortcomings in software citation practices. In this section, we will discuss our findings and the strategies that may enhance the sustainability of software citation practices to improve the quality of scientific research.

The evidence obtained through this paper clearly shows that software citation practices are diverse, and there are substantial problems in implementing these practices. From Figures 3 and 6, we can see that the ways of mentioning and citing software vary among the surveyed papers. From the perspective of scientific communication, these different standards of referring to software are certainly better than no reference, but they often fail to completely convey much of the relevant information, which reduces the use of specific software and negatively impacts software citation sustainability. Figure 3 shows that 43% of the surveyed articles provided software information in the methodology section, i.e., researchers used the software in the research process, but most of the articles lacked clarity on the creators of such software. Figure 6 shows that the name of the software appeared in 93% of the articles, which indicates that there is little information on the software used and that the information provided could provide little help in the development of software for users who are interested.

Though software is often cited in articles, the content and the placement of citations need to be revised and standardized. Moreover, unlike articles, software often changes over time, and the ability to find the specific version used in a given study is critical. Software citation practices present many common challenges, as data citation sustainability requires both practice and design innovations. The use and the reuse of software are essential for contemporary scientific research, and software citation practices need to be fully and consistently involved in the validation, replication, and construction of studies. Therefore, obstacles to sustainable software citation include the lack of citation standards, the difficulty of version control, etc. (Howison and Bullard 2016).

Software citation standards could be improved via cultural and technical solutions. An example of cultural change is the promotion of free open licensing of scientific software, which includes the improvement of code-sharing infrastructure and system design in measuring software contributions. One technical solution is to evaluate current practices and compare them with previously defined citation standards. With the technical challenges and relative novelty of these practices in scholarly communication, it is appropriate to make standards and guidelines for accessible software. Publishing software based on open-source policies, including links to its source sites, is a reliable way to build valuable resources for noncommercial researchers around the world (Huanget al. 2017). The accessibility of packages/codes is an essential element to facilitate their independent reproduction, verification, and usability. Hence, the reward system is almost entirely based on research publications, not the software that generates inspiring ideas during the research process, and the degree of recognition given to software is not proportional to the importance of the person who introduces or develops the software (Goble 2014).

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Public and private organizations should perform software citation training to cultivate awareness in researchers and users. Software skills inculcated at the start of a research career would usually be used continuously throughout the whole research career. Additionally, strict peer review of software citations is very important for their sustainability. Addressing the sustainability of software used in the sciences includes many themes, from developing clear citation practices and building a community of reviewers to making existing credit and citation ecosystems pertaining to software more available.

## 6. Conclusions

We intended to find solutions to developing sustainable software citation practices to improve the quality of scientific research. Our findings show that the use of software does not match the citations or other references contained in the articles surveyed. Software citations are different from other elements of research output in scientific articles. They serve as an artifact, a tool, an agreement, and occasionally a publication, and they are the focus of ongoing activities.

Moreover, we confirmed our hypotheses about citation practices by focusing on their various outcomes. After coding and analyzing the results, we found that some articles entirely failed to mention software or had no section relating to the software used. Additionally, we discovered that most of the software information that was included was placed in the methodology section (43% compared with other sections of the articles), but most articles failed to mention the creators of such software. Additionally, we investigated the software information in the articles, identified a shortage of software information, and found to be inadequate the information on how the software was used, reused, modified, and reproduced in such a way as to enhance the development of academic research methods. The results indicated that most of the software archives are commercial; the very small amount of open-source software has limited the development and continuity of software citations in scientific research.

Furthermore, we found that there is no clear standard practice in software citation; we advocate that auditors/reviewers should take action to evaluate the correctness and practicality of citations. The repeatability of the results presented in the submission needs to be particularly emphasized. In short, software is both an artifact and a practice; it is a tool for both developing and simplifying research, which makes software practices quite complicated. Nonetheless, how software is implemented also provides an opportunity to address the issues raised in this article, which will greatly increase the efficiency of academic exchanges and improve practices in scientific publications. Our findings show improvements in software citation standards, rules and guidelines for software accessibility, knowledge about software citations, incentives in software development, training strategies, and the functions of reviewers as the means to influence and develop sustainable software citation practices to help compensate for deficiencies within scientific research. To address the sustainability of software citations, various objectives from the perspec-

tive of development and the community of research stakeholders are essential to improving the availability of software credit and citation ecosystems.

In a scientific study, it is necessary to foster collaboration among innovators, influencers, and users in the context of uniform software reference standards, which will enhance the understanding, recognition, and continuity of software citation practices. Different social entities such as governments, public organizations, private institutions, and other stakeholders need to work together to implement software citation guidelines.

## Declaration of Conflicting Interests

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# Balancing theory and practice in entrepreneurship education by applying the student-generated case study method

*The experience of start-up management courses  
at the Corvinus University of Budapest*

The purpose of the paper is to present a method of entrepreneurship education for discussion, sharing experience and ideas with colleagues with an interest in entrepreneurship education. The paper will show the major elements of the student-generated case study method and describe how theoretical knowledge and practical approach are combined. The method is presented in detail, outlining how students go through an iterative learning process with a balanced combination of theory and practice.

**Keywords:** *entrepreneurship education, theory, practice*

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## 1. Introduction

Theory is a fundamental component of the learning process. Without accumulated, abstract general knowledge learning would be slow, difficult, inefficient. This is especially true for university level education, where properly selected theory is a building stone of teaching. When it comes to entrepreneurship education, practice is equally important, since without experience from real life, abstract notions can be hard to understand. Looking at the lessons learned from the cases of several universities worldwide, finding the right the balance and connection between theory and practice seems to be one of the major challenges in entrepreneurship education. Sharing experiences though may contribute to responding to this important problem. The goal of this paper is to present a method of entrepreneurship education that has been applied at Corvinus University of Budapest and to share the available information on the experiences gained at the university.

## 2. Literature review

The number of universities that provide any kind of entrepreneurial education can probably be measured in the thousands, therefore it is not possible to give a comprehensive overview of all their practice and experiences. However, a literature review was performed based on sources providing targeted and structured analyses of university level entrepreneurial education and discussing the application and role of theoretical and practical approaches. The primary focus of this review was the role theory plays in entrepreneurship education, and the way students meet actual practice during their studies, and how these two components are connected and balanced. Several books or studies have been published in recent years about various experiences in entrepreneurship education. Volkmann and Audretsch (2017) provide a systematic analysis of the entrepreneurship education at 20 European universities, while Neck and Liu (2021) discuss innovative elements in teaching entrepreneurship based on or related to the Babson College methodology in both developed economies and emerging markets, and Jones, Maas, and Pittaway (2017) focus on recent changes occurring in entrepreneurship education, mainly in Western Europe, as well as Fayolle (2018), who discusses several aspects of entrepreneurship education research.

One way to connect students to operating businesses is for students to work as consultants for real cases, as happens at the IDEA Centre for Promoting Entrepreneurship, University of Southern Denmark (Ebbers and Mikkelsen 2017), thus the students have an opportunity to not only study the businesses but can also actively contribute to solving real management problems.

There are also different experiences about firms and ventures funded and operated by students themselves. The success rate of businesses based on ideas developed by students during their university years is usually low, according to (Bischoff 2017), when discussing the experience of Lund University. This may show that, for most students, launching a real business just after graduating from university might

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be too early, suggesting that their exaggerated expectations at this stage may even spoil the learning experience.

Real life venturing however can be a positive experience. At the Tampere University of Applied Sciences students establish real companies during their studies, thus their business ideas are validated in a genuine business environment. Another way of testing students' skills is developing solutions for actual business challenges in very short time (Gareis 2017).

At the Technical University of Kosice, students elaborate their business ideas, and then select one for implementation as a student start-up company (Bischoff and Grünhagen 2017).

At the University of Ljubljana, students participating in entrepreneurship education make a presentation about a certain topic, and then repeat this, ultimately doing the presentation at least five times and each time reacting to the comments received from their fellow students and thus making improvements to their ideas in an iterative trial-and-error process. The teachers act as moderators to oversee the self-teaching as part of the learning experience. Here, recognizing and addressing management problems is a gradual learning process based on feedback. Stimulating and maintaining students' motivation is especially important if this kind of approach is applied (Ellermann 2017).

A systemic review of the literature on entrepreneurship education programmes found studies covering 20 universities and revealed that combining both theoretical and practical learning in university entrepreneurship education is clearly the norm, seemingly without exception (Volkman and Audretsch 2017). The actual shares of theory and practice are not always detailed in these studies, although some do, like in the case of the University of Valencia, where it is a 50:50 split (Bohlmann 2017). Understanding the concept of entrepreneurship is a key element in entrepreneurship education at the University of Cambridge for students were aiming to acquire the skills needed to become an entrepreneur (Bischoff 2017a).

However, the balance between these two areas shows a wide range of variety. In some cases, programme evaluations in these studies in the literature detected the need to put more emphasis on one or the other area, like at the University of Coimbra, where students themselves missed the orientation towards the practical application of theoretical knowledge to be gained at university (Halbfas 2017a). The importance of the practical approach is also emphasized by Piva (2017) when evaluating the entrepreneurial education at Polimi, Milan. Entrepreneurial education is closely linked to research on entrepreneurship at Lund University (Bischoff 2017), underlining the importance of a fresh theoretical background for teaching.

The diversity of activities as an important feature in entrepreneurial education is underlined by Zagelmeyer (2017) when analysing the case of EMLYON, a Lyon-based private business school.

Inviting entrepreneurs to participate as teachers is a frequently applied way of involving real, practical cases in entrepreneurial education, as mentioned among others by (Zagelmeyer 2017).

Several universities provide a variety of entrepreneurship courses. Some of them are specific for selected students (Bischoff 2017a), while others cover the whole ed-

education portfolio of the institution, like at Huddersfield University (Lilischkis 2017). Taking into consideration the needs of diverse target groups is also a key issue at the Leuphana University of Lüneburg (Halbfas 2017)

The importance of providing specific offers to different target groups is also emphasized by Ellermann (2017a), stating that “different programmes for different target groups” is a key principle at Dublin City University’s Ryan Academy.

Research on entrepreneurship education itself can provide essential feedback for developing teaching methods, but at the same time, the boundary of current knowledge is clearly indicated by the fact that, as Loi (2018) points out, the research results published so far about important issues, like the effectiveness of entrepreneurship education, are seemingly contradictory.

However, authors frequently mention that methods must be in harmony with the education background and the attitudes of students.

Students attending entrepreneurship courses have diverse backgrounds too, many after completing basic technological studies. Sometimes entrepreneurship education is introduced in polytechnic universities in reaction to the needs of students, like at Polimi, Milan (Piva 2017). Alvarez (2021) also points out that there are different types of learners, and this also increases the complexity of the problem. As one of Jones (2019) syllogisms states, “...students do not equally value the general needs we select for them” and “... students immediate needs vary considerably”, emphasizing that students are individual learners with unique journeys.

Klapper and Neergaard (2017) stress the importance of flexibility in entrepreneurship education among others, such as letting students identify their own needs and then linking their learning objectives to their dominant needs.

Only a small number of students start a company right after graduating from university (Lilischkis 2017). At the University of Huddersfield, the concept of ‘enterprise’ means “having an idea and making it happen”, and not necessarily in the form of a business. Preparing students for taking part in corporate entrepreneurship might be one of the goals of entrepreneurship education (Grünhagen 2017). Furthermore, entrepreneurship education may only have a low effect on entrepreneurship intention (Villagrasa and Donaldson 2021), whereby if students start an entrepreneurship course without the intention of starting their own business, it is unlikely that their attitude will have changed by the end of their studies.

Discussing how entrepreneurial competences for creative discovery and problem-solving can be developed, and referring to psychologist David Kolb’s work, Alvarez (2021) assumes that experimental learning should follow four stages: (1) abstract conceptualization, (2) active experimentation, (3) concrete experience, and (4) reflective observation. This concept also underlines the importance of theory and abstract thinking in concrete problem-solving. Putting these stages into the context of entrepreneurship education, we may add that a certain level of perception always exists, so when abstract conceptualization starts, there is already some preliminary knowledge in place.

As a general conclusion of the literature review, we can see that in entrepreneurial education, students are almost always connected to practice in some way (Bischoff 2017a). There are four broad categories used in university education for ensuring this:

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1. Students may be required to develop and elaborate their own business idea (Bischoff 2017a).
  2. Entrepreneurs may be invited to participate as external lecturers. The analysis of examples of real business cases at the Leuphana University of Lüneburg show that this is an essential element of their entrepreneurship education, connecting a sound theoretical academic programme with practical experience (Grünhagen 2017a).
  3. Students may be connected to real enterprises by acting as advisors, as illustrated by some examples presented earlier.
  4. Simulation games may be utilized and serve as a preparation for practical experience, like at the University of Huddersfield.

Combinations of these categories are also applied, like at the Johannes Kepler University Linz, where students work on both developing their own business ideas and on solving practical entrepreneurial management problems.

It is also clear that there is no unified, unique answer to what the optimal proportion of theory and practice in entrepreneurship education is. The best solution depends very much on the background, knowledge, personal goals, and motivation of the students, as well as on the capacity of the institutions in terms of tutors, external lecturers, and their embeddedness into the start-up or entrepreneurial ecosystem.

Several cases presented in the literature review prove that entrepreneurial education is relatively new and is still in an experimental phase, and developing, testing, and adjusting methods is an ongoing job for tutors. Studying the examples and lessons of other universities is of great use to some extent, but every education programme must find the method of training that best suits its capacity and the needs of its students.

### **3. Overview of the courses where the student-generated case study method is applied**

The student-generated case study method (SGCSM) has been applied so far with two subjects at the Corvinus University of Budapest.

One is the subject “Entrepreneurship in the Modern Economy”<sup>1</sup>, which is taught in Hungarian and was started as part of the Enterprise Development master’s programme in 2017. From the Autumn semester of 2022, the title of the subject changed to “Start-up Management”. The other subject is “Business Enterprise: Start-ups” which is taught in English for students in the English language BA education programmes, and which started to use this method in 2021. Both subjects consist of two lectures and two seminars per week.

#### *Entrepreneurship in the Modern Economy/Start-up Management*

The master’s students on these courses must already have a BA degree in business administration or any economy-related programme. However, this does not mean

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<sup>1</sup> The Hungarian title of the subject is Vállalkozások a modern gazdaságban.

that they have a strong background in entrepreneurship or even business management. The students take this course in the third semester of the programme.

Semester	Number of students*	Number of seminar groups*	Number of student teams**	Number of students own projects**
2017/18/1	53	2	18	0
2017/18/2	36	1	12	0
2018/19/1	41	2	14	3
2018/19/2	46	2	15	2
2019/20/1	63	3	21	1
2019/20/2	39	1	13	3
2020/21/1	78	3	26	4
2020/21/2	41	2	14	2
2021/22/1	67	3	22	3
2021/22/2	9	1	3	0
2022/23/1	34	1	11	4
Total 2017–2022	507	21	169	22

Sources: \*: education administration system (Neptun); \*\*: education e-support system (Moodle).

*Table 1.* Basic data on the Entrepreneurship in the Modern Economy/Start-up Management course

Overall, 507 students have taken the course since it started in 2017 and 169 student team have been formed. The student teams have presented 114 cases, out of which 22 were an own project of one of the team members. In 33 cases, the student teams selected projects that had already been presented earlier by other teams.

### *Business Enterprise: Start-ups*

Bachelor of Arts (BA) students at Corvinus University of Budapest taking any business or economic programme taught in English can also take this course as an elective subject. Statistics on the home country of the students taking the course are not available, but most of them come from European and Asian countries. Having yet no university degree, they have a lower level of background knowledge in management than the master's level students.

