



Digitalisation of teaching, learning, and student life

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Context and Concepts in a Digital Era of European Higher Education

Although digitalisation of higher education has been gaining importance in recent years (Cockburn et al., 2001; Fűzi et al., 2022; Hochschulforum Digitalisierung, 2017; Orr et al., 2020; Rampelt et al., 2019; Tømte et al., 2019), the measures taken in the course of the COVID-19 pandemic (social distancing, institutional lockdown, etc.) led to an unprecedented turning point in digitalising teaching, learning, and student life (Alina et al., 2024; Doolan et al., 2021; Jakoet-Salie & Ramalobe, 2023; Mališ et al., 2022; Petrovica et al., 2022; Rapanta et al., 2021). With all the negative effects of the pandemic, it can consequentially also be interpreted as a universal “boost” for digitalisation processes in tertiary education that have hitherto been progressing at different speeds across Europe (Gilch & Stein, 2023). The ministers responsible for higher education in the European Higher Education Area (EHEA) also endorsed this interpretation of the pandemic as an opportunity when they drew up their Ministerial Communiqué in Rome in 2020, at the same time embedding digitalisation (and its limitations) in the

broader framework of a socially inclusive EHEA:

“Digitalisation has allowed most of our systems to continue to function during the COVID-19 pandemic, although the intensified use of digital means has brought to light certain limits. (...)

We commit to reinforcing social inclusion and enhancing quality education, using fully the new opportunities provided by digitalisation. (...)

We recognize that digitalisation does not offer ‘one size fits all’ solutions, and ask the BFUG to propose ways in which all learners can benefit from the new technologies.”

(EHEA Ministerial Conference, 2020)

As such the (forced) boost of digitalisation creates both: Possibilities for increased inclusion of under-represented student groups in higher education on the one hand, and challenges with regard to an inflexible overreliance on digital formats for other student groups on the other hand.

Institutional services

From teaching and learning to examination and support services, institutions have increasingly embraced digital transformation (Grosseck et al., 2020; Hense & Goertz, 2023; Tømte et al., 2019) and greatly increased their digital offerings. A comprehensive assessment of the extent to which higher education institutions have implemented digital

tools and most importantly, how students evaluate these offers from a (potential) user perspective, becomes essential:

- To what extent are students satisfied with the digital availability of study contents and institutional support structures?

Alignment between preferences and actual modes

Higher education institutions can be considered providers of a specific good, namely higher education. From this perspective, it follows that students represent the demand side. Therefore, in examining the digitalisation of higher education, it is relevant to assess whether the supply of digital and in-person teaching aligns with the demand on the part of students. At this, higher education providers have to take into account the whole spectrum of demands of their (potential) target audience and pay attention to the demands of different student groups

with their diverse needs with regard to the mode of studies (in-person vs. digital). Appropriate opportunities can enable a large number of social groups to participate in higher education and contribute to their remaining in higher education (Basner, 2023; Doolan et al., 2021; Gaebel & Morrisroe, 2023).

- To what extent are studies digitalised and does the degree of digitalisation tally with the different student groups’ demands?

Students' digital resources

Not only the institutional requirements towards digital higher education and their digital support structures are relevant, but also the extent of students' abilities to approach and use them (Doolan et al., 2021; Janschitz & Penker, 2022; Whitworth, 2020). Following the concept by Ragnedda et al. (2020) two dimensions of students' capability for digital higher education – access to infrastructure for studying at home on the one hand and the extent of students' digital skills on the other

hand – are relevant in order to map the extent of "digital capital" (i.e. the sum of digital assets available to students) in a student population. Thus, the following question is approached in order to evaluate the ability to study digitally:

- Do students have access to remote study infrastructure and how do students assess their digital skills?

Academic success in the context of diverse study modes

Traditionally, it is assumed that physical contact among students and between students and their teachers promotes social and academic skill development and thus contributes to study success (Colbeck et al., 2000; Cotten & Wilson, 2006; Knoster & Goodboy, 2020; McMillan, 1987; Terenzini et al., 1984, 1995). More recent research has examined further the increasing importance of virtual forms of socialisation as well as alternative (e.g. virtual) teaching and learning formats, and explored their role in building social and academic networks/capital (Cockburn et al.,

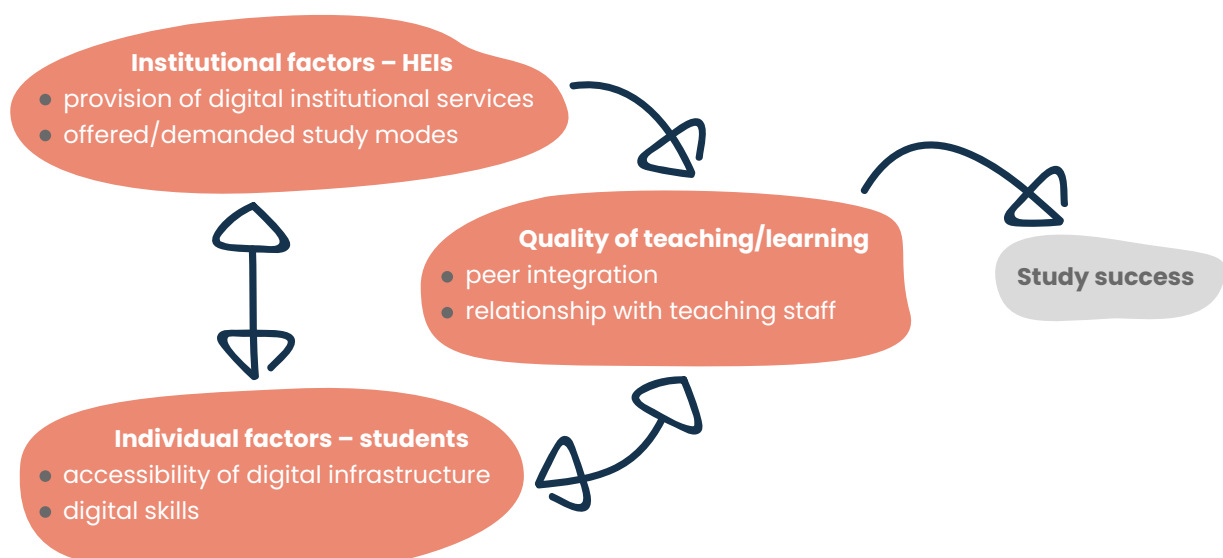
2001; Ellison et al., 2007; Engel et al., 2023; Fúzi et al., 2022; Gaebel & Morrisroe, 2023; Loh et al., 2023). However, a direct comparison of the relationship between digital and personal teaching and learning formats on academic success on a broad empirical basis is still lacking.