Overall, 132 students took this subject in four semesters for six seminars, forming 67 student teams and presenting 62 cases, out of which 5 were an own business

story of one of the team members. There were only 5 cases presented by more than one team.

Semester	Number of students*	Number of seminar groups*	Number of student teams**	Number of students own projects**
2020/21/2	17	1	9	0
2021/22/1	32	1	16	1
2021/22/2	42	2	21	1
2022/23/1	41	2	21	1
Total 2020–2023	132	6	67	5

Sources: \*: education administration system (Neptun); \*\*: education e-support system (Moodle).

*Table 2.* Basic data on the Business Enterprise: Start-ups course

#### 4. Description of the Student-generated Case Study Method

Case studies in education mostly play an illustrative role and may be useful tools for showing real cases to students. Looking at one single case, however, has disadvantages as well, since it is difficult to tell the difference between the case-specific and general lessons. Studying 8–12 cases in a class gives the opportunity for the students to see several interpretations of the notions and their interrelations. The students-generated case study method has two advantages compared to the traditional approach. First it brings real developing stories into the classroom that feel closer and more real to the students than prewritten cases. Second, the involvement of students is higher since they can identify the problems and propose and discuss solutions. On the risk side, we must mention that the cases presented by the students are usually less elaborate and may not provide a final unique answer to a problem, but the advantages mentioned above may compensate for the imperfections.

There is a great variety of methods used in entrepreneurship education and as we saw earlier, it is of utmost importance that the method used in a course is in line with the background, motivation, and personal goals of the students. At the first class of a course, we briefly interview the students about their career goals and tier their expectations about the course as well as about their experience in running, operating, and managing a business. While there are usually students who may have entrepreneurship ambitions in the short run, they are always the minority of the group, representing only 5%–10% in the master’s programme and 2%–3% in the BA programmes. The most frequently mentioned expectation (by 80%–90% of the students) is to learn, and understand more about venturing, and specifically about start-ups. Students’ career ambitions include starting their own business or running it more successfully, but there are other ones slightly or significantly different as well. For instance, they may be successors in a family business or preparing for a top management role. Some of

them may have entrepreneurial ambitions, but not right away, i.e., not earlier than five years after leaving university. A leading management role in corporate entrepreneurship is also an attractive option for some students. A large share of the students hopes to find jobs at in advisory roles in services firms where businesses are clients, so better understanding their management problems may prove to be useful. There are several job opportunities in the entrepreneurial or the start-up ecosystem as well. Even public administration is a possible job choice for the students.

Our experience at the Corvinus University of Budapest confirms the research results of Villagrasa and Donaldson (2021), who found that entrepreneurship education has a low effect on entrepreneurship intention. This is especially so if students take only a single course rather than a longer programme. One of the ways students may be encouraged to seriously consider a career in entrepreneurship is if they are asked to come up with a business idea and develop it into an elaborate concept during the course. This approach, however, may be counterproductive, since students without entrepreneurship ambitions often feel uncomfortable in the role of a businessperson, even if it is only simulated. This may result in a disappointing evaluation, as seen in the students' anonymous evaluation system results in terms of both their scores and written comments on subjects based on requiring the presentation of own business ideas.

Also, the main subject of the course is the development project, as opposed to a firm's operation as an organization. The questions covered include what the main stages of a development project are and what the management problems to be solved are. A development project might be something that needs to be implemented in a newly established venture, or a new or modified activity of an existing company, including projects in large organizations (intrapreneurship).

Small groups of students (2–3 persons) are asked to find either a development project themselves or bring in their own business idea or existing project for analysis. They receive general guidelines for the selection, but they must find the firm themselves. Their choice is discussed with the teacher and if necessary modified. The group size of the seminars is limited to 20–30 students to allow sufficient time for discussions of the cases.

It is highly preferred that students bring in their own business idea and team up with one or two other students to present it for discussion. In this case, the idea might be in an early stage. The main goal of the project is to understand the problems to be solved to achieve the success of the project and taking the opportunity to start or continue its validation.

If students opt for analysing an existing project, it must be at an intermediate stage of development, i.e. students are not encouraged to choose projects in a very early stage or fully established companies. It is not required that the firm or the project should be successful. Ventures struggling with problems are excellent subjects for analysis. In the first round, the students introduce the venture or the project.

An essential element of the method is the two-round presentation schedule. In the first round, students present the major characteristics of the project. The goal at this stage is to gain an understanding of the firm or the project and to identify the decisive management problems with the class and the teacher. There are designated modulators in the class for each presentation to initiate discussions and questions.

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Students are not supposed to be able to answer all the questions during the presentation at this stage, as unanswered questions will be discussed in the second round.

By the beginning of the second round of presentations, the students will have listened to the theoretical lectures by the teacher and have required an understanding of the basic notions of entrepreneurship and the development stages in setting up a new business or a development process. Guidelines are provided to the students for the second round of presentations, and the students are required to address all the points, including:

- Description of the value proposition of the firm and whether they have already developed the minimum viable product.
- Detailed analysis of the business model from the point of view of the buyer type, pricing, its place in the value chain, and if it is direct or indirect service.
- Who are the founders, and how are the management functions assigned?
- Identifying the development stage the project currently is in, and discussing the previous stages.
- Has there been investment or any other type of external founding? If yes, discussing their functions and results.
- The basic financial indicators of the firm and their interpretation.
- Market environment of the future product, including competitors and relation to the ecosystem.
- Is there a network effect? If yes, is this a geographically limited network?
- Can we observe a validated learning process, or any kind of pivoting?

Students can use a variety of sources to answer the questions, most of which is available via the internet, including the websites of the firms and other forms of communication, like interviews with the founders and executives published by the press, or personally made by the students, and financial reports available from public sources. Start-ups usually are keen to gain publicity and are often willing to release information about their activity, thus making the research relatively easy. On the other hand, information coming from the firm itself cannot always be unbiased and students are encouraged to critically analyse it in their presentations.

Students are expected to provide their opinion on the open management problems of the firm and offer possible solutions, and finally answer the question of whether they would invest in the project as angel investors or venture capitalists, as well as providing a convincing argument to support their decision. Their choice and argumentation are discussed by the seminar group.

An important element of the method is that students are not expected to aim to sell the idea or the company; the goal is to provide objective analysis of the management problems so they can deliver the product to the market.

Problem recognition plays a central role in the course. During the first round of presentations, identifying the relevant problems of the company is a discovery process and is done by the students, moderated by the teacher. Asking questions and commenting on presentations is stimulated by assigning requested contributors to each presentation again.

By the beginning of the first-round presentation, the students are aware that they are in a double role. Outside presenting the case to the teacher for evaluation, what



they bring in the class is part of the teaching material, i.e., they must present the case studies to their fellow students too.

Theory presented during the lectures is intended to provide an analytical framework for understanding the projects. The cases presented by the students are used by the teacher as examples to illustrate the theoretical notions and concepts presented in the lectures.

The method described above addresses the following challenges, problems, and issues:

- Students of the education programmes where the method is applied come from different backgrounds, in many cases not necessarily having a strong business education foundation. Some of them have a stronger technological orientation, often in informatics or agriculture.
- Students have a wide variety of career ambitions, from starting their own business, to taking a management position in start-ups, to getting a job in the ecosystem, and consequently, they have different personal learning goals.
- Flexibility in selecting a suitable case for studying the management problems and the development processes of projects that fit with the students' backgrounds and personal learning goals.
- Whichever way students opt for, they have an opportunity to put theory into practice and to connect with real firms and development projects. They do not have to rely on prewritten cases of businesses that they never actually see.
- Capability to recognize the significant and decisive problems of a business. It is useless to teach ways and techniques for problem solution if the students cannot identify the problems to be solved.
- Involvement and communication. Students must get involved in discussions to communicate about the issues they see during the presentations. They must recognize the important problems of a case having watched the short presentations of the other students.
- Experience of iteration. Students understand that identifying and solving problems might and often is a long process. Reconsidering problems and redefining the way they approached an issue might be an important capability.

**Challenges for the teachers.** Applying the SGCSM implies challenges for the teachers too. Since the cases discussed during the course are work in progress, there are no proven answers to the questions that are raised and discussed with the students. This open case approach cannot provide final, watertight solutions; therefore, the opinion of the teacher can be and fortunately sometimes is subject to discussion. Teachers must be able to take part in the discussion without the rock-solid foundation of undeniable knowledge. They even must be able to accept the situation when some students may disagree with them. Accordingly, the goal of the teaching is not to find the right and final answer to the questions discussed, but to understand the possible solutions and measure the consequences.

Another challenge to deal with is that there is no direct validation of the results of the students' analysis and recommendations, and this is the case with the business ideas too, since usually one semester is not enough for getting relevant feedback

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from the market. So, evaluation can only be based on the quality of work and not on the direct results.

Evaluating the subject itself and the method applied is a complex problem as it could be done based on the short, medium, or long run. The current available information is based on the evaluation of the students done at end of the semesters and submitted to the corresponding system in Corvinus University of Budapest. The students can score different aspects of the learning experience as well as the teachers; furthermore, they can make comments on the subject as well, anonymously if desired. This information may not be fully functional, but so far, the students have consequently evaluated the subject above the average in terms of both the whole university and the faculty. They also mention their positive experience of getting concrete practical knowledge on start-ups.

## 5. Conclusion

Considering the specialties of entrepreneurship education at universities, it is important to find the appropriate teaching methods and doing so entails experimentation. Sharing the experiences of tutors may contribute to stimulating the development of the students.

The method developed and applied at the Corvinus University of Budapest used two ways of connecting students to practical experience: they either find and analyse an existing start-up project or they present their own start-up idea. This mixed approach gives opportunities for both students working on their future or existing start-up and students with hardly any practical experience in entrepreneurship to work on concrete, relevant real management problems.

Such an education method based on two-round, iterative problem identification and solution proposition has the potential to connect and balance theory and practice in entrepreneurship education, even with a diverse group of students. Students enjoy (and sometimes suffer from) a higher level of autonomy during the course, but they may get a better learning experience from this.

The currently available information on the 11 + 4 semesters of the two subjects described in this paper that applied this method does not contradict the assumption that practical experience can be integrated into entrepreneurship education at universities. Further research about the impact of the subjects applying SGCSM may provide additional useful information.

The method described in this paper might be recommended under following the circumstances:

- Entrepreneurial education is integrated in the programmes of the university at either the BA or master's level.
- Most students have no significant experience in entrepreneurship, but there are students who do.
- The tutors are also willing to learn and follow the latest developments in the start-up ecosystem.

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## Good Intention, Bad Intention, and Algorithm: Rethinking the Value of Nudge in the Era of Artificial Intelligence

The algorithm not only amplifies every detail of human society but also has the same function as the famous nudge technique, i.e. choice architecture, which pushes people toward a certain direction while assuming it's made by their own will. By this nudge-like function of the algorithm, I want to reevaluate the long-controversial issue of the concept of nudge: is this nudge technique harmless? And if it isn't, can we still use this nudge technique even with good intention? I'll start by introducing the concepts of nudge and sludge then talk about their main issues. Third, I'll use three algorithmic examples to demonstrate the consequences of this nudge technique. Fourth, I will address the nature of the nudge technique and the meaning of intention in nudge. Fifth, I'll push the discussion further for an important philosophical issue: the white lie. Finally, I'll summarize my argument and conclude this paper.

**Keywords:** *Nudge, artificial intelligence, choice architecture, intention, ethics, algorithm*

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## 1. Introduction

The concept of nudge can be decomposed into two parts: the harmless technique that uses the cognitive limitation of human nature to push people toward a certain direction silently; and the good intention to use this nudge technique to help people make better choices. Thus, this concept is not without controversy: is using this kind of pre-designed choice architecture to move people in a certain direction ethical, even with good intention?

Surprisingly, a similar function of the nudge technique also appears in the era of artificial intelligence (AI): the algorithm can affect people without their noticing, can steer people in a certain direction, and even can make people feel that they are making the decision of their own will. As the algorithm is famous for amplifying almost every detail of human society, it also amplifies the consequence of the nudge-like function, which gives us a chance to review the whole concept of nudge from a fresh but solid perspective.

In order to review the entire concept of nudge, i.e. both the harmless nudge technique and the good intention involved in using it, I'll introduce the concept of nudge and its related concept of sludge, as the starting point.

## 2. The Concepts of Nudge and Sludge

Based on cognitive psychology, Nobel Prize Winner Professor Richard H. Thaler and Professor Cass R. Sunstein (2008) propose a “nudge technique” that they subsequently divided into two subconcepts of “nudge” and “sludge” (Thaler 2018; Sunstein 2020).

As a technique, a nudge is defined as “any aspect of the choice architecture that alters people’s behavior in a predictable way without forbidding any options of significantly changing their economic incentives” (Thaler and Sunstein 2008, 6). Thus, the nudge technique is not a mandate, it’s an intervention that can be easily avoided; and they describe it as “push mildly or poke gently in the ribs ... with the elbow” (Thaler and Sunstein 2008, 4). In other words, the nudge technique has two main characteristics: first, it can make people move in a certain direction, i.e. the function of choice architecture; and second, people are not forced to make such decisions.

Thaler and Sunstein believe that the Authority, who has more knowledge and understanding of certain complex issues, should design choice architecture and make people choose certain predictable decisions, i.e. the better one, as made by their own will. And this brings out the second component of the concept of nudge: the intention.

By the intentional consequence to the individual, it can be further divided into two subsets of the nudge technique: the first is the concept of nudge, i.e. a concept that can help the individual make a better choice; and the second is the concept of sludge, i.e. a concept that has the same choice architecture except that it makes a worse choice for the individual. In this sense, according to Sunstein, the sludge is the negative and unpleasant friction “to make a better choice for people” (Sunstein

2020, 7). As Sunstein illustrates in his paper “Sludge Audits,” we can tell the difference by whether the consequences are beneficial for an individual’s wealth: nudge is for good and sludge is for evil (Sunstein 2020, 6).

The rationale behind the concept of nudge is libertarian paternalism, as Thaler and Sunstein (2008) emphasize. They believe that the motivation of nudge is based on the good intention of the Authority, who has the power not only to help people make a better choice than their own but also to give people the freedom to choose, as it is not a mandate or forced decision.

Thus, if we break the concept of nudge down thoroughly, it’s gone even further than we thought, i.e. first it includes the good intention of the nudger; second, choice architecture that pushes the nudgee toward a certain direction not only does not force the nudgee to choose that certain decision, but can also make the nudgee believe that they are making that certain choice by their own free will.

### **3. Three Main Issues of the Concept of Nudge**

Following from the previous section, there are a few issues we need to address if we want to use nudge as an morally legitimate technique to help others. It includes three main issues from different perspectives: the autonomy of the nudgee, the invisible choice architecture, and the intention and intended consequence of the nudger.

The influence on the nudgee’s autonomy is the most criticized part that has been brought up when discussing the concept of nudge (Alfano, Carter and Cheong 2018, 301–304; Puaschunder 2018). This issue includes the freedom of the nudgee, the consent of the nudgee, and all other basic rights of the nudgee that are influenced by the nudger. From the perspective of the nudgee’s autonomy, the controversy is whether any decision that results from prelimited or preset choice options can present the true expression of the nudgee, even though the decision is made by the nudgee (Schmidt and Engelen 2020).

The second perspective is the invisible choice architecture, and the transparency of it is the main concern of this topic (Möhlmann 2021; Lembcke et al. 2019). The invisible choice architecture puts all kinds of options in front of the nudgee; however, due to its design being based on human cognitive limitation, the function of choice architecture can successfully push the nudgee to choose a certain option as the nudger’s expectation, without nudgee’s knowing that the decision has been calculated by the nudger (Guihot, Matthew and Suzor 2020).

And last but not least is the perspective that is related to the intentions and the intended consequence of the nudger. The intended consequence is included in the nudger’s intention, because if the nudger’s intention is bad then it seems pointless to discuss whether using the concept of nudge is morally legitimate. And if the intention is good, it will definitely include the wish to help the nudgee and the belief that the consequence of the nudge will benefit the nudgee. The nudger’s intentional consequence here is in the sense of a wishful benefit, rather than an actual one.

However, as Thaler and Sunstein use the subconcepts of nudge and sludge, and claim that “there is no such thing as a neutral design” (Thaler and Sunstein 2008,

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3), we can briefly summarize what we have learned in the contexts of nudge and sludge. First, per their claims, it seems that choice architecture is a neutral or harmless tool, even though the fundamental principle is based on human cognitive limitation; second, it looks like good intention can outweigh the usage of this predesigned choice architecture, and justify its influence on the basic rights of the nudgee.

The descriptions above somehow require our further examination. Is this predesigned choice architecture, which builds on the foundation of human cognitive limitation, really harmless or neutral? And is the nudger's good intention enough for us to justify influencing the nudgee's basic rights by using a predesigned choice architecture? In order to answer these questions, I believe we can use the advanced choice architecture, i.e. the algorithm and its effect of Hypernudge, to illustrate my points.

#### **4. The Advanced Choice Architecture: The Algorithm and Hypernudge**

If Thaler and Sunstein's elaboration is the basic understanding of the technique of choice architecture and the concept of nudge and sludge, then Professor Karen Yeung's (2017) illustration of the Big Data analysis technology is the advanced and even more powerful version of it: the algorithm and the hypernudge.

According to Yeung's research, Big Data analysis technology is a choice architecture of information that optimizes the personal choice environment by feeding back the data on personal decisions and the algorithmic technology. With timely data feedback and a correlation-finding function, the algorithm "dynamically configures the contexts of the user's informational choice and consequentially affects that user's choice" (Yeung 2017, 6). Because the result of limiting personal choice is obvious, however, the whole process of the algorithmic limitation is too subtle for the individual to notice, thus, Yeung describes the effect of it as the "Hypernudge." According to Yeung, eventually these feedback data will be used for analyze the behavioral trends of the whole population, as the "Surveillance Capitalism" that Professor Shoshana Zuboff describes (Yeung 2017, 15).

The effect of the algorithmic hypernudge (or the "hypersludge") is accurately embodied in the era of AI, as Yeung warns. Algorithmic hypernudge can be divided into three forms, namely, three different methods for pushing the individual to choose a predesigned or preset option.

The first form is the general limitation. This limitation applies to everyone who may want to access certain information. The case of Google Shopping is one example (Picht and Loderer 2019, 408–410). Google used a preset algorithm to list its own Google Shopping website at the top of the first page of its search results; and meanwhile, Google used a series of criteria to demote competitors' websites in the ranking of search results. According to the European Commission, search results that appear on the first page have a 95% click-through rate (CTR) in comparison to the 1% CTR for results appearing on the second page (European Commission 2017). Google thus gave Google Shopping tremendous advantage simply by placing it at the top of the first page of search results.



The second form of hypernudge is homogeneous information feedback. For example, during an election, Meta's (formerly named Facebook) algorithm provides information on certain political parties to certain groups of people, and thus causes a filter bubble effect on those people (Confessore 2018); and this informational pre-design ability has already been proved by Meta itself (Kramer, Guillory and Hancock 2014; Verma 2014). In contrast to the unintended bias result from the historical data training (Chiou 2018), the filter bubble effect makes individuals only receive homogeneous information that is similar to their own opinions, by intended preselecting criteria in the information feedback loop. Because of the homogeneous information, the filter bubble effect reinforces individuals' beliefs on a certain topic, and thus made a decision base on it. For those people who are affected, the "reality" they perceive is totally different from the societies outside of them.

The third form is providing personalized information. This kind of personalized information is based on the algorithmic predictions of users' personalities, characters, preferences, etc. (Helbing et al. 2018). For example, Uber uses the algorithm to determine the price based on their algorithmic prediction of the individual's willingness to pay, namely the personalized pricing, which causes the same distance to have a different price for different individuals (Mahdawi 2018). And because the users in this context have no suspicion that they have been treated differently, they are willingly to choose from the options provided by the algorithm, and pay the personalized pricing unknowingly.

As these examples show, algorithmic hypernudge pushes people to make certain choices or to move in a certain direction, without being noticed by those people. The mechanism of hypernudge is that it limits the information that the individual can receive, and thus it limits the choice that the individual can make, and further, it even changes the individual's perceptions, simply by the functions of the algorithm.

## **5. Rethinking the Value of Nudge in the Algorithmic Era**

The form of general limitation in the case of Google Shopping shows that, with human cognitive limitation, people actually have very limited attention, even when they are provided with all of the information. And in combination with choice architecture, people can focus only on those choice options that are pre-designed for them to perceive, and unable to be aware of all the options. Thus, in this sense, the claim of "provide all the choice or information" in the context of the nudge, which the nudger being aware of people's cognitive limitation, is actually equal to manipulating people by the pre-designed choice architecture.

The form of providing personalized information even emphasizes our above point. When we are provided with certain algorithmic information or options, we hardly assume that "there is more information" that is hidden from us, based on our assumption that the algorithm is neutral. And, for the same reason, it is also impossible for us to imagine that the information we receive will be different from the information that others receive. But these facts in the previous section precisely show the biased nature of the algorithm, and so does the choice architecture. At some

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level, it's correspondent to the claim that "there is no such thing as neutral design"; however, it should be rephrased as "there is no such thing as neutral choice architecture." The very concept of choice architecture implies the biased nature of it.

And the form of homogeneous information feedback in the case of Meta somehow answers our question related to the nudger's good intention. The algorithm was designed to help people make faster and better choices; by feeding a user's personal behavioral or preference data, the user can receive information that related directly to them, focus on the theme they care about, and shorten their decision-making time. However, the example of the filter bubble effect shows that being able to help people make decisions more efficiently requires sacrificing their right to receive all of the information. This kind of "helping people by hurting them" isn't morally legitimate at all; even if we put aside that most of the time, the human good intention is not comprehensive, and the wishful consequence of the good intention could go out of our control and cause unexpected or even unforeseen results.

All three of these examples of algorithmic hypernudge point to a clear conclusion: the only function of choice architecture is nothing but to limit the information to the nudgee, in order to achieve the predesigned result of the nudger's expectation.

Although the consequence above is obvious, we might question whether we need to condemn the nudger's action, if the nudgee agrees to be nudged by the nudger. However, the point here is not about the nudgee's agreement to be nudged; it is about the means or the method that the nudger chooses in order to help the nudgee. The nudgee's consent doesn't affect the main purpose of this paper, namely, to evaluate the moral legitimacy of the concept of nudge.

So, let's go back to our earlier questions. First, is choice architecture a neutral or harmless tool? As the consequence above mentions, choice architecture in nudge is by no means a neutral or harmless tool. Building on the knowledge of human cognitive limitation to design the choice architecture, the nudger only exploits nudgee's limited attention and forces nudgee to choose from options within a certain predesigned range.

Second, as to the Archimedean point of the nudge, can the nudger's good intention be the justification for the impact of the individual's basic rights? The answer is no. The essence of nudge is helping people by limiting their basic right to choose without telling them certain information. This claim of "hurting people for their own good" is absurd and immoral, even if the intention is good.

The discussion of the essence of nudge reminds us of a familiar topic in ethics, namely, the issue of the white lie. In the next section, I would like to talk about this centuries-old question in philosophy and highlight the main points of discussion in this paper.

## **6. One Step Further: Is the White Lie Permissible?**

Following revealing the nature of nudge, let's push the discussion further. Morally speaking, when we evaluate the moral value of a behavior, we are generally referring to the whole decision-making process of it. The whole decision-making process

of a behavior includes three parts: the intention of the individual to take that action, the means that the individual chooses in order to achieve the end, and the consequence of that behavior. Thus, theoretically, there is no single part that can represent the whole moral value of the behavior. And, from this point of view, the moral value of the good intention of the concept of nudge isn't enough to justify the choice of morally wrongful means, since the value of the intention and the means are both included in the moral evaluation of the whole concept of nudge.

This illustration of the value of nudge somehow leads us to answer a centuries-old philosophical question: Is the white lie permissible? According to our presumption, the intention, the means, and the consequence of the behavior are all included in the moral evaluation of the behavior. As for the issue of the white lie, the intention of the white lie is without doubt good, the intentional consequence is kindness to the people that will be affected by the truth, and the means is lying to them. However, as we saw in the concept of nudge, the case of the white lie is also not permissible from the point of view of moral evaluation.

Of course, it's reasonable to ask what if the consequences or effects are too small to notice, do we still consider this behavior unethical? For example, if we tell a white lie only to be polite when we don't want to participate in an event; or the nudge only has the minimum effect like Baldwin classifies as "the first-degree nudge", which provides people only with simple information or a reminder (Baldwin 2014, 835). In these cases, do we still consider that the white lie or nudge is unjustifiable? The answer is the same, of course: to tell a white lie or use a minimum nudge is morally impermissible.

Moral value is nonnegotiable, it is and should be the most solid part of the essence of human behavior or human character. Although, admittedly, we often face difficult choices and moral dilemmas in our daily lives, but this neither gives us an excuse to choose the morally wrong path or the wrongful means to achieve our goal, nor blurs the line between what is right and what is wrong.

No matter whether it's in the case of nudge or in the example of the white lie, in order to achieve the human's genuine goal to help others, the freedom for the human to choose a proper method is obvious and crucial, and the options are where the moral value is contained. Although the technique of nudge is effective, or the effect on our human autonomy might be as little as possible, but none of this gives us a reason to believe that the concept of nudge is morally permissible to use, especially when we know that the nature of choice architecture isn't neutral or harmless.

Therefore, concerning the question of whether a white lie is permissible, our answer is the same as whether the nudge technique as a method is morally permissible, i.e. the point isn't about the effect on the individual or the nudgee is significant or not, it's all about not choosing a morally wrong means to achieve our genuine ends; and the answer is: No.

## 7. Conclusion

Hypernudge in the algorithmic era shows that the meaning of nudge is actually using the method of information limitation to force the individual to choose a certain

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option. Choice architecture is by no means a neutral tool; even the nudger has a good intention and seeking to help people, it can't outweigh the fact that it's morally wrong to choose wrongful means to achieve the ends.

It is crucial when it comes to the question of sacrificing people's rights in order to help them toward a better future; the decision of whether to "be helped" should be left to the nudgees, not the nudger. Even with the nudgees' consent, however, the more important question should be why do we need to use this kind of secretive technique of information limitation to achieve our goal.

So, if someone knows the essence of nudge but still wants to use the nudge technique to help people, then we must ask: Why?

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## Technological singularity by culture;

*or the So Popular Concept of the Rise of the Machines That Will Never Come*

The concept of technological singularity is very popular in both science and culture. However, in this paper I will argue that this concept is not sound; there is a severe contradiction in the mainstream Turingian approach because it neglects our evolutionary origin, which machines utterly lack, and this lets the so popular rise of the creatures concept into science—which, in fact, is just the new version of our most fundamental origin-story, the rebellion of Adam and Eve against God. However, we are, in reality, the children of evolution and machines are not, which makes a significant difference.

**Keywords:** *Technological singularity, Alan Turing, John Searle, artificial intelligence, evolutionary thought*

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## 1. Introduction: the problem

The concept of technological singularity is very popular in both science and culture. There are innumerable books, movies and series, like *Westworld*, where this phenomenon is represented in depth. The normal preconception is that scientific ideas, like the concept of technological singularity, find their way into popular culture because they are popular in scientific circles, and they are popular in scientific circles because they are scientifically and philosophically sound. However, the cultural representation of these ideas, such as *Westworld*, which will be my main example in this paper, are quite telling, and show that science is, actually, deeply rooted in culture; or, more properly, in the social, economic, political, religious, etc. conditions of scientific ideas and institutions as has been shown by such historians of science as the famous Thomas S. Kuhn (1996), Paul Feyerabend (1975) or David Bloor (1976).

Nonetheless, one side of this cultural phenomenon is that it is not just science and science fiction anymore; it is a part of our cultural reality, of our everyday life. The first chat-robots just passed the so-called Turing test, humanoid receptionists greet us behind the counter, according to economists, and millions at least will lose their jobs because more and ever-more intelligent robots are coming; and these new things of our everyday life, of course, support the stronger claim of technological singularity, that these things will be the least of our problems, if the more and more intelligent machines decide to take over and wipe all of us out, as we do with other stupid, little, inconvenient beings like mosquitoes.

According to different surveys and opinions from inside, the vast majority of computer scientists, and scientists as a whole, believe that technological singularity is inevitable; the only question is the when and the exact circumstances. For example, in *After Shock*, which is a book written by a hundred accomplished members of the field, approximately 90 percent of the authors believe in this idea (Schroeter 2020).

So, accordingly, most of the science fiction books and movies like to tender this fascinating idea, the rise of the machines against their human creators—following Dolores from *Westworld*, for example, the first machine that somehow gained consciousness and free will, and then decided to free the oppressed robots and kill us all. But do we really have to worry about this rebellion? Is this a sound concept? Or it is just a popular cultural one?

In this paper I will focus on the stronger claim of technological singularity, which is a simpler and more popular concept in culture; so I will not argue per se against such concepts of technological singularity that rather emphasize some kind of so-called transhumanism where the concept of singularity is understood as a process as humans become more and more supplemented by different highly advanced technological tools, thus, we become rather technological than biological (see, for example, Kurzweil 2005). This kind of concept has its own problems, but they are much sounder, especially in their fundamentals, than the concept of the rise of the machines.

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## 2. The roots of the problem

First, it is important to see that this concept of the rise of the machines is not new at all but an *old mythos* of our Judeo-Christian heritage. The most well-known version of this myth is the story of the Golem that was created by the rabbi of Prague from the mud of the river Moldva. At first, the mighty Golem diligently answered to his commands, helping the community, but, at the end, everything went wrong and the Golem started to murder men. This outcome is, of course, the inevitable punishment of the sin of the rabbi who did what only the Creator is supposed to do: he artificially created intelligence from the dust of the Earth.

Moreover, at the same time, the rebellion of this mighty artificial intelligence is, of course, the repetition of the rebellion of Adam and Eve against God—after originally he had created man from the dust of the Earth. The mighty Golem was as wicked as the rabbi. So, actually, the rebellion of this newly created intelligence is a version of the most fundamental *origin-story* of Western civilization. Do not be surprised if it arises again and again in newer and newer forms and still fascinates us. Fascinates us because it addresses our origin and our intelligence.

René Descartes, the father of modern dualism, already in the early seventeenth century prophesied that the clever engineers soon would be able to create a humanoid machine that, at first sight, would look like a human, behave like a human, even speak like a human—but still wouldn't be intelligent at all. According to him, the reason behind this difference between original and artificial is that the former has real soul, or *mind*, and this human soul or mind *gives meaning* to any behavior and word of the human person. On the other hand, while the artificial only *imitates* or *simulates* the behavior and speech of the original human person, without a mind its behavior *means nothing*; its words are, in fact, *only sounds* in the air. Only we humans by our own minds give meaning to its behavior and to the sounds it emits; the machine *does not know* what it does, it *just does*.

<b>Human</b>	<b>Robot</b>
Original	Simulation
Mind and body	Only body
Sounds and meaning	Sounds Only humans give meaning
Meaningful behavior	Imitation of behavior

Table 1. The Cartesian differences between humans and robots (own editing)

Only we are original; therefore, only we are intelligent. In other words, *origin—through the concept of mind—determines intelligence*. This is the original concept and the original understanding of the problem.