- Does the degree of digitalisation of studies relate to the social and academic integration of students and – in the medium term – their academic success?

In summary, the report at hand seeks to explore how institutional services and demands interplay with students' needs and requirements and how

diverse modes of study in turn relate to higher education participants' satisfaction and study success prospects (Figure 1).

Figure 1. **Conceptual framework**



Results

Satisfaction with digital availability of study contents and institutional support structures

Which digital services do students want? Figure 2 shows a widespread demand for the following offerings, which only small percentages of students indicate “not needing”: Digital provision of study materials (four percent “not needed”), services of administration (seven percent) as well as live online (nine percent) or recorded courses/lectures (eleven percent). In contrast, online exams (17 %) and counselling services (24 %) in particular account for much larger shares expressing a preference for traditional methods on cross-country average.

Students’ (i. e. users’) satisfaction with digital availability of most of these aspects is generally high, with only counselling services as an exception. While this overall picture is quite encouraging at first glance, there is a considerable variation between countries:

- Estonia (82 % “very satisfied”), Latvia (73 %), and Iceland (73 %) showcase exceptionally high satisfaction rates for live online courses, while in contrast dissatisfaction is notable in Austria (33% “very dissatisfied”), Denmark (28 %), Portugal (27 %), and Norway (25 %).
- Recorded courses receive high endorsement in Iceland (73 %), Estonia (71 %), and Azerbaijan (68 %), while they appear to pose challenges in Portugal (47 %), Austria (41 %), Denmark (40 %), Romania (40 %), and Croatia (38 %).
- Online exams witness a standout satisfaction rate in Latvia (79 %), Iceland (77 %), Estonia (76 %), and Lithuania (76 %); students in Portugal, Romania, the Netherlands, and Austria, however, face hurdles with online exams, recording dissatisfaction rates of around one third of students, respectively.
- For online provision of required study materials, Azerbaijan and Estonia lead with satisfaction rates of 81 % and 74 %, respectively, and – on the other end of the spectrum – Croatia and Slovakia exhibit dissatisfaction rates of 23 %.
- Notably, Estonia stands out with an 83 % satisfaction rate for digital administrative services followed by Azerbaijan (75 %), while comparably large shares of students in Croatia (28 %) and Portugal (24 %) seem to encounter challenges.
- Counselling services receive comparably high satisfaction rates from students in Azerbaijan (61 %), while shares of dissatisfied students are noteworthy in Romania (47 %), Croatia (45 %), Portugal (37 %), Poland (37 %), and Hungary (32 %).

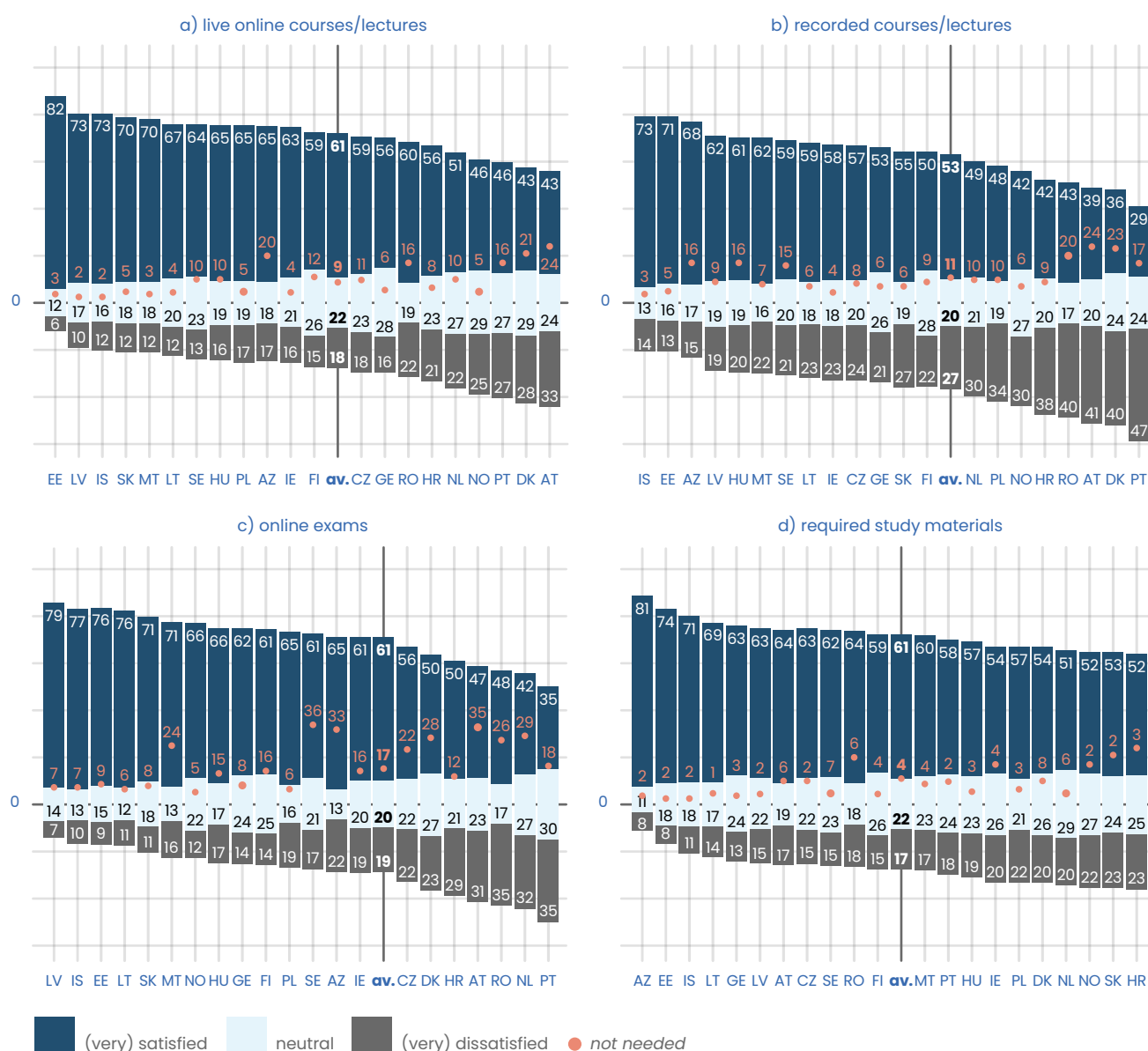
Widespread demand for digital services: Digital provision of study materials, administrative services, and live or recorded courses are highly desired, with only few students indicating they do not need these offerings.