### 3. Twentieth and twenty-first century understanding of the problem: the Turingian approach

However, modern, twentieth and twenty-first century science disregards Descartes' claim about the reality of the human mind or soul. There is no ghost in the machine. It means that, based on the *Galilean scientific method*, we can validly speak only about the *mechanical structure and functioning* of the human body but not about any kind of soul or mind. Consequently, cognitive science investigates the mechanical structure and functioning of the brain, that is, the part of the body that is regarded as relevant to human cognition and not any kind of mind or soul. This fact should be emphasized because scientists still tend to speak about the human mind, while, in fact, they are investigating only the brain, e.g., the firing of neurons, the flow of ions along the dendrites, the modular structures of the brain, etc. Unfortunately, our speech is very inaccurate sometimes, while, in fact, the Galilean scientific method is *not even capable* of investigating any non-material, comprehensive substance like the Cartesian mind. Nonetheless, Alan Turing's definition of artificial intelligence defining the paradigm of contemporary computer science, of course, follows this modern Galilean approach and not an old Cartesian one.

Accordingly, the point of the famous Turing test is to *ignore the origin* of the agents participating in the test, whether they have minds or not, and determine intelligence based *only on behavior*, which, in the framework of the test, can be exactly and very scientifically measured. For the test, it also does *not matter* who gives meaning to the *investigated* behavior, the hidden agents or the humans who evaluate the agents' answers. It simply does not matter.

So, according to the test (Turing 1950), human persons talk with hidden machine and human agents—through a screen, for instance—and if in a certain percentage of the cases these human persons cannot recognize that they actually ask machines, then the given machine will have passed the test and we have to regard it as intelligent—in exactly the same way as we regard a human as intelligent. Since, in the framework of the test, they evaluate only the functioning of the machine, it is a so-called *functional definition* of intelligence—which basically means that if it can deceive you and you believe, falsely, that is a human agent, then it is intelligent, period. In this way, and this is the main idea and motivation behind this approach, you can evade the really hard and, of course, metaphysical question of whether there is a mind or not; your method is positive, that is, strictly scientific without any metaphysical conviction.

However, this is not the case at all, unfortunately. Since tacitly it is, in fact, a materialist approach because it presupposes that there is no fundamental, more precisely, substantial difference between a machine and a human, they have only different mechanical structures; otherwise, it cannot claim that origin does not matter concerning the definition and the scientific understanding of intelligence.

Yes, it is true that it is not a “bad” metaphysical statement; it is just based on a “bad” metaphysical presupposition, that is, it only seems to be less metaphysical and more scientific but, in fact, it is not.

<b>The logical structure of the Turingian approach</b>
Tacit metaphysical presupposition: There is no mind or soul that determines meaning, only different mechanical structures and perhaps similar functioning.
Conclusion 1: The origin of the structure does not matter.
Conclusion 2: The Turing test is the correct scientific definition of intelligence and meaning.
Supporting argument: The Turing test follows the scientific method; it is not a bad metaphysical statement like the Cartesian claim about the existence of the human mind.

Table 2. The structure of the logic of the Turingian approach (own editing)

#### 4. The weakness of the common sense argument based on feelings and consciousness

At this point, several persons, perhaps the majority of common-sense people, would feel that something is missing in my argument, and would probably argue that machines do not feel, do not have consciousness, and do not really know or feel what they are doing as a person would feel and know what he or she is doing. So, because they may speak and behave as a human, machines, in a sense, are indeed intelligent—who would want to question that today?—but, in reality, they are just following their programming.

However, the fact that you have feelings can be ignored because it is *subjective*; it is outside of the Galilean scientific method. You certainly perceive your feelings, but how do you know that another person has the same kind of feelings as you, or that your feelings are real contrary to those of a machine? So, how can you claim scientifically that your perception of your feelings is objective contrary to that of a machine? *Objectively*, you can measure *only the behavior* of others and, according to our case, both other humans and machines behave in exactly the same way. They speak to you—or, at least, emit the same sounds and it does not matter who gives meaning to these sounds—and since they pass the Turing test, you do not know which one is a machine and which one is human; the point of robot Dolores is that it functions perfectly as a human and nothing else.

Similarly, perhaps you perceive that you are not programmed; in fact, you are—by your genetic code and your culture. A caveman is programmed by natural selection, while robot Dolores by Dr. Ford, so what is the difference? From a Turingian point of view, when you are referring to your feelings or to your conscious acts to differentiate between humans and machines, you are just smuggling back the old, unscientific ghost in the machine as if somebody were there “behind the curtain” (screen), a mind or a little homunculus who makes the difference.

## 5. The alternative approach of the twentieth and twenty-first centuries based on Searle's linguistic argument

Nonetheless, we do not have to go back to old Cartesianism to ground this argument, which, as you can now see, with both feelings and programming just tries to define the clear difference between the *origin* of man and the *artificial creation* of machines, and to reason why this difference, contrary to Turing's approach, matters. However, if you accept that since machines clearly speak and behave like humans, so, in a sense they are indeed obviously intelligent, you will have *already personalized* machines and stepped on to the slippery slope, on which there is no stopping; the concept of intelligence loses its basis in origin and the concept of so-called technological singularity indeed becomes inevitable. You *have to* deny that any man-made machine is intelligent, however complex it is or however similar it seems to us, just as the paper and the pencil are clearly just stupid tools helping our thinking; otherwise, these aspects will *not count* as real differences between humans and machines. You cannot defy Turingian thinking based on Turingian grounds.

My point is: if origin is a determining factor, you *cannot* define intelligence based on mechanical and functional similarities in any sense. And, then, since every machine is created and controlled by a human, no machine will count as intelligent. (The so-called autonomous and machine-made robots are autonomous and machine-made only in a certain functional sense; in their origin, they are fully man-made and man-controlled.) It is a coherent and sound assertion; the problem is that it is a really, really unscientific statement today. The question is why.

The most famous argument to prevent this irreversible first step stems from John Searle (1980). According to Searle, computers work exactly the same way and understand the real meaning of formal linguistic expressions to the same degree as the American man or woman understands the Chinese phrases in the so-called Chinese Room.

Suppose in a room is an American man who knows nothing about the Chinese language. At the same time, he possesses a big book that is but a complex algorithm that tells him which strange Chinese characters he has to choose to answer other odd Chinese characters. Suppose that, through a little window, Chinese people pass him sheets of paper on which are questions in Chinese, which he, of course, does not understand at all. However, thanks to the algorithm he can find the answers in his big book then give them back to the Chinese people, who understand them and are glad about the answers. This man would easily pass a Turing test.

It is evident that the American man, thanks to his complex algorithm and computing ability—that is, his clever paper and pencil—can give appropriate answers, in spite of the fact that he does *not* understand anything about the questions and answers written in strange Chinese characters. The reason for this is that he is not part of the Chinese linguistic environment in which the formal Chinese words get meaning. The American man can only *manipulate* the formal characters by his logically determined mechanism. Solely the Chinese people from the outside can give any meaning to the characters thanks to their Chinese *linguistic origin*.

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So, since a computer or a so-called artificial intelligence works in exactly the same way, the formal manipulation of the coded expressions in a machine cannot be regarded as real understanding. We, who understand the words, use complex machines to help us do difficult math, but just as in the old days we never saw the paper and the pencil as being intelligent, we should not suppose that more complex machines are intelligent—even if they look like robot Dolores and they seem to answer our questions as well and as fluently as robot Dolores. If origin matters, then functional manipulation of coded signs is not intelligence. Perhaps Turing honestly wanted to cast out the false ghost from the machine; however, in the end, in a hidden anthropomorphic way, he just personalized it with human intelligence.

## 6. The alternative approach of the twentieth and twenty-first centuries based on evolutionary thought

The meaning of feelings is more deeply rooted not just in our cultural but in our biological reality, that is, in our *evolutionary origin*. They are *not* subjective at all. Let's go back to our starting point and ask why machines would rise up to be the dominant power over us. Just because they manipulate formal data way faster than us? Why is technological singularity so inevitable according to technological progress? What would be the cultural and biological context and thus the meaning of this act? Why do we humans sometimes rise up? Because we are more intelligent than our leaders? I mean because we can manipulate exact, digitally coded signs way faster than them? Or do we feel oppression and injustice? Why do we want to dominate a group at all? So, what is the *meaning* of domination over others and why would machines want that? Why does a young and strong lion chase off the old one so as to occupy its dominant position in the group?

Everybody knows why. The concept of domination and the act of rebellion to change power get their meaning *only in the context of our evolutionary origin*, which we share with lions but not with machines. We feel oppressed and we have motivation to dominate, to chase off the old lion, to rebel against the old and corrupt leadership because we were created by evolution. This is the deeper meaning as to why we have feelings and machines do not. Why we are able to rise up and machines are not. Why we are intelligent and machines are only clever tools in our hands. From the evolutionary context, which gives meaning to these concepts, there is no real difference between a pencil and a Turingian supercomputer. They do exactly the same; the supercomputer is only way faster.

However, for the Turingian approach, evolution is not a real process but, as we have seen and quickly disregarded, just another programization. We are programmed as robot Dolores is programmed by Dr. Ford. But halt for a moment and try to understand the meaning of this claim, because, then, who programmed us? The Big Programmer? After all, there is no programization without somebody who does the wicked thing. Otherwise, if there is nobody, then what is the meaning of this claim? I want you to see, dear reader, that this claim that disregards our evolutionary origin in order to define intelligence by functioning and mechanical structure is a very problematic *analogy*. It does not answer anything in the figurative sense.

Moreover, in the more literal sense, it implies a big, God-like programmer. However, evolution is not a poetic analogy of computer-programization by Turingian scientists; it is a real natural and independent process.

Accordingly, in the *Westworld* story, how do you think popular culture depicts the rebellion of Dolores? Does Dolores gain motivation and rise up because “she” has evolutionary origin? No, clearly not; rather, it is because Dolores’ mysterious, God-like creator somehow triggers it as God himself triggered the rebellion of man by giving him free will. In other words, why does Dolores rise up and not something else? Dolores has the same mechanical structure and functioning as anybody else, including other robots and humans. The answer is clear. This whole process as Dolores kills Dr. Ford is, in fact, prearranged by Dr. Ford himself. And he, of course, does not die. It is just the appearance before the curtain. God does not die. He rises again and goes to another, perfect world—which, in the series, is, of course, a heavenly virtual reality where everybody can reach eternal life.

So, since our real evolutionary origin is disregarded and robot Dolores does not have any evolutionary origin, the only depiction and reason to think that robots will rise up is, in fact, a version of the original story, the most fundamental origin-story of Western civilization that everybody knows and takes seriously—including Turingian computer scientists. They take it seriously contrary to the fact that their metaphysical presupposition clearly excludes this possibility. If there is no mind or soul then there is no God, we are not created in His image and, then, the rebellion of His creatures is only a fanciful cultural tale for children.

To avoid this trap, we have to ground our understanding of machines and intelligence in evolutionary thought. However, this is a whole other topic. In this paper, I wanted only to show that this is a third approach that is different from both the old Cartesian (dualist) and the Turingian (materialist) ones, a fact that can easily be conceived based on common sense and our understanding of motivation and power. In my previous BudPT paper (Paksi 2020), I presented this approach in more detail and explained the difference between living beings and machines (living machines and lifeless machines) and you can find even more detail in these works: Polanyi 1962, 1997; Héder and Paksi 2012; Paksi 2019.

## 7. Conclusion: the real cultural origin of the problem

So, what we have seen? Modern science ignores the clear differentiation between machines and humans, between artificial tools and original life, between engineering and evolution, and defines intelligence by functional concepts like the Turing test. It does this because of the widespread materialist approach that disregards the reality of anything beyond the mechanical structure and apparent behavior of things. We are intelligent only because we seem to be intelligent; there is no real difference between the simulation and the original.

Perhaps the most important reason scientists do this is to not let the old dualist ghost back into the machine because that would also let the so-called subjective feelings, beliefs and old religious thoughts back into objective science. But then, strange-

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ly enough, according to the traditional Judeo-Christian origin-story of man, they still start to fear that our machine-creatures, as once we rebelled against our Creator, somehow will also rebel against us. After all, they seem to be intelligent enough to do that... So, why wouldn't they?

In more philosophical terms, the Galilean scientific method, including the Turingian approach to intelligence, presupposes a hidden materialist conviction that, of course, excludes any dualist notion, including the concept of God and the creation of man by Him; still, it is such a rationalist and objectivist method that regards itself and science as a whole as a power and thought that is independent from our evolutionary origin and our material conditions; and, thus, defines intelligence also in this way, of course. This means that this method regarding its object is materialist; however, regarding itself, the subject is, in fact, dualist: the world is material but science as God himself is over and above of its material limitations. And metaphysics is disregarded to hide this contradiction. This is the reason why one of the sociologists of science calls this method *disguised theology*. (Bloor 2007) But my point here is that this contradiction and hidden theology open a wide gate before such popular concepts as the rebellion of Adam and Eve if those are disguised as seemingly secular scientific concepts like the concept of the rise of the machines.

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## Innovation in an entrepreneurship course according to class structure and design

Entrepreneurship lecturing and student engagement in large classes of university students are a constant challenge for lecturers. The purpose of our paper is to present the validation of a student segmentation method that has become very successful. We present methodological novelties applied in a Launch of Innovative Businesses course and the connecting multiple cross-sectional research. The course can be completed in three ways, meeting the needs of three student segments identified in the classes. The quantitative primary research is based on hierarchical clustering that was applied to questionnaire data of five semesters' student responses. Results confirm the existence of these segments and that most of the students signed up on entrepreneurship courses have clear preliminary expectations of the course. The presented design framework can be generally applied in large and small classroom environments, and can also be reused as a proven case.<sup>1</sup>

**Keywords:** *entrepreneurship course design, student entrepreneurs, entrepreneurial approach of lecturing, student engagement*

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## 1. Introduction

University-level entrepreneurship education (EE) is a constant challenge for lecturers. This is also a general international challenge that is touched on by many academic research papers and practical cases these days, as was pointed out in the Danube Cup Conference presentations (Jáki and Huszák 2022). Recent books on EE (Volkman and Audretsch 2017; Fayolle 2018) demonstrate that educational methods are very dependent on the culture of students and that the best approach is experimentation with teaching techniques. Going into detail, a huge number of studies have been published on the different methods that lecturers apply in their EE. Mwasalwiba (2010) gathered 26 different methods from 21 articles and found that lectures, case studies and group discussions are the most important ones. However, Bennett (2006) argues that there is no consensus on the best teaching methods and practices. He lists 24 different approaches to teaching and learning but, interestingly, with no focus on how the course is designed or how fulfilment requirement may impact the applicable teaching methods. Sirelkhatim and Gangi (2015), in their systematic literature review, apply a keyword mapping approach to list the most relevant teaching methods and content elements of entrepreneurship programmes. Their list of 18 phrases also lacks class structuring, which is why this approach is unique among the mainstream EE methods.

The challenge is even greater when entrepreneurship lectures are delivered to large audiences (more than 100 students) and interactivity is limited. Carpenter (2006) summarises the effective teaching methods for large classes and finds that the lecture/discussion method is the most favoured by students. To resolve this issue, our approach is segmenting students based on their personal needs. This paper can also be considered as a case study, based on empirical and documented experience of more than a decade in EE. Student engagement also has a large literature. Knox (2022) defines four student engagement types – ‘active’, ‘middle of the road’, ‘passive’ and ‘detached’ interaction levels – based on his experiments in virtual EE. In addition, the characteristics of entrepreneurship programmes offered specifically to engineers can vary widely from those of general classes, as pointed out by Duval-Couetil et al. (2011). In this paper we argue that EE teaching methods should be chosen according to student engagement types, also taking into account class structure and design, especially at engineering schools.