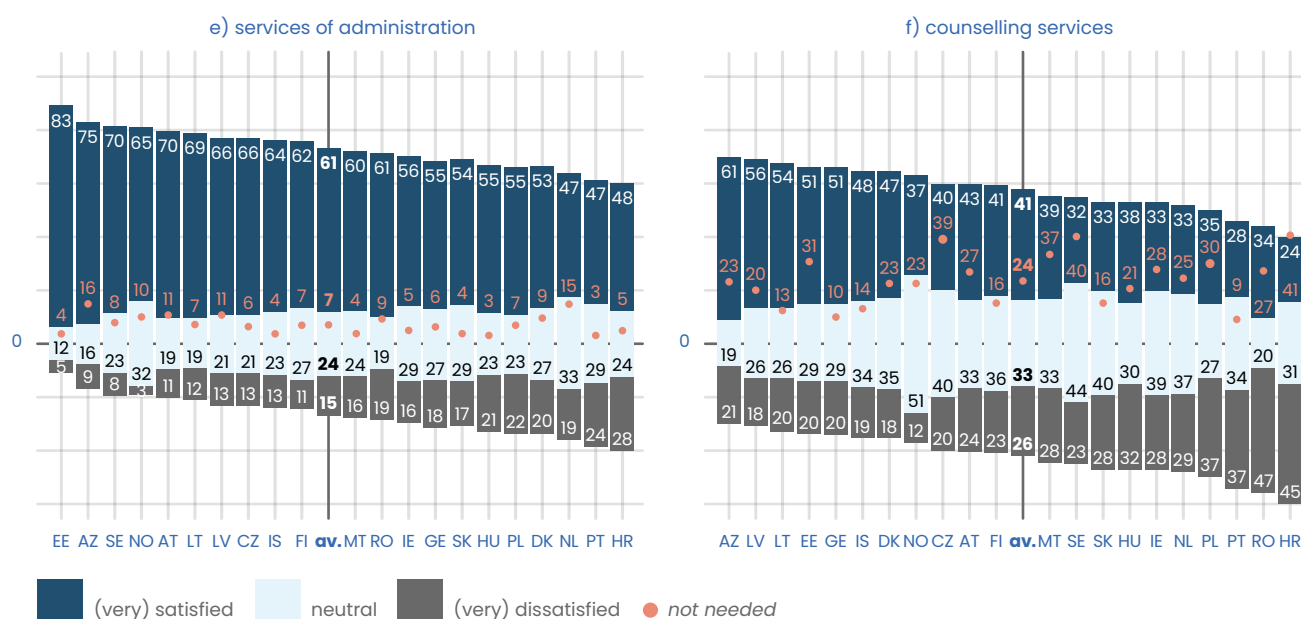
In summary, the data reveals a generally positive outlook on the digitalisation of various institutional provisions. The notable demand for online courses and recorded lectures, as evidenced by the low average of students deeming them “not needed”, underscores the widespread acceptance of digital learning modalities. While countries like Azerbaijan, Estonia, Iceland, and Latvia showcase high satisfaction rates in multiple aspects, comparatively low rates of satisfaction with several aspects in Austria, Croatia,

Satisfaction and challenges in digital availability of services: Students express high satisfaction with digital aspects, except for counselling services. This underscores the importance of incorporating diverse support systems to enhance the overall well-being of students in the digital era.

Portugal, and Romania underscore the importance of addressing specific shortcomings to ensure a more universally positive experience of digital services. In considering the social dimension of higher education, the mixed response and relatively low average satisfaction with digital counselling services, coupled with a quarter of students deeming them “not needed”, emphasise the importance of incorporating diverse and inclusive support systems to enhance the overall well-being of students in the digital era.

Figure 2. **Satisfaction with digital availability of study aspects.** (share of students in %)





Note(s): Categories from “very satisfied” to “not satisfied at all” rescaled to 100%, excluding the “not needed” category.

Institutional supply and students’ demand

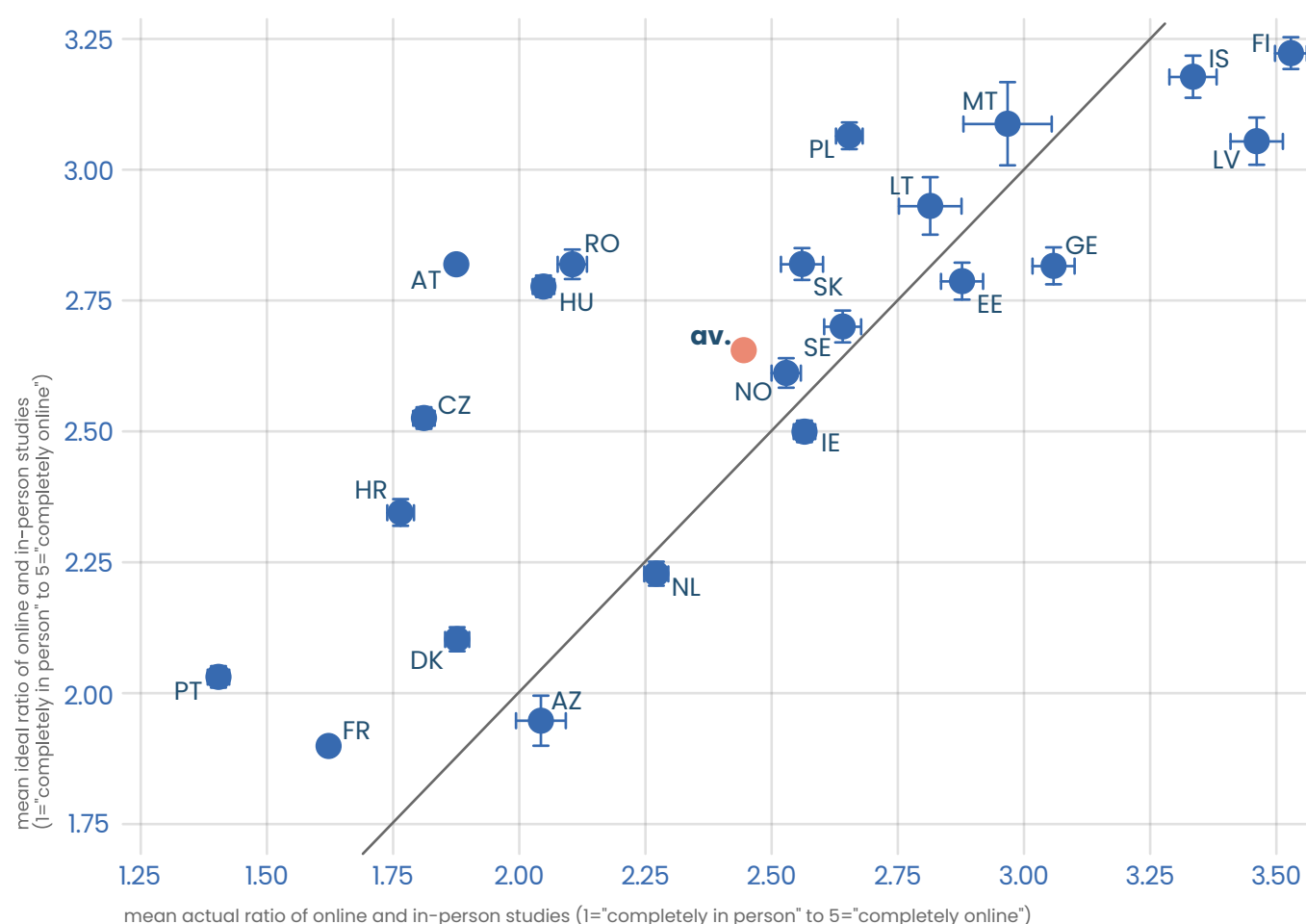
Figure 3 illustrates the balance between institutional supply of teaching modes and student demands. It maps the convergence and disparities between the average actual (horizontal axis) and preferred (vertical axis) ratios of online to in-person studies. Both axes theoretically range from 1 (entirely in-person) to 5 (entirely online). The cross-country average reveals an actual ratio of 2.4 and a preferred ratio of 2.6, suggesting an approximate consonance between demand and supply from this macro perspective.