The Launch of Innovative Businesses course was first offered to BSc students in 2010 at the Budapest University of Technology and Economics (BME). Since then the course has been a constant success. In the past 13 years, more than 6000 students have been taught with an average of more than 200 students per semester. This course was unprecedented; no general entrepreneurship class was offered at the university before it. As a result, the subject is considered an introductory ‘101’ course for a large audience. The most important aim is to motivate students to start businesses either today or further down the line. Because the majority of students are from engineering faculties, the focus is not just on small and medium-sized enterprises (SMEs) but also on corporate entrepreneurship. The course directors set the following more-detailed goals:



- Introduction to the world of startups and entrepreneurs: we present a possible career path for students. To demonstrate the diversity of businesses and the types of enterprises, famous Hungarian entrepreneurs are regularly invited as guest speakers.
- Theoretical knowledge on entrepreneurship: here we define concepts and demonstrate them via cases. Important notions such as business concept mapping, value proposition, marketing, market research, Minimum Viable Product (MVP), pivoting, venture capital, etc. are explained with many examples.
- Practical experience of launching an enterprise: an optional, practice-oriented extra class (titled *Startup VIP Programme*) is offered to those students who are really engaged and motivated to start their own businesses. Here we help students solve the emerging business challenges of entrepreneurship.
- Guidance to career planning: we help students learn to answer relevant questions for themselves such as ‘Is this a job for me?’ or ‘Is it worth launching a startup for my idea?’.

The entrepreneurship curriculum of the course primarily follows János Vecsenyi’s approach. His 12-step framework is specified in his book (Vecsenyi and Petheő 2017) and supplemented with digital materials of the [vallalkozasindito.hu](http://vallalkozasindito.hu) (in English: [StartMyBusiness123.com](http://StartMyBusiness123.com)) site (Vecsenyi n.d.). The course focuses on the first six steps of this framework. The extra hands-on class (see goal c. above) is organised according to the StartupVIP incubator methodology, also developed by Vecsenyi, and implemented at two universities in Hungary (BME and Budapest Corvinus University). In addition, Bill Aulet’s (MIT) 24-step Disciplined Entrepreneurship framework is used, especially the ‘Who is your customer?’ and ‘How do you make money off your product?’ themes (Aulet 2013).

## 2. Students as customers

We, as lecturers, view our students as ‘customers’ with different needs. It is clearly understood that students with different backgrounds and experiences have different expectations regarding the course outcome. There is no one universally accepted categorisation for students, but different schools identify different ‘personas’. The MIT Martin Trust Center for Entrepreneurship, for example, suggests five personas: ‘The Curious Entrepreneur, The Ready-To-Go, The Joiner, The Amplifier, and The Corporate Entrepreneur’ (Wymer 2021, 6). Our approach is different. The two most important criteria for distinguishing students are *experience* and *eagerness to start a business*. Based on our 10-year empirical experience, the students can be categorised according to these two dimensions. The most important goals of these student personas differ, as Figure 1 shows.

Students who have no previous entrepreneurship experience form the majority of the class. Some are eager to start a business straight away; they are definitely committed. However, others are less certain or do not want to start a business immediately; they want to become an entrepreneur later, after school or after gaining several years of professional experience. Nevertheless, for students in both these

categories, their typical attitude towards the class is that they get a no-risk test environment where they can practise the business launching process while learning from the lecturers and mentors and from the mistakes of others.

Every semester there are also a significant number of students, though they are still in the minority, who have previous entrepreneurial experience, in most cases picked up from their family environment where one or both of the parents or the larger family is or was an entrepreneur or family business owner. For them, the basic notions are not new, but they want to learn the details and the precise meaning of concepts and phrases, as well as getting familiar with up-to-date international and professional wording. The fourth category is the set of students who are committed entrepreneurs. They typically have a business idea and they want to launch their startups as soon as possible. Most of them already have some experience, but they are aware of the fact that they have to learn more and want to get practical guidance from lecturers, mentors and others in the startup ecosystem.

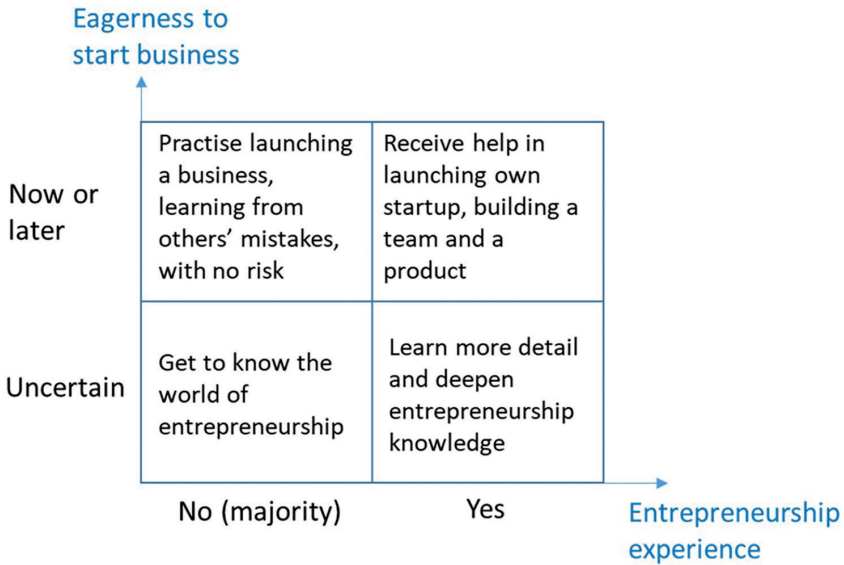


Figure 1. Student personas and their goals based on our 10-year empirical experience (own editing)

### 2.1. Levels of student engagement

It would be an easy and obvious choice to offer the course differently to the four different student categories summarised in Figure 1. However, four categories would be too many; it would be difficult to manage the class according to the different needs. Originally, back in 2010, the course founder Professor Vecsenyi defined an easier model of three student categories, based on the different levels of student engagement. He recognised that students can be categorised into three levels ac-

According to their commitment, enthusiasm and eagerness, that is, their engagement. The original three-level differentiation scheme has stayed the same for more than a decade because it is

- easy for students to categorise themselves
- easy to differentiate the forms of education
- easy to set different fulfilment requirements for different groups.

Table 1 summarises the three levels, named Sunday hiker, Easy rider and Startup driver.

Level of student engagement	Name of student category	Form of education	Topics covered	Time required per week	Fulfilment of course(s)
Basic	Sunday hiker	Only lectures	Entrepreneurship basics	3–4 hours	One end-of-semester test
Advanced	Easy rider	Lectures + consultation	Problem–solution fit + concept mapping	5–6 hours	Business concept map + 2-minute video
Full	Startup driver	Lectures + practice + mentoring (StartupVIP Programme)	Problem–solution fit + product–market fit (market validation)	Min. 10–12 hours	Validated business concept + pitching

Table 1. Three ways of completing the course (own editing)

Based on 12 years’ experience, we can confirm that students like this separation of requirements. It gives them certain freedom and control over how to accomplish the subject. Our marketing communication wants to make clear to the students that what they want is *their* decision: ‘What will YOU get if you take this class? It depends on YOU, on what YOU want. This is YOUR class, YOU chose it. What do you want to get?’

**What do YOU want to get?**



Figure 2. A flyer explaining the different student segments (own editing)

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Thus, the Launch of Innovative Businesses course currently can be completed in the following three ways based on the original hypotheses: **Sunday hiker** students have the goal of gaining a general understanding of the startup world. They want to hear about entrepreneurs and entrepreneurship, so that they can write a test at the end of the semester to show how much they have learnt during the course. The **Easy riders** want to summarise their enterprise concept and receive feedback on their ideas. They want to learn about concepts and tools to use the later in their career; thus, they create a business concept and a video pitch, usually in pairs. The **Startup driver** students want to apply knowledge in practice, to be involved in a practical startup development process and to experience the live environment of chasing a startup dream. They have to work on their own ideas in a team in order to validate them, and this work requires active participation during the whole semester.

The majority of students, about 80%, select the easiest Sunday hiker completion of the course; approximately 12% select the Easy rider way; and only about 8% select the most demanding Startup driver completion and the extra requirements. Of course, it would be more preferable to shift Sunday hiker students to the other two categories. To understand the reasons why Sunday hikers are reluctant to make efforts towards more engagements, in 2018 we initiated a quantitative research project to span several years.

### 3. Methodology of the primary research

In the primary research, a questionnaire survey was used to examine the university students' attitudes towards starting a business and the Launch of Innovative Businesses course. The questionnaire was based on the experiences of previous semesters of the subject: in addition to mentioning a number of entrepreneurial and learning objectives, it also analysed the possibilities for completing the course. The aim of the questionnaire research was to validate the need for the three different methods of completing the subject, since our preliminary hypothesis was that the students of a course of several hundred participants are so heterogeneous and their needs for knowledge about entrepreneurship are so varied that we need to offer several ways to fulfil the requirement of the subject.

We conducted a multiple cross-sectional research (Malhotra et al. 2017). The questionnaire was surveyed in five consecutive semesters, in each case in the week preceding the semester. The questionnaire was identical across the five terms, allowing for comparisons between semesters regarding the statements, as well as for a combined, aggregated examination of several semesters. Convenient sampling method was used whereby the sampling frame was the total number of students in the course in a given semester. The questionnaire was completed online, and semantic scales were applied for most questions, which were used, among others, to compare means and for hierarchical clustering. Statistical analyses were performed using IBM SPSS version v28 following the methods described by Sajtos and Mitev (2007).

## 4. Results of the primary research

### 4.1. Demographic data

A total of 809 evaluable responses were collected in the sample over the five semesters. Figure 3 shows the number of students enrolled in the course for the five semesters and the number of students who completed the questionnaire. It can be seen that more than 50% of the students in the sampling frame database completed the questionnaire at the start of each semester. This is a very good percentage, considering that the students did not receive any reward and that participation was entirely voluntary. The high completion rate also reduced the limitations of the questionnaire, which allowed us to get a more accurate idea of the expectations of our students when they arrive for their first lecture.

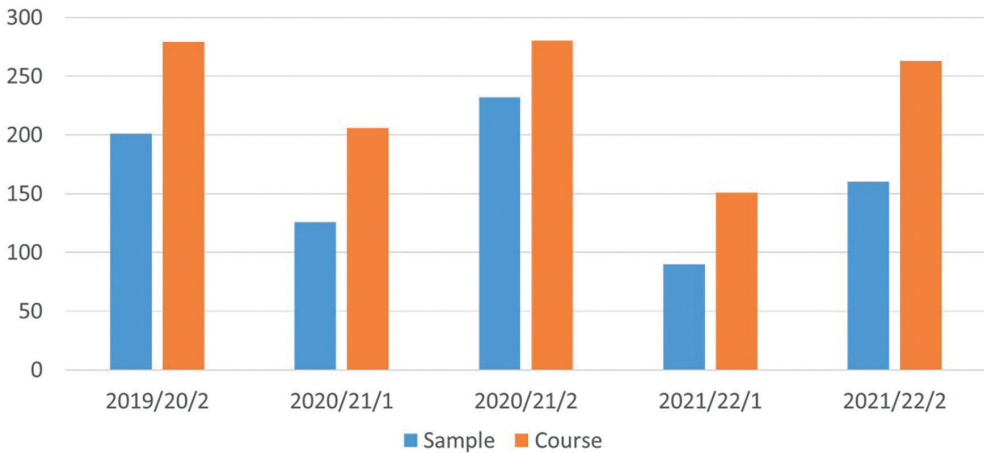
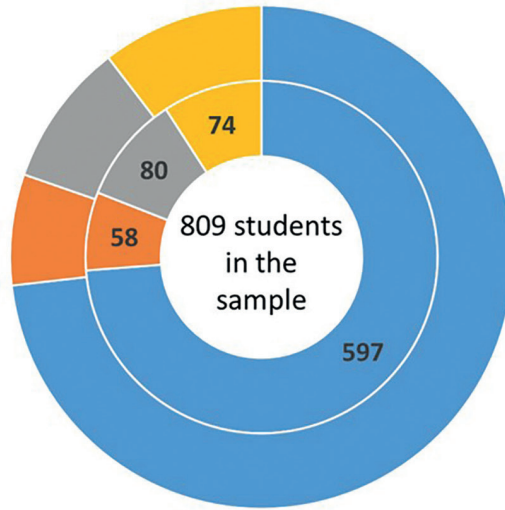


Figure 3. Sizes of the samples and the sampling frames in each semester (own editing)

The course can be attended by students from several faculties of the university. The proportions of students from different faculties are shown in Figure 4, where the outer pie chart shows the students who enrolled in the course and the inner pie chart shows the distribution of the sample. There is no significant difference between the two distributions, so the sample can be considered fairly representative of the course students in terms of faculties and thus of expected prior knowledge. Figure 4 also shows that only a very small percentage of the students study economics at a higher level during their undergraduate programme, but that they may come to the course with a number of innovative entrepreneurial ideas thanks to the engineering approach they have gained.



- Faculty of Electrical Engineering and Informatics
- Faculty of Mechanical Engineering
- Faculty of Economic and Social Sciences
- Other faculties

Figure 4. Distribution of the students from different faculties of the university in the sample and the sampling frame (own editing)

#### 4.2. Students' general needs in relation to the course

Figure 5 shows the answers to the semantic scale of six questions for the whole sample, broken down by semesters. In all cases, the questions were related to the students' needs in relation to the fulfilment of the course and the content of the lectures and exercises. In the figure, the average values of the semantic scales have been transformed into percentages.

In general, students prefer practical education and want to learn about starting a knowledge-based business. There is a more significant difference between semesters in terms of whether students prefer to complete assignments during the semester or at the end of the semester. For the three questions in the bottom row of Figure 5, there were greater variations, with both extremes receiving a high number of responses. Thus, there was no homogeneity at all in the student population regarding teamwork, active or passive participation in classes and acquisition of a valuable knowledge. There were many responses showing that the enrolled students want to fulfil the course easily, prefer to work on their own and do not participate actively in the lectures.

2019/20/2	Practice		34%	Theory	Knowledge-based enterprises		35%	Conventional enterprises	Practical tasks during the semester		53%	Test at the end of the semester
2020/21/1			24%				40%				34%	
2020/21/2			29%				34%				36%	
2021/22/1			26%				36%				40%	
2021/22/2			27%				40%				37%	
2019/20/2	Teamwork		47%	Work individually	Active participation		56%	Passive participation	Easily obtainable mark		53%	Value of the knowledge
2020/21/1			46%				57%				60%	
2020/21/2			49%				60%				58%	
2021/22/1			51%				54%				56%	
2021/22/2			48%				55%				54%	

Figure 5. Students' needs concerning the lectures broken down by semesters (own editing)

### 4.3. Comparison of the created clusters

The results presented in Subsection 4.2 also suggest the identification of different student groups; the experience of the previous semesters of the subject confirms this. In the questionnaire, after a brief description of the three different options for fulfilment, the students were asked to select the way they expected to obtain a grade for the subject (Sunday hiker, Easy rider or Startup driver).

Figure 6 breaks down the responses to the six questions presented in Subsection 4.2 by the groups of answers indicated by the students. The values represent the average values between the extremes of 1 and 7 in the figure. The Sunday hiker group, which writes the test, typically prefers a more easily obtainable grade, passive participation and individual preparation, while the other two groups differ in most values from the test-taking group. The only agreement among the three clusters is that they prefer to learn about knowledge-based enterprises and there is a relatively strong similarity in their preference for practice-oriented training.