A perfect balance between the mean actual and mean preferred study modes is represented by the diagonal line. Countries situated close to this line on the chart, such as Azerbaijan on one end of the spectrum (their ratio tending comparatively strong towards actual and ideal in-person studies), and Malta or Iceland on the other end of the spectrum (with comparatively strong actual and preferred ratio towards online studies), exemplify a well-aligned equilibrium between current instructional methods and students’ demands.

Countries situated further away from the diagonal line reveal distinct patterns in the digitalisation of teaching modes. In Austria, Romania, Hungary, and the Czech Republic, for example, the notable gap between the mean actual and preferred

ratios suggests a considerable disparity: Here, students are predominantly taught in person, yet express a pronounced larger desire for more online teaching, signalling a potential disconnect between current instructional approaches and students’ preferences. Conversely, in countries like Latvia or Finland online education modes are above-averagely common, yet students express a slightly stronger desire for in-person teaching. These variations underscore the intricate dynamics shaping the landscape of digital education in the European Higher Education Area, necessitating tailored strategies to bridge the gap between existing instructional modes and the evolving preferences of diverse student populations.

Figure 3. Comparison of mean actual and mean ideal study modes (mean values)



Note(s): Figure includes 95% Confidence Intervals for the means of each countries' student population (assuming normality of sample means and sample Standard Deviation).

Understanding student preferences in study modes is key to comprehending their educational needs and aspirations. Beyond the general insights of Figure 3, Figure 4 offers a deeper look into these preferences across various student demographics, revealing the dynamics of their preferred study modes in relation to their actual educational experiences. Again, the mean ideal ratio of online to in-person studies (from 1 = "completely in person" to 5 = "completely online") is presented for diverse groups of students in the form of cross-country averages. Additionally, a mean match of preferences and actual provision is introduced, where a score of 3 signifies a perfect alignment between individual students' desired and actual study

modes (vertical line). Conversely, a mean match score of 1 indicates a scenario where students experience considerably more online teaching than desired, while a mean match score of 5 indicates considerably more in-person teaching than desired by students.²

On average, the mean ideal ratio of 2.6 for all students roughly indicates a preference for a balanced mix of online and in-person studies, only slightly leaning towards in-person modes of study. Encouragingly, the mean match value of individuals' actual and ideal ratios stands at a value of 3.1, signifying an almost perfect alignment between students' desired and actual study modes on

2 A value of 3 results regardless of the respective orientation on both scales, but simply whenever the values on both items agree with one another and thus includes both students who want complete online studies and those who want complete face-to-face studies – provided that they actually study in their preferred mode. In the "more in-person teaching wanted" scale, for example, students can be found who actually experience predominantly online teaching and want a balanced mode ratio, but also those who already receive predominantly face-to-face teaching but would like even more of the same. The opposite logic applies to the scale direction "more online teaching wanted".

cross-country average. This suggests that, overall, students are experiencing a close match between their individual preferences and the current reality of their educational experiences.

Analysing student preferences for study modes reveals expressive trends among different demographics, emphasising their inclinations towards either in-person or online education (refer to the blue symbols in Figure 4). The following groups exhibit a marked preference for in-person studies, as indicated by their lower mean ideal ratios (in brackets), suggesting a preference for traditional educational formats:

- Younger Students (below 22 years; 2.4),
- students with tertiary education background (2.6),
- full-time students (2.6),
- students dependent on public student support (2.4) or family income (2.5),
- students in Arts and Humanities as well as in Natural Sciences, Mathematics, and Statistics (2.4, respectively).

Conversely, certain groups demonstrate a preference for online studies, indicated by their higher mean ideal ratios (indicated in brackets). This preference highlights the value placed on the flexibility and accessibility of online learning modalities:

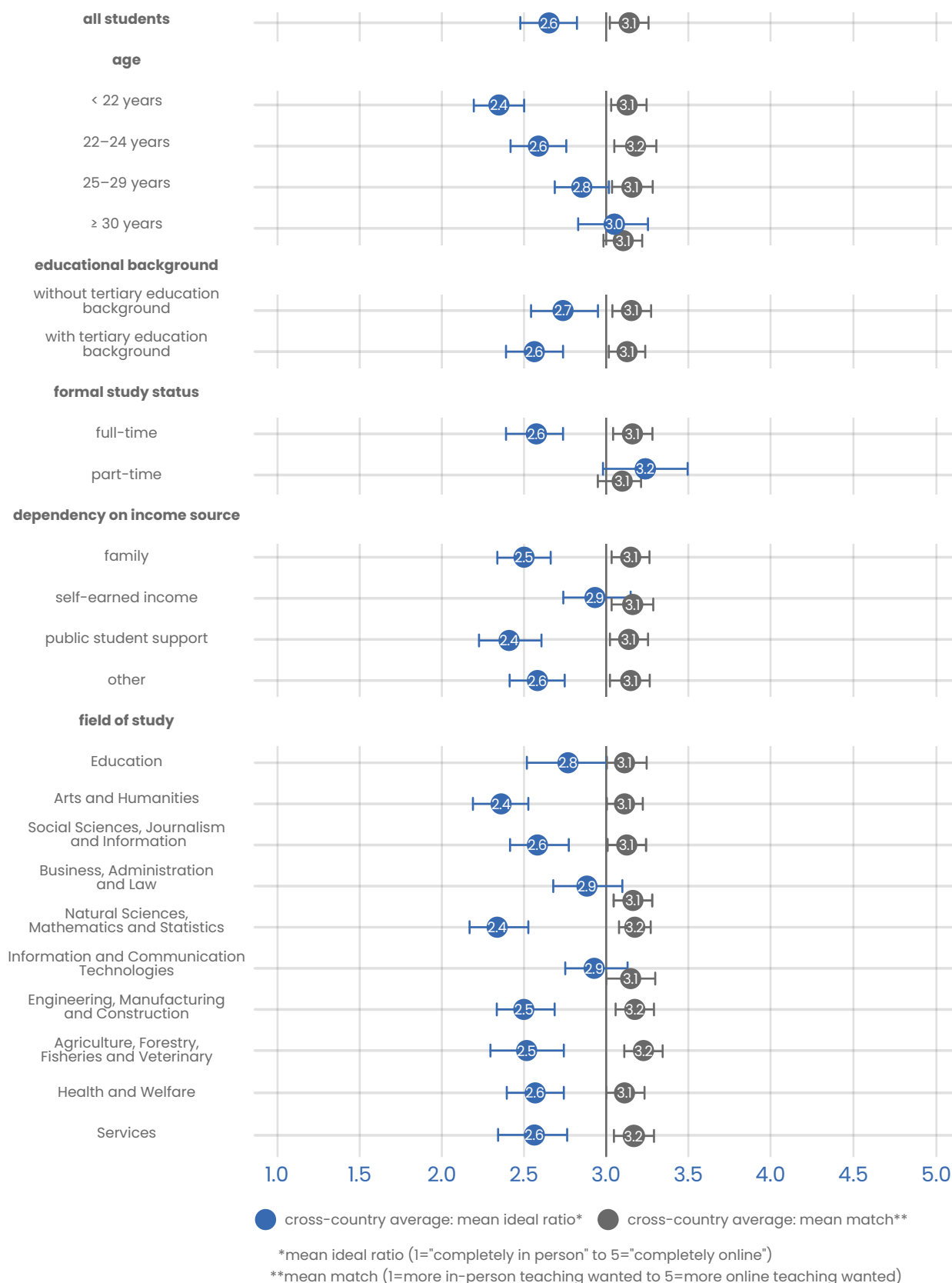
- Older students (30 years or older; 3.0),
- students without tertiary education background (2.7),
- part-time students (3.2),
- students dependent on self-earned income (2.9),
- students in Information and Communication Technologies (2.9), Business, Administration and Law (2.9), as well as Education (2.8).

If we further examine the indicator regarding the alignment between preferred and actual study modes (refer to grey symbols in Figure 4), an encouraging picture emerges: Younger and older students, both educational background groups, full-time and part-time students, students with various primary funding sources, as well as students across all subject groups of the ISCED-F 2013 classification, show an average score between 3.1 and 3.2 at the cross-country average. This indicates that, in all examined student groups (at least on cross-country average), there is a nearly perfect alignment between desired and actual study modes.

In conclusion, the data portrays an encouraging scenario where, on cross-country average, students in higher education experience a close match between their preferences and the current modes of study. However, the nuanced patterns across demographics highlight the need for flexible approaches to accommodate diverse student needs in the evolving landscape of digitalised higher education, as the findings reflect only the views of those students who have successfully enrolled and persisted in their study programme.

Alignment between preferences and actual modes: Encouragingly, there is an overall alignment between student preferences and actual study modes. However, nuanced patterns across demographics emphasise the need for flexible approaches to address diverse student needs in the evolving landscape of digital higher education

Figure 4. Mean ideal study mode and mean degree of match between actual and ideal study modes by different groups of students (cross-country averages)



Note(s): Figure includes 95% Confidence Intervals for the means between countries (assuming normality of sample means and sample Standard Deviation).

Students' ability to participate in remote studies

An examination of cross-country averages for the different elements of digital capital shows satisfactorily high results for both self-assessed digital skills (4.3), as well as the availability of computers (4.8), desks (4.6), sufficient internet connections (4.5) and quiet workplaces (4.1; Annex Tab. 1). However, there is some variation between countries: While in Austria, for example, all values are above average, in some other countries either individual dimensions (e.g. desks in Iceland or internet connections in Poland) or all dimensions (e.g. in Georgia) can be below average.

The biplot analysis in Figure 5 visualises the complex relationships between countries based on these mean values across all five dimensions related to students' digital skills and their resources for remote studies. The depiction serves to illustrate similarities and differences between country groups with regard to the extent of digital capital in their student population.

Dots on the biplot reveal clusters of countries with similar characteristics: A large group of countries in the centre form a group with similar characteristics with regards to their student populations' digital capital assessments. This centre of the biplot represents the average or typical profile of the data; as such, most countries' student populations have an overall good level of digital resources available to them. Azerbaijan, Georgia, and Iceland, however, stand out as unique.

Furthermore, the analysis looks at how different aspects of digital resources and skills are related in various countries. In simpler terms, it examines how things like having enough digital skills, access to a computer, a desk, a sufficient internet connection, and a quiet place to study are inter-connected. When two of these factors are closely related, they are shown as vectors (or lines) pointing in similar directions on the graph. For example,

if a countries' student population has sufficient access to computers, it usually also has access to strong internet connections. Similarly, having