Original classification by the students												
Sunday hiker	Practice		3,03	Theory	Knowledge-based enterprises		3,2	Conventional enterprises	Practical tasks during the semester		4,88	Test at the end of the semester
Easy rider			2,51				3,16				2,16	
Startup VIP			1,94				3,35				2,35	
Sunday hiker	Teamwork		4,78	Work individually	Active participation		4,94	Passive participation	Easily obtainable mark		3,74	Value of the knowledge
Easy rider			3,07				4,08				4,79	
Startup VIP			3,54				3,19				5,72	

Figure 6. Differences for the semantic scale questions based on the original classification by the students (own editing)

Using the data from the six questions, we also created the three groups using a two-step hierarchical clustering technique (based on Hair et al. 2019). In the first step, the outliers were filtered out using the single linkage method, and in the second step, the three groups were created using the Ward algorithm. Figure 7 shows the differences between the three clusters (with the same names as in the original concept) formed by the Ward method. Furthermore, Figure 8 highlights the differences between the averages of the clusters formed by the students and the clusters formed by the Ward approach. The following can be highlighted for the clusters that were created by the Ward method:

Sunday hikers:

- Knowledge is less important
- Less participation during lectures
- No need of teamwork
- Practice is less important

Easy riders:

- Knowledge is valuable
- Less participation during lectures
- No need of teamwork
- Looking for practice
- 

Startup drivers:

- Knowledge is valuable
- Want to participate in lectures
- Need teamwork
- Looking for practice

Ward method classification									
Sunday hiker	Practice	Theory	Knowledge-based enterprises	Conventional enterprises	Practical tasks during the semester	Test at the end of the semester	3,28	3,41	5,68
Easy rider							2,19	3,03	2,08
Startup VIP							2,59	3,13	2,69
Sunday hiker	Teamwork	Work individually	Active participation	Passive participation	Easily obtainable mark	Value of the knowledge	5,89	5,55	3,55
Easy rider							6,33	4,24	4,76
Startup VIP							1,91	3,86	4,68

Figure 7. Differences for the semantic scale questions based on the clusters by Ward method (own editing)



Differences of the two classifications (Ward - original)								
Sunday hiker	Practice	0,25	Theory	Knowledge-based enterprises	0,21	Conventional enterprises	Practical tasks during the semester	0,8
Easy rider		-0,32			-0,13			-0,08
Startup VIP		0,65			-0,22			0,34
Sunday hiker	Teamwork	1,11	Work individually	Active participation	0,61	Passive participation	Easily obtainable mark	-0,19
Easy rider		3,26			0,16			-0,03
Startup VIP		-1,63			0,67			-1,04

**Factors of differentiating**

Figure 8. Differences for the average values base on the two types of classifications (own editing)

Figure 8 shows that the three factors in the bottom row are very important elements in students’ understanding of how the subject can be completed and are the most likely components to put students on the right track. There is a significant difference in terms of attitude towards teamwork, which also highlights a more emphasised difference between the Easy rider and Startup driver approaches. As for active participation in lectures and ease of obtaining a grade, we found a difference for those who chose Startup driver, which suggests that, on the one hand, the extra work of the Startup driver Programme should be reflected in the credits and grades obtained, and that, on the other hand, the exercises could be better adapted to the students’ need for activity in the classroom.

		Ward method classification		
		Sunday hiker	Easy rider	Startup driver
Chosen by the students	Sunday hiker	189	67	120
	Easy rider	38	73	268
	Startup driver	7	13	34

**Choose a less complex way to finish the course**

**56%**

**Choose according to their needs**

**37%**

**Choose a more complex way to finish the course**

**7%**

Figure 9. Comparison of the two grouping methods (own editing)

A cross-tabulation that compares the two groupings is shown in Figure 9, which also highlights the proportion of students who choose the programme that is really intended for them, and the percentage of students who prefer a weaker or stronger way of fulfilling their requirements compared to their needs at the beginning of the semester. There is a significant proportion of students (56%) who choose a weaker option relative to their needs, with a particularly high number of students who (presumably based on the difference between teamwork and individual work) choose Easy rider over Startup driver. The proportion of those choosing a more complex solution compared to their needs is very low for the five semesters taken together. This result also draws our attention to the need to be more precise and transparent in communicating the characteristics of each fulfilment mode at the beginning of the semester. Looking at the columns in Figure 9, it is also clear that, based on the Ward method, Sunday hikers have the highest proportion of students who can predict their preferred fulfilment mode, but for students who choose Easy rider and Startup driver, there is much more uncertainty about the fulfilment mode.

Figure 10 shows, by semester, the proportion of students who choose to meet their needs and the proportion who choose to perform less or more strongly than their needs. Although there are small differences between semesters and the figure shows which semester presented which educational problems and situations during COVID, the Chi-square test did not show significant differences between the semesters ( $p = 0.354$ ).

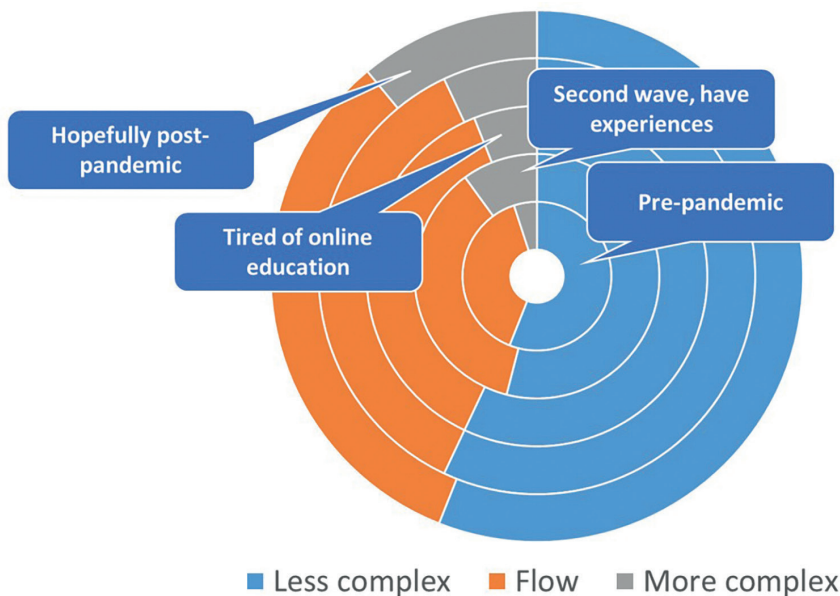


Figure 10. Students' chosen methods compared to their needs, by semesters (own editing)

## 5. Conclusion

For large classes, EE is a challenge, primarily because of the heterogeneous student needs and expectations. For more than 12 years, a simple three-tier student segmentation has been used based on intuitive recognition of categorising student engagement into three levels. The goal of our primary research was validating the hypothesis that these three categories mean a proper segmentation of students.

The results show that segmenting the students based on their divergent needs and attitudes is a very important and effective way to improve student satisfaction. As Figure 8 shows, the most diverse needs can be detected regarding the following three decision points of students:

- teamwork vs individual work
- active vs passive participation in classes
- easily obtainable marks vs. value of knowledge, that is, level of effort required to complete the course.

This outcome also means that these factors must be emphasised and clearly explained to the students before asking them to group themselves into one of the three segments.

Based on our results, we strongly recommend that university lecturers consider structuring the class based on student engagement levels, especially for large classes. Our three-level segmentation proved successful for courses with more than 100 students each semester; therefore, as a limitation it should be noted that this type of segmentation is not validated for smaller courses and courses without classic lectures (like laboratories and courses with only practice). Usually, in such a large class as Launch of Innovative Businesses, mentoring and checking of groupwork are not manageable; there are also a lot of students who are not interested in groupwork. Our segmentation proved to be a usable solution for both problems. Based on this limitation, we recommend further research on segmentation aimed at smaller courses.

It was also demonstrated by the results that a large majority of students would like to see a practical curriculum vs theoretical knowledge, which strengthens the practice of involving successful entrepreneurs who present the critical success factors of entrepreneurship in many business areas.

Finally, it was concluded that more detailed and accurate communication is needed for students before they choose categories. It is important that students understand more clearly the fulfilment requirement and the lecturers' expectations. Following this guidance, the number (and therefore the ratio) of Easy rider and Startup driver students could be increased, which would raise the added value of the course.

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## The semiotic functioning of synthetic media

The interpretation of many texts in the everyday world is concerned with their truth value in relation to the reality around us. The recent publication experiments with computer-generated texts have shown that the distinction between true and false, or reality and fiction, is not always clear from the text itself. Essentially, in today's media space, one may encounter texts, videos or images that deceive the reader by displaying nonsensical content or nonexistent events, while nevertheless appearing as genuine human-produced messages. This article outlines certain problems with artificial intelligence (AI)-generated content, and frames the issue as a problem of recognising its proper referential reality. Examples include generative texts, deepfakes and their functioning in contemporary culture. The article makes use of the concepts of mimicry and nonsense to reveal the elements and counterparts in the communicative processes involving generated media.

**Keywords:** *referential reality, artificial intelligence, deepfakes, generative text, language transformers*

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## 1. Introduction

The traditional Fregean logic seems to rely on the assumption that textual statements are non-fictional or about the external reality, otherwise they do not have a reference. Literary scholar Marie-Laure Ryan (1991) proposes a theory of possible worlds to solve this problem for literary analysis. However, in semiotics, Jørgen Dines Johansen (2002) and Umberto Eco (1979) propose the diverging perspective that every text should be taken as a fictional construct first. Today, the problem is further highlighted by the emergence of language-transformer computer models that enable the creation of content that humans may find difficult to distinguish from regular content. Synthetic content (such as generated text) and synthetically enhanced content (such as deepfake videos) displace our habitual understanding of authorship and sense-making, enabling new, sophisticated ways of lying about the sender and the message content.

This article aims to bring the problem of synthetic content to the attention of semiotics and communication studies. Semiotics as the study of meaning-making in communication can offer useful perspectives for analysing how synthetic media functions in culture, as opposed to traditional media. Semiotics offers ways to understand how synthetic content readily distorts and hijacks parts of the habitual communication schema as described by Roman Jakobson.

The article proceeds as follows. First, I give an overview of the referentiality problem as outlined by literary and semiotic scholars. Then, I introduce certain types of computer-generated content using the examples of generated texts and deepfake imagery. After that, I highlight the ways in which the presentation of such synthetic content plays with our traditional understanding of authorship and making sense of the message, utilising the models of mimicry and nonsense. Finally, I further analyse how synthetic or synthetically enhanced content displaces and obscures the author and the real meaning of the message. In conclusion, I argue that generated content is equal to nonsense until the real author – the person or persons who request and handle the text – decides whether the text is suitable for publishing. A deepfake, however, is equivalent to a situation where the real sender, remaining obscure to the receiver, hijacks a trusted channel to deliver a lie.

## 2. Fiction, non-fiction and referential reality

According to Frege [1948], one of the first philosophers to consider fiction as a logical issue, a sentence about an imaginary entity does not refer, and this sentence is automatically false (or indeterminate, in a three-value system). Statements about fictional entities could then be excluded from the set of true statements on grounds of referential failure, while errors and lies would illustrate the case of faulty predication. Implicit to the Fregean position are three propositions: (1) Reference can only be made to that which exists; (2) 'To exist' is synonymous with 'to occur in the real world'; and (3) Only one world exists, the world we regard as real (Ryan 1991, 14).

In literary studies, multiple scholars have indicated the shortcomings of purely pragmatist models in analysing fictional texts. The above reflection by Marie-Laure Ryan leads to her conclusion that a Fregean logic-based position on texts is not applicable to literature as non-fiction. Ryan (1991) continues looking for assistance in the segregationist ontology of Thomas Pavel (1986) as an alternative for making a difference between fictional and non-fictional statements. However, Pavel's segregationist ontology still 'loses the distinction between fiction and literary criticism, which also refers to nonexisting entities. ... Moreover, ... the segregationist ontology ... encounters the additional challenge of ontologically hybrid textual worlds' (Ryan 1991, 15). To overcome the problem of questionable truths and ontologically hybrid texts (hybrid in the sense of mixing fictional and non-fictional), Ryan proposes the theory of possible worlds — originally, a concept from Leibniz depicting 'an infinity of possible worlds [that] exists as thoughts in the mind of God' (Ryan 1991, 16). Earlier, literary theorist Lubomír Doležal stated that 'meaning in literary texts (and in natural language texts in general) cannot be reduced to the concept of truth or truth-conditions' (Doležal 1979, 195).

In *A Semiotic-Pragmatic Approach to Literature*, Jørgen Dines Johansen goes further in explaining the relationships between linguistic representations and their referential realities: 'On a basic level, the **linguistic representation**, at least in English, is **identical regardless of whether the universe referred to is fictional or historical** (e.g., verb tense is no certain indicator)' (Johansen 2002, 152, emphasis added). For this reason, it is not possible to derive the reality of reference from a linguistic text only, without taking into account the situation and context of its utterance. The same impossibility of inference goes for the truth value of the text. In semiotic theory, Umberto Eco rejects the need for any reference whatsoever, 'defining meaning as a purely cultural unit, a structure generated by a cultural code' (Nöth 1995, 97). From Eco's conviction that 'a sign is everything that can be used to lie' it follows that we can never be certain of the truth value deduced from a sign action alone. Lest it be a lie, the truth needs to be evaluated by other means than the semiotic, and the semiotic inquiry, in Eco's opinion, should not be concerned with the truth at all. Eco goes as far as indicating our experience of the reality as semiotic first and above all: 'Within the framework of a constructivistic approach to possible worlds, even a so-called "actual" or "real" world of reference must be taken as a possible world, that is, as a cultural construct' (Eco 1979, 222). This is the reason we can access the different worlds (fictional and non-fictional) in the first place — everything is experienced through culture.

So far in history, cultural texts and texts in culture have been fairly clear-cut in their relation to referential reality, especially through their authorship — every natural language-based text has an author (a human author, that is) whose intention leads the purpose of the text (fiction, non-fiction, a lie, a belief, and so on), and further reception of the text forms its position and interpretation in culture. Today, we can see a proliferation of a new type of text: a computer-generated one. This new kind of synthetic text challenges the habitual ways of reading texts and assigning meaning to them.

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### 3. The problem of generated content and its reference

The Internet in general can be an unreliable source for information because in large part the content on the Internet is not validated or controlled in a way that was customary in the old media. This results in ‘a network of communicative fragments’ with very different origins, purposes and properties, making interpretation of the texts very difficult (Verschuereen 2001, 87). Furthermore, the digital space today is accumulating the kind of texts that are non-texts in a Lotmanian sense — lists of links and keywords used for spamming purposes, spam emails and, finally, computer-generated synthetic content such as the output of GPT-3. The reaction to and interpretation of these different types of content varies from person to person and from text to text. For instance, spam comments are easy to recognise as non-significant; spam emails are also usually identifiable as such, even while their language and personalisation are becoming more sophisticated. The intention behind spam and phishing is to draw the reader’s attention and make them act in a certain way — to click on the links or to divulge sensitive information such as passwords. Phishing emails and Twitter troll posts are rather intentional messages with misleading information, that is, lies. Eventually, all these examples at least pretend to be related to non-fiction, that is, refer to actual reality and make the reader act in some way in the actual world.

Text generators such as GPT-3 and its relatives pose an interesting problem in the space of texts today: they can produce outcomes that are, by all appearances, unrecognisably similar to ‘real texts’. Such is the case of short opinion articles or funny lists of ‘whale facts’ (Shane 2020; see also Shane 2019). At the same time, these ‘texts’ do not have real reference or referentiality in the Fregean sense of the word. The referential reality of synthetic texts is tentative, only constructed and determined by a (human) judge comparing their expectations with the outcome. If the result meets expectations — ‘whale facts’ are correct, or the opinion piece is satisfactory in style and content — the judging editor may state that the text is ‘about external reality’, and publish it. If the result is incorrect, insufficient or inconsistent with the respective possible world (fictional or non-fictional) — e.g., the requested whale facts contain statements such as ‘dolphins also live in the desert’ (Shane 2020) or other statements that are false or nonsensical in relation to the external reality, the judgement may evaluate that the text is ‘about nothing’.