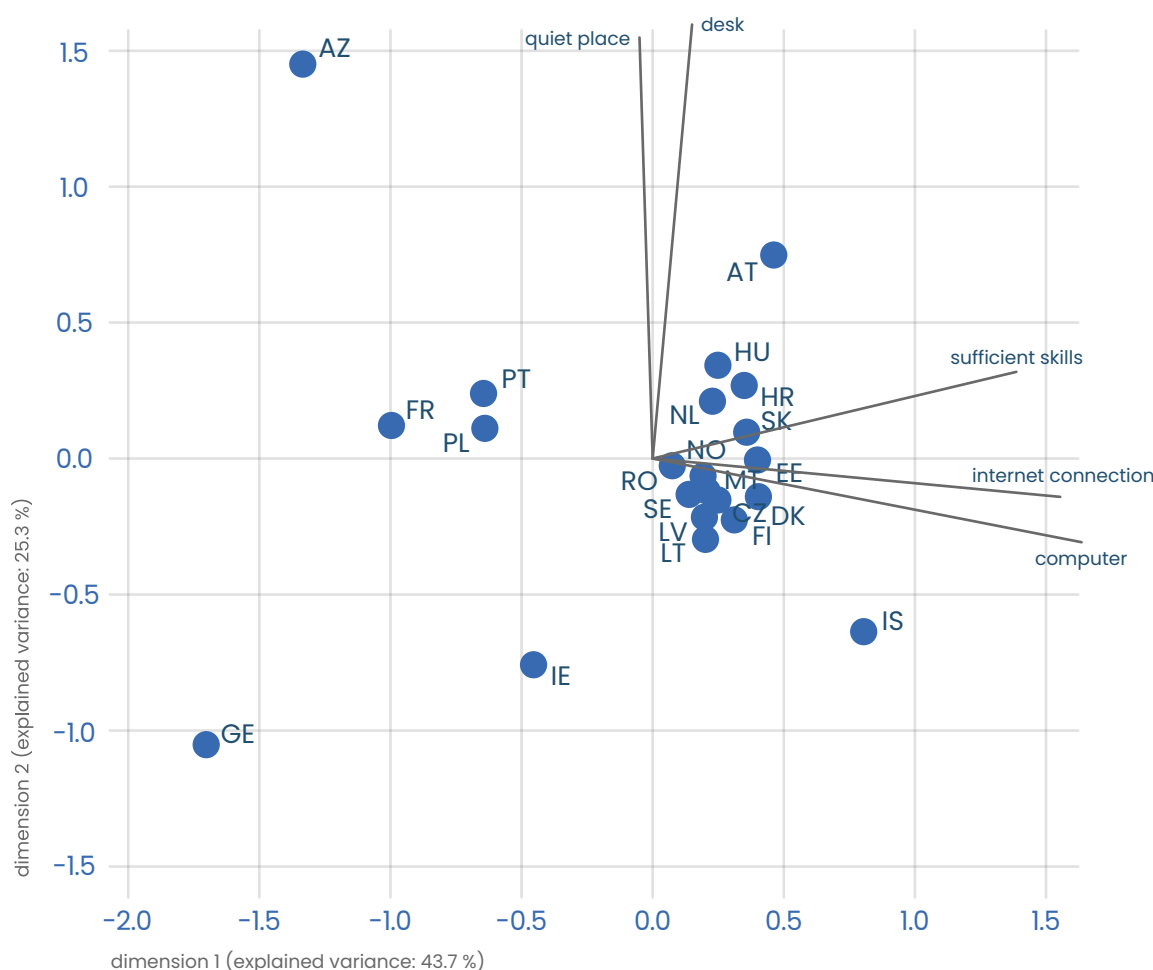
a desk is often linked with having a quiet place to study. This suggests that there are two main areas to consider: One is the physical setup for studying at home (like having a desk and a quiet place), and the other is the digital infrastructure (like computers and internet). Furthermore, the analysis finds that students' digital skills are influenced by both their study environment at home and the

digital equipment they have access to. In essence, if students have a good study environment and the necessary digital tools, they are likely to feel confident in their digital skills.

Azerbaijan's unique position near the vectors of "desk" and "quiet place" signifies a distinctive digital capital profile: This suggests that while students in Azerbaijan may typically have a conducive study environment at home, there might be room for improvement to their access to digital infrastructure. In contrast, Iceland's proximity to the vectors of "computer" and "internet connection" highlights a strength in digital infrastructure, potentially contributing to students' proficiency in digital skills, while there is room for improvement regarding to the physical setup for studying at home. Georgia's (and to a lesser degree, also Ireland's) considerable distance from all vectors indicates a distinct digital capital landscape, suggesting challenges in both physical setup for studying at home and digital infrastructure as well as digital skills.

Students' digital capital: Students' are overall well-equipped with digital resources, with varied digital capital profiles in some countries. Factors influencing digital capital include the physical setup for studying and the quality of digital infrastructure.

Figure 5. **Extent of digital capital in student populations** (biplot analysis of countries' mean values)



Note(s): Analysis based on mean values (ranging from 1="Never" to 5="Always" for TM.53 to TM.56 and from 1="Not sufficient at all" to 5="Completely sufficient" for TM.63) excluding "not applicable"/ "not relevant for my studies" categories (Annex Tab. 1). Biplot calculation implemented using Stata's "biplot" command with "std" specification.

Digitalisation, student integration, and academic success

Students' social and academic integration fosters a supportive and collaborative learning environment and contributes to successful completion of studies. The mode of studies, whether predominantly online, in balanced modes, or predominantly in person, may significantly impact students' integration, potentially presenting challenges that need to be addressed for optimal academic success.

Overall, students across all countries express a moderate degree of knowing fellow students with whom to discuss subject-related questions, with mean values ranging from 3.0 to 3.9 (Figure 6.a). Notably, in almost all countries, there are significant differences among students in various

teaching modes, indicating that predominantly online learners tend to have considerably lower integration compared to those in balanced or in-person modes. Conversely, Lithuania and Romania exhibit relatively low differentiation between teaching modes, suggesting a consistent level of social integration among peers regardless of the study mode.

Students generally perceive their lecturers as providing helpful feedback to varying degrees, with mean values ranging from 2.8 to 4.4 (Figure 6.b). In countries like Georgia, Romania, Hungary, Poland, Malta, and Sweden students studying predominantly in online teaching environments report a considerably better feedback provision when

compared to their peers studying in balanced or predominantly in-person modes, while a reversed pattern emerges in Estonia, the Netherlands, Finland, and Croatia. In contrast, Azerbaijan, Latvia, Iceland, Lithuania, and Austria show minimal differences among teaching modes, indicating a consistent experience of lecturer feedback regardless of the chosen learning format.

Across the surveyed countries, students, again, report receiving a varying level of motivation from their lecturers, with mean values ranging from 3.0 to 4.2 (Figure 6.c). Noteworthy distinctions are observed in countries such as Georgia, Hungary, Malta, Romania, and Poland, suggesting that predominantly online teaching correlates positively with increased motivation from lecturers, while a reversed pattern (with inferior reported motivation) is apparent in countries like Estonia, Denmark, Finland, and the Netherlands. Students in Azerbaijan, Iceland, Latvia, Lithuania, and Austria exhibit less pronounced differences, indicating a relatively consistent motivational experience across diverse teaching approaches.

Overall, students perceive their lecturers as reasonably proficient in explaining course content, with mean values ranging from 3.2 to 4.1 across all countries (Figure 6.d). Notable variations are evident in Georgia, Malta, Romania, Slovakia, Poland, Hungary, and Austria, where students studying predominantly online perceive the effectiveness of lecturers in delivering clear explanations

superior to students of other modes of study. The Netherlands, Denmark, Croatia, and Finland emerge as countries where online studies seem

to be associated with inferior clarity of course content when compared to the other modes of studies. On the other hand, students in Azerbaijan, Iceland, Estonia, Lithuania, and Latvia display minimal differences among teaching modes, suggesting a consistently high perception of lecturers' explanatory skills regardless of the chosen

learning format.

Ultimately, the data presents a clear and consistent trend indicating that a surplus of online learning disrupts peer integration (meaning the interaction among students) across all countries. However, the picture is much more diverse between countries when it comes to interactions between students and their lecturers. Notably, a group of countries, including Iceland, Latvia, and Lithuania, stands out for the absence of significant differences in student-lecturer interactions across different learning modes. On the other hand, in countries such as Georgia, Hungary, Malta, Poland, and Romania students engaged in predominantly online studies report more positive interactions with their lecturers. Contrastingly, in the Netherlands and Finland, and to a lesser extent in Croatia, Denmark, and Estonia, students studying online consistently express lower satisfaction with their lecturers compared to peers engaging in primarily in-person learning.

Impact of teaching modes on academic integration: Online learning disrupts peer integration across countries. However, there are diverse interactions between teaching modes and student-lecturer relationships.

Figure 6. Students' perceived study integration by mode of studies
(mean values from 1="do not agree at all" to 5="strongly agree")



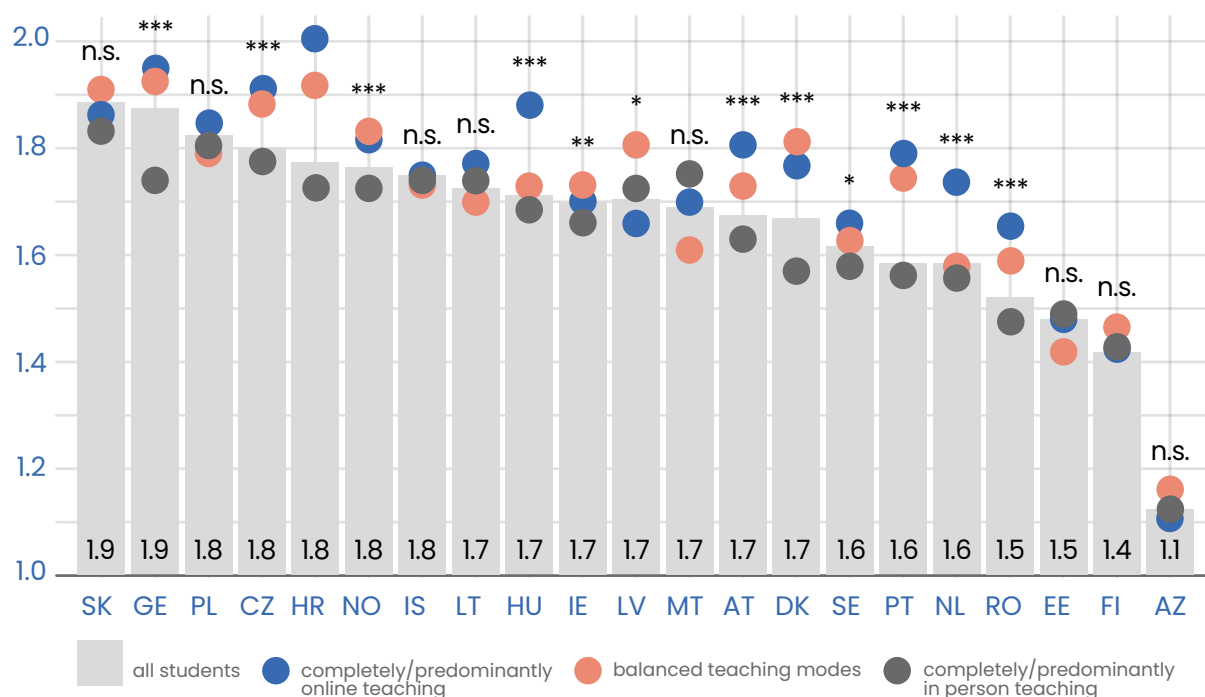
Note(s): Significance levels based on ANOVA ($p \geq 0.05 = n.s.$, $p < 0.05 = *$, $p < 0.01 = **$, $p < 0.001 = ***$).

The data on students' intention to abandon higher education reveals varying degrees of dropout intention across countries, with mean values ranging from 1.1 to 1.9 (Figure 7). In countries like Slovakia, Poland, Iceland, Lithuania, Malta, Estonia, Finland, and Azerbaijan there are only minor or insignificant differences in dropout intention among students in different teaching modes, suggesting a consistent trend – throughout the respective student populations – regardless of the mode of study. On the contrary, countries

such as Georgia, the Czech Republic, Croatia, Norway, Hungary, Austria, Denmark, Portugal, the Netherlands, or Romania exhibit significant variations, indicating a complex relationship between dropout intention and the challenges posed by online learning. The nuanced interplay of factors influencing students' academic experiences and intentions requires further examination for a comprehensive understanding of the impact of digitalisation on higher education outcomes.

Teaching Modes and Dropout Intention: There is a varied relationship between teaching modes and dropout intention. While some countries show minor differences, others exhibit significant variations, highlighting the complexity of the impact of online learning on dropout intention.

Figure 7. **Students' intention to completely abandoning higher education studies by mode of studies** (Mean values from 1="do not agree at all" to 5="strongly agree")



Note(s): Significance levels based on ANOVA ($p \geq .05 = n.s.$, $p < .05 = *$, $p < .01 = **$, $p < .001 = ***$).

Take-away messages ...

... for policy-makers

Informed policy making and effective strategies in the area of higher education require an understanding of

- the digital availability of study contents and institutional support structures (Figure 2)
- as well as alignment between preferred and actual study modes (Figure 3, Figure 4),
- students' ability to participate in digital studies (Figure 5),
- and the relationship between study modes and academic success (Figure 6, Figure 7).

Although the overall picture is encouraging in terms of the balance between student wishes and fitting with the reality of their studies, it is to be noted that our sample includes only students who have (so far) had a successful course of studies and excludes those who have already abandoned higher education.

... for HEI staff

In fostering socially inclusive higher education, it is imperative for academic institutions to recognise the importance of providing digitally available counselling services (Figure 2.f). This approach ensures accessibility and support for all students, addressing diverse needs and promoting a more inclusive learning environment. By embracing digital platforms for counselling, higher education staff can actively contribute to the well-being and success of a diverse student body, fostering an inclusive academic community.

In order to achieve a comprehensive and inclusive tertiary education landscape, flexibility in terms of study modes should be expanded in order to enable everyone to gain access to higher education and to pave the way to successful completion for disadvantaged groups.