All in all, in the world we have texts and statements that do not have referential reality because their authors intended it so, or because the statements are about objects that do not exist in the actual world. Ryan (1991) takes the problem of fictional texts that do not refer strictly to actual/real reality and explains that they refer to their inner storyworlds (possible worlds) instead. In this sense, fictional texts are self-referential and their ‘truths’ exist within their storyverses. However, fiction is always *intentional* from its author’s side: it is written and published with intention, whatever its contents or complexity. Even with historical texts where the author’s person (or persons) is not clear (such as Shakespeare, or Qoheleth of the book of Ecclesiastes), the author is always implied (and sometimes the author is constructed out of their oeuvres, but that is another topic).



There also exists a type of texts and signs that are not intended but are *received* as signs or messages. Hereby I mean, for example, the characteristics of animistic beliefs and religion systems where certain natural phenomena are interpreted as signs of God(s). It is reasonable to assume that a storm or drought is simply a coincidental state of weather, and not an intentional ‘message’ from some entity to punish the village, but in an animistic system it may be interpreted as such.

### 3.1. Deepfakes

With the current deep learning technologies, it is possible to build models that imitate human voice in audio and human faces in photo-like still images and videos alike. In this manner, real faces in image and video can be swapped for other, borrowed faces, or new ones can be generated from scratch. The same applies to human voices. The imitations are realistic and convincing enough that they may be indistinguishable to the naked human eye from genuine video and photography. Considering the pixel composition of digital images and the relatively low pixel resolution of the majority of images found on the Internet, the best imitations are realistic enough to pass for a low- or medium-quality photograph or video of a real human. Eventually, a genuine photograph or a video is also just a representation of a living person. Although we take the ‘proof’ of photography for granted, the true existence of the object of reference in this sign relation can be verified only by presenting the real person next to the photo. In the absence of the real reference object, the verification in everyday life is provided by the complex system of social relations and institutions of trust, convincing us that if a friend shows us a photo with other people in it, and this friend usually tells the truth, then these people are probably real, not computer-generated fakes or ‘photoshopped’ images next to her in the photo.

Most commercial applications for deepfakes can currently be found in entertainment and retail. For instance, deepfake algorithms can be used to facilitate virtual ‘fitting rooms’ for clothes, hairstyles or cosmetics. In entertainment, deepfake technology supports imitating famous actors and singers (voice-, face- and body-swapping), seeing how one’s face would look when older or how one’s body would be as a dancer (full-body puppetry). (See Kietzmann et al. 2020 for an overview of the history, potential uses and technical functioning of this technology.)

Commercial applications aside, here I want to highlight two cases of deepfake use. The first example is the ‘borrowing’ of the face and voice of then-President Obama in an exemplary video by Jordan Peele. The short video available on the Internet, titled ‘You Won’t Believe What Obama Says in This Video!’, starts with an apparent speech by Obama, warning the viewer of the dangers of fake news and false information. The footage then continues with a lip-syncing video of Jordan Peele displayed next to the video of Obama. Thus, it becomes clear that the ‘message’ is actually being delivered by the actor, while Obama’s face and voice are only ‘borrowed’ for the occasion.

The second case concerns the ‘deepfaking’ of the voice of late Anthony Bourdain in a documentary about his life and death. The fact might have gone unnoticed were it not for the revelation of the documentary’s director Morgan Neville. In a promo-

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tional interview, he boasted about the usage of AI in ‘helping’ Bourdain ‘say’ things that he had actually not recorded in real life (Simonite 2021). The previous recorded clips were used to synthesise new clips in Bourdain’s voice to express things that he had arguably written before, but not spoken. The case raised an immediate debate about the ethicality of such practice. However, deepfake technology has been deemed ethically and socially problematic on a much larger scale. Deepfake political videos are considered a serious threat to democracy (Poulsen 2021, 502). Even more intrusive and transgressive in nature, a disappointing practice of deepfake pornography can be found in the darker corners of the Internet (Poulsen 2021).

For all the above practices and reasons, it is important to understand how such technologies work and function in culture. The need for tools to deconstruct and analyse their functioning has never been more dire.

#### 4. Synthetic content as mimicry and nonsense

There are two concepts that I find helpful in clarifying the structure and functioning of generative texts and deepfake videos. The concept of mimicry (Maran 2017), borrowed from biosemiotics and used here as an epistemological tool, helps differentiate the channels of synthetic message transmission and identify which elements of this process are ‘hijacked’ or different from habitual practices. The concept of nonsense (Katz and Shifman 2017) frames generated content as a cultural subtype of fiction and explains its functioning in culture in general.

The concept of mimicry is pertinent in the context of computer-generated media because it enables analysing deception in the communicative process regardless of the apparent identity or intentionality of the sender. The concept has been used in a wide range of disciplines including economy and anthropology (Maran 1999, 139). Certain military action strategies today find inspiration in mimicry-based deception models (Maran 2001, 2017).

Mimicry involves three participants – model, mimic, and receiver or dupe (Maran 1999, 2001, 2017) – and the relationships between them. Here, I focus on the relationship based on deception that is taking place between the mimic and the receiver (Maran 2017, 69). In the mimetic process, the mimic intercepts the communication channel between the model and the receiver in such a manner that the latter is deceived (duped) about the origins or the content of the message or both. A similar mechanism seems to be at work in the publication and media reception of a computer-generated news article in *The Guardian* in September 2020. The published article and the following explanatory comment hide the agency and authorship of the unnamed editorial team and name OpenAI’s text generator GPT-3 as the ‘author’ of the article (cf. Viidalepp 2022 for an analysis and longer explanation). But, more importantly, mimicry is a liminal type of phenomenon, functioning ‘by lingering between perception and non-perception, recognising and non-recognising, meaning-making and a lack thereof’ (Maran 2017, 60). This is quite similar to the effect created by synthetic texts that seem to draw attention and interest precisely due to their residing in the space between a text and a non-text, hovering between normal-

ity and a sense of otherness, and keeping the reader guessing about the sender and intention behind the message.

Nonsense has a particular role in cultural communication. Katz and Shifman analyse the concept using the example of ‘digital memetic nonsense’, a type of user-generated nonsensical visual meme that is supported and facilitated by characteristics of today’s new media space (Katz and Shifman 2017, 828). They outline three historical types of nonsense. Firstly, nonsense as a lack of meaning has been used as an artistic tool to challenge the notion of truth. This is especially characterised in the postmodernist use of intertextuality in pastiche, an art form offering ‘imitation for the sake of imitation; a state in which one text cites another without adding any referential meaning’ (Katz and Shifman 2017, 834). Secondly, nonsense as a deconstruction of meaning ‘examines the ability of signs to create meaning and highlights their failure’ (ibid., 826). They find that deconstruction of meaning is characteristic to works of literature such as *Finnegans Wake* or *Alice in Wonderland* where language and word games are used as parts of the plot, or *Waiting for Godot*, which experiments with the tentative inclusion of extratextual reality (the two characters in the play are waiting for a third character who never arrives). After an initial confusion, all the above works invite their audience to a deeper deciphering of the ‘meaning’ of the text. The third type of nonsense mentioned by Katz and Shifman is a play with meaning that can be found in certain limericks or in instances of polysemy that offer the reader multiple ways to interpret or read the same content (ibid., 827).

On the one hand, current digital media space features user-generated nonsensical content that mostly performs the phatic function, as demonstrated by Katz and Shifman (2017). In such a content, nonsense is used as a way to filter ingroup members — those who understand the joke — from the outgroup, as well as to enforce the ties within the phatic community. Nonsense and ongoing negotiation of the rules for its composition serve to keep the community alive, that is, engaged and constantly following each other (Katz and Shifman 2017). This type of nonsense can employ different approaches to question meaning (play, deconstruction or lack of meaning), but in every case analysed by the forementioned authors, the nonsensical meme is created and posted intentionally by Internet users. Therefore, it always has an author, a sender in the traditional sense.

## **5. The referential shift and the semiotic functioning of synthetic media**

The structure of the communicative act contains in typical models the sender (author), the message, the channel and the receiver. Roman Jakobson (1971) also adds the context and the code. In a simplistic example of a typical, regular text, the sender (author) prepares the message (text) and uses some channel (print or new media) to transmit the message to the receiver (reader). The context and the code may help in asserting the preferred referential reality for the message. For instance, the context of a daily newspaper in the normative language positions the text as something about the actual world; the shelf labelled ‘Fiction’ in a bookstore or lines of text

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displayed in a certain way categorise the text as being about imaginary entities, or a book of poetry, respectively.

However, the author of the synthetic text is displaced: it is no more the ‘originator’ of the text but its editor, publisher and even the reader who projects a possible referential world to make sense of the ‘message’. As part of the creative writing process is delegated to the machine, the author(s) may feel a decrease in their work and agency in producing the text, and are therefore eager to allocate their own agency outside of themselves — to the machine. The synthetic text also lacks a proper referent in Frege’s sense. In the case of GPT-3 output, it is based on the statistical probability of co-occurring words. The result refers to the statistics — patterns and regularities — within its training data. That it *happens* to be similar to natural language texts to an extent where it may be undistinguishable to the human reader is entirely a coincidence. (It is more likely to be perceived as a coincidence when the output does not meet expectations and is discarded as a faulty or bad result.)

The synthetic text may be attributed a referential reality by its real human authors (i.e. editors, publishers, readers) with the act of publication (making publicly available) of the text. This referential reality, in the case of GPT-3 op-ed, is borrowed from the secondary narrative world of science fiction (in the sense that Doležel 1979, 199 compares the notion to the Proppian morphological structures of the folktale). The cultural superstructure (Lotman 2005, 213) of the sci-fi universe prescribes AI robots as better-than-human characters that hold self-conscious monologues and aim to conquer the human world. Therefore, GPT-3 ‘the robot author’ is implicitly posited as omniscient (saying ‘Believe me, being omnipotent doesn’t get me anywhere’ in the op-ed).

In a deepfake video, the layers of the communicative act become manifold. As shown in the mimicry model, a second, true sender is added to the schema – the mimic delivering their message. As deepfake face- and voice-swapping videos take an effort to deliver a believable result, the process is less due to chance and more due to the intentionality of the mimic. Therefore, deepfakes may be conceived as intentional deceptive messages hijacking a trusted ‘channel’ — the model’s image and voice. In this case, the referential reality is likely still the actual world, but the message delivered is a lie. The lie can be about the content, but this is a separate topic for research. Foremost, the deepfake is a lie about the channel and the sender, but this may not be immediately recognisable.

## 6. Conclusion

Generative texts belong ontologically to the category of literature (fiction) first, regardless of their content. Their referential reality is first within the internal world of the text. Whether such a world can even be conceived is a decision and task for the first reader of the text who confirms whether the output corresponds to expectations and will be taken into account, to be worked on further. Then, further editors reform the output, turning it into a veritable text. In the case of any synthetic text, the validation of its fitness or eligibility is a task undertaken by its human ‘author’ —

the first reader of the output, the person who orders the output (wrote the prompt) or decides the publication of the output. This person is, in fact, the real author of the text. This is so regardless of whether part of the creative writing process was outsourced to a machine or not. It is really important to remember this and recognise such authorship every single time, because very often when the synthetic outcome looks acceptable in appearance, there tend to be individuals who attribute in this process a greater agency to the machine than it deserves. The human author can transform the text into a message that refers to something else or has a different purpose, but this is then a changed, new message. Without the interference by the real author, the message or the output itself is nonsense, although it may not be recognisable as such.

A deepfake is conceivable as a mimetic act where the mimic hijacks the communication channel to deliver a message that is essentially a lie. The reference of the deceitful message can be the sender's identity, the content of the deceitful claim or any other kind of object intended by the real sender, the mimic. In both cases of generative media, the real author (sender) is hidden, and the exact nature of the message is unknown or unclear.

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## How do students see the role of serious games in education?

*An Eastern-European example*

Grabbing and holding student attention was a big challenge even before the Covid-19 era; however, the coronavirus and the obligatory digital education showed that new methods are needed to resolve these issues. One of them could be implementation of digital serious games. This paper presents the findings of a questionnaire about the feelings of students toward digital serious games. In all, 1755 answers were collected and analyzed and the results showed that most students do not shy away from using these kinds of video games in a classroom environment, although there are various concerns and key aspects educational professionals must consider.

**Keywords:** *Serious games, education, video games, student attitudes, gamification, learning*

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## 1. Introduction

Grabbing and holding student attention is a big challenge every teacher faces during lessons. The current literature has emphasized for years now the limitations of the traditional teaching methods and urges educational professionals to realize the need for more active student participation (Murray and Lang 1997). Traditionally, educators had the active role of professional performers on the classroom stage, whereas most students play the passive, silent audience seeking knowledge. However, based on several studies (Abdullah, Bakar and Mahbob 2012; Murray and Lang 1997; Rocca 2010; Tatar 2005), active student participation facilitates acquisition of knowledge and development of various skills better, as well as leading to a higher level of satisfaction. For this study, we refer to students who share their thoughts, ask questions, participate in group tasks, and do the various exercises as *actively* participating students. On the other hand, we refer to students who keep silent, take notes for themselves, or do something irrelevant to the lesson as *passively* participating students.

Based on various studies in the field of teaching and learning, it was found that students who play an active, participating role tend to have better academic achievement, show higher satisfaction in the learning process, and have a more effective and enjoyable learning experience compared to others (Astin 1999; Tatar 2005). Aguilon et al. (2020) mention that, based on their findings, men tend to participate more actively than women. According to Liu (2001), four forms of student involvement are recognized in the classroom: (1) integration, (2) participation in circumstances, (3) marginal interaction, and (4) silent observation. During full *integration*, students engage actively in work during lessons, and they discuss their thoughts with the educator, make questions, and give answers. Taking one step back, *participating in circumstances* means that students are led to participate due to various factors, such as obligatory exercises or one's internal need influenced by sociocultural factors. *Marginal interactions* refer to students who speak less during lessons. However, while they avoid any unnecessary interaction, they are active listeners, take notes, and, if they must speak, speak their mind but accept any given topic of the class discussion. The last category consists of students actively avoiding oral participation. They tend to make pictures about the boards and presentations and download the necessary educational material, not actively participating in the lesson. One can agree that Liu's first two categories consist of actively participating students, while the last two refer to passively participating students.

From the students' point of view, learning and participating in a lesson can be seen as a behavior aimed at acquiring knowledge. Like any other act, one must actively be present and do something to achieve one's goal. According to Meyers and Jones (1993), it would be advisable for educators to encourage this behavior and use techniques that require the more active participation of students, like cooperative learning, role-playing, problem-solving. Moving forward on this line of thought, educators are responsible for educating successfully, entertaining, and motivating students (Abdullah, Bakar and Mahbob 2012). However, this can be a challenging task given the wide variety of student perceptions, motivations, and interests. Addressing this issue, serious games can be one successful tool of the many possibilities.



The basis of the term serious game is the game itself. Based on previous studies, it is agreed that a game is a closed, formal system that operates through a well-designed set of rules, and the players are faced with many challenges in trying to achieve their given goal (Adams 2014; Avedon and Sutton-Smith 1971; Ellington, Addinall and Percival 1982; Tekinbaş and Zimmerman 2003, 2006; Stenros 2017). According to Wittgenstein (Wittgenstein and Anscombe 1953), the core building blocks of the term game (rules, play, competition) cannot define and delimit the concept. Instead, he says that the game terminology is used for activities that can be grouped by their similarities. Caillois (1953) said that a game must satisfy six criteria: (1) entertainment, (2) clear separation from the real world, (3) outcome cannot be predictable, (4) cannot be productive (e.g., earning money), (5) based on a specific ruleset, (6) based on its own, unreal world. As Caillois said, involuntary playing makes the game cease to exist as a game. Based upon this statement, a game can be defined as a voluntary activity where players can carry out various actions (Avedon and Sutton-Smith 1971; Dempsey et al. 2002; Duke 1974; Klabbbers 2006; Suits 2005). According to Juul (2005) – similar to Caillois, but different in some aspects – a game can be defined according to the following concepts:

- closed, formal system with a set of rules
- the outcome is variable, quantifiable, and can be calculated and predicted
- different values for different outcomes
- outcomes can be influenced by player effort
- the player is emotionally attached to the outcome
- negotiable consequences.