In (even) larger contexts – nationally as well as across the European Higher Education Area – a discussion should be held about the preparedness of school leavers to study in higher education (Usher, 2023): The findings in the present study relating to peer integration (Figure 6.a) give rise to doubts about the suitability of the current use of digital media formats for learning cooperative and collaborative skills that are extremely relevant in professional life.

HEI looking to improve their digitalisation efforts could take cues from countries where students have expressed higher levels of satisfaction. Finland, for example, has implemented a novel measure where teachers are temporarily replaced to focus on developing digital teaching content. Spain has taken a different approach by providing targeted funding for universities to digitalise rooms and equipment, complete with measurable indicators.

... for researchers

Many insights from the present study are limited by the aggregate data structure. As soon as the EUROSTUDENT 8 Scientific Use File is published (summer 2024), more in-depth analyses will be possible: Which (of the partially correlated) characteristics of students have a lasting influence on the preferred mode of study and the correspondence between the preferred and actual mode of study when tested against each other (Figure 4)? How wide is the variance of digital capital within countries (i.e. between the students of a country; Figure 5) and what influence does the educational background of students have (Loh et al., 2023)?

Does the study mode have a persistent influence on the social and academic integration of students when other study success characteristics are counter-tested (Figure 6) and to what extent does social and academic integration moderate the average study performance and the intention to abandon studies (Figure 7)? How do various factors like the degree of happiness, feelings of isolation, and the balance between digital and in-person learning interact with each other? Are poor ratings of teaching quality in fact resulting from poor infrastructural equipment on students' ends?

Methodological notes

In the eighth round of the EUROSTUDENT project, data were collected in spring 2022 – summer 2022 except CH (spring 2020), DE (summer 2021), AT, ES, FR, PT, RO (spring 2023 – summer 2023). Overall, 22 of the EUROSTUDENT 8 countries reported data for this topical module and are therefore included in this report³.

Within-country confidence intervals

The coordinate system in Figure 3 includes 95% confidence intervals for each country's mean values in both dimensions. These intervals convey the range within which we can be 95% confident that the true averages for each country lie. Essentially, they act as a statistical "margin of error" around the plotted data points: The wider the interval, the less precise our estimate with regards to actual or ideal ratio of online and in-person studies within a country (e.g. Malta), while a narrower interval suggests greater confidence in the presented averages (e.g. Austria). This information helps to account for the inherent variability in the data and may guide decisions with a recognition of the uncertainty surrounding the reported averages.

Between-country confidence intervals

In addition to the cross-country averages, Figure 4 includes 95 % confidence intervals of these arithmetic means. From a statistical point of view, they can be interpreted as a range within which we can be 95 % confident that the true population mean lies. Such a technical interpretation is not necessary, however, because their meaning in the application example is quite simple: The wider the distance between the endpoints of a confidence interval, the greater the uncertainty or variability in the individual values of the countries in the EUROSTUDENT sample. While the short width of the confidence interval around the cross-country average for the "mean match" for students in the Natural Sciences, Mathematics and Statistics subject group means that the value for this student group in a large number of countries are close to this average value (and therefore particularly meaningful), the comparatively large distance around the country mean in the "mean ideal ratio" for students with a formal part-time study status shows that there is a large variation between countries (and the mean therefore less representative).

Biplot Interpretation

The biplot analysis in Figure 5 visualises relationships between countries and dimensions based on mean values. Dots represent countries, showcasing their positions in the analysis. Vectors represent dimensions like digital skills and the four variables measuring availability of resources for remote studies. The distance between dots reflects their degree of (dis)similarity: Closer dots share similar characteristics. Vector length indicates the importance of each dimension. The cosine between vectors shows the extent of correlation between variables with parallel vectors signifying positively correlated dimensions. Dots' projection on vectors highlights a country's proficiency in a specific dimension. This biplot aids in identifying countries with similar needs and understanding the key factors influencing digital skills and study resources on a broad scale.

3 Except Figure 2, where French data is missing.

Analysis of variance between student groups

In order to statistically identify countries where differences exist among students who predominantly study online, have a balanced approach, or predominantly study in-person concerning the degree of their study integration, “analyses of variance” (ANOVA) were conducted using the respective mean values for each of the three groups of students within each country (Figure 6, Figure 7). ANOVA involves comparing the variance within each data group to the variance between the groups. Specifically, it calculates the F-statistic by dividing the variance between groups by the variance within groups, helping to determine the statistical significance of observed differences. A significant F-statistic from ANOVA indicates differences between at least two groups. The results offer valuable insights into the specific countries where significant variations exist in the degree of study integration among students with different modes of learning.

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Annex 1. **Digital capital components** (mean values)

“How sufficient do you think your professional digital skills are compared to what is currently required of you in your studies?” (1=“not sufficient at all” to 5=“completely sufficient”, excluding category “not applicable”)		“In your home, when you need it for your studies, do you have access to ...?” (1=“never” to 5=“always”, excluding category “not relevant for my studies”)			
		... computer/ laptop/ tablet	... desk	... sufficient internet connection	... quiet place to study
AT	4.5	4.9	4.7	4.6	4.3
AZ	4.0	4.3	4.9	4.2	4.5
CZ	4.3	4.9	4.7	4.6	3.9
DK	4.5	4.9	4.4	4.6	4.2
EE	4.5	4.9	4.6	4.5	4.0
FI	4.2	5.0	4.4	4.7	4.2
FR	4.0	4.9	4.5	4.3	4.2
GE	3.9	4.3	4.2	4.1	3.8
HR	4.7	4.8	4.7	4.5	4.1
HU	4.4	4.9	4.7	4.5	4.1
IE	4.1	4.9	4.4	4.3	3.8
IS	4.6	5.0	4.3	4.8	4.0
LT	4.4	4.9	4.6	4.5	4.0
LV	4.3	4.9	4.6	4.5	3.9
MT	4.3	4.9	4.7	4.5	3.9
NL	4.5	4.9	4.7	4.4	4.1
NO	4.3	4.9	4.4	4.5	4.2
PL	4.4	4.9	4.7	4.2	4.0
PT	4.0	4.9	4.7	4.5	4.1
RO	4.5	4.8	4.4	4.5	4.2
SE	4.2	4.9	4.4	4.6	4.3
SK	4.4	4.9	4.8	4.6	3.9
av.	4.3	4.8	4.6	4.5	4.1

About EUROSTUDENT

The EUROSTUDENT project collates comparable student survey data on the social dimension of European higher education, collecting data on a wide range of topics, e.g. the socio-economic background, living conditions, and temporary international mobility of students. The project strives to provide reliable and insightful cross-country comparisons. The data presented here stem from the eighth round of the EUROSTUDENT project (2021–2024).

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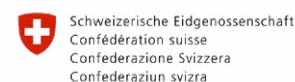
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