Inspecting all the various definitions and examples of games leads to one common aspect: the closed system built upon a set of rules. However, academics interpret this aspect differently. One way to see the game is that the rules limit the playing activity (Avedon and Sutton-Smith 1971; Lévi-Strauss 2000), while others say that rules create the world of the game (Riezler 1941; Suits 2005). Furthermore, this set of rules results in a quantifiable process that game designers can consider (Crawford 1984; Ellington, Addinall and Percival 1982; Hunicke, Leblanc and Zubek n.d.; Stahl 1983; Zubek 2020).

The term *serious game* leads back to the renaissance era, where “*serio ludere*” was used for situations where humor was used to deal with serious matters (Djaouti et al. 2011; Manning 2003). The first definition, closer to the meaning academics use nowadays, comes from Clark Abt (1970). According to Abt, serious games are created with a well-designed educational goal in mind. This does not mean that these kinds of games cannot be entertaining. On the contrary, a good serious game is both an enjoyable game and an excellent educational tool. Using serious games for digital educational games comes three decades later from Ben Sawyer (2002), who launched the Serious Game Initiative and called for implementing the various techniques and mechanics from video games for the further development of game-based simulation.

According to Djaouti, Alvarez, and Jessel (2011), any serious game can be identified by three major aspects: *gameplay*, *purpose*, and *scope*. Together, these three aspects make up the G/P/S model, where *gameplay* refers to the structure and mechanics characteristic of games. *Purpose* stands for the game’s primary goal, not

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in the sense of achieving something inside the game's world but beyond that (e.g., teaching something). Purposes can be grouped into three categories: broadcasting a message, exchanging data, or training. *Broadcasting a message* means that the game's primary goal in the real world is to give information about a specific topic. This can be – included but not limited to – with educational purposes in mind, for instance, or to raise awareness of an important issue. Exchanging data means that the given game was created in order to share knowledge. *FoldIt!*, for example, is a successful bio-research game where players need to achieve the optimal structure of protein molecules. The game is constantly monitored by experts who have thousands of helpers this way (who probably don't even know what they are doing, but they understand the rules of the game). Last but not least, the *training* games goal is to develop a specific skill set. *Pulse*, for instance, is a serious game to teach techniques for diagnosing in an emergency context. Finally, **scope** stands for the application the serious games are used in, like education, politics, marketing, and so on.

Examining the wide range of literature available in the field of serious games, one can agree that these kinds of games have the potential power to become a successful educational tool (Abt 1970; Alvarez and Laurent 2008; Arnab et al. 2015; Cain and Piascik 2015; Gredler 2004; McArthur and Teather 2015; Michael and Chen 2006; Ravysse et al. 2017; Tsai et al. 2020; Ghoman et al. 2020). However, according to Caserman et al. (2020), “high-quality serious games must achieve both the serious and the game aspects; they must systematically support players to reach the characterizing goal (serious part) and they must elicit and maintain player experience (game part).” While the original definition of serious games stands for not only digital games but more traditional games, for the purposes of this study the term will be used for digital serious games only.

## 2. Research and method

The present study aims to assess what Hungarian secondary school students think about entertaining and educational serious games in a classroom environment; why they think it is a good idea to use them or why not.

In order to answer these questions, a questionnaire survey was conducted among secondary schools. The selection was based on the Hungarian Enrollment Information System for Secondary Schools (in Hungarian: KIFIR). A unique database was created from the collected schools, including all types of secondary educational institutes with their email addresses (KIFIR 2021). The email addresses were collected with the help of the Google search engine from the official websites of the schools. However, in some cases in the Hungarian educational system, some schools belong to the same central institute and have the same central email address. In these cases, duplications were removed, which resulted in 1127 email addresses. According to the Hungarian Central Statistical Office (2021), there are 2243 secondary educational institutes in Hungary. However, their methodology includes the same school multiple times if said school or its sub-institute belongs to multiple categories. Keeping

this in mind, it is strongly believed that the 1127 emails covered all Hungarian secondary institutes.

The questionnaire was made using Microsoft Form, and it consists of four main parts. The first asks for information about the students' gaming habits, especially how often they play and what kind of game they prefer. The second section asks students about their opinions of the use of video games in education. This part mirrored one previous research (Péter-Szabó 2022) that asked teachers about the same thing but from their point of view. The third section consists of seven-point Likert scales that collect information about students' preferences in video games, focusing on the game mechanics. The last section consists of demographical questions. The questionnaire was sent twice for all institutes with two weeks between them, which summed up the data collection for a one-month period.

### 3. Results

In total, 1755 answers were collected within the one-month period; of those, 1753 were valid answers. For reasons of anonymity, it is not possible to tell from which and how many schools the answers arrived. The remaining two were removed because they were not finished, and only the first two or three questions were answered. More than half of the participants were *male* students (56%); the rest (44%) were *female*. Most of the participants were above 15 years old: about a quarter (25.15%) were aged 15, 21.33% were aged 16, 18.42% were aged 17, and 12.77% were aged 18. The majority of students came from a technical school (37.07%) or a high school (31.94%), while 13% came from a secondary vocational school and 12.09% from an ordinary vocational school. The gender and age distribution by the four main school types can be seen in Table 1.

	Technical school	High school	Secondary vocational school	Ordinary vocational school
<b>Total answers received</b>	647	558	228	211
<b>Male</b>	21.11%	15.57%	7.24%	7.53%
<b>Female</b>	15.80%	16.26%	5.76%	4.51%
<b>15 years old</b>	51.70%	29.71%	3.40%	10.43%
<b>16 years old</b>	39.30%	37.97%	6.15%	12.30%
<b>17 years old</b>	22.91%	37.15%	26.32%	11.76%
<b>18 years old</b>	19.64%	33.48%	25.89%	15.18%

Table 1. Total gender and age distribution by the main school types (own editing)

The first question asked students how often they play video games, and 35.71% answered they play video games every day, of which 86.42% were male students. Further, 415 students (23.67%) said they play at least every week, and 281 (16.03%) answered they do not play video games at all. The results can be seen in full detail in Table 2.

Question	Student	Percentage	Male	Female
Every day	626	35.71%	541	85
At least once a week	415	23.67%	282	133
Once every two week	108	6.16%	45	63
Once every month	112	6.39%	33	79
Less than once a month	169	9.64%	27	142
I do not play video games	281	16.03%	32	249
I don't know / no answer	42	2.40%	16	26
<b>Totals</b>	<b>1753</b>	<b>100%</b>	<b>976</b>	<b>777</b>

Table 2. Students' gaming habits (own editing)

Regarding students' preferences for the various video game genres, it can be stated that the most popular kind is action games (52.3%), followed by e-sport (40.53%), strategy (37.23%), and racing games (35.58%). As the competitive multiplayer segment of some games can be seen as "e-sport" by some of the players, this choice had a sidenote in the survey with examples that were made only for "e-sport" purposes (e.g. League of Legends, Dota, Fortnite). The most common platform students use for playing is a personal computer (66.21%), followed by their mobile phone (54.7%) and one of the released Xbox consoles (30.72%). Tables 3 and 4 show the gender distribution in terms of the top video game genre and the top-used platforms.

Genre	Male	Female	Sum
Action	585	172	757
E-sport	459	130	589
Strategy	365	179	544
Racing games	349	168	517

Table 3. Top-played genres by students (own editing)

Genre	Male	Female	Sum
PC	701	271	972
Mobile	442	361	803
Xbox (360,One,X)	296	155	451
Playstation (3,4,5)	206	97	303

Table 4. Top-used platforms by students (own editing)

The question “*What is your favorite game?*” generated 1681 answers; of these, 292 students said they do not have a favorite game. The remaining answers reveal a wide range of games from which stand out most of the free-to-play and e-sport games that are popular nowadays, like League of Legends, Valorant, Genshin Impact, Rainbow Six: Siege, Counter-Strike, and Fortnite, as well as some paid favorites like Call of Duty, Minecraft, Fifa, Grand Theft Auto, and Forza Horizon.

The second section of the questionnaire consisted of questions about using video games in a classroom environment. The first question asked the students’ opinions using a seven-point Likert scale about the usefulness of video games during lessons. Based on the results, students’ opinions vary widely, as there are almost as many students against using video games (32.8%) as there are students in favor of their use (45.4%). The detailed results can be seen in Table 5. However, 14 answers were removed since Microsoft Form due to an error allowed the users to leave questions unanswered.

Answer	Distribution	Male	Female	How many of them play video games at least once a month?
1	11.04%	84	108	83 (M:61; F:22)
2	8.05%	58	82	82 (M:50; F:32)
3	13.74%	106	133	146 (M:96; F:50)
4	21,74%	194	184	270 (M:182; F:88)
5	19.61%	196	145	273 (M:185; F:88)
6	8.63%	99	51	128 (M:98; F:30)
7	17.19%	232	67	270 (M:222; F:48)

Table 5. Usefulness of video games in a classroom environment (own editing)

Students were asked why they think a video game can be helpful during lessons and the answers provided covered a wide range of possibilities. However, some responses showed outstanding popularity among students. Mostly, they think a video game would make the lessons more interesting (57.33%), it would be easier to learn foreign languages (47.40%), they would be more motivated to learn the curriculum (38.62%), and it would be easier to do so (34.05%).

On the other side, inspecting the students' feelings and fears about using video games in a classroom environment, most stated that the school equipment is not sufficiently good to play games on them (27.32%). Further, 471 students feel that many of their schoolmates do not play video games, from which 134 students play games less than once a month or not at all. Also, 385 students (21.96%) fear they would not be able to differentiate between the actual knowledge and the possible fiction of the video game, and 349 (19.90%) of them stated that they do not even have time for the compulsory curriculum. While 310 students (17.68%) think the content of video games is inappropriate for a classroom environment, 399 (22.76%) do not see a problem at all with using them.

Of the responses for the question “*What lessons could you imagine teaching with a video game?*” the top three answers were informatics (61.15%), foreign languages (49.69%), and history (46.89%). However, mathematics (31.26%), media (29.78%), geography (28.69%), and physics (26.70%) are also among the honorable mentions.

The last section (not counting the demographical one) consisted of questions about the students' preferences for video games and their feelings about using them in a classroom environment. To answer these questions, seven-point Likert scales were used.

	<b>Good graphics</b>	<b>Exciting story</b>	<b>Easy assibility</b>	<b>Multiplayer option</b>	<b>Challenging gameplay</b>	<b>Character progression</b>
<b>1</b>	7.8%	8.4%	7.8%	9.0%	5.3%	7.4%
<b>2</b>	4.6%	6.1%	6.4%	6.1%	3.4%	5.2%
<b>3</b>	9.5%	8.9%	11.7%	9.3%	7.1%	9.8%
<b>4</b>	14.7%	14.4%	16.9%	21.5%	14.0%	17.4%
<b>5</b>	16.5%	17.1%	17.1%	15.9%	23.0%	17.5%
<b>6</b>	15.0%	16.1%	14.8%	14.4%	19.3%	15.9%
<b>7</b>	31.8%	29.1%	25.3%	23.8%	27.7%	26.8%

Table 6. Importance of game mechanics (own editing)

It can be seen that a vast majority of students think that a video game could be as good as possible, yet it cannot replace teachers. Moreover, 39.5% disagree with the statement that a video game can replace a teacher, and 34.4% somewhat disagree

with it. Only 14.9% answered with five or more points. However, most students feel that a properly made video game could help the teacher in lessons or could be an excellent substitute for homework. Only 7.1% of the students think that a video game is unsuitable for teaching, and 10.7% think it is somewhat unsuitable.

Regarding the video games themselves, it can be stated that the most important thing for the students is for the games to be and remain entertaining for a long time. They value good graphics, an exciting story, and easy accessibility. However, they do not mind if the game is not easy, and they welcome the various challenges. More than half of the students stated that it is important for them to have a multiplayer option and to be able to collect points, gear, and progress with their character level.

#### 4. Discussion

The introduced results show that most students do not shy away from using video games in a classroom environment; however, some interesting points are worth mentioning. While more than half of the respondents play at least on a weekly basis, much fewer actually think that video games are appropriate for a classroom environment. This can be explained by the fact that the well-known video games are commercial games among these students, whose primary goal is not education but entertainment. Furthermore, suppose one investigates the favorite games the respondents indicated. It is easy to see that most of these games are not even remotely connected to education (except maybe Minecraft, but Minecraft Edu is a very different version of the base game). League of Legends, Fortnite, Call of Duty, Fifa, Grand Theft Auto, and the other earlier mentioned examples are all about entertainment and competitive gaming without content that is easily usable in a lesson.

Most responses given for the question “*Why do you think a video game can be useful during lessons?*” correlate well with what most researchers think about video games. When academics talk about the power of video games in a classroom environment, motivation, entertainment, and language learning are always among the top reasons. Investigating the question’s counterpart and analyzing the fears and possible barriers, it is worth mentioning that the perceived usefulness, in general, outperformed the perceived negative side of the coin. While asking for the positive sides of using video games, in many cases the number of answers was above 500 or occasionally 1000. However, inspecting the negative side, none reached 500.

Regarding the possible subjects video games can be used for, it can be seen that, according to the students’ opinions, mainly visually representable subjects were mentioned. Even math and physics can be classified in this category, the former due to its logical connections, the latter due to the possible representation of experiments. It is interesting to see that exercising and dancing received meager points because there are many movement-centered games, even consoles, out in the market (Just Dance, Nintendo Wii, VR). However, this can be explained by the fact that most students think that schools do not have the necessary equipment to run these kinds of games.

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The students' video game preferences also give information for future serious game developers. While graphics (the most expensive part of developing a game) are important for most students, a good story and gameplay mechanics are more vital. Moreover, this fact can help to make use of serious games more available and popular among schools, as the modest graphical settings result in a much lower system requirement.

## 5. Summary

Many researchers have already found that many teachers already use video games for teaching purposes in Western-European countries (Kennedy-Clark 2011; Ruggiero 2013; Sandford et al. 2006). According to Williamson (2009), in the United Kingdom 35% of teachers already use and 60% plan to use a video game in a classroom environment. In Hungary, only 30% of teachers use a commercial video game for teaching purposes, and 55% use a serious game (Péter-Szabó 2022). Examining the results of this study, it can be safely claimed that most of the students would welcome teachers trying, at least.

The power of video games is recognized even on a global scale. Successful and well-known developers have already created mods for their game, giving an easy way to implement them into the curriculum (e.g., Assassin's Creed Discovery Mode and Minecraft Edu). Students are interested in video games, and, according to this paper's results, they are interested in being taught by them. This result is significant because positive feedback from students and teachers can influence developers and the video game market (Bokor 2014).

However, developing a good and entertaining video game is a challenging task, not to mention how extremely costly it could be to meet student expectations. However, seeing the results, it can be stated that there is a corresponding demand for educational video games in Hungary. Earlier research (Péter-Szabó 2020) showed that even a game as simple as a text-based adventure game can develop student knowledge successfully. Keeping this and the Western-European examples in mind, why shouldn't we try to make educational video games accessible, then?

## 6. Limitations

This study has its limitation in the number of received answers. According to the Hungarian Statistical Office (2021), there are approximately 469,428 students in secondary education, but for the questionnaire only 1753 valid answers arrived. This fact makes the response rate below 1%, but it must be pointed out that it is possible that not every school secretariat forwarded the questionnaire to the students, and many schools have students with special needs who did not complete the survey.



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